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The Global Financial Crisis and the Monetary Policy of the United States of America

Master's thesis within Financial Economics

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Abstract

Since its revival in the 80's, monetary policy's role and importance has reached new highs. The Federal Reserve, guardian of the U.S. monetary policy, has two contrasting goals: ensure price stability and full employment. The federal fund rate is the Federal Reserve's main policy tool in attaining these goals.

In 2007, the monetary institution was put to the test with the emergence of the global financial crisis. The Federal Reserve responded by lowering interest rate and when that wasn't enough it relied on discretionary unorthodox measures

This paper combines a theoretical analysis with an empirical study in order to determine the impact of the global financial crisis on the U.S. monetary policy. The theoretical framework incorporates an analysis of the U.S. monetary policy since the creation of the Federal Reserve and a thorough breakdown of the global financial crisis. The empirical study focuses on federal fund rates from the past two decades.

The results show that Federal Reserve in the short run will have to unwind facilities set up during the crisis in order to prevent the financial system from collapsing. In the medium run, it will have to accept an inflation rate slightly higher than its target rate so the unemployment rate can fall to its natural rate, and in the long run, continue to assure its dual mandate and take measure to contain moral hazard

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1 Introduction

Thirty years ago, monetary policy was viewed as having little to do with inflation and in no matter an instrument for demand management. Today it is mainstream knowledge and even self-evident that monetary policy's aim is price stability. In the 80's developed countries faced double-digit inflation. High inflation led to instability and was very costly in terms of employment and real output. Through though monetary policies, inflation was tamed to levels judged stable[1] by the end of the decade. Monetary policy not only restored price stability but also showed it had short-term effects on the real economy. The latter is widely used by the Federal Reserve, the United States' monetary authority.

The Federal Reserve System (Fed), the U.S. central bank, has two legislative goals; price stability and full employment. The Fed eases monetary policy in the face of a recession to jump-start the economy, and tightens monetary policy when it faces inflationary pressure. The dual mandate is in contrast with most of its peers: the Europeans Central Bank, the Bank of England, and the Riksbank, whom are all inflation-targeting central banks.

The Fed's dual mandate has been largely exploited during the time Alan Greenspan was chairman. Greenspan transformed the U.S. monetary policy from rule guided to discretionary. This proved very useful for the institution in the future.

In 2007 erupted the most severe financial crisis since the Great Depression, and created havoc throughout the entire financial system. The crisis took its roots from a combination of imprudent mortgage lending, complex financial innovation and human frailty. More illumination on the causes of the crisis will be provided further on. As the crisis, unraveled financial stability became the Fed's chief concern, thus replacing inflation and prompting drastic interest rate cuts. A series of ten rate cuts from September 17 2007 to December 16, 2008 resulted in the federal fund rate dropping form 5.25% to in between 0-0.25%. With the Fed's primary tool at virtually zero, monetary authorities had to be very creative in combatting the crisis. Now that the worst

[1] Arbitrary depending on the monetary institution but generally in the range of 1.5%to 3%

is behind us and the economy has stabilized, what will be the Federal Reserve's next move?

The monthly federal fund target rate set by the Federal Open Market Committee (FOMC) is highly anticipated by economic agents. Unlike its counterpart such as the Bank of England which explains via macro-econometric model how it calculates its main interest rate, the U.S. Federal Reserve applies a discretionary setting policy. The federal fund rates have been subject to speculations by the markets for years. The perennial question on the mind of economists is how monetary policy should be set.

Friedman (1960) is one of the first to tackle the issue. Friedman proposes that the central bank maintain a constant growth rate of money supply, the famous K-percent rule. In the mid 80's monetary aggregates' importance in the conduct of monetary policy diminished considerably, federal fund rates became the main monetary policy tool. Taylor (1993) prescribes a simple rule for setting federal fund rates. The Taylor rule represents a reactive response of federal fund rate to changes in inflation and macroeconomic activity. The rule is summarized in equation 1

$$\boldsymbol{FFt = rt + \pi t + 0.5(yt - yt*) + 0.5(\pi t - \pi *)} \qquad \textit{(1)}$$

Where $\boldsymbol{FFt}$ is the federal fund target rate, $\boldsymbol{rt}$ represents the real interest rate; $\boldsymbol{yt}$ and $\boldsymbol{yt}*$are respectively GDP and potential GDP and the difference $(\boldsymbol{yt - yt}*)$ is referred to as the output gap. $\boldsymbol{\pi t}$ and $\boldsymbol{\pi t}*$are the inflation rate and the target inflation rate respectively, their difference $(\boldsymbol{\pi t - \pi}*)$ represents the inflation gap.
This rule indicates that monetary authorities will raise federal fund rate by 0.5 of the output gap $(\boldsymbol{yt - yt}*)$ and 0.5 of the inflation gap $(\boldsymbol{\pi t - \pi}*)$ Taylor (1993).

Since Taylor's publication, many academics have built models derived from Taylor's initial work. Modification in the Taylor rule includes inflation loss functions Rudebusch and Svensson (1998), inflation-forecasting model Batini and Haldane (1998) and Clarida, Galı and Gertler (2000). Models would become more and more complex as interest in monetary policy rose: King-Wolman (1999), McCallum-Nelson (1998).

Taylor (1999) conduct a study to determine the most efficient and robust model. Models studied differ greatly from one to another, from three equations to as many as 98

equations, open and closed economies. However, all the models have one thing in common they all are a function of the output gap and the inflation gap.
The results of Taylor's study are surprising. Simple models fared better than complex ones in determining the appropriate monetary stance central bankers should adopt.

Previous studies are delimited from the 80's to pre financial crisis. The latest to date is Mehra and Minton (2007), they applied the Taylor rule to the Greenspan era. They concluded that the simple rule replicates federal fund rates well.
The crisis has tested the Fed's capacity in many ways. The Fed was forced to be very bold in its response with the use of unconventional methods never before used. There is a vivid discussion among macroeconomist on: How the crisis will affect monetary policy in the short and medium run?
This study is a combination of theoretical analysis and empirical analysis to answer the research question previously stated.

The purpose of this research is to determine 1) can the Taylor rule be used to determine the federal fund target rate as it did during the Greenspan era. 2) If yes, the simple rule will be used to determine the major guidelines of future monetary policies. If not, analyses of deviation from the simple rule and combine them with theories to determine an outlook on monetary policy.

The study will be of three sections. Section two will start out by explaining the structure of the U.S. Monetary system. Then will follow a brief history of the U.S. monetary policy from the late 70's until today. Emphasize shall be made on the two decade reign of Alan Greenspan who has introduced gradualism in monetary policy and numerous other approaches. This will constitute the theoretical background of U.S. monetary policy.

Section three, will consist of an analysis of the financial crisis. The goal here is to understand the crisis itself. What are the sources? How has it spread? Why was it so severe? What actions have the Fed's taken?

Section four is an empirical analysis of the federal fund rate. The goal of this part is to determine if the federal fund rate, the primary instrument of monetary policy, can be assimilated to the Taylor rule. Ex-post data is used to calculate the federal fund rate based on the Taylor rule. A comparison between our results and the rates established by

the FOMC will follow. Significance will be given to crisis periods to see if correlations, if any, still hold in such times.

Section five will conclude with the results of the findings and determine how future monetary policies will be conducted in the short and medium run.

Readers of this thesis are expected to be familiar with basic monetary theory.

2 Monetary Policy in the U.S.

This section is intended to provide an analysis of the U.S. monetary policy from the early years, explain the legal framework of the U.S. Federal Reserve system and the decision process behind policies. The analysis will start in 1914, the year the Federal Reserve System was established.

Section two is structured as follow

Part 1 is a theoretical overview of monetary policy, and will comprise of two parts: (1) the nature of monetary policy goals; (2) the role of monetary policy;
Part 2 will discuss of the Federal Reserve System and the U.S. Monetary policy and comprise of two parts: (1) will be to illuminate on the structure of the Federal Reserve System. The Fed's approach to monetary policy and in which way monetary policy is conducted; (2) will be a recap of uncle Sam's monetary policy and the nature of the monetary policy practiced by the Fed in recent years with an emphasize one the two decade tenure of former chairmen Alan Greenspan.

2.1 The Theory of Monetary Policy

Two macroeconomic tools lie in the hand of every government: fiscal policy and monetary policy. The latter refers to the actions undertaken by a central bank to influence the supply money and credit to help promote economic growth. Monetary policy is generally delegated to an independent source, the central bank. The central bank is assumed and is independent in all developed countries. The major concern of any macroeconomic policy resides in the extent and the nature of the government's[2] intervention.
A discretionary or activist monetary policy involves frequent government intervention in order to achieve predefined goals. An alternative is to provide a stable medium term framework that removes the ability make discretionary changes.

2.1.1 Policy Goals

The choice of goals made by policy makers have considerably changed throughout the decades. Variability in goals has changed when runaway inflation started plaguing the industrial world. In the 70's and 80's, double-digit inflation in developed countries had

[2] Refers to the Central Bank which is an independent Government entity

proven the destructive force of inflation. Primacy was given to the control of inflation. Studies by Khan and Senhadji (2000) have found a robust and significant relationship between inflation and growth. Inflation, persistently over 1-3 % and 7-11% respectively in developed and developing countries, has a negative effect on growth. When inflation lies within the threshold, they have found a positive or non-existing relation between inflation and growth. Robert E Lucas (2000) has shown the welfare cost of high and/or large fluctuations in inflation ranging from ineffective investment decision, to exaggerating social inequalities.

High and volatile inflation were direct consequences of previous monetary policy. Let us reexamine the major monetary goals from the great depression to the present.

2.1.2 Monetary policy under the "Glorious Thirties"

The predominant policies during this period were Keynesians and were full-employment driven. Policies were countercyclical, they consisted of cooling down the economic machine when it was overheating[3] and jump starting it when it stated to stagnate or enter recession. At first, the goal was to achieve economic growth and reabsorb unemployment thus leading to a tradeoff between inflation and unemployment.

In this context, monetary policy was used as an economic stimulus however considered less effective than fiscal policy. Monetary policy was then reduced to accompanying fiscal policy. Deficits were associated with an increased supply of currency by the monetary authorities.

Inflation in the late 60's and especially in the 70's will put an end to this conception of monetary policy. In the 70's economist were stunned to notice a permanent and constant rise in inflation and high levels of unemployment (stagflation). High inflation was only viewed with low employment.

The paradoxical phenomenon of stagflation gave birth the monetarist conception of inflation.

[3] When output grew at a rate greater than its natural rate.

2.1.3 Monetarist Policies

The first monetarist theories emerged with the publication of a series of papers from Clark Warburton[4]. Clark Warburton is the first to have provided empirical evidence of the effect of money on the real economy. Milton Friedman (1956) followed him. It was not until the late 70's that actual monetary policies emerged with the Keynesian economics unable to explain the coexistence of inflation with unemployment.

Monetarist considered that monetary policies were more effective than fiscal policies (Friedman & Schwartz, 1963). Monetarist view high and volatile inflation as a direct consequence of an increase in money supply. In their very influential book, "*A Monetary History of the United States 1867-1960"* Milton Friedman and Anna Schwartz argue, *"inflation is always and everywhere a monetary phenomenon"*

Friedman's recommendations for monetary policy are listed below:

- Monetary policy should not be used for recovery purposes because the effects in the long run are inflationist.
- It is possible to reduce inflation by gradually reducing money supply.

Faced with stagflation and the impotence of Keynesian policies, governments turned to monetarist theories. Observations in most countries show a focus on monetary policy with the goal of price stability.

Price stability has since become the major goal of monetary policy throughout the world. In the case of the Fed, it is associated with full employment.

2.2 Role of Monetary Policy

The role assigned to monetary policy has change throughout time. In the 1920's monetary policy was praise for providing stability to the system throughout its fine-tuning. It was widely accepted that advances in monetary policy had eliminated business cycles. In the face of recession, monetary policy would take an expansionist

[4] "The Volume of Money and the Price Level Between the World Wars", 1945, *JPE*
"Monetary Theory, Full Production and the Great Depression", 1945, *Econometrica*
"Monetary Theory, Full Production and the Great Depression", 1945, Econometrica

role and stimulate the economy back to growth. This type of policy would stimulate banks to participate in the financing of investment and economic recovery.

These convictions were quickly dismissed in the wake of the great depression. The pendulum swung to the other extreme. Keynes and most other economists believe that the great depression occurred despite an aggressive expansionary policy. Peter (1989) found the contrary; the quantity of money in the United States had fallen by one third during the great depression. His analysis can be conceptualized by figure 1:

Figure 1:Temin Peter (1989) analysis of the great depression

↓ Money supply → ↑ interest rate → ↓ investment and consumption → ↓ income

The role assigned to monetary policy throughout the following years was to keep interest rates low so government would have a ceiling on their debt service.

These convictions resulted in the 70's and 80's spike in inflation, which ultimately led to the revival of monetary policy as cited 2.1.2.

Today there is a consensus that price stability is the main goal of monetary policy. Other roles are associated to monetary policy depending on the country.

Let us stress out the can and can't of monetary policy.

What can't monetary policy do?

From the misinterpretations of the role of monetary policy after the great depression, two limitations of monetary policy have been exposed: 1) pegging of interest rates, (2) pegging of unemployment.

For the former, history has already convinced us of the failure of cheap money policies prevailed by Keynesians and pegging of the government bonds prices was a mistake. The second limitation goes against current thinking. Monetary growth is seen to tend to stimulate employment and monetary contractions to contract economic activity thus

increase unemployment. Monetary authorities can only increase or decrease employment by means or inflation and deflation respectively[5].

What monetary policy can do?

History, also teaches us the first and most important lesson about what monetary policy can do. Monetary policy can prevent money from being a major source of problem. The severity of the great depression could have been very much been reduce if monetary authorities hadn't made the dreadful mistake of reducing money supply and failing to be the lender of last resorts to financial institutions. The 60's would have been less bumpy if authorities had been less erratic in changes of direction. In the early 1966, money supply grew too rapidly, and by the end of the year the breaks were pushed too hard. Expansion was resumed in late 1967 at a pace that could have only led to double digit.

The second thing monetary policy can do is to provide a stable backbone to the economy. This can be achieved by providing price stability. The economic system works best when producers and consumers, employers and employees can assess future price movements.

The final can do of monetary policy is to offset major disturbances in the economic system. A good example would be the massive post war expansion. Monetary policy could have cool down the economic machine. If budget deficits threatened inflation fears, monetary policy could control inflation by increasing interest rates, which would in turn reduce the growth of money supply.

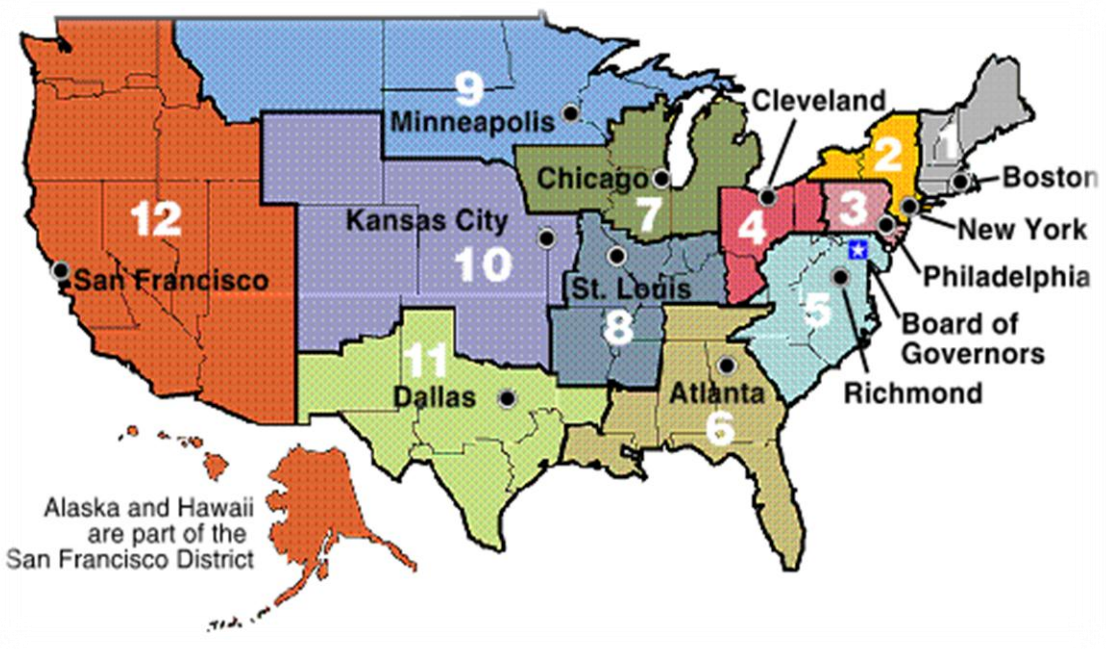
Throughout the 20th century, monetary policy has been through a series of trial and errors. Relatively a new discipline that was sided through most of the postwar, monetary policy has been revived by inflation in the second half of the century. Inflation and deflation have proven to be very costly. Monetary policy has roared back as one or not the most important policy tool in the government's tool kit.

[5] For thorough analysis of these two limitation see MILTON FRIEDMAN, *"The Monetary Theory and Policy of Henry Simons,"* Jour. Law and Econ., Oct. 1967, 10, p 5-11

2.3 The Federal Reserve System and Monetary policy

The Federal Reserve System, the United States' central bank, is widely regarded as the most powerful economic policy institution in the world. The current U.S. central bank, the Federal Reserve System (the Fed), was not established until the early years of the 20th century. The Federal Reserve System was established in 1914, after President Woodrow Wilson signed the Federal Reserve Act on December 23, 1913. The System consists of a seven member Board of Governors with headquarters in Washington, D.C., and twelve Reserve Banks located in major cities throughout the United States.

Figure 2: The Federal Reserve System



Source: The Federal Reserve H.4.1

The Federal Reserve has three tools at its disposal for the conduct of the nation's monetary policy:

Open market operations: consisting of Purchase and sales of U.S. Treasury and Federal Agency securities. These operations are the Fed's principal tool for implement monetary policy. The Federal Open Market Committee specifies open market operations. More light shall be shed on these operations in 1.3.3.

The discount rate: interest rate charged on loans by the central banker to commercial banks and other depository institutions (discount window). There exist three discount window programs: 1) primary credit consisting of very short-term loan

(usually overnight) to healthy depository institutions. 2) Secondary credit also consisting of short-term loans but to depository institutions facing short-term liquidity needs thus not eligible for primary credit. 3) Seasonal credit is granted to small depository institutions facing seasonal swings in funding needs. Eligible institutions are generally located in agricultural and tourist areas.

The rates charged are ascendant; the primary credit rate is above the FOMC's target for the federal funds rate. The spread between these two rates may vary. Given the premium to market rates, institutions will use the primary rate as backup rather than a source of funding. In the financial world, the use of discount rate usually refers to the primary rate. The secondary rate is set above the primary rate. The seasonal rate is an average of selected market rates. The market rates used are decided by the Board of Governors of the Federal Reserve System and reset each first business day of each two-week reserve maintenance period.

***Reserve requirement*:** amount of funds that a depository institutions must have in reserve against specified deposit liabilities. Law bound reserve requirement and the board of Governors has sole authority over changes in reserve requirements. The following table shows the reserve ratios that are prescribed for all depository institutions, banking and U.S. branches and agencies of foreign banks for 2010.

Table 1: Reserve ratios for all depository institutions

Reserve ratios	*Category*	*Effective date*
	Net transaction accounts:	
0 %	For the amount from $0 to (and including) $10.7 million	12-31-09
3 %	For the amount over $10.7 minion to (including) $55.2 million	12-31-09
10 %	For the amount over $55.2 million	12-31-09
0 %	Non personal time deposits	12-27-90
0 %	Eurocurrency liabilities	12-27-90

Source: Reserve Maintenance Manual, Federal Reserve System, October 2009

2.3.1 Legislative guidance:

As an institution created by law, the Fed is always subject to the tacit concurrence of the Congress. In other words, it is never completely independent. The Congress has throughout legislative bills directed and/or limited the activities of the Federal Reserve. A quick recap of the legislative acts that transformed the macroeconomic mandate of the Fed follows:

Employment Act 1946 states "it is the continuing responsibility of the Federal Government to use all practicable means . . . to foster and promote free competitive enterprise and the general welfare, conditions under which there will be afforded useful employment opportunities, including self-employment, for those able, willing, and seeking to work, and to promote maximum employment, production, and purchasing power (15 U.S.C. 1021.)"[6]. Even though this does not implicitly state the Fed, it makes it take into account.

Full Employment and Balanced Growth (Humphrey-Hawkins) Act of 1978 sought to define the Fed macroeconomic policy. This act obliges the central bank to provide a semiannual analysis of the state of the economy, objectives and goals set out by the FOMC.

On expiration of the Humphrey-Hawkins Act, the FOMC has interpreted the charge as follow "The Federal Open Market Committee seeks monetary and financial conditions that will foster price stability and promote sustainable growth in output".[7]

2.3.2 Political Role

The Federal Reserve System is governed by the by the board of Governors. The president of the United States appoints the seven members of the board for a fourteen years term. Two board members are also designated by the president to be the Chairmen and Vice Chairmen for a four-year term. The board's role is to express the nation's monetary policy.

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[6] United States Congress Joint Economic Committee (1985, p. 1).

[7] Policy directives resulting from the FOMC meeting of January 31, 2006.

The board members constitute the majority of the twelve-member Federal Open Market Committee (FOMC). The other five members are selected among the presidents of the Reserve Banks. The FOMC is required by law to meet at least four times a year, but since 1981, eight regular yearly meetings have been. The FOMC makes the decisions regarding the cost and availability of money and credit in the economy. The Board sets reserve requirements and shares the responsibility with the Reserve Banks for discount rate policy. These two functions plus open market operations constitutes the monetary policy tools of the Federal Reserve System.

In addition to monetary policy responsibilities, the Federal Reserve Board has regulatory and supervisory responsibilities over banks, bank holding companies, international banking facilities in the United States, and the U.S. activities of foreign-owned bank

2.3.3 The Federal Open Market Committee (FOMC)

Open market operations constitute the primary tool of national monetary policy and they are overseen by the FOMC. These operations influence Federal Reserve balances thus overall monetary and credit conditions. Foreign exchange market operations undertaken by the Federal Reserve are also directed by the FOMC.

The FOMC is composed of the seven members of the Board of Governors and five of the twelve Reserve Bank presidents. The president of the Federal Reserve Bank of New York is a permanent member; the other presidents serve one-year terms on a rotating basis[8]. The FOMC under law determines its own internal organization. Tradition has the chairman of the Board of Governors is elected as its chairman and the president of the Federal Reserve Bank of New York as its vice chairman. Formal meetings are held eight times a year in Washington, D.C.

Open market operations (OMOs), the purchase and sale of securities in the open market by the Fed are a key tools used by the Federal Reserve in the implementation of monetary policy. In theory, the Federal Reserve could conduct open market operations by purchasing or selling any type of asset. In practice, it needs to be able to buy or sell very large volume of securities that are liquid and have a sizeable market. The U.S.

[8] The rotating seats are filled with, one Bank president from each group: Boston, Philadelphia, and Richmond; Cleveland and Chicago; Atlanta, St. Louis, and Dallas; and Minneapolis, Kansas City, and San Francisco.

Treasury securities satisfy these conditions. The U.S. Treasury securities market is the broadest and liquid market in the world. Transactions are over the counter and most of the trading occurs in New York City.

The Federal Reserve has guidelines that limit its holdings of individual Treasury securities to a percentage of the total amount outstanding. These guidelines are designed to help the Federal Reserve manage the liquidity and the maturity of the System portfolio. As of March 31, 2010 the Fed's portfolio of securities also called the System open Market Account (SOMA) are illustrated in table 2.

Table 2: System Open Market Account Securities Holdings, March 31, 2010

Security type	***Total par value***
U.S. Treasury bills	18
U.S. Treasury notes and bonds, nominal	709
U.S. Treasury notes and bonds, inflation-indexed[9]	49
Federal agency debt securities[10]	169
Mortgage-backed securities[11] (MBS)	1069
Total SOMA securities holdings	**2009**

Billions of dollars Source: The Federal Reserve H.4.1.

Up until November 25th, 2008, the SOMA was only composed of U.S. treasury securities. To help reduce the cost and increase the availability of credit for the purchase of houses, on November 25, 2008, the Federal Reserve announced (Monetary press release) that it would buy up to $1.5 trillion direct obligations of Fannie Mae, Freddie Mac, and the Federal Home Loan Banks, and up to $200 billion MBS guaranteed by Fannie Mae, Freddie Mac, and Ginnie Mae.

[9] Includes inflation compensation

[10] Obligations of Fannie Mae, Freddie Mac, and Federal Home Loan Banks

[11] Securities guaranteed by Fannie Mae, Freddie Mac, and Ginnie Mae.

This is part of the numerous unorthodox actions taken by the Fed in order to keep financial stability in the wake of the financial turmoil. More explanations will be provided in section three.

2.3.4 The Greenspan Standards

Alan Greenspan was sworn in as Chairman of the Board of Governors of the Federal Reserve System on August 11, 1987. He would be at the helm of the institutions for 18 years and become one of the most influential people in the world. The Maestro, as he was referred to, has contributed greatly to the science of monetary policy.

Monetary policy as we know it today is relatively a new field. The first theories appeared in 1945 with the work of Clark Warburton, but we had to wait until 1979 for the emergence of monetary policies, with the appointment of Paul Volker, a monetarist, as President of the Federal Reserve. The result was the creation of the desired price stability. Since 1990, the classical form of monetarism has been questioned because of events, which many economists have interpreted as being inexplicable in monetarist terms, namely the decoupling of the money supply growth from inflation in the 1990s and the failure of pure monetary policy to stimulate the economy in the 2001-2003. Interest rate were lowered to as low as 1% (June 25, 2003). What succeeds is Greenspan's contribution to the science of monetary policy and an explanation of why they matter so much.

***Discretion rather than rules**:*

Modern thinking on monetary policy in clearly in favor of rules rather than discretionary policing[12]. The idea behind the theory is, after all what matters most is long-term interest rate. Long-term interest rates are the backbone of most economical decision private or public. Another argument in favor of rules is expectation management. If the central banker adopts and follows a rule, it can steer the private sector's expectations in a way that ensures that there will be some automatic stabilization of shocks[13]. Barro and Gordon (1983) even argue that period-by-period discretionary policies will lead to inflation.

[12] Kydland Prescott (1977) and Fisher (1990)

[13] Woodford (1999)

Greenspan disagrees[14] with these claims and prefers discretionary methods rather than blindly follow preset rules. The Fed has controlled inflation without rules and serious pre-commitment.[15] Greenspan officially and permanently dismissed the use of monetary aggregates in 1993 as one of the key variables in the FOMC decision-making process. He has also refuted the Phillips curve with a 6% natural rate. Studies such as Phelps (1995), Stiglitz (1997) and Ball, Laurence and Robert (2002) have confirmed a time varying natural rate of unemployment, which fosters a negative correlation with productivity gains.

Greenspan never accepted that model with unchanging coefficient could describe the U.S. economy adequately. He views the economy as in constant change and views the central banker as always learning.

Greenspan's unwillingness to follow any preset rule has made the Fed very flexible in dealing with numerous crises throughout his reign (Greenspan 2004).

Real interest rate and the federal fund rate

Greenspan's most important contribution to monetary policy is with no doubt his choice of policy tool. Greenspan has favored the federal fund rate as the Fed's main ammunition. By setting Fed fund rate, the Fed also indirectly sets real federal fund rates. This is possible due to the slow moving nature of expected inflation (π^e). When the FOMC sets the federal fund rate (i) it also sets the real one (r). The real interest rate is no other than the federal fund rate to which we subtract inflation, this is described by equation 2

$$r = i - \pi e \qquad (2)$$

The real federal fund rate is then compared to the neutral real rate (r*). The deviation of the federal fund rate (Δr) is calculated as follow.

$$\Delta r = r - r^* \qquad (3)$$

The concept of neutral real rate was first used by Wicksell (1898), but then, he called it the natural interest rate. In Keynesian terms it refers to the interest rate that will result in

[14] Feldstein (2003), Fisher (2003), Yellen (2003) share Greesnpan's view

[15] The Fed's press releases in which it would write: " for a considerable period", at a pace that is likely to be measured" serving as weak Pre-commitment

an output gap equal to zero, therefore the difference between r and r* can be viewed as an indicator of the stance of monetary policy (Woodford 1998)
Just like the natural rate of unemployment, there are many ways to calculate the natural real rate of interest. Blinder (1998) proposes a rate at which inflation neither rises nor falls.

By asserting the federal fund rate as the main policy tools Greenspan has set a standard that is currently used by almost every central banker around the world.

Fine-tuning:

Blinder and Reis (2005) define fine-tuning as "*using frequent small changes in the central bank's instrument, as necessary, to try to hit the central bank's targets fairly precisely"*

By the time, Alan Greenspan became chairman; fine-tuning had already been tossed out. Lars Svensson (2001, p1) claimed, complex transmission mechanism and sluggishness to affect the real economy prevented the use of fine-tuning. The Maestro through his actions would prove that fine-tuning is an optimal way of conducting monetary policy.
Prior to June 1989, the FOMC under Greenspan changed the funds rate 27 times in less than two years, only six of those changes where of ±25 basis point. However, since June 1989, the FOMC has changed rates 68 times, and 51 of those changes were of ±25 basis points. Sixteen of the other 17 changes were of ±50 basis points.

Greenspan's legacy as one of the world's best central banker will carry on through his standards. His two-decade reign has undeniably changed the face of U.S. monetary policy. An important fact about these standards is Greenspan did not invent them; he has either introduced them or underlined their importance in monetary policy. This does not take away any credit on his part for his brilliant career as chairmen of the Fed.

The Maestro has introduced other standards, but due to the debate surrounding the righteousness of these standards, this paper has only taken into account the unanimous ones. A prime example of a controversial standard would be the bubble conundrum. For Greenspan, the Federal Reserve should not interfere with asset prices. He reckon that bubbles are hard to identify, and even if the Fed did successfully identify one, the tools at its disposal are not surgical tools but a sledge hammer (the general level of short term interest rates) which when used should be used with brute force to even dent the

bubble[16]. This in return would have a negative impact on the economy as a whole to the bubble. In the case of the 1998-2000 dotcom bubble, how do you dissuade investors who expect returns averaging 100% per annum? The answer is self-evident. A shift in interest rates large enough to dissuade would have drastic consequences on the economy.

Bernanke and Gertler (2001) study on the Fed and asset prices conclude that the Fed should react indirectly to asset prices by responding to their effect on the inflation.

[16] Greenspan (2008)

3 The financial Crisis

At the beginning of 2007, very few people had heard of the word "Subprime". This was about to change by the end of the year[17] with the unraveling of the subprime crisis.

A subprime loan is a type of loan that is offered with a premium to people who would not otherwise qualify for loan via regular credit channels. This concept was extended to mortgages. When a borrower applies for a mortgage, the lender checks the borrower's ability to pay back the loans via credit reporting agencies. The assessment of the borrower's riskiness is referred to as underwriting the loan. Subprime mortgages are handed out to people, who do not qualify for prime mortgages.

In the 90's the subprime mortgage represented 5% ($35 billion) of total mortgages in the U.S., and by 2005, it had jumped to 20% ($600 billion) of total mortgages[18]. In 2006, the percentage of defaults started to rise in this particular segment, and would trigger what would be called the subprime crisis. The subprime crisis would contaminate to the whole U.S. financial sector and spread to the world to give birth to the global financial crisis.

How has trouble in a $600 billion market managed end up triggering a global recession and costing up to $7.7 trillion and wipe out 14% market capitalization?

What follows is a thorough analysis of the unraveling of the crisis, how it has spread out and how policy makers have dealt with it. The analysis will be limited to the United States.

3.1 How the system set up the crisis

A combination of macroeconomic and microeconomic factors set the founding blocks of the crisis.

[17] The term Subprime was mentioned in 6000 articles in 2006 and 162000 times in 2007 according to Factiva (Business information and research tool owned by the Dow Jones)

[18] Source, the 2007 Mortgage Market Statistical Annual

3.1.1 Macroeconomic Imbalance

The U.S. current deficit is the starting point in the analysis. In 1991, the U.S. posted its first current surplus in 8 years 0.7% of GDP. Ever since Uncle Sam grew a current deficit of $811 billion (6.1%) by 2006; the biggest deficit ever contracted by a country. The current account represents the net result of saving and investments. The U.S. savings rate had sharply fallen from 7.5% in 1991 to 1.9% at the end of 2006. The difference was made up by borrowing from surplus countries such as Germany, China and OPEC countries. By 2005, the U.S. absorbed 80 percent of international saving that crossed borders.

Ben Bernanke (2005) explains that the problem emanated from the rest of the world and that the U.S. imbalance is a reaction to it. Bernanke states that, the growing surplus generated by oil exporting countries, countries with an aging population (Germany, Japan) and countries with huge trade surpluses (China, South Korea….) are the causes of the U.S. deficit. Bernanke refers to the excess saving outside the U.S. as the *"saving glut"*. These countries do not have capital markets capable to absorb the surplus; therefore, they turn to the U.S., which has the deepest and liquid markets in the world[19]. The U.S. reacted as a magnet to foreign capital. This surplus of demand gave rise in asset prices in the 90's. Higher stock market wealth, stimulated Americans to consume more thus save less and less while contracting more debt.

Bernanke's theory provides a suitable external explanation to the deficit. Internal causes have to also be factored in. The U.S. budget deficit kept growing at the same pace as the current deficit, giving birth to the *"Twin deficit"* hypothesis.

However, the sparks accelerating the imbalances came after the burst of the dotcom bubble in 2000. We thus examine the role of monetary policy during the Greenspan era

In January 2001, the technology bubble, which had built up over the past 5 years, went burst. The tech wreck threatened to send the economy into recession. Staying faithful to his standards, *"Ride the booms and cushion the bursts"*, Greenspan lowered interest rate in order to keep the economy afloat. Shortly afterwards the September 11 events occurred and sent shockwaves throughout the system. The Fed, determined to avoid a Japan style deflation, which cost Japan a decade's worth of growth, began a series of

[19] US treasuries are the most liquid markets in the world.

rate cuts in order to provide liquidity to the market to fend of the deflationary pressure and keep the economy form falling into a painful recession. After 13 rate cuts, as shown in Table 3, the Fed funds stood at 1% in June 2003 from a high of 6 percent in January 2001. Rates would be maintained at 1% for a year.

Extremely low interest rate helped a highly leveraged indebted corporate America restructure its balance sheets and navigate through the storm. Low rates also helped created a new imbalance, this time in the housing market. Low interest rates implied low mortgage rates leading to a boom in mortgages. This had two implications: 1) the excess demand for housing lifted house prices and directly increased household net worth. As Americans, felt richer they started consuming their newly acquired wealth. Consumption soared to more than 70 percent of GDP and saving fell to as low as 1.9 percent, this led to more and more imports, widening the current account deficit. 2) As mortgage lending soared the market began to saturate, so lender turned to more risky customers with subprime mortgaged increasing demand in an already buyers' market. Mortgage companies also started to pop up like mushrooms. This was made easy because lending terms were eased by banks[20].

Low interest rates are not the only culprits in the housing boom; legislative measures set the bedrock for the boom, which started well before 2001 as shown in Figure 2. Congress pushed Freddie Mac and Fannie Mae, two government sponsored enterprises (GSE), to increase their purchase of mortgages going to low and moderate income borrowers. In 1996, specific targets were given to our two GSE's: 42 percent of mortgage refinancing was to go to borrowers with income below the median income of their area. The figure rose to 50 and 52 percent respectively for 2000 and 2002. Meeting targets was easy because Freddie Mac and Fannie Mae both enjoyed government backings; they were thus able to borrow at very low rates. By 2006, the two enterprises had bought billions of subprime mortgages.

[20] Further explanation on this is given in 2.1.2.1

Table 3: Target federal funds rate, 2000-2004.

Date	*Increase*	*Decrease*	*Level (percent)*
2000			
16-May	50	–	6.5
2001			
3-Jan	–	50	6
31-Jan	–	50	5.5
20-Mar	–	50	5
18-Apr	–	50	4.5
15-May	–	50	4
27-Jun	–	25	3.75
21-Aug	–	25	3.5
17-Sep	–	50	3
2-Oct	–	50	2.5
6-Nov	–	50	2
11-Dec	–	25	1.75
2002			
6-Nov	–	50	1.25
2003			
25-Jun	–	25	1
2004			
30-Jun	25	–	1.25

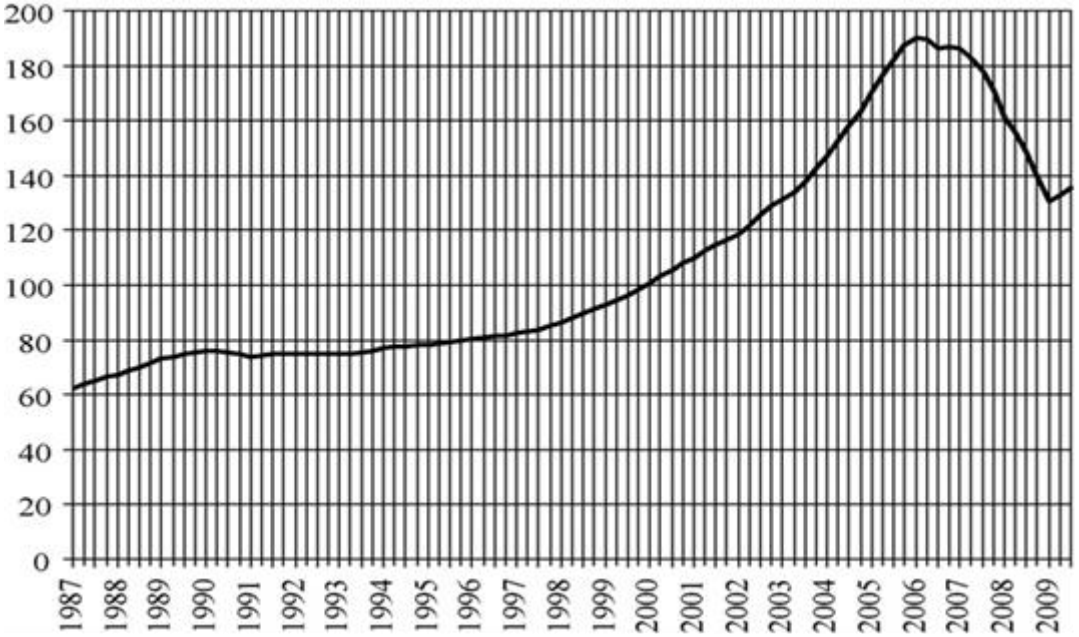
Source: The Federal Reserve Board.

The Fed's policy indirectly increased world liquidity via two channels: 1) increasing foreign exchange reserves in net exporting countries. With American consumption at its highest, Asian countries enjoyed a boom in export to the U.S.. They accumulated huge amounts of dollar reserves. Leading the pack, China and Japan saw their reserves grow respectively from $212.2 and $387.7 billion in 2001 to $ 1,104.7 and $880 billion in 2007. Some of this money found its way back in the U.S. through financial markets, adding more liquidity to the U.S. market thus driving prices higher. 2) Countries such as China and most Asian countries have their currency pegged to the dollar; they indirectly imported Uncle Sam's expansionary policies resulting in an increase in domestic liquidity.

Why wasn't this increase in global liquidity translated into inflation? The 80's hawkish monetary policies proved successful, average inflation of OECD members was reduced from 15 percent to less than 5 percent. Volatility in inflation was also reduced considerably. This was coupled with the "great moderation" a decrease in GDP volatility throughout the world and fierce competition which drove prices down

(especially among Asian countries). Monetary institutions had the faith of the private sector in keeping low inflation. The result was low inflation expectation in the short run and medium run.

Figure 3: S&P/Case–Shiller U.S. national home price index.



Source: Standard & Poor's

3.1.2 Microeconomic shakiness, the quest for higher return and securitization

Macroeconomic imbalance gave ground to microeconomic shakiness in the financial sector and gave birth to excessive risk taking and complex financial products.

After the dotcom bubble burst, panic could be read all over the market. In such time investor run for in fixed income markets, government bonds, especially the U.S. treasury market. This situation is referred to as flight to safety; investors weather the storm by taking refuge in fixed income security. Treasury securities offered security but the returns were miserable consequence of historically low interest rates. With global liquidity at its highest in decades, banks held excess liquidity and face heavy competition from alternative funds (private equity firm and hedge funds) that generated double-digit returns. Their returns differed from others due to their high leverage ratios. With interest rates so low, this did not constitute a problem in the short term. Alternative fund started poking investor from traditional investment banks, which were

not able to offer the same returns. In a need to bolster returns investment banks began to be more and more creative and started taking more and more risk. This is the beginning of an unprecedented boon in complex financial products. Traditional banks also started to soften lending term in order to increase returns, leading to a boom in mortgage lending. For regulatory purposes, an increase in loans needed to be couple with an increase in capital. Banks and lenders have found a brilliant way to go around this: Securitization

Securitization contrary to common believes is not a new practice, it has been used for over half a century. The first such operations were completed by GSE (Freddie Mac and Fannie Mae). Securitization is a financial technique used to transform traditional illiquid bank loan into marketable securities. Securitization only concerned mortgages at that time and were referred to as mortgage-backed securities (MBS).

Thanks to financial innovation, securitization would be extended to all type of credits and GSEs would no longer hold the monopoly. Asset backed securities (ABS) are securities backed by a pool of loans other than mortgages (Consumer credit, auto credit etc...) Collateral debt obligations (CDO) are securities backed by a pool of marketable loans (Bonds, commercial papers). The returns of the securities are guaranteed by the interest paid on the loans.

Securitization transfers the credit risk from the lenders to the markets, it takes the loans of the lenders' balance sheet therefore no need to increase capital and even better, they could give out more loans. Securitization has developed very quickly; total securitized market was worth $10 trillion representing 40 percent of the bond market[21] at its peak in 2006. Securities were sold by different category of risk meaning different type of returns.

The riskiness of the new securities was accessed by rating agencies. Based on the ratings assigned to each tranche of security, their valuations are determined. Senior tranches were the most secure and rated AAA/Aaa, then came mezzanine, with a little more risk and rated BBB/Bbb and equity tranches the riskiest of them all with non-predefined retunes and with a high-expected return.

[21] Excluding US treasuries

Securitization expanded so rapidly, institutions started buying securitizes securities on the market. It became so complex, bankers did not know who had what, hence were not able to access the risk related to these securities. This did not matter much to them because they had bling faith in the rating assigned by rating agencies and they believed that the risk had been spread out throughout the markets.

3.2 The Meltdown

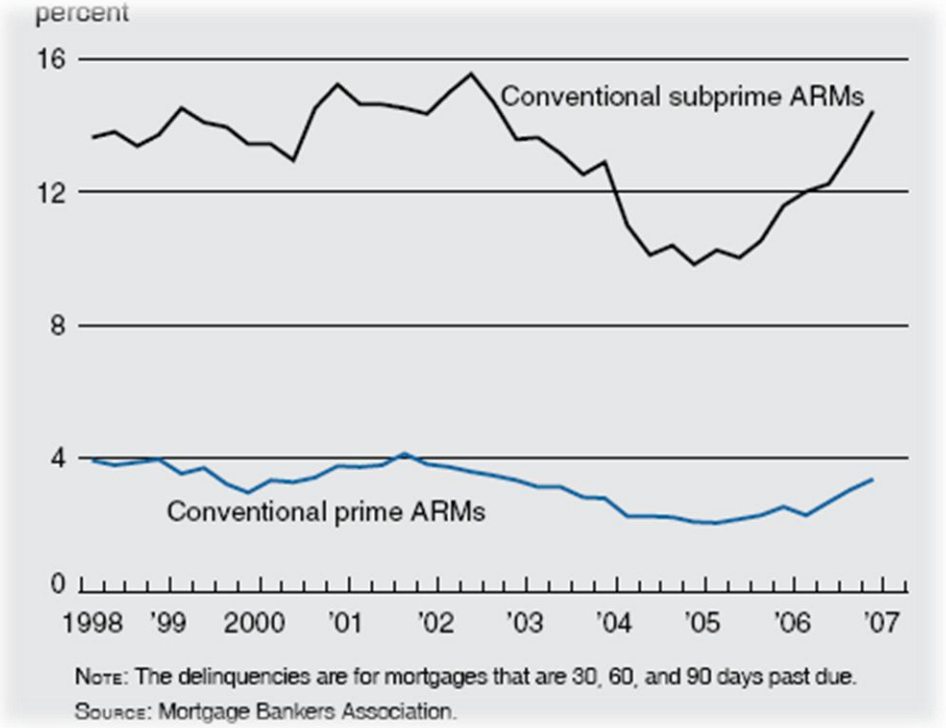
The previous subsection explained the frail built up of the system. The frail system was a castle of card. All was well until on component moved or defected, triggering a mass domino effect.

The perennity of the system was based on two pillars. The first pillar was stable and low interest rates. This allowed interest paid on debt to be low. It also allowed lenders to be more expansionists. The second pillar is a direct consequence of the first, housing prices should continue to rise, hence making household richer and entitling them to borrow more with their houses as collateral.

Pillar 1 was brought down with the tightening of monetary policy for fear of rising inflation. Interest rate progressively climbed from 1 percent to 5.25 percent between 2001 and 2006. The rise in Fed fund rates constitutes the triggering of the domino effect that led to frenzy in the markets.

With a high volume of adjustable mortgages, household felt the pinch when interest rates their upward march. This increased the delinquency rate on mortgage payment as shown in figure 3.

Figure 4: Prime rate mortgages Vs Adjustable rate mortgage delinquency rates



Source: Observatoire Français des Conjonctures Economiques(OFCE)

A rise in delinquency rate meant that cash flows to holders of MBS's were not guaranteed. This in turn prompted rating agencies to reevaluate their rating on MBSs. The dominos effect was set in motion.

June 15th	Moody's degrade 131MBS from AAA to BBB and put 250 more on their watch list.
July 10th	S&P put $7.3 billion worth of on a negative watch list and Moody's degrades $5 billion MBSs from AAA to BBB.
July 11th	Moody's puts 184 tranches of TGC Home's MBS on negative watch list.
July 26th	Sales of new home fell almost 6.6 percent compared to a year earlier.

With interest rate going up less and less borrowers were able to shoulder the burden of the monthly mortgage rate. By end, 2007 there was a serious gap between offer and demand for new houses in favor of the former. This drove house prices down destroying the second pillar of the system and gave way to the free fall. Figure 5 explains the series of chain reactions that followed.

Excess housing put downward pressure on prices. This decreased household's net wealth and made it hard to refinance under favorable terms. Monthly mortgage rate increased and lower end borrowers were not able to meet repayments deadlines. This in turn decreased the cash flow to securitized asset, therefore prompting rating agencies to lower ratings. A lower rating highlighted more risk, which implied a higher rate of returns. This drove the prices drown. Banks bought the AAA rated securities and used them as collateral in their balance. With most of the MBSs downgrade, they did not meet the standards of collaterals imposed by Basel II. Banks had to recapitalize in order to satisfy regulation.

At this point, none of the major financial institutions knew what the length of their exposure to these toxic assets. An accelerator of the downfall was the mark-to-market or fair value accounting. This obliged institutions to value certain categories of asset (this included MBS, ABS and CDO) held on their balance sheets at market value. During the crisis this was a huge problem, there was no market for these securities because no one was buying them and their prices just kept on collapsing, prompting another series of write-downs and recapitalization.

The rapidity of the contagions was due to the sophistication of new financial products, the mispricing of risk, and the inability to evaluate holdings. Nobody knew what others exposures were and this triggered a confidence crisis. Banks were unwilling to lend to each other even on the shortest term, overnight. The interbank market dried up. What had started out as a subprime crisis due to over liquidity had mutated in to a confidence and liquidity crisis.

The road to recession come through the credit channel, banks in urgent need to bolster their balance sheet, simply stopped giving out credits. This has the same effect as to cash strap business that was not able to roll over their debts. This in response triggered massif layoffs. Fewer workers meant less disposable income as a whole thus less consumption. Consumption is the main propeller of the U.S. economy, a steep drop in consumption led to the economy to a grinding halt, which in turn led to more layoffs, thus lowering consumption, and the vicious circle goes on.

3.3 Policy response

The Fed has been aggressive in combatting this crisis and to avoid a total market meltdown. The Fed's main priority during the crisis was financial stability. Ben Bernanke, widely renowned as one of the best experts of the great depression, was the right man for the job. The Fed used convention and unconventional methods within its legal limits to ensure stability. The conventional methods are the usual rate cuts during FOMC meeting. The rate cut are displayed in Table 4.

Table 4: Target federal funds rate cuts in response to the crisis

Date	Increase	Decrease	Level (percent)
2007			
18-Sep	–	50	4.75
31-Oct	–	25	4.5
11-Dec	–	25	4.25
2008			
22-Jan	–	75	3.5
30-Jan	–	50	3
18-Mar	–	75	2.25
30-Apr	–	25	2
8-Oct	–	50	1.5
29-Oct	–	50	1
16-Dec	–	75–100	0–0.25

Source: The Federal Reserve Board.

In the mist of the crisis interest rate cuts were not enough, the Fed relied on non-conventional tool to shore up market with liquidity in the form of term auction facility (TAF), rescue of Bear Sterns, term securities lending facility (TSLF) and the primary dealer credit facility (PDCF):

The discount window failed to reduce the spread in the interbank market. The FOMC announced it would auction predetermined amount of liquidity. The Fed implements the term auction facility (TAF) in December 2007. Banks were reluctant to use the discount window. A use of the discount window would trigger a negative signal to the market. Auctions were fortnightly and initially in small amounts, $20, $30, and $50 billion for a period of 28 or 35 days. Any of the 7,000 plus commercial banks could participate in the auction. The minimum bid rate was set according to the Fed fund target rate.

Facing liquidity problems Bear Sterns was bought March 17 by JP Morgan Chase & Co, then the U.S. 3rd largest bank by market capitalization, for $240 million[22] a tenth of its value. The Fed provided financing for the transaction, and pledged to support $30 billion worth of Bear Sterns assets.

The TAF had failed to significantly impact the spread between the three-month LIBOR and the three-month expected federal funds. The Fed then came up with the TSLF. The basic idea is as follows. In regular time, institutions would short sell treasury securities to each other with the prospect of buying it on the market before the delivery date. This would represent in some way a short term financing for the shorting firm. If the seller was not able to buy the treasury in the market, it could go to the Fed and borrow the security for 24h. The procedure was change in three ways to give birth to the TSLF program. First, the loan time was extended to 28 days. Second, the collaterals used were broadened; AAA mortgage-backed securities were accepted as long as they were not on downgrade watch. Third, the Fed was willing to loan up to $200 billion through the TSLF.

Primary dealers are banks and or security brokers who are allowed to trade directly with the Fed. Nineteen of these dealers are not bank thus unable to use the Fed's discount window. The PDCF allows these dealers to use the discount window.

With interest rates barely above zero, the Fed only had unconventional method at its disposal. Ben Bernanke's knowledge of the great depression and the inefficiency of the Japanese decade zero rate policy proved handy in stabilizing the financial system on the brinks of collapse. The following section will be an empirical analysis of the federal fund rate using the simple Taylor rule in order to determine 1) can the Fed fund in time of crisis be guided by a simple rule and 2) how will the crisis impact future monetary policy in the short and medium run

[22] 10 per share, the company was worth less than its headquarters it owned.

4 Empirical Analysis

This section is devoted to the analysis of the U.S. federal fund target rate from 1988 to 2009. The methodology and an ample explanation of the data are supplied prior to the results of the empirical analysis.

4.1 Methodology and Data

The best predictor of U.S. federal fund Rate is the simple Taylor rule, therefore the analysis will evolve around this simple rule. The study period is from 1988 to 2009 and encloses three major recessions: 1) the 90's saving and loan crisis 2) the tech recession also known as the dotcom recession and 3) the financial crisis. The Fed's dual mandate obliges it to take into account negative fluctuations of output, thus in order to identify how the Fed responds to such events, a separate analyses will be conducted on the three recession periods.

The analysis will be of two stages.

Stage 1 begins by calculating the federal fund target rate according to a modified Taylor rule. Modifications brought to the rule are the results from critics emanating from Orphenides (1997). Taylor's original calculations use revised data, which were not available to the FOMC at the time of the meetings. To go around this problem we use unemployment gap to replace the output gap. The Consumer Price index (CPI) excluding food and energy is used in place of inflation.

For comparative reason we use two different modified version of the Taylor rule:

One without Okun's law, referred from now on as T1

$$\boldsymbol{FFt = rt + \pi t + 0.5\,(ut* - ut) + 0.5(CPI - \pi*)} \qquad \textit{(4)}$$

with the Okun's law referred to as T2

$$\boldsymbol{FFt = rt + \pi t + 0.5\,Okun\,(ut* - ut) + 0.5(CPI - \pi*)} \qquad \textit{(5)}$$

u_t*: represents the natural rate of unemployment or the non accelerating inflation rate of unemployment: NAIRU. The NAIRU is subject to changes over the long run, and is

positively correlated with technological progress. The NAIRU rates used in the analysis are estimated by Ball Mankiw (2002) and are displayed in table 5.

Ut is the monthly unemployment rate published by the Bureau of labor and Statistics (BLS) and $(ut^* - ut)$ is defined as the unemployment gap. CPI and $\pi t*$ are the consumer price index and the target inflation rate respectively, their difference ($CPI - \pi*$) represents the inflation gap.

Okun represents the relationship between Unemployment and GDP. Attfield & Silverstone (1997) estimate the relationship to be of the order of three (3) for the U.S. economy. An increase of 1 percent in the unemployment rate will translate into a 3 percent reduction of GDP

Table 5: NAIRU rates

Time Period	1988--1992	1992--1999	1999--2009
u_t^*	6%	5.40%	5%

Stage 2 in the analysis is an OLS regression of the modified Taylor rule to which we add two independent variables: U.S. industrial production index and the Personal consumption expenditure survey index. The former is a front-runner indicator of future economic activity. The later account for approximately 64 percent[23] of GDP in the U.S., and is an indicator of the private sectors expectation on the future path of the economy. When consumers have a bleak picture of the future they tend to reduce their consumption and save more.

A first regression is conducted on the whole data. The second is a series of regressions, all the same as the first but conducted solely on recession periods in order to identify changes in the coefficient of independent variables.

The results of stage 1 and 2 are then pooled together in order to draw conclusions about the usefulness of the Taylor rule.

[23] Average over the study period, source BEA

4.2 Analysis and Results

Analysis starts with descriptive statistics of the data[24] set: the federal fund target rate (FF) and the rates given by the modified Taylor rule without Okun's law, and with Okun's law.

Table 6: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
FF	**264**	**0,12**	**9,81**	**4,4298**	**2,31376**	**5,353**
Taylor Rule	**264**	**0,75**	**9,40**	**5,1049**	**1,73867**	**3,023**
Taylor-okun rule	**264**	**-4,10**	**9,70**	**4,7614**	**2,58223**	**6,668**

The data is composed of 264 observations representing the number of month in the period of study. The means are relatively close to 4%, which would be the federal fund rate under the Taylor rule if inflation gap and unemployment gap was both equal to zero. This reflects the central banker's role in maintaining inflation at relatively low rates. The average inflation throughout the period was 2.85%[25]

In order to compare the likelihood of the two Taylor induced data set with the fund rate, we conduct a paired t-test. A paired t-test calculates the difference between two variables for each observation and tests to see if the average difference is significantly different from zero. We want to see how well our data replicates the fund rates. Results are displayed in table 7&8. Table 7 is a pared correlation test and determines how correlated the non-modified and modified Taylor rule are with the federal fund target rate. Table 8 is a paired t-test; this test determines how significant the differences between the non-modified and modified Taylor rule are with the federal fund target rates.

[24] The data set is found in Appendix A

[25] Arithmetic average of monthly CPI from data set

Table 7: Paired Correlations FF&T1, FF&T2

	N	Correlation	Sig.
Pair 1 FF target rate & Taylor Rule (T1)	**264**	**,844**	**,000**
Pair 2 FF target rate & Taylor-okun rule (T2)	**264**	**,882**	**,000**

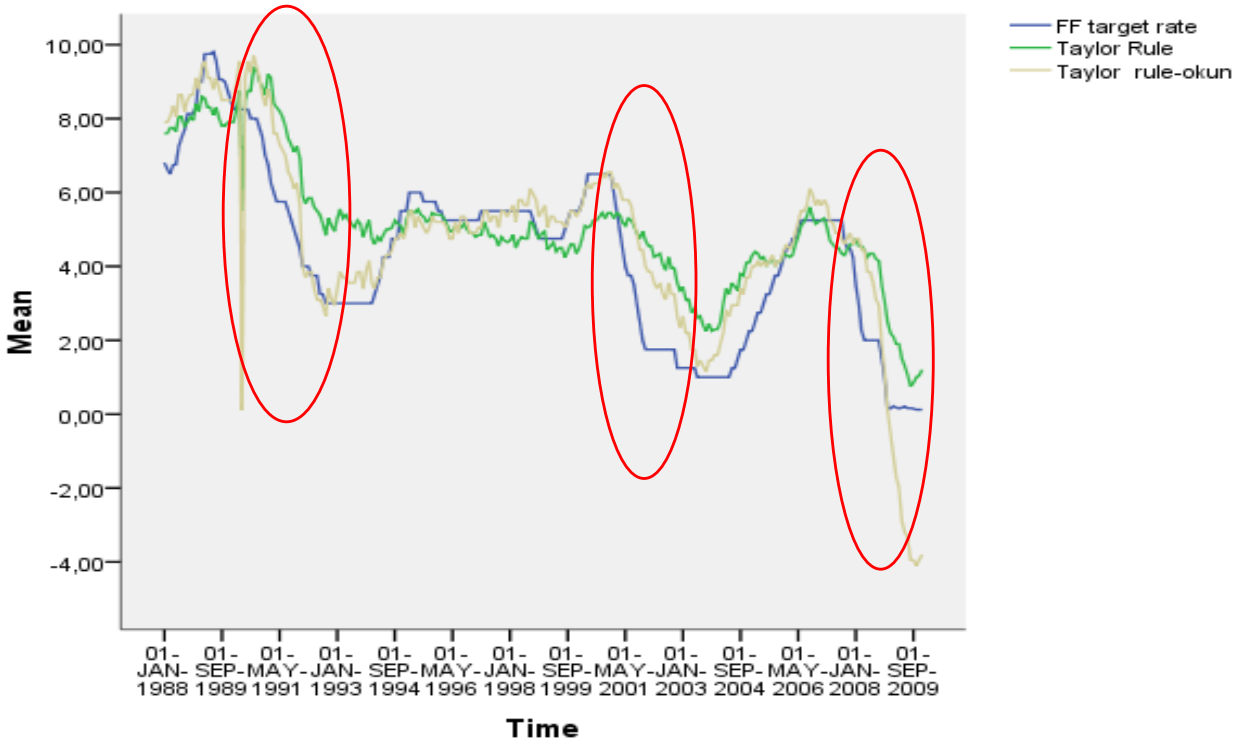
Table 8: Paired T-Test FF&T1, FF&T2

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	FF target rate - Taylor Rule	**-,67511**	**1,25797**	**,07742**	**-,82756**	**-,52267**	**-8,720**	**263**	**,006**
Pair 2	FF target rate - Taylor-okun rule	**-,33155**	**1,21930**	**,07504**	**-,47931**	**-,18379**	**-4,418**	**263**	**,018**

T1 and T2 have strong positive correlations with the federal fund target rate, with a slight advantage for T2. T1 and T2 estimate federal fund rate with an accuracy of 84% and 88% respectively. The Sig. (2-tailed) are less than 0.5 implying significance differences between T1&FF and between T2&FF. In more simpler terms the Taylor rule and Taylor-okun rule are to some extent able to explain policy decision made by the FOMC.

The federal fund target rate, the Taylor rule and Taylor-okun are plotted in figure 6 in order to give a visualization of the three variables. The plots reveal the Taylor-okun rule mimics the federal target rate better than the Taylor rule as was numerically shown by a higher correlation ratio.

Figure 5: FF,T1&T2 plot



Visual observation shows T1 and T2 have difficulties predicting the fund rates in times of recession. Between 1988 and 2009, the U.S. has had 3 recessions

1990: loan and saving crisis (Q2 1990- Q3 1992)

2000: tech recession (Q3 2000-Q2 2002)

2008; financial crisis (Q2 2008- Q4 2009)

The recession periods are circled in red in figure 6.

The Fed's dual mandate obliges it to respond to economic down-term, thus giving more importance to unemployment gap in regards to inflation gap. In a recession, inflation fears are replaced by deflationary fears. This is interpreted inT1 and T2 by giving more weight to unemployment gap. Dichotomy give use the following weights 0.6 and 0.4 for unemployment gap and inflation gap respectively.

By implementing the changes and conducting independent analyses on recession periods, we observe improvement in the paired T test for all three-recession periods. Figure 5, 6, and 7 in the appendix gives use a visual of the improvement of in replication of the T1 and T2.

As a result of reassigning weights correlation ratios improve significantly, from 66% to 83% for the 90's recession, 73% to 95% for the Tech recession and finally 76% to 92% for the financial crisis[26].

To confirm the finding in stage 1, the same procedure is used with regression analysis. The analysis starts with a simple linear regression of the data set then the same method is applied to recession periods in order to determine if and how elasticities change in times of crisis.

In order to reduce the number of variables to a strict minimum we have proceeded with a removable method. The methods starts with incorporating the all explantory variables and proceed to remove them one by one until we get the best model in terms of R Square with the least explanatory variables. The base model is summarized in equation 6

$$FF_t = \beta_0 + \beta_1 (u_t^* - u_t) + \beta_2 (CPI - \pi^*) + \beta_3 IP + \beta_4 PCE + \varepsilon_t \qquad (6)$$

Two new explanatory variables have been added to the unemployment gap and the inflation gap. The first is the Industrial production index (IP) and the second is the personal consumption index (PCE)

β_0 is the intercept and β_1, β_2 , β_3, β_4 are the elasticity of the federal fund rate in respect to the output gap, inflation gap, the IP and the PCE respectively.
The model with the highest R Square covers the whole data set and uses all four independent variables: unemployment gap, inflation gap, the U.S. industrial production (IP), and personal consumption expenditure (PCE). Table 9 summarizes the results of the regression on the whole data set.

[26] Paired T test and graphs for each crisis period are provided in appendix A

Table 9 : Coefficients

Variables	Coefficients		.		Correlations			Collinearity Statistics	
	B	Std. Error	t	Sig	Zero-order	Partial	Part	Tolerance	VIF
(Constant)	**3,300**	**,150**	**22,034**	**,000**					
(u_t* - u_t)	**1,093**	**,057**	**19,295**	**,000**	**,628**	**,770**	**,541**	**,950**	**1,053**
(CPI - π*)	**1,406**	**,063**	**22,382**	**,000**	**,683**	**,814**	**,628**	**,983**	**1,017**
U.S. Industrial production Growth	**,145**	**,099**	**1,453**	**,147**	**,104**	**,091**	**,041**	**,890**	**1,124**
Personal consumption expenditures Growth	**,083**	**,022**	**2,084**	**,038**	**,230**	**,129**	**,058**	**,871**	**1,148**

R	R Square	Adjusted R Square	Std. Error of the Estimate
,894[a]	**,800**	**,796**	**1,02874**

a. Dependent Variable: FF target rate

The regression model covering the whole study period has a R^2 of 80%, which means the model replicated correctly 80% federal fund target rates. The variance-inflating factors (VIF) are well above their tolerence level (0.5) which excluds multicollinearity.

The following step in the analysis is to run the sam regression analysis on the three recession periods identified earlier. The goal iscapture changes in elasticity of federal fund target rate with respect to explanatory variables. Once again the goal is to have the model with the highest R Square but with the fewest variables. Table 10 and 11 summarizes the resuts.

Table 10: Model Summary, recession periods

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
90	**,816**	**,667**	**,640**	**,99548**
Dotcom	**,974**	**,948**	**,937**	**,48340**
Fin crisis	**,970**	**,940**	**,920**	**,24138**

Table 11: Coefficients recession periods

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
90's Crisis					
(Constant)	**,087**	**1,166**		**,074**	**,941**
(CPI - π*)	**,036**	**,187**	**,027**	**,194**	**,848**
(u_t* - u_t)	**2,149**	**,380**	**,800**	**1,656**	**,070**
Dotcom crisis					
(Constant)	**7,734**	**3,774**		**2,049**	**,055**
(CPI - π*)	**,943**	**,833**	**,066**	**-1,132**	**,272**
(u_t* - u_t)	**,868**	**,055**	**,830**	**5,699**	**,143**
U.S. Industrial production	**,243**	**,267**	**,066**	**,908**	**,375**
Personal consumption expenditures	**6,374E-5**	**,009**	**,018**	**,306**	**,763**
Fin Crisis					
(Constant)	**1,347**	**,295**		**4,567**	**,000**
(CPI - π*)	**,165**	**,112**	**,308**	**1,477**	**,162**
(u_t* - u_t)	**1,504**	**,478**	**,657**	**3,150**	**,047**

a. Dependent Variable: FF target rate

The result of independent crisis period study confirms our results in stage 1.

During the 90's crisis only inflation and output gap are retained, the other variables are insignificant. Inflation gap explains only 27% the value FF down from 63% on the other hand; unemployment gap explains 80% up from 62%.

In the period of the Dotcom, all variables are significant. The elasticities of FF with respect to inflation gap drops to 6% and unemployment gap rises to 83%. The very low elasticity assigned to inflation gap is a direct consequence of the bursting of the tech bubble, creating a deflationary chock. Inflation did not constitute a short-term threat; focus was put in restarting the economy.

During the Financial Crisis, consumer expenditure and industrial production are excluded from the model, leaving only inflation and unemployment gap to explain 38% and 65% of federal fund levels respectively. Unemployment gap only explain 3% more of the FF level. As of December 2009 federal fund rated have been fixed in the range of 0-0.25%, while economic conditions continue deteriorate suggesting further rate cuts.

The fact is, rates cannot go any lower, which prompted the Fed to take unconventional measure as explained in section 3.3. This is reflected in Figure 5 where statistically we the model would preconizes negative inflation rates.

4.3 Results

The modified Taylor rules represent a simple and efficient predictor of federal fund target rate. With a paired correlation ratio largely above 80% in all the cases studied and an average standard deviation of 1.22%, the modified Taylor rule is a guide for future monetary policy. The standard deviation is high though, a 1.22% deviation in federal fund rate has significant ramification for the economy. Therefore, the modified simple rule is not a rule of thumb but a tool shedding light on the discretionary policies of the FOMC.

The rule presents numerous advantages. It can be easily used to predict future trends in federal fund target rate. The data used in its calculation is accessible to the common individual. The rule does not rely on historical data; it is a forward-looking rule. It is even more valuable in predicting interest rate of countries such as Sweden and England where central banks focus solely on inflation (Kozicki 1999*)*

Empirical study confirms our finding. We proceeded to add two independent variables, industrial production index (IP) and personal consumption expenditure index (PCE). These variables are key economic indicators of future economic prospect. Form our analysis, IP and PCE explain less than 1 % of the changes in federal fund rate; whereas unemployment and inflation gap explain roughly 55% and 63% of fluctuations respectively.

By conducting the same analysis to the recession period, we find that IP and PCE are excluded from the model during the 90's and financial crisis recession.

In times of crisis, the analysis shows on average that the unemployment gap explains 76% of the level of federal funds. This also confirms our previous results. Due to its dual mandate, the Fed in times of recession has to stimulate the economy to keep GDP on a sustainable and non-inflationary trend, which translates into rate cuts, which in turn eases credit and floods the economy with liquidity.

Now that light has been shed on how the FOMC sets interest rates, combining it with the theoretical framework, one is able to determine the effects of the global financial crisis on the future monetary policies.

With current interest rate in between 0-0.25%, the only way rate can go is up, the question reside in when and how fast will they rise. Under normal conditions, we would turn to our modified Taylor rule for guidance. However, with unemployment above 9% and inflation at 2.1 % the rule would suggest rate cuts, which is not an option. In post-recession periods in our data set, a tradeoff can be observed between inflation and unemployment. Whoever this is unlikely to occur in the present case, and for several reasons: 1) the severity of the recession has created many bankruptcies and restructuring leaving fewer companies to hire people. 2) Recessions are usually followed by waves of consolidation in numerous industries (Berger & Humphrey, 1995), and consolidation is synonym to layoffs. 3) Inflation will pick up speed faster than usually because of commodities, demand from emerging countries such as China and India who have barely felt the crisis have kept commodity prices from falling too much. The emergence of OECD countries from recession will put upward pressure on prices. Even though the Fed uses core inflation[27], high commodity prices will create imported inflation. 4) Deficits restrict the government in using fiscal policy as a stimulating tool.

To combat the rise of inflation, without sending the convalescent economy back into recession, monetary authorities will proceed as follows:

- Eliminate special facilities granted during the crisis in order to secure financial stability. These facilities provided liquidity to the market during the crisis. It is unclear which facilities will go first or whether they will be gradually or abruptly ceased but this will mainly depend on the strength of the recovery and the stability of financial markets.
- The Fed will proceed to cleaning it balance sheet of CDOs, MBS, and ABSs bought during the crisis in order prevent these markets from collapsing. The sale of these securities will act on open market operation in which the monetary institution by selling these securities proceed to reduce the overall liquidity in the economy. A reduction of liquidity will help slow down inflation.

[27] Inflation excluding food and energy

- When the two first steps are completed, the Fed will proceed in incremental interest rate hikes to fend off inflation. At this point if the economy is, still week or growing significantly below its potential rate the Fed will accept a short-term tradeoff between inflation and employment in favor of the later.
- Once the Fed's balance sheet is back to pre-crisis status quo, special lending facilities have been ceased, then and only then, it may start rising interest rates. When this happen the modified Taylor rule can be used to guide us on future monetary policy trends.

The long run effect of the crisis on monetary policy will reside in the dual mandate of the Fed. Expected to be the lender of last resort and being able to stabilize market in extreme situations, the Fed will have to be creative in combatting new crisis ahead. The panoply of unconventional tool used during the crisis will in the future judged as conventional in times of financial instability. This will increase moral hazard and make the central banks task harder. The private sector will have overconfidence in the institution and expect the Fed to be able to ensure financial stability in the worst of scenarios. To ensure moral hazard does not spread out of control the Fed would have to send a clear message to financial markets; such message could be to let a significantly important institution fail.

5 Conclusion

Monetary policy came back into the spotlight due to years of stagflation. Monetary policy is now regarded one of the most importance policy tool at a government's disposal. Monetary policy is however not an exact science far from that. The unpredictably of the economy, macroeconomic crises, and the mitigated effects of policies make it hard to quantify monetary policy. the analysis in the study combines theory and practice in order to determine how the biggest crisis since the great depression will affect the central bank's job in the future. Three major results were obtained: 1) the federal fund target rate is the Fed's main policing tools. The U.S. central banker changes its fund target rate when the economy is indifference stages of the business cycle and in response to chocks to the economy; 2) changes in the federal fund target rate are explained by the Taylor as a response by the central banker to deviation in output from its trend level and deviation of inflation from the Fed's inflation target rate. The elasticity of the federal fund target rate in respect to output and inflation changes depending on the state of the economy. Federal fund target rate is a positive function of output gap and inflation gap; 3) there is no guidebook for monetary policy, when interest rates are at the vicinity of zero the central banker has to be creative and come up with solutions in order to tackle the problem. This was the case with the financial crisis.

Timing is of essence, leaving rates too low for too long or too high has dire consequences for the economy. Unless the federal fund rate is at zero, the Taylor rule is the best predictor of future policies.

With the globalization and interconnection of economies throughout financial markets, the Fed will have to take into account shocks outside its jurisdiction. Future studies could be conducted to determine the impact of external shocks on the U.S. monetary policy, determine the channels in which they affect policies. An interesting topic would also be incorporate financial markets in the model on monetary policy and determine the affect financial markets have on monetary policy.

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Appendix

90's Crisis:

Table 12: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	FF target rate	**5,8750**	**28**	**1,65901**	**,31352**
	F2	**6,539286**	**28**	**2,5301280**	**,4781492**
Pair 2	FF target rate	**5,8750**	**28**	**1,65901**	**,31352**
	F2(0,6-0,4)	**5,962857**	**28**	**2,8435175**	**,5373743**

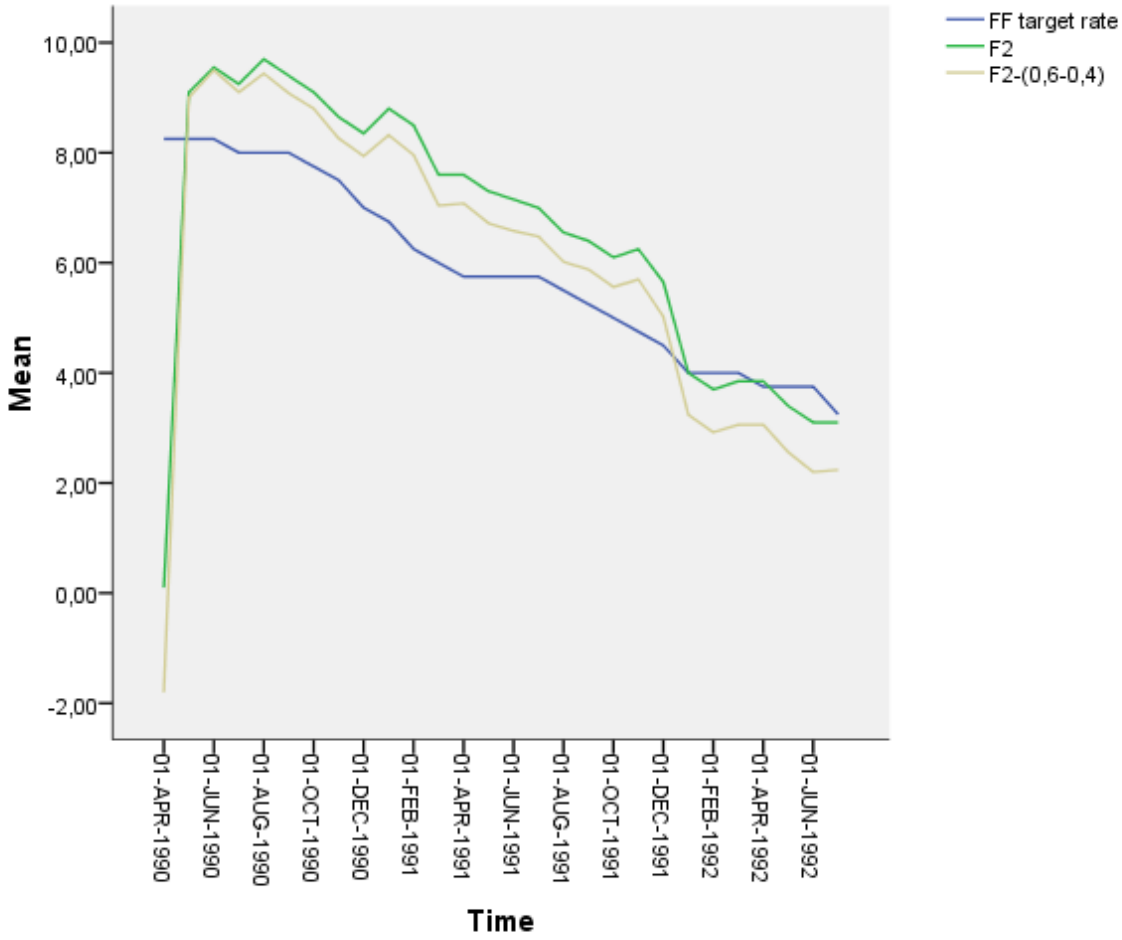
Table 13: Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	FF target rate & F2	**28**	**,663**	**,000**
Pair 2	FF target rate & F2(0,6-0,4)	**28**	**,837**	**,000**

Table 14: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	FF target rate & F2	**-,6642857**	**1,8947226**	**,3580689**	**-1,3989824**	**,0704110**	**-1,855**	**27**	**,075**
Pair 2	FF target rate & F2(0,6-0,4)	**-,0878571**	**2,1978396**	**,4153526**	**-,9400904**	**,7643761**	**-,212**	**27**	**,834**

Figure 6: FF vs. F2 vs. F2 (06-04)



Dotcom Crisis

Table 15: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	FF target rate	**3,7500**	**24**	**1,92664**	**,39327**
	F2	**5,0563**	**24**	**1,22858**	**,25078**
Pair 2	FF target rate	**3,7500**	**24**	**1,92664**	**,39327**
	F2(0,6-0,4)	**5,0358**	**24**	**1,44848**	**,29567**

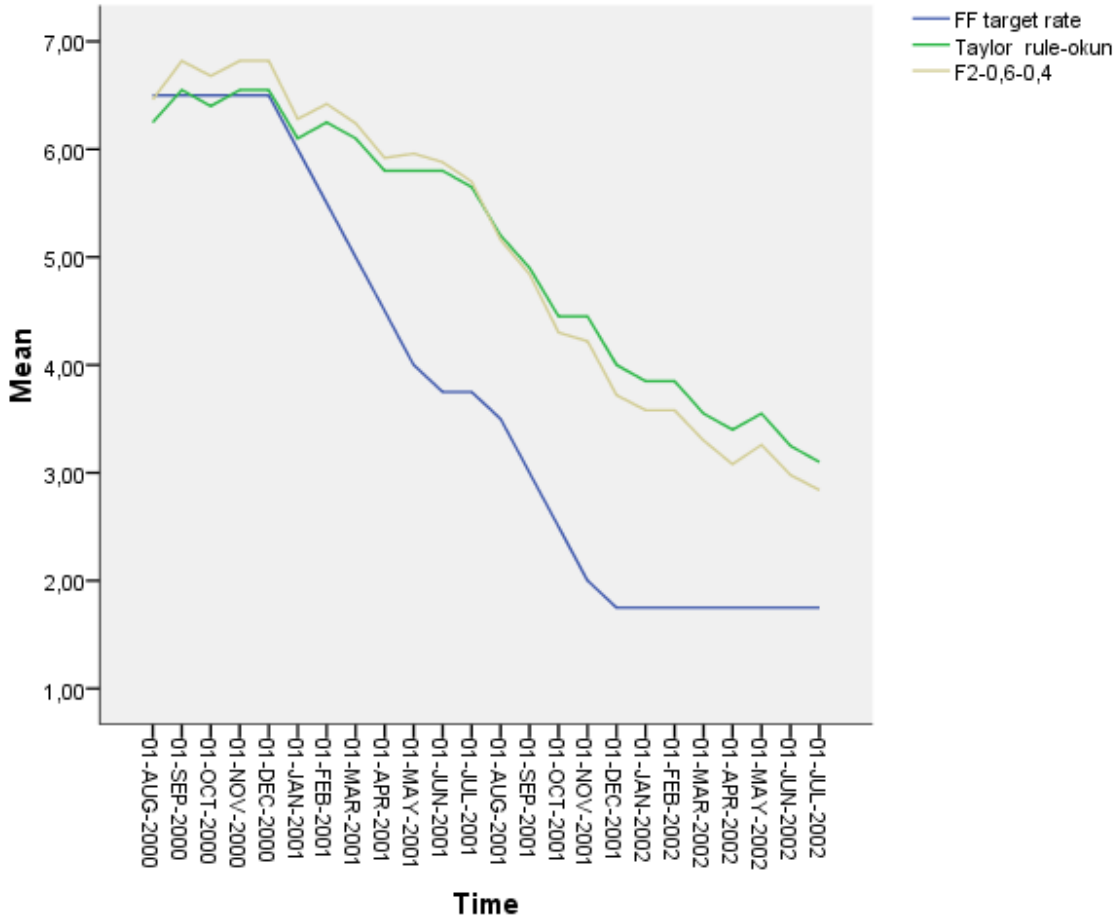
Table 16: Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	FF target rate & F2	**24**	**,736**	**,000**
Pair 2	FF target rate & F2(0,6-0,4)	**24**	**,952**	**,000**

Table 17: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	FF target rate & F2	**-1,306**	**,86267**	**,17609**	**-1,67052**	**-,94198**	**-7,41**	**23**	**,000**
Pair 2	FF target rate & F2(0,6-0,4)	**-1,285**	**,70282**	**,14346**	**-1,58261**	**-,98906**	**-8,96**	**23**	**,000**

Figure 7: FF vs. F2 vs. F2 (06-04)



Global Financial Crisis

Table 18: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	FF target rate	**,7290**	**20**	**,82609**	**,18472**
	F2	**-,7025**	**20**	**3,00799**	**,67261**
Pair 2	FF target rate	**,7290**	**20**	**,82609**	**,18472**
	F2(0,6-0,4)	**-1,6130**	**20**	**3,48095**	**,77836**

Table 19: Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	FF target rate & F2	**20**	**,763**	**,000**
Pair 2	FF target rate & F2(0,6-0,4)	**20**	**,919**	**,000**

Table 20: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	FF target rate & F2	**1,43150**	**2,26832**	**,50721**	**,36989**	**2,49311**	**2,822**	**19**	**,011**
Pair 2	FF target rate & F2(0,6-0,4)	**2,34200**	**2,74137**	**,61299**	**1,05900**	**3,62500**	**3,821**	**19**	**,001**

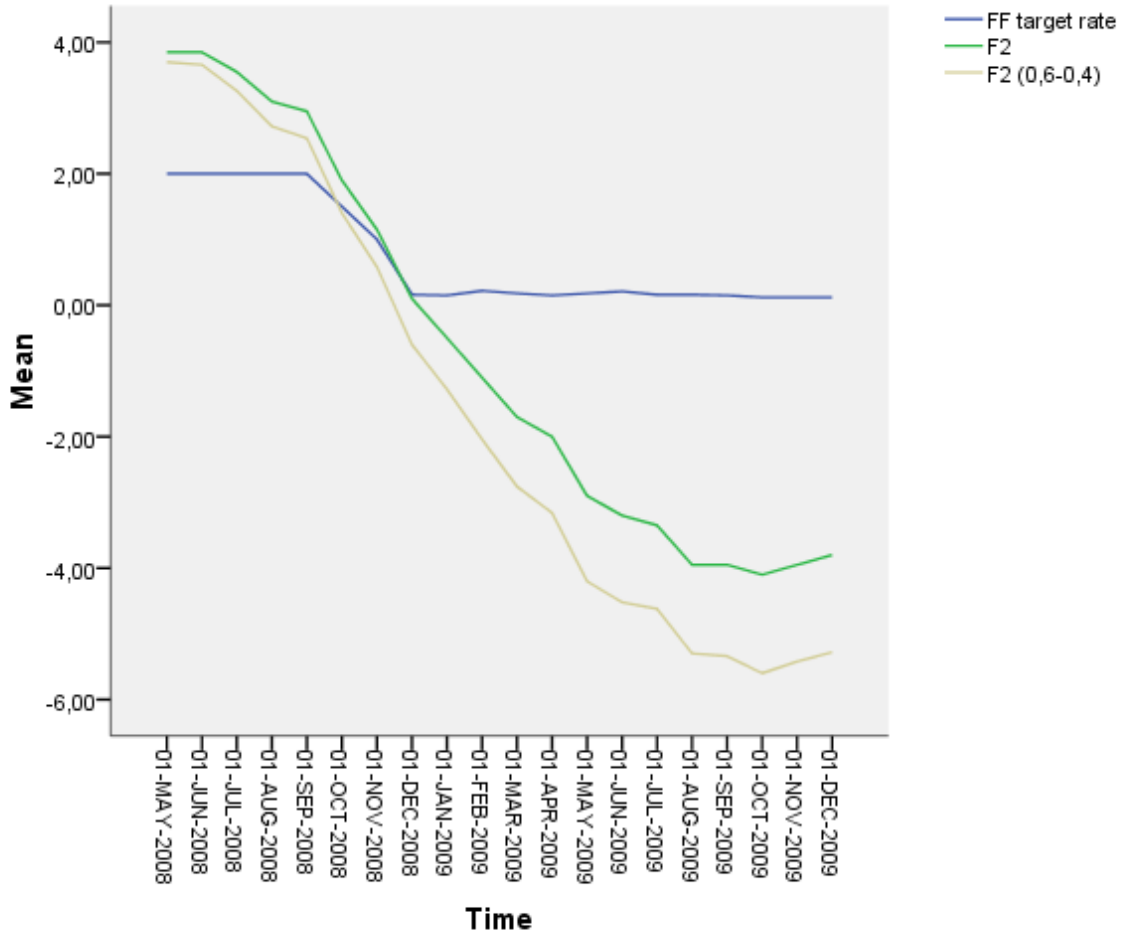



Figure 8: FF vs. F2 vs. F2 (06-04)