A modelling analysis of monetary policy rule

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Abstract — This paper employs a quarterly time series to determine the timing of structural breaks for interest rates in USA over the last 60 years. The Chow test is used for investigating the non-stationary, where the date of the potential break is assumed to be known. Moreover, an empirically examination of the financial sector to check if it is positively related to deviations from an assumed interest rate as given in a standard Taylor rule. The empirical analysis is strengthened by analysing the rule from a historical perspective and look at the effect of setting the interest rate by the central bank on financial imbalances. The empirical evidence indicates that deviation in monetary policy has a potential causal factor in the build up of financial imbalances and the subsequent crisis where macro prudential intervention could have beneficial effect. Thus, my findings tend to support the view which states that the probable existence of central banks has been one source of global financial crisis since the past decade.

Key words: Taylor rule, Financial Imbalances, Central Banks.

I INTRODUCTION

The practice of central banking has developed during the last 60 years in a way that affected their ability to target both economic growth and inflation through their effect on short interest rates and/ or growth of monetary and credit aggregates (McCallum, 1999), thus leading to the formulation of a number of simple reaction functions spanning the evolution of the monetary-policy framework. This last was consistent with the Taylor-type rules (Taylor, 1993) which showed that US monetary policy after 1986 was well characterised by a rule for the Federal Reserve's interest rate, whereby the interest rate responds with fixed, positive weights to inflation and the output gap. (Judd & Rudebusch, 1998) found as well that the Taylor rule reproduces the evolution of Federal Reserve funds rate on the basis of quarterly US Data over the 1987-1992 periods.

As a standard reference, modern central banks have relied increasingly on Taylor's conception on the formulation of monetary. First, the use of such models as documented in (Asso, Kahn, & Leeson, 2007) evolved from a long intellectual history that debated the merits of rules versus discretion [(Mccallum, 1988), (McCallum, 2000), (Goodhart, 1988, 1994), and (Taylor, 1999)]. Second, the practice comes from its simplicity, intuitiveness and focus on short-term interest rates as the instrument of monetary policy, which simply relates the policy rates directly to the goals of monetary minimizing fluctuations in inflation relative to its objective and output relative to potential output. Instead of forecasting employment, the Fed used to state its policy objectives in terms of economic growth and price stability, because of their effect on employment through what is called the Okun's law 1962 (Thornton, 2012).

The rule has been subsequently developed in a theoretical and empirical perspective in order to perform the original models and to optimize the monetary policy guidance. Thus, leading to the formulation of different versions which span the evolution of monetary policy; including econometric estimates of the coefficients for the United States by [(Judd & Rudebusch, 1998), (Clarida, Gali, & Gertler, 2000)] extended versions for the standard equation by imputing financial condition indexes, use ex-ante data to estimate the policy rule instead of ex-post (revised) data, or range from a simple monetary policy to a backward-versus forward looking. The debate is about how the objectives of monetary policy should be expended to include financial variables in order to reduce (or prevent) financial crisis.

A. Problem of the Research

The common second area of central bank responsibility is financial stability. But easy monetary policies did indeed lead to excessive credit growth that eventually bred this issue, claiming that central banks policies contribute to the build-up major imbalances.

Feedback instrument rules involve line causality between mechanical deviations in the level of the policy rate from systematic or rule-like behaviour to deviations of inflation from its target, and of output from its potential. Such deviations are identified as a potential cause for the occurrence of global imbalances, which are perceived as an important factor in the financial crisis. The literature has not reached yet consensus in this issue. In this study, there is evidence of a multiple structural breaks in the behaviour of interest rates based on political factors allowing the instability, which is in turn correlated with the monetary regime switches.

B. Research Question

The present work departs from the literature and the hypothesis and builds its analysis on two areas. Basically, an estimate of the backward-looking Taylor rule for United States with constructed variables with statistical techniques was taken into consideration. This procedure will answer the following questions: is the Fed reacting differently to levels of inflation and output above or below the target? Does the Fed attempt to hit the macroeconomic target or keep some margin of fluctuations? What about the timing of structural breaks in regressions? The linear specification of the Taylor rule has been extended with the financial indexes to check if the Fed is still reacting to the macroeconomic aggregate as to the information contained in the index.

Similarly, an application of a linear model took place where the presence of deviation in the policy rate is taken into the structure of the model. The principal objective in this area is to test the presence of ruptures in the monetary policy, whether or not such shifts occur at politically important times (e.g. near elections, with changes of party of administrations, FOMC decisions… etc.). The secondary objective is to question if the monetary policy contributes to financial imbalances.

Obviously, this paper is organised as follows:

The first section covers a construction of the variables to be used. Besides that, the second section includes econometric specifications and empirical estimates of the policy rule for different periods in the U.S presidency (the terms of Arthur Burns and William McChesney-Martin (1955-1978), the terms of Paul Volcker (1970-1987) and the terms of Greenspan and Bernanke from 1987 to date): For each period, rupture on the coefficients on output and inflation was estimated. Additionally, the third section discusses possible explanations of the findings, and finally the fourth section concludes.

II LITTERATURE REVIEW

There is of course a vast literature on monetary policy which includes financial variables to forward guidance, and finds evidence of strong linkages (transmission mechanisms) between monetary policy and financial conditions. Indeed, one of the most important issues facing central banks is their capability of correctly identifying bubbles in real time in order to justify leaning against the bubble, or prevent crisis. In (Bernake & Gertler, 2000), the issue is how to respond to **variability** in asset prices. This model incorporates non fundamental movements in asset prices into a dynamic macroeconomic framework. Authors found that it is neither necessary nor desirable for monetary policy to respond to changes in asset prices, except to the extent that they help to forecast inflationary or deflationary pressures. In (Bernanke, Gertler, & Ghilchrist, 1999) authors helped to clarify the role of credit market frictions in business fluctuations using a DSGE model. They argued that changes in credit market conditions might affect the intrinsic costs of borrowing and lending, which is associated with asymmetric information and might run financial crisis within a financial accelerator mechanism. Moreover, (Filardo, 2001) examined the macroeconomic performance of an economy where the central bank usually responds to changes in forward-looking inflation information contained in asset price inflation. The monetary policy rule is substituted by the IS-PC-AP system of equations, which is simulated with random numbers representing shocks to output, consumer price inflation, and asset price inflation. The coefficients of the model are then chosen to minimize the central banks loss function L. The view of using these asset prices to improve economic outcomes is not promising. The price inflation of housing shows some power to predict the future inflation, but stock market price inflation exhibits no power in the prediction of the future consumer price inflation. Finally, the monetary authorities should not respond to asset prices if there is any considerable uncertainty about the macroeconomic role of asset prices (if they cannot distinguish between fundamental and bubble asset price behaviour). Also, (Castro, 2008) analyzes the possibility of the rule to be augmented with financial conditions index containing information from some asset prices and financial variables. Therefore, the results indicate that the monetary behaviour of the Federal Reserve of the United States can be well described by a linear Taylor rule. It also suggests that the Fed is not reacting to the financial conditions.

Policy actions following financial crisis in which central banks just clean up after the bubble are not without risks. What has been missing in this debate so far is the possible evidence which can reveal if the central bank is the one which contributes itself to financial crisis.

A. Hypothesis:

Uncertainty in the monetary policy as claimed by Bernanke had increased in recent decades, giving rise to the volatility of interest rates as well as exchange rates. According to (FOMC, 2009), "members noted the possibility that some negative side effects might result from the maintenance of very low short-term interest rates for an extended period, including the possibility that such a policy stance could lead to excessive risk-taking in financial markets or an un-anchoring of inflation expectations." According to the subprime crisis, the drastic change in the monetary policy stance had let to a sudden raise in the US subprime mortgage market.

H_1: Structural changes in the monetary policy stance have a significant impact on the money conditions (bank lending), related forecasts, and consequences on the volatility of the financial markets linked to it.

III METHODOLOGY

This study is concerned with the impact of deviations in interest rate on asset price inflation and output. The standard Taylor rule along with the modified version which contains looking variables is proposed, and later estimated on (Batini & Haldane, 1999). The following forms of panel regressions are estimated, where *i* represents the interest rate.

A model of possible deviation from a simple linear model was stated previously in this study. As originally described, the rule requires knowledge of only the current inflation rate and the output gap. Using Quarterly report data, a series of robustness checks and tests of the effectiveness of simple financial ratios were performed, being considered as predictors in respect to future financial crisis and analyse the impact of the deviations on financial turbulences. It is expected to find a relationship between dynamics in monetary policy decisions and financial imbalances, the mean that the Fed strategy is likely to contribute to financial crisis. In this article, imbalance is defined as a persistent deviation in asset prices from historical trend on a variety of financial indicators (credit supply, liquidity growth, financial asset prices).

The following forms of panel regressions are estimated, where *i* is the nominal interest rate, (π_t) inflation rate over the previous year, $(y_t - y^*)$ the per cent deviation of the logarithm of the real GDP (y_t) from estimate of the logarithm of its

unobserved potential level (y^*) and ε_t is a white noise error term.

The rule sets the level of the nominal federal funds rate (i_t) being equal to a natural rate that is seen as consistent with full employment (originally defined as ($i^* = 2$)), plus the inflation rate over the previous year (π_t), plus an equally weighted average of two gaps: (a) The four quarter moving average of actual inflation less a target rate (π^*), and (b) the output gap.

Generally, a brief description of the theoretical model is provided, which in turn refers to the original specification introduced by (Taylor, 1993). Although there is no consensus about the size of the coefficient of policy rule; (Taylor, 1993) assumed that the weights the Fed gave to deviations in inflation and real GDP from trend same coefficient equal to 0.5, and the equilibrium real interest rate and the inflation target equal 2%. The generalized form of the rule has been considered in order to suggest an interest rate feedback rule that describes the US monetary policy over 1955 to 2012 (the frequency is quarterly). The model takes the following form:

$$i_t = i^* + \pi_t + \alpha_\pi(\pi_t - \pi^*) + \beta_y\,(y_t - y^*) + \varepsilon_t$$

A measure of output gap, potential output, inflation and equilibrium real rate plays an important role on policymaking and is useful before proceeding to any monetary analysis. (See the Appendix 1 for details on data construction). Note that the slope coefficient on inflation in the equation is: $(1 + \alpha_\pi)$; hence the two response coefficients are: $1 + \alpha_\pi$ and β_y. Also, note that the intercept term is: $i^* - \alpha_\pi \pi^*$.

[(Clarida, Jordi , & Mark, 1998), (Orphanides, 2001), (Rudebusch, 2002) and (Castelnuovo, 2003)] are followed by including an interest rate smoothing parameter in order to avoid excessive movements in the aggregate variables subsequent to sudden and frequent change in interest rate. The Interest rate equation is entered with a lag of one quarter. Moreover, the equation is assumed to relate interest rate to lag in output gap (Orphanides, 2001) as shown in equation 2:

$$fi_t = r^* + \pi_t + \alpha_\pi(\pi_t - \pi^*) + a_y Y_t + \delta(L)Y_{t-1} + \gamma(L)fi_{t-1} + \varepsilon_t$$

In another term:

$$fi_t = r_t^* + \pi_t^* + \alpha_\pi(\pi_t - \pi^*) + a_{y1}Y_t + a_{y2}Y_{t-1} + fi_{t-1} + \varepsilon_t$$

Then, (Kahn, 2009) was followed by including financial ratios into the interest rate reaction function. Kahn found a statistically significant influence of the interest rate on financial ratio. While, (Svensson, 2003) argued that adding variables could increase the explanatory power of the rule, leading to an optimal rule in this context. This issue has been the centre of a large discussion in the literature: as some authors consider important that central banks target asset prices ((Cecchetti, Genberg, Lipsky, & Wadhwani, 2000) (Borio & Lowe, 2002), (Borio, 2005), (Goodhart & Hofmann, 2002 (Chadha, Sarno, & Valente, 2004), others disagree (Bernake & Gertler, 2000) and (Bullard & Schaling, 2002). A model of possible deviation from a simple linear model is presented.

$$fi_t = r_t + \pi_t + \alpha(\pi t - \pi) + a_{y1}Y_t + a_{y2}Y_{t-1} + fi_{t-1} + Bankindex_1 + Bankindex_2 + Bankindex_3 + Bankindex_4 + Liquidityindex + Liquidityindex(-1) + \varepsilon_t$$

The following forms of panel regressions are estimated, where (i, t) indicates respectively the loan type and time index, thus the results indicate that the Fed deviates from the interest rate target and does not pursuit the pre-announced or defined targets. This is considered an interesting result that might help in understanding part of the story behind financial crisis.

It is worth stating that the reaction function-based assessments of US monetary policy are so sensitive to the chosen potential output and inflation target which can be unreliable. Therefore, one should be careful when interpreting such variables. Orphanides argues that the Taylor rule is sensitive to the choice of the variables and the period, which may result in reaching to a different policy. The implementation is then considered to be far from being simple (Orphanides, 1997, 2001) To start with estimating variables, they are classified as follows:

A. Determining r^* and π^*

For the construction of the USA inflation objectiveπ^*, the U.S. Federal Reserve System has no official inflation target. Upon this, the HP filter technique is used to determine inflation trend. The appropriate measure of natural real interest rate because it is consistent with stable inflation and output equal to potential. (NRR) r^* for the united-states over history also presents some difficulties: r^* is likely shifting all the time (contain time subscripts because they may be time-varying). However, the policymaker took a stand where the average r^* will be over some time period. For simplicity, we set its level at 2% as it was assumed in the Taylor rule.

B. Determining i_{taylor}

The interest rate setting in the USA using annual data is analysed from 1955 to 2012. Since there was no single policy interest rate, we used short-term money market rates, i_t as a measure of the stance of monetary policy.

C. Determining y^* and $(y - y^*)$

Calculating y^* is problematic indeed. The most common in the literature is the use of Linear trend (Taylor, 1993), a quadratic trend (Clarida, Jordi , & Mark , 1998), or a Hodrick Prescott filter (Taylor, 1999).

In this paper, a structural definition of potential GDP is used which is in turn developed at the (CBO, 1995). The output gap is measured as the percentage difference between real GDP and the estimate of its potential level. In macroeconomic terms, potential output is defined as a sustainable output, that is, the level of real GDP is consistent with a stable rate of inflation (CBO, 2003, 2004). It is denoted as y^*, and the associated gap is shown in figure 1 in the appendix 2.

Clearly, the construction of the output gap seems difficult since potential output is not observed. (Orphanides, Porter, Reifschneider, Tetlow, & Finan, 2000), (Orphanides, 2001) shows that the central bank can make large and persistent mistakes in the estimation of potential output in response to productivity and cost shocks. The output estimates has an ineligible consequence on policy behaviour and inflation dynamics. Theoretically, it should provide information regarding future inflation. (Orphanides & Van Norden, 2003).

Several techniques have been traditionally used to estimate the potential output, which is usually identified as the output trend as reported at (CBO, 2004). (Taylor, 1993) simply fitted a line through log-levels of real GDP over a short sample period (1984 Q1 to 1992 Q3) as a proxy for potential output. One can also fit trends to lag factor-input and multifactor productivity data and plug these trends into an estimated production function (see CBO, 2004).

Given the applied focus of the paper, the first section profile statistical de-trending methods considered in this paper for estimating potential output:

1) The linear method
2) Moving average
3) The Hodrick-Prescott filter (The HP filter, a purely statistical method, was also used to estimate potential output and the natural rate of interest).

It is worth stating that the MA filtering, the HP filter, and the Beveridge and Nelson decomposition are often used to extract the trend from GDP directly. Indeed, the main evidence is that the HP filter methodology outperforms all models.

1. The output gap using a linear regression method.

The simplest method considered; which was used until the early 70's, involves a linear regression of (the log of) real GDP on a constant and a time trend. So, the trend in (the logarithm of) output is well approximated as a deterministic function of time, given by: $y_t = \alpha + \beta.t + \varepsilon_t$ (1)

The residuals ε_t from the regression equation provide a measure of the output gap, and y_t is the chosen measure of output (in logarithms). This method builds on the basis of an assumption that the GDP can be decomposed into the sum of a slowly evolving secular; which is classified as cycle c_t, and a transitory deviation from it; τ_t which is a linear function of time.

The results from the estimated equation are given in appendix 2. In figure 1 in appendix 2, the graph of actual and potential output is shown. In the beginning of the 1915s and throughout most of the 1920s, output was above its potential level. From 1960 until 1980, the output exceeded potential output, to later approach the fitted value after 1980.

2. MA filter

The second method, which is today's statistical filtering, assumes that the logarithm of output can be decomposed into a cyclical component c_t and a trend component τ_t, $y_t = c_t + \tau_t$ Where τ_t, is the moving average of the output.

Transform output series by a centred moving average of order 2p+1 is given by:

$$\tau_t = \sum_{i=-m_1}^{m_2} \theta_i y_{t+i} = \theta_{-m_1} y_{t-m_1} + \theta_{-m_1+1} y_{t-m_1+1} + \cdots + \theta_{m_2} y_{t+m_2} \quad (2)$$

Where, $\sum_{i=-m_1}^{m_2} \theta_i = 1$; $m_1 \geq 0, m_2 \geq 0$

3. The Hodrick-Prescott filter

Another method to calculate the trend in real share prices uses the Hodrick-Prescott filter (Hodrick & Prescott, 1997) (henceforth, HP). Time series are decomposed into a trend, a cycle, and a noise that is, $y_t = c_t + \tau_t + \varepsilon_t$

Based on this, the filter is given by the equation (3) where the trend m_t is the result of the following optimization problem:

$$\min_{\{g_t\}_{t=-1}^{T}} [\sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=1}^{T} [(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})^2]] \quad (3)$$

In the case of a HP filter, one also has to choose a value for the "penalty" parameter λ, which determines how smooth a trend can be. The larger the value of λ, , the smoother the growth component, and the greater the variability of output gap. A smaller value indicates a smaller importance of cyclical shock and yields a more volatile series of output gap. The larger the value, the more growth component approaches a linear time trend.

In this article, λ is set at 1600, as suggested in literature for quarterly time series (Hodrick & Prescott, 1997) also (Ravn & Uhlig, 2002), (Baxter & King, 1995), and (Backus & Kehoe, 1992) gave similar justifications..The result extracted from this method shows a large positive swing in output gap during 1950s, in the 1980s and recently (2006-2008). However, the HP filter has remained popular because of its flexibility in tracking the characteristics of the fluctuations in trend output and its simplicity in the economic literature.

IV DATA

Dataset were quarterly at the source and included the short-term interest rate (fedf) commonly used as the monetary policy instrument, the real GDP (RGDP), and the consumer price index (CPI). To generate the output gap we used the HP filter with a smoothing parameters settled on the standard value of 1600 as suggested previously in the literature. That is, □ = 100 × (ln RGDP - GDP POT). The CPI, is used to measure inflation that is, □□□ = 400 × ln (CPI) - ln (CPI).

Real-time data for the CPI and real GDP growth were respectively obtained from Bureau of Economic analysis and Bureau of Labor Statistics.

In a further step, all variables except the interest rates; measured in percent, were transformed into their fourth order log-difference form to ensure stationary given the existence of unit root in their level forms, that is, (log Xt – log Xt-4).

Similarly, the following individual asset prices have been considered: the real stock market price (RSP), the real housing price (RHP) and exchange rates (ER), a measure of financial conditions *proxied* by the financial conditions index (Goodhart & Hofmann, 2000) as an extension of the monetary conditions index, representing a linear combination of interest rates and exchange rates, to include housing and stock prices, and a broad credit aggregate. The latter represents alternatively the three categories of the balance sheets of all commercial banks in the United States: Real Estate Loan (Real_LN), consumer loans (Cons_LN), Commercial and industrial loans (Bus_Loans) and Bank credit (Inv_LN). [The model includes the variables comprised in the table 5. Other variables would be subject to a macro prudential supervision.Some credit booms could be identified as a key factor behind financial crises.

Total credits are used as an early warning indicator for systemic banking crises. The indicator used here is the credit-to- GDP and it's backward looking long-term trend (calculated by using a HP filter). To start with the calculation of the

deviation which was done from a trend (Figure 1 to 8) and a proxy of the threshold beyond the gap of credit to its long-term trend (the credit boom) gave a certain episode of financial crisis in the sample. Specifically, by comparing the financial destabilizing effects of excess liquidity versus credit growth, such global excess liquidity (household and business) are argued to be more significantly correlated to an economic bubble (house price bubble, financial bubble…). Accordingly it is more appropriate to study the impact of the leverage expansion rather than excess liquidity.

Based upon that, a broad measure of excess liquidity of banks is applied which measures the gap between the growth of the money supply and the demand for the narrow money (M0) defined as the ratio (M0/GDP) in a long-term horizon. Liquidity ratio enters the equation with a lag of one quarter to capture possible past effect of the variable on the interest rate. Panel constructed equations are estimated using the OLS estimator.

V RESULTS AND ANALYSIS

Based on the results in Tables 1, 3 and 4, the primary results of the analysis are as follows. First, consider the LS model, column 2 in table 1 presents the results of Taylor rule original version. The results show a positive significant relation between deviation in interest rates and deviation in inflation rates and output gaps variable from stance. In accordance with the main hypothesis, these results suggest that central banks tend to accord more importance to inflation rather than the output gap. Having this result confirms the empirical evidence from the literature.

Second, the Chow test (1960) for structural change in the same regression model was used with a known couple of break dates: 1970, 1979, 1987 and 2006; associated with the move of the U.S. presidential election (See Table 2). As indicated, the most major structural break in this series (indicating a significant change in both the intercept and the slope) over the period 1955-2011 occurred during the late 1970s (Table 3). This particular break may be attributed to the gradual effects of several policy changes during this time, including: (i) Deregulation in the financial industry under Volcker government (Monetary Control Act of 1980). (ii) Expansionary monetary policy stance employed by the Fed (iii) and the innovation that took hold on increasing the credit market which is associated with the functioning of the economy. All of these elements tends to decrease risk aversion over the long term and influenced on the nearly development of **systemic** crisis.

Concerning the augmented version model, it was found that credit indicators would enhance central bank performance (Table 4). To be more precise, I found that there is a positive significant relation between interest rates and all credit ratios. However, the interest rate response to credit ratios is lower than the two conventional objectives. This highlights the Federal Reserve assistance to the credit bubble: The private sector demand responds to easier monetary conditions and may shift their credit origination toward riskier borrowers.

A. Regression results

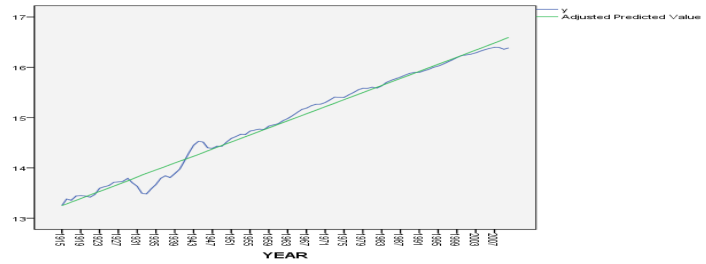

Figure 1: Potential GDP vs. actual based on linear regression estimates

R	R Square	Adjusted R Square	Std. Error of the Estimate
,993[a]	,987	,986	,11489

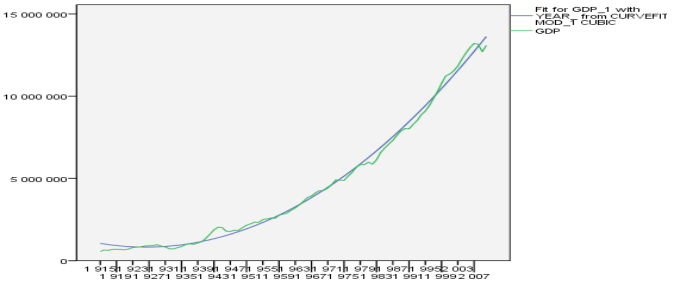

Figure 2: Potential GDP vs. actual based on MA

Model Summary and Parameter Estimates

Dependent Variable:MA(GDP,5,5)

Model Summary

	R^2	F	df_1	df_2	Sig.	Cst	b1	b2	b3
Eq. Cubic	**,997**	12,71 1,724	2	89	,00	4.44E +12	- 3,459,871 ,785	,00	,311

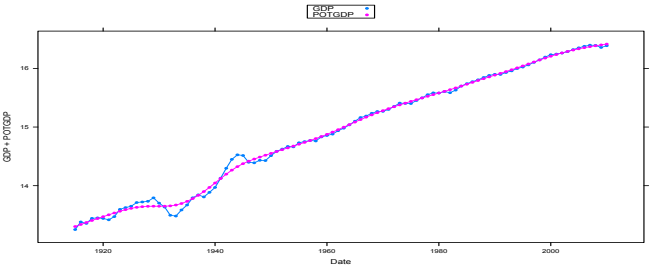

Figure 3: Potential GDP in log terms vs. actual based on HP filter estimate

1) lm (i ~ p + y)
2) **Model estimates:** where significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 and residual standard error: 2.933 on 93 degrees of freedom.(1 observation deleted due to missing)

Residuals:

Min	**1Q**	**Median**	**3Q**	**Max**
-6.0113	-1.9225	-0.4232	1.3605	11.1068

	Estimate	Std Error	t	Pr(>| t|)
(Intercept)	**0.07322**	1.1256	0.065	0.948275
p	**1.31745**	0.3372	3.907	0.000177 ***
y	**0.51222**	0.73975	0.692	0.490391

VI CONCLUDING RESULTS

The findings which declare that the monetary policy regime might have changed in significant ways over time, tend to have implications on financial stability. As drawn by the relationship between persistently low policy rates—measured by Taylor rule deviations—and financial variables- it is derived from examining the correlation and lead-lag relationships between Taylor rule deviations and financial crisis from 1955 to 2012. By responding to the inflation, this should help the central bank's ability to respond to financial disruptions that do arise. Since systemic crisis often occur at low level of inflation, when investment booms and rapid credit expands, the money created could provide the fuel of financial bubbles. Moreover, stated evidences show that the Federal Reserve Bank is not targeting the financial conditions in certain periods, so the lack of consideration to financial markets might be one of the causes of crisis such as the recent credit crunch that started in the United States. I conclude that the recurrence of financial crisis has its roots in the fact that lenders offer increasingly money and lead to a higher-risk borrowers comportment. In my view, the most important challenges to monetary policy related to structural change in this recurrent crisis episode arise from possible changes in political atmosphere. Being a causal factor for a number of recessions and degradation in economic and social conditions affecting human beings, fluctuations in interest rate policy are a significant problem in the study as we suppose. Nowadays, the recurrence of financial crisis is at a very high rate in the United States and across the world as reported by the (BIS, 2009). Unless radical changes in the US monetary policy are applied, the United states will face another one in the near future that are assumed to be more systemic because of financial innovations (securitizations, derivatives, etc.); see for example (Allen & Carletti, 2006), (Rajan, 2005), and (Sveiby, 2012) among many others who assess the systemic effects of financial innovation.

Table 1: What can Taylor rule say about monetary policy in United-States over the period (1955:1-2012:4)?

	-1	*p value*	Std. Error	-2	*p value*
Inflation-∏	0.18*** (3.57)	0.0004	0.050644	0.59*** (8.07)	0
Output gap	0.27*** (8.50)	0	0.032242	0.34*** (6.60)	0
ff(-1)	0.71*** (19.39)	0	0.036473	0.042*** (3.42)	0.0007
∏	0.30*** (7.77)	0	0.038269	1	
r	0.29*** (6.30	0	0.046511	1	
Adj. R2	0.95			0.88	
Log Likelihood	-254.83			-364.32	
HQC	2.28			3.2	
Mean dep. var	5.300173			5.300173	
S.D dep var	3.473406			3.473406	

Source: *Author calculation* (Eviews) /Table for LS regression

Table 2: Presidents of the United States of America over the period (1955-2012)

9th	**1951–1970**	William McChesney Martin	Q2, 1951 to Q1, 1970
10th	**1970–1978**	Arthur F. Burns	Q2, 1970 to Q1, 1978
11th	**1978–1979**	G. William Miller Pr	Q2, 1978 to Q3, 1979
12th	**1979-1987**	**Paul Volcker**	**Q4, 1979 to Q3, 1987**
13th	**1987-2006**	Alan Greenspan	Q4, 1987 to Q1, 2006
14th	**2006 -**	Ben Bernanke	Q2, 2006-

Table 3: Structural changes by Chow test

H_0	H_1	Statistics F	p-value	Results
1955-2012	[1955:1-1970:1:]$_{(1)\text{ and}}$ [1970:2-2012:4]$_{(2)}$	3.195	0.0244**	Structural break in 1970
1970-2012	[1970:2-1979:3] and [1979:4-2012:4]	4.072	**0.0077*** **	**Break in 1979**
1979-2012	[1979:4-1987:3] and [1987:4-2012:4]	3.798	0.0110**	Break in 1987
1987-2012	[1987:4-2006:1] and [2006:2-2012:4]	2.767	0.0426**	Break in 2006

Source: *Author*/Eviews

Common values of significance level (p-value) below which the null hypothesis will be rejected are 5% and 1%.

Table 4: Taylor rule augmented with financial variables, liquidity and credit (1955 :1-2012 :4)

	-3	*p value*	Std. Error
Inflation-∏	0.58*** (8.21)	0	0.07
Output gap	0.32*** (5.73)	0	0.055
ff(-1)	0.04*** (3.07)	0.0024	0.014
$Bankindex_1$	-0.007*** (-2.93)	0.0038	-2.93
$Bankindex_2$	0.008*** (2.03)	0.0431	0.004
$Bankindex_3$	0.0098*** (2.91)	0.004	0.003
$Bankindex_4$	0.012*** (3.88)	0.0001	0.003
Gap_DJ	0.0003*** (1.92)	0.0559	0.0002
M_0/PIE	-29.47 (24.16)	0.2238	24.15628
M_0/PIB(-1)	-28.01 (24.88)	0.2614	24.87837
Adj. R^2	0.89		
Log Likelihood	-350.25		
HQC	3.18		
Mean dep. Var	5.3		
S.D dep. Var	3.47		

Table 5: Independent variables summary

Variables	Definition	Sign (expected)	Source
$Bankindex_1$	1947Q1 2012Q4 // bankratio1=loaninv-loaninvtrend	+, High	*Federal Reserve Bank Author calculations Data are quarterly, in billions $.*
$Bankindex_2$	1947Q1 2012Q4 // bankratio2=consloan-consloantrend	+, Average	Ibid.
$Bankindex_3$	1947Q1 2012Q4 // bankratio3=busloan-busloantrend	+, Average	Ibid.
$Bankindex_4$	1947Q1 2012Q4 // bankratio4=mortgloan-morgtloantrend	+, Average	Ibid.
M_0/PE	Monetary base as percentage of gdp.	High	Federal Reserve Bank of St Louis.
Gap_DJ	Asset price gap represented by the Dow Jones *(the HP filter is used to calculate the trend).*	High	S&P Dow Jones Indices LLC › Dow Jones Averages.

APPENDIX: Figures and tables from this article

Appendix 1

Table 1: Data

Definitions	Source
Output Gap is the proportional deviation of real GDP from its long-run trend (Hodrick & Prescott, 1997) smoothing parameter = 100.	Real Gross Domestic Product obtained from (Johnston & Williamson, 2013) for 1789 to present.
The inflation gap is obtained by taking the difference between actual and target inflation. The Fed does not have an official target rate; therefore we determine the trend inflation using the HP filter, and we redefined the inflation gap as the difference between actual inflation (percentage change in the log of the GDP deflator expressed at an annualized rate) and trend inflation.	GDP deflator obtained from (Johnston & Williamson, 2013) for 1789 to present.
i_t is measured by the commercial paper rate for the years 1879-1914 and by the federal funds rate for the years 1954-2010.	Federal Reserve Bank of Saint Louis (Louis)

Table 2: Summary of Crisis

Crisis Type	Threshold	Period	Maximum
Inflation	An annual inflation rate 20% or higher. We also examine separately the incidence of more extreme cases where inflation exceeds 40% per annum	1500-1790 1800-1913 1914-2006	173.1 159.6 9.63E+26
Currency Crashes	An annual depreciation versus the US dollar (or the relevant anchor currency) of 15% or more.	1800-1913 1914-2006	275.7 3.37E+09
Currency debasement Type I	A reduction in the metallic content of coins in circulation of 5% or more.	1258-1799 1800-1913	-56.8 -55.0
Currency debasement Type II	A currency reform where a new currency replaces a much depreciated earlier currency in circulation	The most extreme episode in our sample is the 1948 Chinese conversion at a rate of 3 million to 1	

Appendix 2

As a first step of the study it is useful to briefly review the data. In the following figure the inflation and interest rates move closely together in the period under consideration. This suggests the presence of one nominal trend. The inflation rose at the end of the 1980s, declined continuously from 1990 to 1998 and increased from 1999 to 2000 before falling again. Both the short and long term interest rate move in similar ways, with the exception of a peak in 1995 that followed a tightening of monetary policy in the US. The Dow Jones Industrial Average provides a view of the US stock market and economy. Originally, the index was made up of 11 stocks; it now contains 30 component companies in various industries. Figure 6 shows an annual time series of the U.S. Real market over the period 1915 the 2010. There is a clear trend. But in addition the earlier part of the figure marked cyclical behaviour as the economy moves from boom to recession; that's why it is important to add a cyclical component in a model for USA GDP.This evidence leads us to the 1920s, a period which marked the birth of modern central banking in the United States. Moreover, at this time the Fed was fairly independent from the government (see). The properties of the series change after the end of the Second World War and illustrate another aspect of economic and social time series that don't remain over time. The first 14 points and the last 72 points after 1945 are the layer at the bottom of the figure and suggest an orderly market. The remainder clearly reflect the subsequent turmoil in this market. The model we will examine is with an addition of a log trend as used in Taylor (1993)

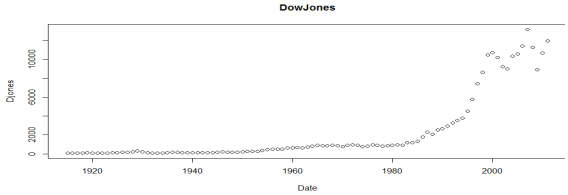

Figure 4: Dow Jones
Source: FRED economic data. Federal Reserve Bank of St Louis.

The Dow Jones Industrial Average provides a view of the US stock market and economy. Originally, the index was made up of 11 stocks; it now contains 30 component companies in various industries

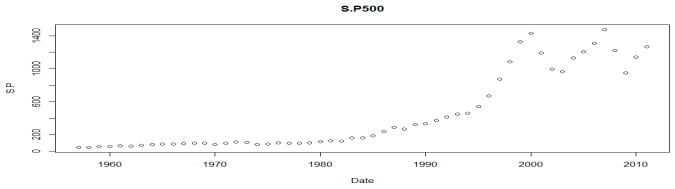

Figure 5: S&P 500

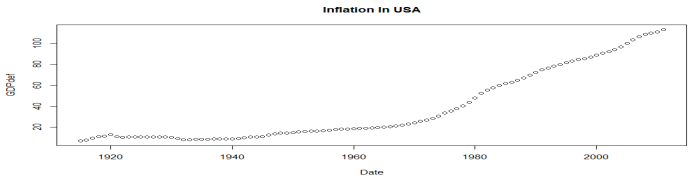

Figure 6: Inflation in USA (GDP deflator)

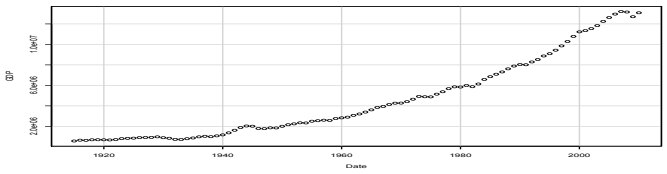

Figure 7: U.S. Real market

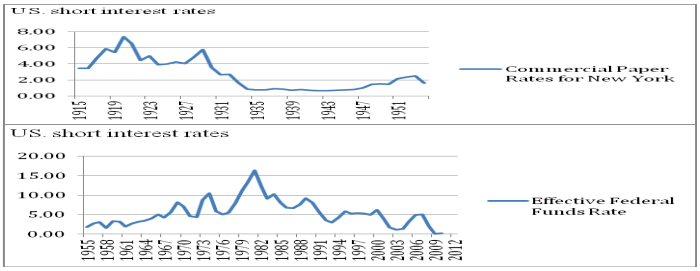

Figure 8: US. Short interest rates
Source: Federal Reserve Bank of St Louis

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