Fear of depression - Asymmetric monetary policy with respect to asset markets

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Fear of depression and asymmetric monetary policy with respect to asset markets

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Summary
The paper suggests that during Greenspan's incumbency the *fear of depression* caused the Federal Reserve to lower interest rates rapidly when asset price developments suggested a crisis potential. Whereas, when asset markets were growth-supporting, it did not raise interest rates. This asymmetry contributed to a downward-trend in interest rates which pushed US interest rates down to zero in the current crisis.

Keywords: Fear of depression, Monetary policy, Taylor rule, Asset prices.
JEL: E52, E61.

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1 Introduction

In times of financial turmoil monetary policy responses are of special interest for the academic community. This was especially the case after the Asian crisis 1997/98, when the Bank of Japan (BoJ) cut interest rates down to zero. In the US, first the bursting dot-com bubble in 2000 and now the subprime market crisis justified sharp interest rate cut to stabilize markets, which now brought world interest rates close to zero. In this regard, an increasing number of authors argue that in the past interest rates were not increased symmetrically when markets stabilized and boomed. Accordingly, interest rates remained too low for too long. This provided low-cost liquidity to flourishing markets (Belke et al. 2008, Taylor 2008, Schnabl and Hoffmann 2008, Weber 2008). The aim of this paper is to test for asymmetric monetary policy with respect to asset markets as described by these authors.

Especially in the aftermath of the dot-com bubble reactions, previous research brought up the question of whether asset prices have an impact on monetary policy decisions. While Rigobon and Sack (2001) and Dupor and Conley (2004) find evidence for monetary policy reactions of the Federal Reserve (Fed) towards asset markets, Fuhrer and Tootell (2004) find the opposite. The evidence remains unclear. This is similar to the results of the studies that test for reactions towards asset markets in the euro area. Here, Botzen and Marey (2006) and Belke and Polleit (2006) challenge Bohl et al. (2004, 2006) in showing that monetary authorities adjusted interest rates following changes in the dollar/euro exchange rate and stock markets. However, monetary policy decision parameters may vary for different time periods taken into account.

While these papers test for a symmetrical reaction of central banks towards asset price changes, little research focuses on whether a *"fear of depression"* may trigger asymmetric interest rate behavior in certain periods. In order to close this gap, the analysis in this paper applies the methodology of Danne and Schnabl (2008). They show that due to a *"fear of* *appreciation"* against the dollar the BoJ lowered interest rates in appreciation periods in the 90s to support growth. However, it did not increase interest rates in depreciation periods to the same extend to keep the economy competitive. Thus, the BoJ systematically lowered interest rates until they reached the zero bound.

The paper is organized as follows: In section 2 I discuss different monetary policy frameworks to give an overview how they have changed over time and to help derive the reasoning for taking asset prices into account for monetary policy. In section 3, the prospect theory is applied to provide an explanation for asymmetric interest rate setting behavior. In section 4, tests are carried out to determine whether the Fed, reacted asymmetrically towards positive and negative deviations of asset market developments. Section 5 concludes.

2 Monetary policy and asset prices

2.1 From money to inflation targeting

Monetary policy frameworks have changed over time. Traditionally central banks in advanced economies tried to achieve price stability by broad money targeting. Broad money targeting as proposed by Milton Friedman (1956), is based upon *"the quantity theory of money"*. According to this theory, money growth is the ultimate source of inflation – in the long-run. It is based upon Fisher's equation that sets changes in broad money equal to changes in output plus inflation, under the assumption that the velocity of money is constant. Therefore Friedman (1956) proposes that broad money growth should not exceed output growth plus an agreed rate of inflation.

Building upon this concept, the Deutsche Bundesbank saw M3 growth within a corridor of four to six percent as inflation neutral. Similarly, the European Central Bank (ECB), standing in the tradition of the Bundesbank, introduced a two-pillar strategy including a monetary pillar for its interest rate decisions. The ECB formulated a goal for money growth of 4.5 percent. However, since the 1990s broad money has grown at annual rates of ten percent in the advanced economies.

With inflation holding steady in the 1990s, despite broad money grew rapidly, many authors question the relation of money to inflation. For instance De Grauwe and Polan (2005) show that, in the short term, differences in money growth among countries cannot explain differences in their inflation rates. Money demand, being the reciprocal of the velocity of money, is widely argued not to be constant over time – especially in the US.[1] Fluctuations of GDP growth, credit demand as well as the stock market also affect money demand (Carpenter and Lange 2003).

As money demand is unstable, Estrella and Mishkin (1997), Gerlach and Svensson (2002) and Stock and Watson (2002) argue that money growth is not a good indicator to predict future inflation. Instead, they propose current inflation and output as indicators to forecast future inflation. Furthermore, Alesina et al. (2001) and Begg et al. (2002) find that monetary targets restrict liquidity, even if inflation rates are stable. Therefore they argue that money growth is not only a bad inflation forecast, but also has a negative impact on growth. As consumer price inflation seems to be a more reliable monetary policy target than broad money growth, these authors propose inflation targeting frameworks (Alesina et al. 2001, Begg et al. 2002, Gali 2003, Bernanke and Mishkin 1997, Estrella and Mishkin 1997, Mishkin 2000, Svensson 1999, 2002 and Gerlach and Svensson 2002).

The New-Keynesian models of optimal monetary policy focus on interest rate rules to explain how the central banks should adjust the nominal interest rate in response to changes in inflation and output. These rules are based upon that of Taylor (1993). According to these models, stabilizing inflation also stabilizes output and employment (Woodford 2003). Thus,

[1] For the euro area, Brüggemann (2000), Clausen and Kim (2000) and Coenen and Vega (2001) find that money demand is stable in the long-term.

the interest rate is the main operating target to control consumer price inflation. Furthermore, secondary goals (e.g. output) can be stimulated by lower interest rates as long as consumer price inflation is stable (without reference to money growth). Money growth is only considered via the secondary pillar of the ECB. The Fed no longer publishes any data concerning M3 growth.

2.2 Asset markets and monetary policy

A newer strand of literature finds that liquidity expansions have a positive impact on asset prices (Aladid and Detken 2007, Bagus 2008, Borio 2008). They argue that additional liquidity creation first pours into the real estate and stock market rather than into consumer prices. In this sense Rigobon and Sack (2004) and Bernanke and Kuttner (2005) find that interest rate decisions have an impact on the US stock market. While Bohl et al. (2007) emphasize that (unexpected) interest rate cuts increase stock prices in the euro area, Greiber and Setzer (2007) find evidence for a bidirectional relation between money growth and the US and European housing market. Equally, Goodfriend and Hofmann (2008) find multidirectional links between money growth and house prices to have increased after 1985.

Asset prices again, have an impact on the output of an economy. For instance Bernanke and Gertler (1999, 23) explain that positive stock market developments can improve a company's balance sheets and reduce its risk premium. By reducing risks escalating asset prices make lending cheaper, thus backing investment and growth. Furthermore, bull markets go along with higher consumption expenditures of households, as wins increase the income of an asset holder. Increasing output and consumption, asset prices can turn into inflation in later periods. Roffia and Zaghini (2007), Belke et al. (2006) and Aladid and Detken (2007) show periods of monetary expansions are followed by inflation, if asset prices increase beforehand.

This interrelation of asset prices, output and monetary policy is the reason for an academic discussion about the inclusion of asset prices into monetary policy decisions. On the one hand, Filardo (2001) and Polleit (2005) argue that monetary policy shall respond towards asset market developments if they contain information on future inflation or output. Johnson (2001, 180-182) proposes to include further measurable (forward-looking) indicators in the monetary response function, for instance foreign exchange, bond and commodity market developments. To prevent future inflation and instability, this strand of literature emphasizes the need for central bank reactions in order to smooth asset market developments (Lowe 2002, Borio et al. 2003, Borio 2008, Cecchetti et al. 2000 and White 2004).

On the other hand, Bernanke and Gertler (1999) argue that there is no need to take asset markets into account at all as they are already considered via the output and inflation channel. In this sense, Blinder and Reis (2005) want the Fed not to intervene when asset market developments are friendly for the economic performance, because the Fed is not a market player. They fear the Fed cannot judge correctly whether there is exuberance. However, a bursting stock market bubble may cause instability. Accordingly, monetary policy should react with respect to bursting bubbles. Otherwise it should remain passive (Blinder and Reis 2005, 67).

Similarly Mishkin (2007, 40) explains that confronting bubbles is not the task of a central bank. However, monetary authorities should respond quickly after a bubble has burst to better the outcome for the economy. As American central bankers widely agree on this issue, this position is also known as *Jackson Hole Consensus*. By proposing interest rate cuts when bubbles burst, but not wanting interest rates to rise in boom periods, the *Jackson Hole Consensus* implicitly proposes an asymmetric behavior towards asset market developments.

3 Asymmetric monetary policy with respect to asset markets

3.1 The fear of depression

While the bidirectional relation of money growth and asset markets as well as the inflationary tendencies or the growth-support argument of hiking asset prices and exchange rate stabilization may be reasons to include asset markets into monetary policy decisions, this does not explain asymmetric behavior. The Prospect Theory of Kahneman and Tversky (1979) may provide a rationale for asymmetric monetary policy reactions towards asset markets as proposed in Blinder and Reis (2005). The theory offers an explanation for decision making under uncertainty by modelling real life choices instead of optimal choices.

In short, according to the prospect theory, decision makers go through two phases: In the editing phase the problem is analyzed and possible decisions are considered. For possible decisions, the possible outcomes and probabilities are evaluated. The decision is made in the second phase. Here, the outcome of a decision is taken into account relative to a reference point, set by the decision maker. Outcomes above the reference point are wins and outcomes below are losses. Due to risk aversion the subjective absolute value of an outcome above the reference point is lower than that of one under the reference point.

However, risk aversion is asymmetrical. While in loss situations, decisions are rather risk friendly, in win situations they are risk averse. Furthermore, the theory implies that losses influence decisions more than wins. Kahneman and Tversky (1979) show that fair bets, with a possible loss and win of x and a probability of 50 percent for each, are not attractive. Here, loss sensitivity is greater than that of wins. Therefore, more effort is put into avoiding losses. Additionally, extreme outcomes with small probabilities have more weight in decision making than the probability for the output suggests.

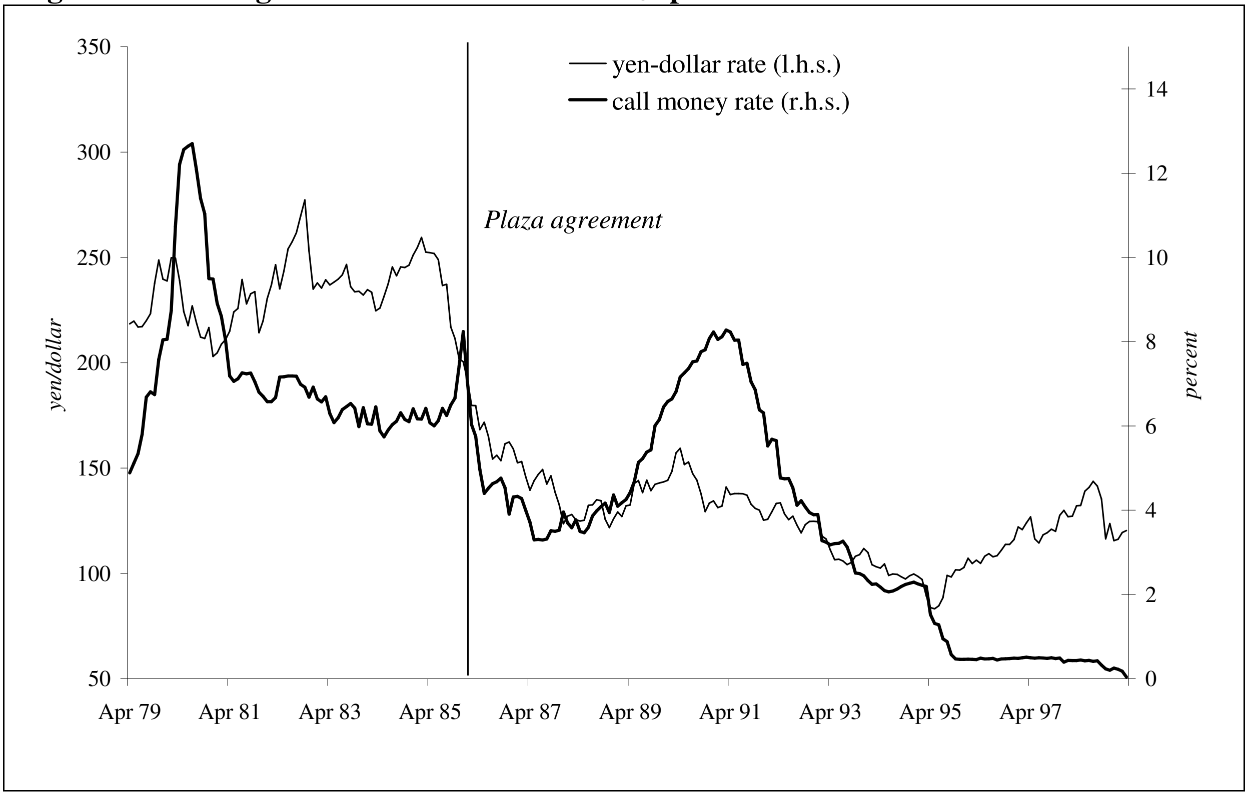
I apply this theory to the interest rate decisions of the Fed with respect to asset markets to explain asymmetric behaviour in accordance with the *Jackson Hole Consensus View*. It is assumed that the Fed can influence future growth and inflation via interest rate decisions. If asset prices play a role for interest rate decisions, the Fed would react less sensitive to deviations from trend that support growth as long as inflation remains low. Gains are perceived relatively too small (reference point). However, the Fed would react sensitive towards negative deviations that may have a negative impact on growth (loss sensitivity).

Further, as in the US a stock market crash brought about the Great Depression in 1929, decision makers hesitate to intervene and to stop asset market bubbles. They do not want to cause a crash. This is a sign of risk aversion in the boom. On the contrary, the Fed cuts interest rates heavily with respect to a negative asset market deviation from trend to keep the economy from losses. Here, the Fed is rather risk friendly as heavy interest rate cuts may also contribute to future inflation. The possibility of a severe *depression* due to a stock market crash is overestimated in the loss function (extreme outcome).

Danne and Schnabl (2008) empirically analyze asymmetric monetary policy behavior with respect to exchange rate changes for the BoJ. Figure 1 provides an intuition for an impact of the foreign exchange market on interest rate decisions, in particular after the Plaza agreement when the US forced Japan to appreciate its currency to reduce its current account surplus (up to 1995). As indicated by Figure 1 exchange rates and interest rates have developed very much alike from 1985 to 1995. This was the time when Japan appreciated its currency which was assumed to be negative for exports and growth. Whereas, when the yen depreciated, the BoJ did not raise interest rates.

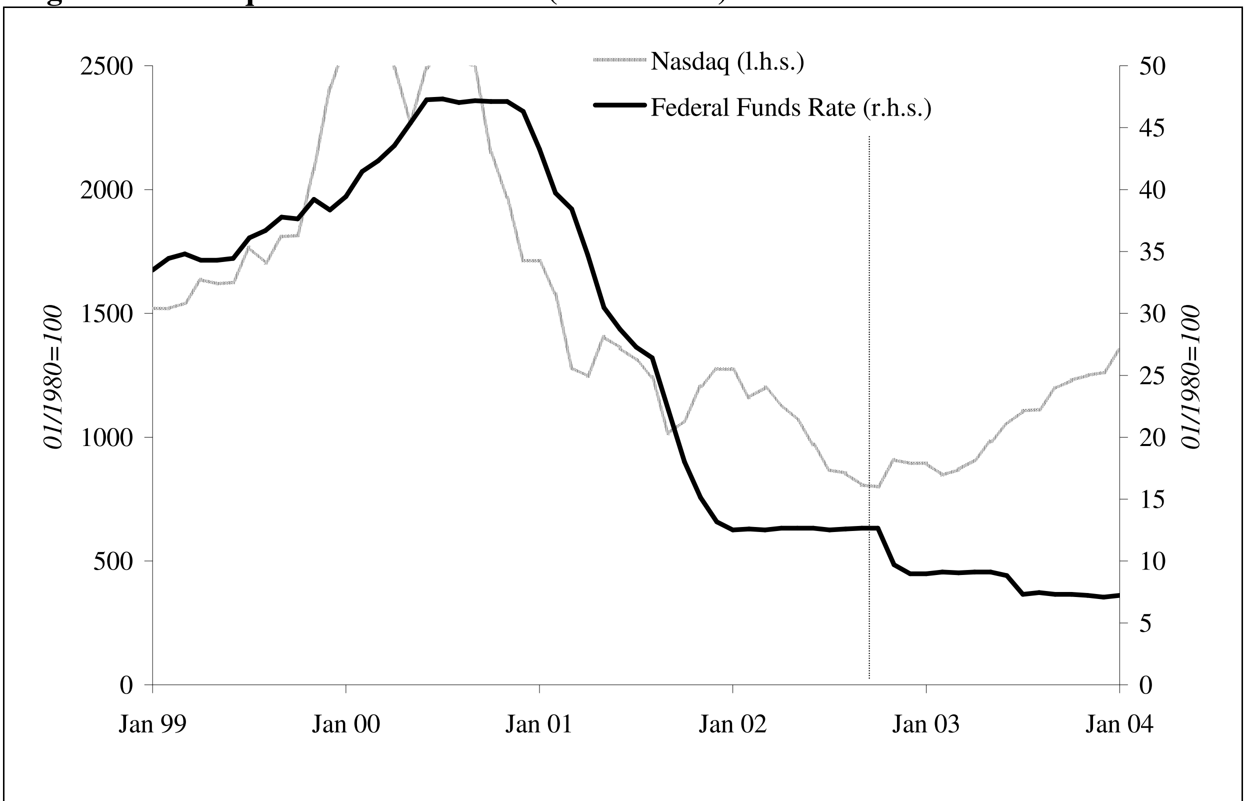
Furthermore, Schnabl and Hoffmann (2008) argue that the US Fed reacted with strong interest cuts following the burst of the dot-com bubble in 2000, whereas when markets calmed down in 2002 the Fed did not increase interest rates as it lowered them in response to the bubble to keep the economy growing. Instead, from mid 2002 up to 2004 the Fed further cut interest rates although asset prices increased (Figure 2).

Figure 1: Exchange rate and interest rates in Japan 1979 to 1998



Source: IMF, IFS 2009.

Figure 2: Nasdaq and Fed Funds Rate (1999 – 2004)



Source: IMF: IFS 2009.

3.2 The model

To test for *fear of depression behavior* and asymmetric monetary policy decisions with respect to asset markets, I use a monetary policy function based on Clarida et al. (1998, 2000):

$$i_t^* = \bar{i} + \beta(E[\pi_{t+12}|\Omega_t] - \pi^*) + \gamma(E[y_t|\Omega_t] - y_t^*) \quad (1)$$

Equation (1) shows the decision parameters for the central bank to set its nominal interest rate i_t^* in time t. The decision depends on the gap between optimum rates of inflation π^* and expected inflation π_{t+12} (twelve periods ahead) as well as optimum output y_t^* and the actual output gap y_t. Because future inflation and output are not observable in time t, expected values have to be used that depend on information availability. Thereby E indicates the use of expected values. Ω_t stands for the information available in time t. The coefficients β and γ weight the importance of inflation and output gap for setting the nominal interest rate. John Taylor (1993), who introduced the Taylor rule approximated β to be 1.5 and γ to be 0.5 in the US.

Finally the decision depends on the natural rate of interest $\bar{i}$, which is the interest rate where inflation target and output target are at the desired level. Then, the inflation and the output gap is zero. In contrast to Taylor (1993), the policy rule proposed by Clarida et al. (1998, 2000) is a forward-looking rule.[2] It uses future variables for monetary policy decisions. The rational behind the use of future variables is that there is a certain time needed for inflation and output developments to follow interest rate decisions. Therefore central banks

[2] Bohl et al. 2004 states that forward-looking rules best describe monetary policy behavior.

have to anticipate what happens in future and follow a forward-looking rule, rather than using past developments (Bernanke 2003).[3]

Following Bernanke and Gertler (1999, 25-26), Dupor and Conley (2004, 26) and Botzen and Marey (2006, 9) I have to explicitly take asset markets into account in the reaction function, when arguing that asset market developments affect interest rate setting themselves, instead just via the future inflation and output channel. To include asset markets into the decision, I extend the policy rule by the deviation of asset market developments p_t from their optimum path p_t^*. As in previous literature the augmented Taylor rule changes to:

$$i_t^* = \bar{i} + \beta(E[\pi_{t+12}|\Omega_t] - \pi^*) + \gamma(E[y_t|\Omega_t] - y_t^*) + \delta(p_t - p_t^*) \qquad (2)$$

An expectation or uncertainty parameter is not needed for asset prices, as they are known at any time t. Additionally, Clarida et al. (1998, 7-8) introduce interest rate smoothening into the reaction function, as interest rate settings depend on the level of the interest rate in the past. The economic reason behind it is that central banks do not set rates randomly as sudden interest rate adjustments shock markets and signal instability.

$$i_t = (1-\rho)i_t^* + \rho i_{t-1} + v_t \qquad (3)$$

With ρ being a parameter between 0 and 1. The closer ρ is to 1 the higher the degree of interest rate smoothing. The error term v_t is assumed to be normally distributed. Next we

[3] "Because monetary policy influences inflation with a lag, keeping inflation under control may require the central bank to anticipate future movements in inflation and move preemptively. Hence constrained discretion is an inherently forward-looking policy approach." Bernanke at the Annual Washington Policy Conference of the National Association of Business Economists, Washington, D.C. on March 25, 2003.

define $\alpha = \bar{i} - \beta\pi^*$, replace i_t^* by the augmented Taylor rule from equation (2) and eliminate the expectation parameters. The policy rule including interest rate smoothing takes the form:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+12} + (1-\rho)\gamma(y_t - y_t^*) + (1-\rho)\delta(p_t - p_t^*) + \rho i_{t-1} + \varepsilon_t \quad (4)$$

with

$$\varepsilon_t = -(1-\rho)\left(\beta\left(\pi_{t+12} - E\left[\pi_{t+12}|\Omega_t\right]\right) + \gamma\left(y_t - y_t^* - E\left[y - y_t^*|\Omega_t\right]\right)\right) + v_t$$

capturing the unobserved forecast variables and the error term v in time t.

However, equation (4) only allows for a test of an active response towards asset market deviations from their trend. If the Fed reacted accordingly, interest rates would be symmetrically raised and lowered for positive and negative deviations, respectively. When analyzing equally distributed bull and bear periods in the stock market, ceteris paribus, interest rates should oscillate around equilibrium.

This paper aims to find evidence of whether the Fed responds differently towards positive and negative asset market deviations in accordance with the prospect theory. For this purpose positive and negative asset market deviations have to be distinguished in the model. Therefore, following Tong and Lim (1980), Tong (1983) and Schnabl and Danne (2008), a threshold dummy[4] is added to equation (4). The dummy D is 0, when asset prices are above the optimum path ($p_t > p_t^*$). The dummy D is 1, when asset price deviations from the optimum path are negative ($p_t < p_t^*$). Thereby, μ represents the additional effect for monetary policy coming from asset price busts. The equation now takes the form:

[4] Tong and Lim (1980), Tong (1983) first introduced the threshold dummy for time series problems.

$$i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+12} + (1-\rho)\gamma(y_t - y_t^{*}) + (1-\rho)(p_t - p_t^{*})(\delta + \mu D_t) + \rho i_{t-1} + \varepsilon_t \quad (5)$$

with $\varepsilon_t = -(1-\rho)\left(\beta\left(\pi_{t+12} - E\left[\pi_{t+12}\middle|\Omega_t\right]\right) + \gamma\left(y_t - y_t^{*} - E\left[y - y_t^{*}\middle|\Omega_t\right]\right)\right) + v_t$.

4 Empirical Estimations

4.1 Data and methodology

To test for asymmetric behavior with respect to asset markets, I estimate equation (5). Therefore, monthly data that represents the parameters of the equations is taken from the IMF's International Financial Statistics. Industrial production replaces real GDP, due to data availability. The federal funds rate, year-over-year consumer price inflation (cpi), the all shares index (as asset price) and industrial production data from January 1957 to March 2008 is used. I do not use later data to exclude the reactions towards the current crisis which would make the sample biased. It is not yet clear, whether the Fed will raise interest rates as they have been lowered recently. From Bernanke's research output, as presented in section 2, and one would assume that interest rates should not correspond with asset market developments during his incumbency.

The output gap and asset market gap are calculated by subtracting the year-over-year log-differences of industrial production and stock prices from their trends, which is approximated by the Hodrick-Prescott filter (Bjørnland 2005).[5] At the 10 percent significance level, the Dickey-Fuller test did not identify unit roots in cpi, output gap, asset market gaps.

A two-step Generalized Method of Moments (GMM) framework is applied to estimate equation (4) and (5) as it controls for endogeneity of the parameters (Arellano and Bond 1991,

[5] Note that in equation 4 and 5 levels of the output are used to calculate the gap. However, Taylor (1993) explained in a footnote that constructing a gap from growth rates is more sufficient.

Arellano and Bover 1995). Newey West standard errors provide robust residuals. Using realized 12-month forward inflation rates and calculated output gaps in the regression to estimate equation (4) and (5) assumes that expectations of policy makers are accurate in forecasting the variables. This is the standard approach in the literature.

As widely used when estimating Taylor rules, lags of the regressors of up to twelve periods (one year) and a constant are used as instruments.[6] The impact of asset prices for future output and inflation is taken account for by including asset prices as instruments (Fuhrer and Tootell 2004, Bohl et al. 2004, 23).[7] Because more orthogonality conditions (instruments) than needed are used to estimate the parameters, Sargan (1958) and Hansen (1982) suggest a test that proves whether all sample moments are close to zero. Therefore the J-statistic must be multiplied with the number of observations. If the respective value is smaller than the critical value of the $\chi^2(p-q)$ the null hypothesis of validity of instruments is not rejected.

4.2 Estimation Results

First, I estimate equation (4). Comparing the results with previous studies shall prove the accuracy of the model. Afterwards, whether decisions towards asset prices were asymmetric by estimating equation (5). Estimating equation (4) over the whole samples produces the following estimates:

[6] See for instance: Danne and Schnabl (2008) and Dupor and Conley (2004). Botzen and Marey (2006) used less lags due to data availability. They also tested a six-month forward looking rule.
[7] The choice of instruments may be criticized as this procedure is mostly done without a theoretical backbone (Baum et al. 2002), but using lags is the standard procedure.

Table 1: GMM-Estimation of equation (4)

Sample	α	β	γ	δ	ρ
	Constant	*Inflation*	*Output*	*Assets*	*Interest rate*
1957:01 – 2008:03 Federal Reserve	0.002 (0.011)	**1.403***** **(0.274)**	**0.606***** **(0.230)**	**0.140**** **(0.069)**	**0.961***** **(0.008)**

(Standard errors in parentheses, ***,**,* denote significance at 1, 5 and 10 percent levels. Test for over-identifying restrictions: J-statistics multiplied by the number of observations was always smaller than $\chi^2(28)$).

In Table 1 α is a constant and ρ indicates the impact of interest rates smoothening. The constant remains less important. However, past interest rates had a strong impact on interest rate setting. The coefficient β for inflation and γ for the output gap is similar to those known from other papers (Clarida and Gertler 1998, Dupor and Conley 2004, Schnabl and Danne 2008); and on the same level as proposed by Taylor (1993). Inflation seems to be the most important goal and is significant at the 1 percent level. Stock prices δ have a significant but small impact on interest rates in the US.

In the next step, I estimate equation (5) is estimated, where μ represents the asymmetric term added for negative asset price deviations from the HP-trend, to test for an asymmetric behavior of the Fed towards asset markets. Due to the asymmetric term, δ only accounts for positive asset price deviations.

Table 2: GMM-Estimation of equation (5)

Sample	α	β	γ	δ	μ	ρ
	Constant	*Inflation*	*Output*	*Assets*	*A-Term*	*Interest rate*
1957:01 – 2008:03 Federal Reserve	0.028 (0.023)	**1.535***** **(0.327)**	**0.730**** **(0.300)**	-0.199 (0.312)	0.712 (0.601)	**0.967***** **(0.009)**

(Standard errors in parentheses, ***,**,* denote significance at 1, 5 and 10 percent levels. Test for over-identifying restrictions: J-statistics multiplied by the number of observations is always smaller than $\chi^2(27)$).

The coefficients for inflation and output remain at the same level and both asset market terms remain insignificant over the whole samples. Again, using exchange rates does not change the results.

However, using the whole samples suggests that the Fed's policies do not change over time. In contrast, Figures 1 only suggests that in the US the stock market played a role especially with the bursting dot-com bubble. Thus, I estimate equation (4) and (5) again for different time periods that seem to account for the phenomenon described in section 3.

Variation in the sample

Until the Volcker era the monetary policy regime was different as the dollar was the center of the Bretton Woods system. Prior to the Volcker era the Fed's chairmen did not follow a Taylor rule. They focused on fighting unemployment but did not address the inflation problem by raising interest rates. This was a period of macroeconomic instability. Hence, I chose two alternative estimation periods for the Fed, in accordance to the incumbencies of the respective chairmen of the Fed that can be argued to have followed a Taylor-rule as suggested by Taylor (1993). Period 1 represents the Volcker era ranging from August 1979 to August 1987. The Volcker era is assumed to be an era of monetary stability. The Greenspan era, including the first months of Bernanke's incumbency represents period 2 ranging from August 1987 to March 2008. First, equation (4) is estimated to control for an impact of asset price deviations on interest rate setting of the Fed.

Table 3: GMM-Estimation of equation (4) (Fed)

Sample	α	β	γ	δ	ρ
	Constant	*Inflation*	*Output*	*Assets*	*Interest rate*
1979:08 – 1987:08	**0.042*** **(0.025)**	**1.240***** **(0.503)**	**0.696**** **(0.332)**	0.070 (0.104)	**0.898***** **(0.035)**
1987:08 – 2008:03	-0.044 (0.051)	**2.855*** **(1.607)**	**2.508*** **(1.326)**	-0.018 (0.103)	**0.981***** **(0.010)**

(Standard errors in parentheses, ***,**,* denote significance at 1, 5 and 10 percent levels. Test for over-identifying restrictions: J-statistics multiplied by the number of observations was always smaller than $\chi^2(28)$).

Table 3 provides the estimation results for the different estimation periods. α is a constant. ρ indicates the impact of interest rates smoothening. Significance changes in the sub-samples. Relatively to inflation, the Fed has reacted stronger towards output after 1987. Also, inflation is less significant. In both sub-samples, asset prices do not turn out significant at the commonly used levels. Estimating equation (5) brings about different results:

Table 4: GMM-Estimation of equation (5) (Fed)

Sample	α	β	γ	δ	μ	ρ
	Constant	*Inflation*	*Output*	*Assets*	*A-Term*	*Interest rate*
1979:08 – 1987:08	-0.009 (0.045)	**1.404****** **(0.575)**	**0.575**** **(0.272)**	0.406 (0.254)	**-0.770*** **(0.457)**	**0.868***** **(0.052)**
1987:08 – 2008:03	0.011 (0.022)	**2.852***** **(0.856)**	**2.370***** **(0.703)**	**-0.778*** **(0.420)**	**1.692**** **(0.829)**	**0.974***** **(0.007)**

(Standard errors in parentheses, ***,**,* denote significance at 1, 5 and 10 percent levels. Test for over-identifying restrictions: J-statistics multiplied by the number of observations is always smaller than $\chi^2(27)$).

The coefficients of output and inflation are robust to the changes. Now, asset prices turn out to affect monetary policy during the Greenspan/Bernanke era.[8] This result is robust for different sets of instruments and other estimation methods (OLS, 2SLS, 3SLS and one-step GMM).[9]

As δ now represents the coefficient for positive asset price deviations and μ the difference to δ, when asset price deviations are negative, the total coefficient of negative asset price deviations during the Greenspan/ Bernanke period is equal to the sum of the coefficients δ and μ. In order to decide whether the cumulated coefficient is significant, its t-statistic has to be calculated as follows:

$$tstat(\delta,\mu) = \frac{\delta + \mu}{\sqrt{\operatorname{var}(\delta) + \operatorname{var}(\mu) + 2 * \operatorname{cov}(\delta,\mu)}}$$

$$tstat(\delta,\mu) = \frac{-0.78 + 1.69}{\sqrt{0.42^2 + 0.83^2 + 2 * (-0.33)}}$$

[8] Various types of asset price deviations have been used as robustness check, and brought about similar results.
[9] The two-step approach is the most common approach. But I check robustness using further methods that account for endogeneity as well as simple OLS regressions.

$$tstat(\delta,\mu) = \frac{0.91}{\sqrt{0.21}} = \underline{\underline{2.01}}$$

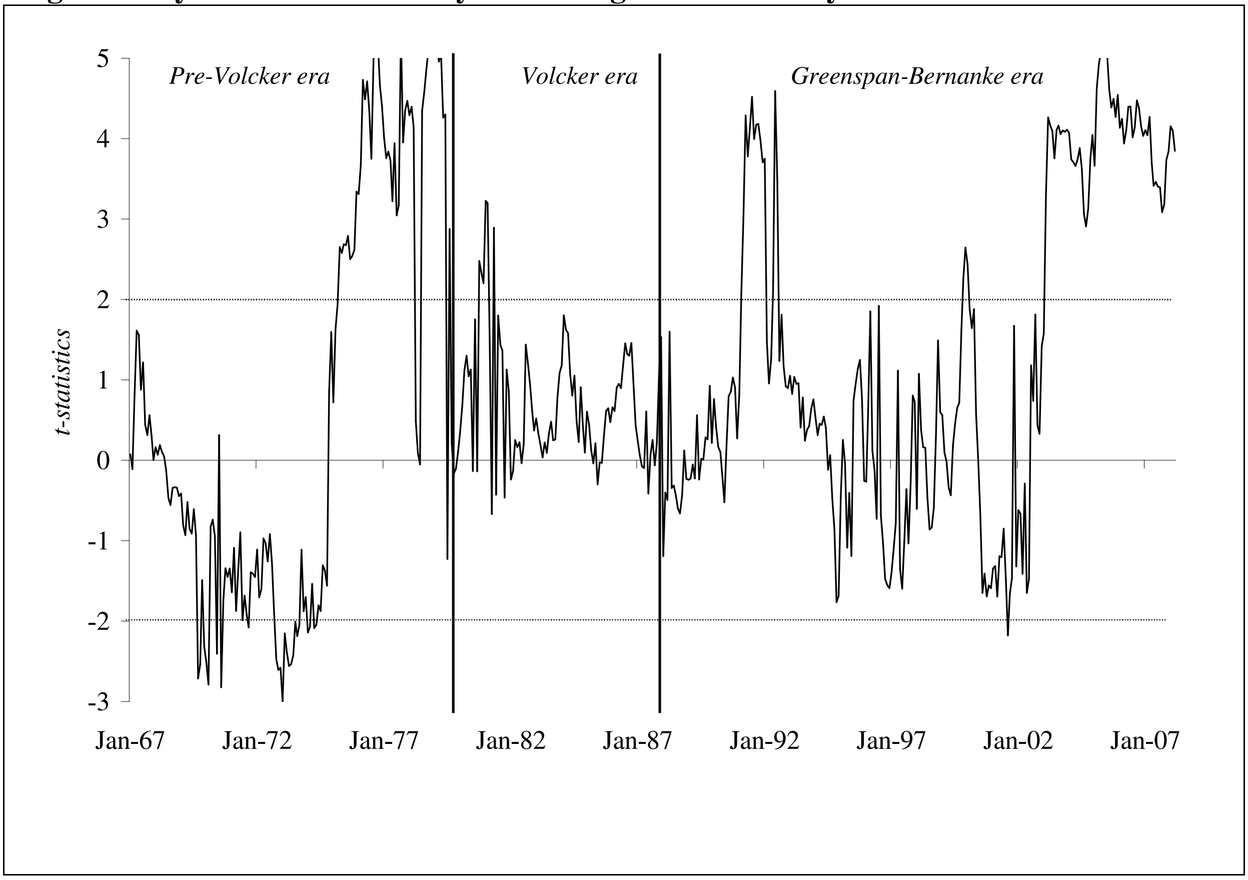
The joint t-statistic for negative asset price deviations is positive and significant at the five percent level. Therefore, the estimation of equation (5) indicates that the Fed reacted asymmetrically towards positive and negative asset price deviations since the late eighties.

Table 4 indicates that the impact of asset prices on monetary policy decisions was weak during the Volcker era, but increased when Greenspan came to power. As significance depends on the time-period taken into account, this may be a reason why Fuhrer and Tootell (2004) do not find a significant impact of asset prices on monetary policy making of the Fed.

Shifts in monetary policy goals

A rolling regression is a useful tool to illustrate these changes over time and identify structural breaks. Therefore, equation (5) is estimated as a rolling regression of a ten year moving window (120 months), starting with the period from January 1957 to January 1967 and moving forward to the period from March 1998 to March 2008. Smaller window sizes may help with checking the accuracy. They yield by far the same results, but worsen robustness due to the smaller sample size. Additionally, the gaps used in the equation have been calculated for each estimated period, to assure the estimates from multicollinearity due to the use of the asymmetric term.

Figure 3: Dynamic GMM - Ten year moving t-statistics: Asymmetric term



Note: 1.96 is the threshold for significance of five percent. The graph starts with the estimation from January 1957 to 1967 rolling forward month by month .

Figure 3 illustrates the rolling t-statistics for μ coming from a rolling regression of equation 5. As explained above, the Pre-Volcker era does not provide any evidence. Therefore significance fluctuates strongly before 1979. This changed with the incumbency of Paul Volcker as chairman of the Fed who first addressed inflation as a problem that has to be solved by raising interest rates. As the regression rolls out of the pre-Volcker era, the results change and become more stable.

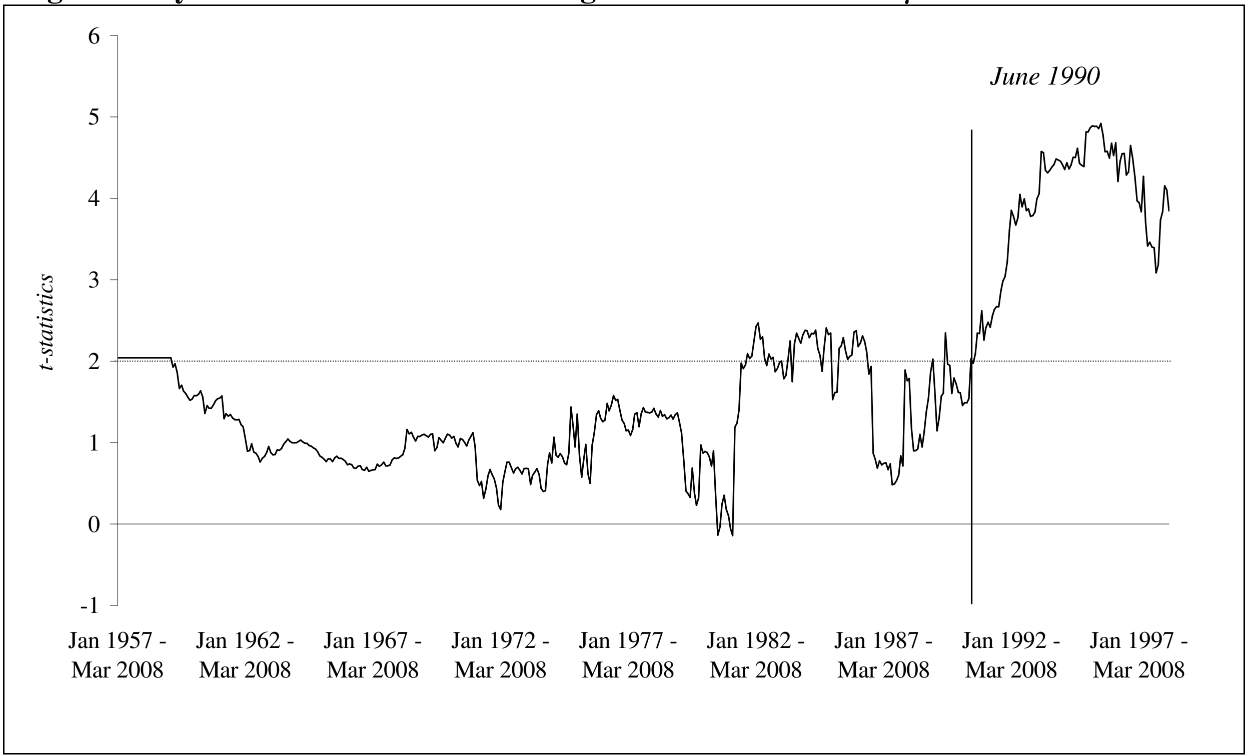
During the Volcker-era negative asset price deviations had no impact on monetary policy. The t-statistics hardly touch levels of significance. This is in line with the static estimations and implies that between 1979 and 1987 asset price deviations were not a major issue for monetary policy decisions. With Greenspan in office, this changes. First, the rolling regression implies that an asset price bust in the early nineties (the Japanese crisis 1990) had an impact on monetary policy decisions. This is in line with the explanation the Prospect theory offers. As the Japanese crisis threatened economic growth and stability, central bankers reacted towards falling asset markets during this period.

Up to the year 2000, asset prices played a minor role for the Fed. Acting according to the Prospect Theory, in this period of stabilization central bankers perceived the gains too small to respond to asset markets. On the contrary, the t-statistics change when the regression includes the period after the burst of the dot-com bubble. For the estimations starting in January 1993 – January 2003 t-statistics stay above the five-percent significance levels. As suggested by the Prospect Theory, the Fed adjusted interest rates downwards as the dot-com bubble burst. The recovery after 2003, again, had no impact on interest rate setting. In contrast, the Fed feared recession too much and kept interest rates at lower levels than suspected, even when estimating a Taylor rule that does not include asset prices (Taylor 2008).

Identifying the structural break in the Greenspan era

The rolling regression implied that with the incumbency of Alan Greenspan, asset price busts had an impact on monetary policy. As the Greenspan/Bernanke era is at the end of the sample period, it is possible to identify this shift in monetary policy (structural break) by a forward reduction of window size (recursive regression). The regression starts out estimating the whole sample, then reducing it forward month by month until only the last period, ranging from January 1998 to January 2008, is left. I find the structural break in June 1990 (Figure 4), shortly after the Japanese bubble economy burst. From then on, the asymmetric as well as the asset price term have had a significant impact on monetary policy decisions.

Figure 4: Dynamic GMM – Recursive Regression: t-statistics for μ



Note: 1.96 is the threshold for significance of five percent.

The dynamic analysis of the Fed's monetary policy reaction function indicates that interest rates have been cut in response to asset market busts, especially during the incumbency of Alan Greenspan. Whereas, when asset markets recovered after 2003, the Fed has not increased interest rates. Therefore the asymmetric term remains significant. Following Aladid and Detken (2007) and Greiber and Setzer (2007) the Fed kept interest rates low while asset markets (instead of consumer prices) absorbed this additional liquidity.[10] With inflation not picking up, the Fed tried to increase growth and consumption by further interest rate cuts. In line with the Jackson Hole Consensus and the Prospect Theory asset price hikes have not played a role for monetary policy makers after 2003. Therefore asset market developments put a downward pressure on interest rates since at least 1993, busts even more so.

[10] A DSGE-model would be able to identify the bi-directional relation of asset markets and interest rates.

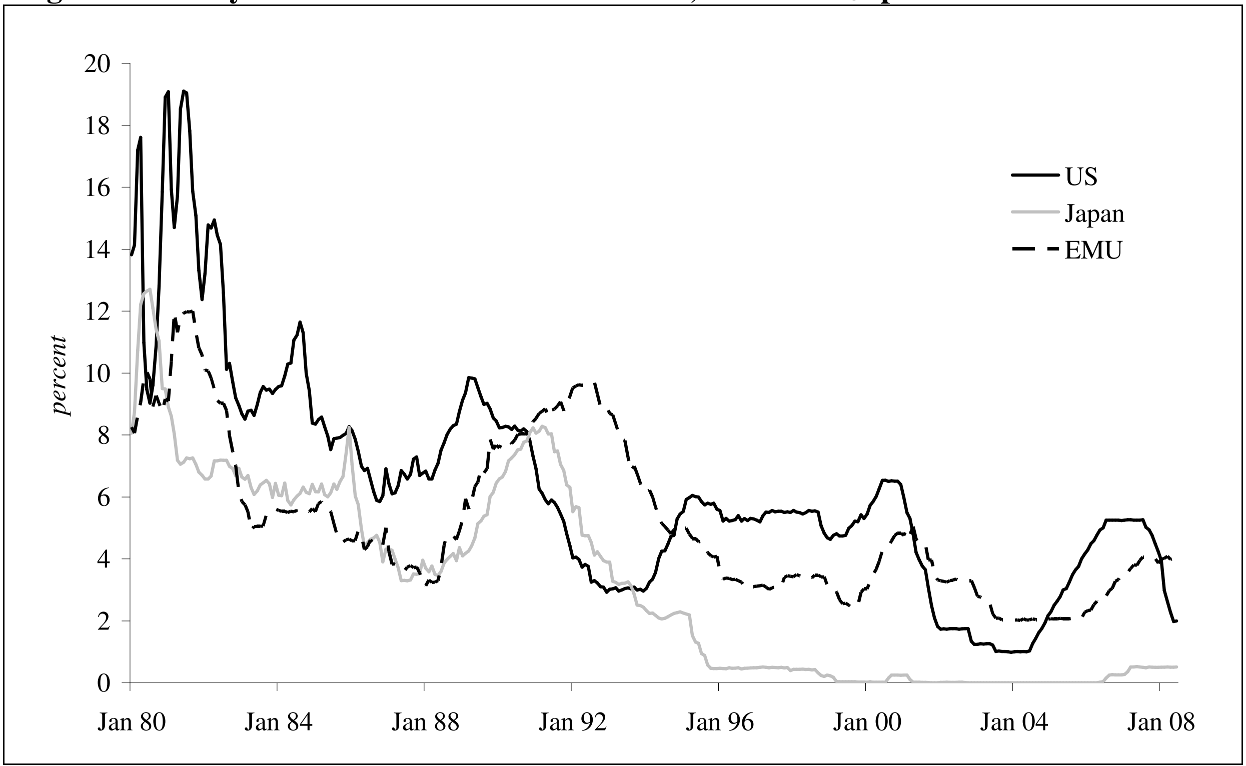
5 Economic policy implications

In this paper I have tested for an asymmetric monetary policy behavior with respect to asset markets in the US. First, the estimations provide evidence for a change in monetary policy goals and their emphasize over time as suggested in section 2. Further, asymmetric monetary policy behavior in line with the Prospect Theory could be found.

The estimation results suggest that the Fed lowered interest rates, when asset markets burst, but did not raise them when they boomed during the Greenspan era. Following the Prospect Theory this may be the case as the *fear of depression* dominates monetary policy behavior in the US. In specific, the Fed reacted asymmetrically with respect to the stock market after the dot-com bubble when interest rates were not raised in accordance with the recovery to keep the economy going.

This behavior holds some severe risks. Even though the Fed supported growth successfully and kept interest rates low, predictable interest rate cuts may cause moral hazard, as cuts may be anticipated and higher risks are taken by the market players (Illing 2007). In the light of the current crisis, this is especially true for banks that are now assured to be too important for the system to fail. Further, as the world interest rate level continuously declined (Figure 5), with inflation remaining widely stable since the early 90s, lower interest rates may promote credit expansions and mal-investment. Meanwhile, the rather expansionary monetary policies after 2001 possibly contributed to excessive investment around the globe (Schnabl and Hoffmann 2008). Therefore it seems plausible when Axel Weber (2008) claims that interest rates have to be symmetrically raised and lowered to reduce the probability of bubbles and stop the downward-trend in interest rates.

Figure 5: Money Market Interest Rates in the US, EMU and Japan



Source: IMF, IFS 2009.

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