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How deviations from FOMC's monetary policy decisions affect bank profitability: Evidence from U.S. banking institutions

ABSTRACT

This paper provides new empirical evidence on how Federal Open Market Committee (FOMC) monetary policy decisions affect the profitability of U.S. banking institutions. It thereby provides a link between the literature on central bank monetary policy implementation through monetary rules and banks' profitability. Using a novel dataset spanning the period 1990 to 2013, the empirical findings show that deviations of FOMC monetary policy decisions from a number of benchmark linear and non-linear monetary (Taylor type) rules exert a negative and statistically significant impact on banks' profitability. The results are expected to have substantial implications for the capacity of banking institutions to more readily interpret monetary policy information and accordingly to reshape and hedge their lending behaviour. This would make the monetary policy decision process less noisy and, thus, enhance their capability to attach the correct weight to this information.

Keywords: FOMC monetary policy rules: profitability; U.S. banks; linear and non-linear rules

JEL Codes: E52; E58; G21; C33

1. Introduction

Theoretical models emphasize the importance of private expectations in determining macroeconomic outcomes (King et al., 2008; Eusepi, 2010; Lamla and Maag, 2012; Givens, 2012). Managing inflation and/or output expectations is a crucial feature of monetary policymaking, so the need for forward policy guidance is dramatically amplified, especially in crises periods. With a few exceptions, the majority of macroeconomic models feature private agent expectations of economic fundamentals that are formed independently of policy actions. There is a growing body of empirical evidence supporting the view that monetary policy actions, in fact, communicate information about the economy to the public, and thereby affect agents' expectations or a number of institutions, such as banks. Usually, the policymakers have better information about the state of the economy than private agents, which captures the central banks' private information about policy targets and their access to some confidential data. In such an environment, rational private agents (i.e., banks) gain information from observations on monetary policy actions that responds to these fundamentals.

A signalling effect of interest rates on beliefs about the future output target alters optimal policy in a way that is similar to the case where policy affects agents' beliefs about future policy through commitment. Moreover, given the delay between policy actions and their real effects, central bank communication provides policymakers with a way to promptly affect private expectations to shorten the transmission lags of monetary policy. It is also widely acknowledged that in spite of the overall very good performance of monetary policy to stay closely to a benchmark monetary policy rule, there have been several episodes of systematic deviations between the actual path of intervention interest rates and the implied rates by a monetary rule (mostly over the period prior to the Greenspan's era).

The goal of this paper is to investigate in what way deviations from FOMC monetary policy–tailed decision-making, spanning the period 1990-2013 has affected banks' profitability. This paper is, to our knowledge, the first to deal with the explicit influence of such deviations of monetary policy decisions on banks' profitability. Moreover, an additional novelty of the paper is that the time frame under consideration is of particular importance in light of the changing dynamics of the U.S. economy which has evolved through states of high inflation, low growth at the start of the Volcker era, to a 'goldilocks' period of low inflation, high growth in the Greenspan era, and onto the Great Recession of the Bernanke era and the recent financial crisis.

The results are expected to be of high importance to a variety of economic agents as well as market participants. A greater understanding of the way those decisions can affect the profitability of banking institutions may allow market participants and banking institutions to revise their expectations more efficiently and rebalance their portfolios appropriately. Moreover, improved forecasting of interest rates would lead to a reduction in the volatility of the impact of such policy interest rate changes on certain components of the real economy, i.e. consumption, investment, lending and borrowing activity. To foreshadow our empirical findings, we find that monetary policy rule deviations have a significant negative impact on banks' profitability. The results survived a number of robustness tests related to alternative types of policy rules, as well as the non-linear case when policy interest rates approach the Zero Lower Bound (ZLB) zone.

The remaining of the paper is organized as follows: Section 2 discusses related literature. Section 3 outlines the data used in our study, while Section 4 details the empirical methodology and discusses the results of the empirical investigation. Section 5 concludes.

2. Literature review

2.1. Monetary policy

The strand of the literature our paper is fundamentally associated with both the role signalling channel in relevance to monetary rules in the central banks' decision process and the implications of the deviations from such a rule. Faust and Svensson (2001) and Geraats (2007) focus on the effect of the signalling channel on the average inflation bias when the central bank has a positive output target. Walsh (2010) and Berkelmans (2011) study the signalling channel under dispersed information using numerical methods. Mertens (2011) shows that monetary policy signals only policy objectives, while Romer and Romer (2000), Campbell et al. (2012), and Nakamura and Steinsson (2013) show that positive interest rate surprises can have positive effects on inflation and output forecasts.

Numerous types of monetary policy rules have been discussed in the literature, with such rules serving as benchmarks for policymakers in assessing the current stance of monetary policy and in determining a future policy path. The rule that has attracted the most attention is that of Taylor (1993), according to which, the instrument of the monetary authority reacts to two key goal variables: deviations of contemporaneous inflation from a pre-set target rate and deviations of contemporaneous real output from its potential level. The rule describes how central banks maintain low and stable inflation, while avoiding large output and employment fluctuations through interventions in the course of policy interest rates. The rule states that nominal interest rates react to the inflation deviation and the output gap, with the seminal contemporaneous rule specified as:

$$i_t = \pi_t + \varphi(\pi_t - \bar{\pi}) + \gamma y_t + R \quad (1)$$

where i_t is the federal funds rate target, R is the equilibrium real interest rate, π_t is the inflation rate, $\bar{\pi}$ is the inflation target, and y_t is the output gap (i.e., the deviations of actual

GDP from its potential level). We use real-time data that was available to policymakers when interest rate decisions were made by the Federal Reserve. Real-time GDP and GDP deflator data are obtained from the Philadelphia Fed. The data of the federal funds rate was replaced by the shadow federal funds rate (Wu and Xia, 2014) starting in 2009:Q1 in our study as the zero lower bound was adapted to the federal funds rate since then. The inflation was proxied by using the four-quarter percentage change in the GDP deflator while the output gap was calculated as the deviation from a real-time quadratic trend[1].

A number of studies in this literature make use of the Taylor Rule to evaluate the efficacy of the central bank's decision making process (Nikolsko-Rzhevskyy, 2011; Ferrero, 2012; Taylor, 2012; among others). This literature demonstrates that a simple monetary rule or its close variations approximate the policy decisions by central banks. Carlstrom and Fuerst (2003) note that the Taylor rule has had a big impact in the way the FOMC implements monetary policy, although they recognize that it is not used as a mechanical rule, but instead as a guide-post for monetary policy, thus, enhancing the central bank's credibility in fighting persistent deviations from a target inflation rate. Batini and Haldane (1999) claim that the central bank has more information about the state of the economy at the time of decision making than is captured by inflation and output data alone, and it is also sensible to assume that central banks make policy decisions based on expected future economic conditions. For this reason, a number of researchers prefer forward-looking, or forecast-based, policy rules in place of contemporaneous Taylor Rule methodology. However, there is not clear empirical evidence in support of forecast-based rules. Taylor (2000) notes that as long as forecasts are not too far into the future they will be very close to their contemporaneous counterparts.

[1] For details of data construction, refers to Nikolsko-Rzhevskyy et al. (2014). The authors also demonstrated that the real-time quadratic de-trended output gaps lead to a closer approximation of "reasonable" real-time output gaps using Okun's Law when compared to alternatives methods including real-time linear and Hodrick-Prescott de-trending.

Moreover, there are several reasons why policy may occasionally deviate from monetary rules. Liquidity crises that require a temporary injection of reserves by the central bank represent one reason why it might be desirable to temporarily lower the policy rate below the level prescribed by a simple rule. Another reason for deviating from rule-like behaviour might be a shock to the aggregate price level. Such a shock might normally call for a tightening of policy, but if the shock is seen as transitory, with no impact on inflation expectations, it might not require the response prescribed by a rule. Finally, policymakers may respond to economic indicators other than those incorporated in the simple rule. In short, a simple rule may simply not capture all of the contingencies that might confront policymakers (Taylor, 1993; 2008). Overall, the lack of flexibility is the main reason why central banks are reluctant to commit to a policy rule. As long as shocks to the economy are frequent and unpredictable, central banks need the flexibility to implement and communicate their monetary policy away from a pre-specified rule.

The literature has dealt extensively with such deviations, essentially, in three major alternative approaches. First, there has been proposed a vast set of variations and enhancements to the explanatory variables in a benchmark monetary policy rule. Clarida et al. (2000) have replaced inflation with expected inflation (as policymakers need to be forward-looking because of the lags in the transmission of monetary policy), and have included lagged interest rate to account for policy inertia. Others, have enhanced the rule with a reaction to additional variables, such as asset prices (Sack and Rigobon, 2003), exchange rates (Lubik and Schorfheide, 2007), or long-term bond yields (Christensen and Nielsen, 2009). A second approach describes the episodes in which the actual policy rates have deviated significantly from the interest rate implied by a monetary policy rule (Taylor, 2012; Nikolsko-Rzhevskyy et al., 2014). Finally, a third approach considers that deviations of actual policy rates from those in a monetary policy rule come from changes along time in the value of the parameters of the rule actually followed by policymakers. A number of studies have also investigated the stability of the U.S. Taylor rule (Bunzel and Wenders, 2010; Alcidi et al. 2011; Wolters, 2012). In this study, we make use of the first approach and we let the others for future research. Finally, Aguiar-Conraria et al. (2015) also assess U.S. monetary policy across time and frequencies in the framework of a Taylor rule. Their results uncover new stylized facts of the monetary rule that could have been detected with conventional time- or frequency-domain methods.

2.2 *Bank profitability*

The literature of banks' performance has focused on identifying the determinants of dictate the behaviour of profitability. In particular, Neeley and Wheelock (1997) and Angbazo (1997) for the case of US banks document that bank's profitability is positively affected by the default risk, the opportunity cost of non-interest bearing reserves, leverage, and management efficiency. Studies by Bashir (2000), Demerguc-Kunt and Huizingha (2001) and Abreu and Mendes (2002) use panel data and find that there exists a link between bank profitability and certain factors, such as the level of interest rates, the unemployment rate, bank concentration, type of ownership, leverage, loans to asset ratios, taxation, financial structure and development, legal indicators and stock market developments.

In a different strand of the literature, the English et al. (2014) paper seems to be close to what we have been doing in this study. They use pre-crisis period data and study the effects of changes in the level of policy rates on bank profitability. They show that following an unexpected increase in the level of policy rates, the positive effect on profitability is offset by a slowdown in asset growth and an outflow of core deposits, which represent an inexpensive source of funding compared to market alternatives. Yet a policy rate cut is typically associated with a steepening of the yield curve. This is consistent with the assumption that monetary easing is effective at boosting economic activity, which should increase inflation and growth expectations.

3. Methodology and data

For the purposes of the panel regression estimations we make use of a number of bank-specific control variables that could impact bank profitability. The control variables that can serve this goal include industry concentration (HERF), operating expenses management (OEM), liquidity risk (LIQ), cost efficiency (CEF), and financial leverage (FLVRG). The Appendix provides a detailed description of the variables used in the empirical analysis.

In terms of our empirical model, we consider the above control variables of bank interest margins, motivated by the dealership model (Ho and Saunders, 1981) and which are in line with previous empirical studies on the determinants of bank interest margins. The first determinant is the Herfindahl index (HERF), which captures the market power for individual banks. The index is defined as the squares of individual bank asset shares in the total banking sector assets for an individual bank. The market power evidence argues that a higher (lower) level of concentration leads to more (less) monopolistic-type of profits, although higher (lower) concentration in the banking sector is associated with less efficient capital markets and, accordingly, with a slower reallocation of capital and, thus, with slower growth (Cetorelli and Strahan, 2006). Other studies make use of the structure-conduct-performance (SCP) model that links market structure to the behaviour of banks and postulates a positive correlation between market power and profit. Goddard et al. (2004) as well as Hahn (2008), find a negative influence of the degree of competition on bank profits. The efficient structure hypothesis, by contrast, assumes that banks with superior management have lower costs and therefore higher profits. These banks will be able to gain market share over time, leading to a higher market concentration (Berger, 2007). As higher market concentration is likely to contribute to higher margins, the estimated coefficient in our model is expected to have a positive sign.

Operating expenses (OEM) also seem to play a substantial role as a determinant of bank profitability. Bourke (1989) provides evidence in favour of a positive relationship between the two variables. The operating costs on the interest margin is proxied by the ratio of non-interest expenses to total assets; a positive estimated coefficient is expected because higher operational costs may cause higher interest margins paid by the customers. We also adopted the ratio of equity to total assets (CAP) as a proxy for bank risk aversion (Maudos and Fernandez de Guevara, 2004) and capital strength; higher risk aversion may lead to higher margins, therefore, the estimated coefficient for CAP is expected to be positive.

CRR measures the credit risk and asset quality of banks, and is proxied by the ratio of loan loss reserves to total loans. Banks with higher ratios of loan loss reserves face higher credit risk, which is likely to be transferred to customers, resulting in higher interest margins. Credit risk is considered to be a significant determinant of profitability since it is related to the presence of bank failures. Jimenez and Saurina (2006) argue that bank's lending hazards are much higher during the boom phase of a cycle than in the midst of a recessionary period. The literature offers a bunch of explanations for such behaviour, i.e. the principal agency problem through which managers aim at growth objectives instead of profitability targets (Mester, 1989). As a result, bank managers opt for higher loan growth and lower the quality loan standards. In addition, the herd behaviour hypothesis supports that bad loan mistakes cannot judged accordingly if the majority of bank managers commit them (Rajan, 1994). The institutional memory hypothesis also argues that in the long run, loan officers become less skilled or experienced to offer loans to high-risk borrowers (Berger and Udell, 2004).

The total assets (TA) of the banks are used as a proxy for bank size. Firm size is a variable that measures the presence of economies of scale in the industry and the ability to diversity portfolio risk. The factor of economies of scale could lead to positive coefficient for profitability while the second factor leads to negative coefficients if increased diversification leads to lower risk and thus lower required return, leaving the true coefficient unclear.

A number of authors find a strong, negative correlation between a bank's capitalization and its profitability (Maudos and Fernández de Guevara, 2004; Carbó Valverde and Rodríguez Fernández, 2007). The authors postulate a link between capitalization and risk aversion. According to this view, banks with a high level of capital and assets are more risk averse and ignore potential diversification options or other methods to increase profitability. Maudos and Fernández de Guevara (2004) found that 10% increase in firm size decreases net interest margin by 0.6 percent. And their result is in line with Kasman et al. (2010) and Claeys and Vander Vennet (2008). Therefore, we define size as total assets, proxying the size of operations; the sign of the estimated coefficient is ambiguous and depends on the net effect of associated credit risk and economies of scale.

LIQ is the ratio of liquid assets to customer and short-term funding, proxying the liquidity risk incurred by banks. The more the demand liabilities (i.e., customer and short-term funding) of the bank are backed up by liquid assets, the lower the liquidity risk of the bank and its interest margins. In other words, a negative sign is expected. We also include the efficiency ratio (CEF), known as the cost to income Ratio, which is an efficiency measure commonly used in the financial sector. Moreover, financial leverage (FLVRG) is measured as the ratio of total debt to total assets. More borrowing may increase sales and productivity. By contrast, the greater the amount of debt, the greater the financial leverage, resulting in lower interest margin (Chen, 2013). Therefore, we do not have a particular prior regarding the expected sign of the coefficient.

4. Empirical analysis

4.1. Monetary rule estimates

Following the existing literature (Taylor, 1993; Nikolsko-Rzhevskyy et al. 2014), we assume equal weights of 0.5 assigned to both the inflation and output gaps, while the inflation target and the equilibrium level of the real interest rate are both equal to 2 percent; equation (1) turns to the original Taylor rule (OTR):

$$i_t = 1.0 + 1.5\pi_t + 0.5y_t \qquad (2)$$

An alternative monetary policy rule increases the size of the coefficient on the output gap from 0.5 to 1.0, to specify the following modified Taylor rule (MTR):

$$i_t = 1.0 + 1.5\pi_t + 1.0y_t \qquad (3)$$

The two policy rules described above may not be able to mimic the Fed's behavior because the choice of parameters is rather subjective. The estimated Taylor rule (ETR) could be obtained by estimating the real-time data associated with Equation (2), and the monetary policy rule could be interpreted as the one favoured by the Fed. The specification of ETR is obtained from Nikolsko-Rzhevskyy et al. (2014)[2]:

$$i_t = 0.37 + 1.49\pi_t + 0.47y_t \qquad (4)$$

(0.30) (0.07) (0.05)

Figures in parentheses display standard errors. The estimates document that the coefficients on both the inflation and the output gap are close to those in the original Taylor rule (Equation 2). The forward-looking Taylor rule describes how central banks respond to the expected inflation deviations as well as to the expected output gap. Among the forward-looking rules (FLR), the most prominent is that proposed by Clarida et al. (1998; 2000):

[2] The data for the calculation of interest rate deviation used in the paper can be downloaded at https://sites.google.com/site/alexrzhevskyy/files/data_rules_discretion.zip

$$i_t = \alpha + \beta[E(\pi_{t+n}) - \overline{\pi}] + \gamma E(y_{t+q}) \quad (5)$$

where β and γ are the coefficients for the inflation gap and the output gap, respectively. We also introduce a constant term $\alpha = i^* - \beta\overline{\pi}$, where i^* denotes the equilibrium nominal interest rate, and $\overline{\pi}$ is the inflation target. Given the expected output gap (i.e., $E(y_{t+q})$), when the expected inflation rate is higher than the inflation target, the nominal rate is expected to increase and this will reduce investment and consumption plans, leading to reduced aggregate demand, and, consequently, to lower inflation. Therefore, a Taylor rule can provide a nominal anchor for the central bank to react to various shocks, as well as an automatic stabilizer for the macroeconomy.

To the empirical ends of this paper, we adopt two specifications of FLR; the first version simply assumes equal weights of 0.5 for both the inflation and the output gap, while in the second one, both the inflation target and the equilibrium level of the real interest rate equal 2 percent, yielding the following FLR:

$$i_t = 1 + 1.5[E(\pi_{t+n})] + 0.5E(y_{t+q}) \quad (6)$$

where $E(\pi_{t+n})$ and $E(y_{t+q})$ are replaced by the data of output gap and GDP deflator forecasts obtained from Nikolsko-Rzhevskyy et al. (2014). An alternative FLR was also derived through the Generalized Method of Moment (GMM) methodological approach (Castro, 2011; Clarida et al., 1998; Clarida et al., 2000; Apergis and Alevizopoulou, 2012). The instrument list contains lagged values of inflation, the output gap, and interest rates.

$$i_t = (1 - \rho)(\alpha + \beta\pi_{t+1} + \gamma y_{t+1}) + \rho i_{t-1} + \varepsilon_t \quad (7)$$

Following Castro (2011) and after incorporating the interest rate smoothing process into the model, equation (7) yields the following reduced form:

$$i_t = \Phi_0 + \Phi_1\pi_{t+1} + \Phi_2 y_{t+1} + \rho\, i_{t-1} + \varepsilon_t \quad (8)$$

where Φ_0 = (1-ρ) α, Φ_1 = (1-ρ) β, and Φ_2 = (1-ρ) γ. Next, we consider deviations of the Fed Fund target from a benchmark nominal interest rate, as it is recommended through a Taylor

(1993) rule[3], and through the model described by Equations (2) through (6). Deviations of the actual Fed Fund rate from the target rate are defined as the absolute value of the deviation:

$$ABSDEV_t = FFR_t - i_t \tag{9}$$

where FFR_t is the actual Fed funds policy rate. The variable ABSDEV is the main independent variable of interest for the determinant of profitability in Equation (10).

4.2. Baseline empirical analysis

In this sub-section we provide baseline evidence on the role of the deviations of FOMC's monetary policy decisions from a monetary policy rule on U.S. bank profitability. This analysis makes use of fixed effect panel estimations to evaluate the impact of those deviations on U.S. banks' interest rate margins, along with the Hausman test that indicates the necessity of using the fixed effect estimator when compared to the random effect model:

$$NIM_{it} = \alpha_i + \beta_1 HERF_{it} + \beta_2 OEM_{it} + \beta_3 CAP_{it} + \beta_4 CRR_{it} + \beta_5 LA_{it} + \beta_6 LIQ_{it} + \beta_7 CEF_{it} + \beta_8 \, FLVRG_{it}\gamma + \beta_9 \, ABSDEV_{it} + \varepsilon_{it} \tag{10}$$

where indices i and t denote bank and year, respectively, NIM_{it} is the net interest margin for bank i in period t, α_i is the fixed effects intercept, and ε_{it} is the i.i.d. error term. Net interest margin (NIM) is used as the dependent variable to measure bank performance/profitability, and it is the performance metric that examines how successful a bank's investment decisions are compared to its debt situations. A negative value implies that the bank did not make optimal decisions, because interest expenses were greater than the amount of returns generated by investments. The remaining variables are defined as above. Table 1 provides summary statistics of the individual variables, as well as the expected

[3] We considered both current period and forward-looking versions of the Taylor Rule and find no qualitative difference in our profitability estimation results. Therefore, to the empirical needs of our paper, we will consider only a forward-looking monetary policy rule. The remaining results are available upon request.

sign of their impact on the bank's performance based on the theoretical implications accepted.

[Insert Table 1 about here]

Next, we determine the deviations from the benchmark monetary rule mentioned above (Equation 9). To this end, we first perform the estimation of a forward Taylor-type rule and then we proceed with deviations, measured as the difference between the Federal Funds target rate from an estimated forward Taylor Rule. The forward-looking rule specification incorporates GDP gaps and GDP deflator (inflation) forecasts obtained from Nikolsko-Rzhevskyy et al. (2014).

The empirical findings from the fixed effect model (10) and under the original Taylor rule (OTR) are reported in Table 2 (columns 1 and 2)[4]. They indicate that all estimated coefficients are statistically significant at the 5% significance level, with the exceptions of the Herfindahl Index (HERF), the ratio of total assets to equity (CAP), and LIQ (the ratio of liquid assets to customer and short-term funding), suggesting that only a handful of major players dominate the market over the period under study. Our most important finding is that the estimated coefficient of ABSDEV is negative, albeit low, implying that a 1% deviation of the actual Fed's fund rate from its target, derived in Equation (2), leads the profitability to drop by 0.04% (Column 2, Table 2).

The estimated coefficient of TA is negatively significant, implying that the effect of credit risk dominates economies of scale. The sign of the estimated coefficient of OEM is positive, indicating that banks transfer their operational cost over to their customers by charging higher interest rates. The coefficient of CAP is also positive, illustrating that higher

[4] This table presents fixed-effect estimates for the model with only control variables without interest rate deviation (i.e. model 1), and the model that incorporated interest rate deviation given by Eq. (2) from 1990 to 2013 for the 195 selected U.S. banks. In particular, Eq.(2) incorporated the original Taylor rule (OTR) of Taylor (1993): $i_t = 1.0 + 1.5\pi_t + 0.5y_t$.

risk aversion leads to higher margins. The negative sign of LIQ confirms that the more the demand liabilities (i.e., customer and short-term funding) of the bank are backed up by liquid assets, the lower the liquidity risk of the bank is, and, therefore, the higher its interest margins are. The coefficient of CEF is negative, denoting that the lower the bank efficiency is, the higher is its profitability.

Although credit risk (QUA) is a significant determinant of profitability, its coefficient turns out to be negative, implying that higher non-performing loans lead to higher losses, which adversely influence the banks' available capital for further borrowing. The literature has provided mixed results on the expected sign of this particular coefficient. For the case of the U.S. banks, Miller and Noulas (1997) find a negative relationship, which represents that loans encounter a stronger risk profile. Alternatively, a negative coefficient could signal that banks are not using efficiently their set of diversified derivatives (i.e., futures, options, and swaps) to hedge counterparty credit risks (Jones and Pérignon, 2013). In that sense, their strategies to transfer such risks to other parties to avoid or reduce the negative impact of such risk and to accept some or all of the consequences of them turns out to be very inefficient (Boudriga et al., 2009; Afriyie and Akotey, 2012). Finally the hypothesis of Chen (2013) also receives statistical support, regarding the negative impact of FLVGR on bank's profitability.

[Insert Table 2 about here]

4.3. Robustness checks: Dealing with the potential problem of endogeneity

This section provides robustness checks of the findings reported in Table 2 through system general method of moment (SGMM) panel data estimates (Windmeijer, 2005) to handle the potential endogeneity. Endogeneity issues among independent variables usually come from the presence of simultaneity bias, reverse causality and omitted variables. The issue of reverse causality may be apparent in our study as lower bank's profitability may lead to wider monetary policy deviations. It is also possible that profitability could cause economies of scale and /or the presence of credit risks. The use of system GMM estimation can overcome the endogeneity bias, after controlling for fixed and time effects, autocorrelation, and multiple endogenous variables (Windmeijer, 2005).

We make use of the SGMM methodological approach because the usual dynamic GMM coefficients may cause the presence of bias in estimates with small samples, given that data are near unit root processes, while the selected instrumental variables are found to be weak. The Hansen test is used to check for the validity of the instruments in the GMM estimator. Instrumental variables (IVs) and residuals are not correlated under the null hypothesis that valid instrumental variables are included[5]. We also adopt a two-step estimator, which is asymptotically efficient and robust to any pattern of cross-correlation and heteroskedasticity (Roodman, 2006). The new findings are reported in column 3 of Table 2.

As we can infer, the estimates of SGMM (column 3), in terms of the sign of coefficients, are similar to those from the FE results (columns 1 and 2). Interestingly, both the size of the coefficient and its statistical significance increase in these SGMM estimations, while the majority of the control variables have turned to be statistically significant and the magnitude of the estimated coefficients has turned to be more economically significant as well. The validity of the IVs estimates is checked through the Hansen test and the findings illustrate that all IVs are valid.

Overall, the empirical findings provide new evidence that deviations of actual FOMC's monetary policy decisions from a benchmark monetary policy rule are expected to reduce U.S. bank profitability. Taylor and Williams (2009) document how the federal funds rate, as well as interest rates on unsecured (i.e., uncollateralized) term loans between banks

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[5] Both the one lagged bank profitability and the variable of provision to bank loan loss were used as IV instruments, because of the lack of information with respect to the exogeneity of regressors.

diverge substantially from the central bank's policy rates and remain unusually volatile for an extended period of time. Funding uncertainty leads to 'risk synergies' between the loan and deposit sides of a bank: an increase, say, in a bank's deposit base reduces the funding risk exposure of further loan commitments, which in turn makes loans themselves more attractive. As uncertainty over funding conditions increases, these risk synergies become stronger, and the bank becomes more concerned with asset-liability management. This is related to an emerging literature on loan-deposit synergies (Kashyap et al., 2002; Gatev et al., 2009) that focuses on interactions between the two sides of a bank's balance sheet.

Furthermore, an increase in funding uncertainty induces highly extended banks with high loan-to-deposit ratios to essentially reverse their prior strategy, i.e. they cut back on their loan commitments, while at the same time try to attract a stronger deposit base with higher interest rates. This result is consistent with the behaviour of many commercial banks throughout the course of the recent financial crisis, including widespread reductions in the leverage and the shrinkage of balance sheets. Funding uncertainty has strong implications for bank profitability. In particular, increased uncertainty over funding conditions reduces banks' expected profits. Moreover, loan-deposit synergies can lead to cross-subsidization where either loans or deposits business becomes a 'loss leader'. In that sense, if the market for loans is very attractive relative to deposits, increased funding uncertainty may induce a bank to offer depositors an interest rate that exceeds its own (expected) funding rate. This implies that depositors' welfare exceeds the level associated with a competitive market.

For robustness purposes, Table 3 also provides both fixed effects and SGMM estimations for both the modified and the estimated rule (Equations (3) and (4), respectively). For the SGMM empirical findings, the results in the case of the modified rule show that the link is not significant. In terms of the estimated rule, the negative impact of deviations on bank profitability turns out to be 0.0333%.

[Insert Table 3 about here]

The forward-looking interest rate rule, based on our estimates, is reported in Table 4. The key results are associated with the estimates of the β coefficient, i.e., of the inflation gap, which is 1.564, implying that the Federal Reserve raises interest rates to 56 basis points, if inflation rises by one percentage point. The coefficient of the output gap is positive as well, albeit smaller when compared to the coefficient of inflation gap. The interest rate smoothing parameter, ρ, is quite large, indicating that the central bank puts a significant weight to past values of interest rates. The J-test for over-identifying restrictions indicates that the instruments are valid in both versions of the rule.

[Insert Table 4 about here]

Table 5 provides the empirical findings on the impact of new policy deviations on banks' profitability in the case of the forward-looking rule. The results illustrate that a 1% absolute deviation of monetary policy decisions from this FLR policy rule reduces profitability by 0.093% (column 2 in Table 5). Finally, the findings in terms of the remaining control variables remain consistently robust.

[Insert Table 5 about here]

4.4. Robustness checks: Monetary policy and the Zero Lower Bound

To combat the financial turmoil and subsequent recessionary phenomena, major advanced countries have adopted monetary policies that keep the policy rates near zero; in that sense they attempt to manage expectations actively, to expand central banks' balance sheets by purchasing long-term government bonds and risky assets, and to introduce schemes that facilitate bank lending (Lambert and Ueda, 2014). In theory, such monetary policies may benefit banks. In the short run, banks can gain from borrowing at low cost and investing in assets delivering higher returns, provided that policies do not depress the returns on those assets. Moreover, banks may take advantage of any reduction in term premia to replace short- with long-term debt and reduce the risk of maturity mismatches in their balance sheets (Stein, 2012).

By contrast, in the medium run, substantially easy monetary policies may hurt banks. The boost in spread income wanes as unconventional policies flatten the yield curve and reduce risk premia. Consequently, banks may rationally take extra leverage and risk (Borio and Zhu, 2008). This could happen, for example, with an extraordinary relaxation of collateral rules that makes funding available at low cost to all banks, regardless of the strength of their balance sheets. Furthermore, with low interest rates, banks may prefer to roll over loans to non-viable firms rather than declaring them non-performing and registering a loss in their income statement. Previous studies found evidence of such 'ever greening' policies in Japan in the 1990s and 2000s (Peek and Rosengren, 2003; Caballero et al., 2008).

To achieve its monetary policy goals, the Fed implemented two forms of that type of policy. First, the use of forward guidance, whereby the Fed attempted to reduce and stabilise longer-term interest rates, by publically committing to maintaining the policy rate close to zero for an extended period of time. Evidence suggests this may have been ineffective in driving economic recovery (Anderson and Hoffman, 2010; Kool and Thornton, 2012). Second, the Fed also introduced Quantitative Easing (QE), where longer-term assets were purchased, in order to reduce long-term rates. Immediately following the announcement of Lehman's demise, primary credit borrowing and Term Auction Facilities (TAF) lending increased markedly. The effectiveness of these actions is reflected in risk spreads, where both short- and long-term spreads, which had increased dramatically following Lehman's announcement, declined markedly (Thornton, 2012). These actions indicate that even after the Fed fund target rate reached the zero lower-bound, the Fed remained aggressive in its policy actions. The effectiveness of monetary policy actions comes through the expectations effect, which seems to be particularly important when the Fed's actions occur at a time when there are significant signs that financial markets need stabilizing mechanisms.

The current hot issue concerning the new role of monetary policy after the recent financial crisis is not just about the effects of policy on inflation, but it is also about the effectiveness of monetary policy in helping the economy to recover from a recession. Moreover, another issue related to the role of low interest rates is the way the monetary authorities signal their intention to change future monetary policy in a credible way. This turns to be a very critical problem given that interest rates are set to zero, and thus, it is highly unlikely that monetary policy changes can signal a change of policy to the markets. Farmer (2012) shows that low interest rate policies could be effective in stabilizing inflation expectations. A standard monetary policy rule provides a unified framework to explain how monetary policy decisions can control inflation in normal times as well as to explain the target of monetary policy when policy attains the zero lower bound. To consider the monetary rule by taking explicitly into consideration the potential role of low interest rates, we make use of a non-linear (censored) rule expressed as:

$$\begin{cases} i_t = \max(i_f, i_t^*) \\ i_t^* = a + \beta [\pi_t - \pi^*] + \gamma y_t \end{cases} \quad (11)$$

where i_f denotes the floor of the Fed policy target rate, and i_t^* is the latent variable in the non-linear Taylor rule, while the remaining independent variables are defined as in (2). We adopted a censored normal model that allows the nominal interest rate floor to change over time. We estimate it as a Tobit model with a nominal interest rate floor of 0%, 0.1%, 0.2%, 0.3% and 0.4% as follows:

$$
\begin{cases} i_t = \max(i_{ft}, i_t^*) \\ i_t^* = a + \beta\,[\pi_t - \pi^*] + \gamma\, y_t \end{cases} \quad (12)
$$

Table 6 presents the fixed effects empirical results of bank profitability by taking explicitly into consideration the potential role of low interest rates, i.e. 0%, 0.1%, 0.2%, 0.3% and 0.4% respectively. The reason we focus on this part of the entire distribution of interest rates is that the Fed brought its policy rates to their respective effective lower bounds in a cold turkey fashion by decreasing them from 1% to 0.4% overnight (between January 10, 2008 and January 11, 2008). Given the experience of the post war period, the probability of experiencing a year as bad as 2008 had been exceedingly low (Williams, 2014). The negative impact of deviations in absolute values on bank profitability turns out to be 0.027% and 0.024% for the lower bound rule of 0% and 0.4%, respectively (columns 1 and 5 in Table 6). In comparison to the results derived in the case of fixed effects estimation, the SGMM findings indicate a larger adverse influence of monetary policy uncertainty on bank profitability; where the negative impact of deviations in absolute values on bank profitability turns out to be 0.032% and 0.045% for the lower bound rule of 0% and 0.4%, respectively (columns 1 and 5 in Table 7).

[Insert Tables 6 and 7 about here]

Overall, the results highlight that deviations from an optimal monetary rule at the Zero Lower Bound zone give rise to a credibility problem in which private agents expect any monetary expansion to be reverted once the economy has recovered (Krugman, 1998). Similarly, Jung et al. (2005) argue that deviations from an optimal commitment policy entail the break of a promise of zero nominal interests for some time after the economy has recovered. Based on the above arguments, the presence of such deviations is expected to increase interest rates and reduce lending activity, thus, contributing to lower bank profitability. Evans et al. (2015), by illustrating the presence of both an expectations and a buffer stock channel, argue that deviations of monetary policy from a monetary policy rule at zero policy rates are expected to have mixed effects for the overall profile of the economy; in particular, they can contribute to higher uncertainty, given that potential premature increases in interest rates raise the likelihood of adverse shocks, while delaying such increases for a long period could lead to an unwelcome surge of inflation. Based on those arguments we can infer that bank profits are reduced since banks are forced to cut down on their lending activity, which has negative spillovers on their profitability. By contrast, in the presence of low interest rates expected to boost economic activity, there will be likely positive effects on bank profits. Our empirical findings opt for the former arguments.

4.5. Robustness checks: A forward-looking monetary policy rule that incorporates financial variables

The effectiveness of monetary policy is also sensitive to the link between monetary policy and asset price movements. This link has been of perennial interest to both policy makers and academic researchers, since asset prices may affect real activity through the main channels of the transmission mechanism from asset prices to economic activity identified in the literature: i) households' wealth effects on consumption expenditure, ii) Tobin's Q effects on investments, and iii) financial accelerator effects on investments. Gilchrist and Leahy (2002) argue that the gains of including asset prices in monetary policy rules in practice adds little to stabilizing output and inflation. By contrast, while financial markets can benefit from FOMC monetary policy decisions through an informational mechanism that conveys expectations about the future course of interest rates. This mechanism allows market participants to revise their expectations about the impact of those interest rates on future asset prices, and, through the monetary transmission channels, to the real economy (Rosa, 2013).

At this stage of the analysis we explicitly consider the role of asset prices in monetary policy rule as 'information variables', and the new model (i.e., augmented forward-looking rule) is the extension of Equation (8):

$$\mathrm{i_t} = \Phi_0 + \Phi_1 \pi_{t+1} + \Phi_2 \mathrm{y}_{t+1} + \rho\, \mathrm{i}_{t-1} + \theta_1 CB_t + \theta_2 HI_t + \theta_3 SP_t + \varepsilon_t \quad (13)$$

where CB, HI, and SP denote 10-year corporate bond prices, housing prices, and stock prices, respectively. Considering a number of policy debates concerning the informational roles of asset prices in the Fed's monetary policy, we choose as a comprehensive list of real asset prices, including 10-year corporate bond (i.e., Moody's Aaa rates), the all transactions housing index, and stock prices (i.e., S&P 500). Data on 10-year corporate bond prices are obtained from 'The Federal Reserve Board of Governors in Washington DC' database[6]. Housing prices are downloaded from 'The Federal Reserve Bank of St. Louis' database[7]. Finally, data on stock prices (i.e., S&P 500) are obtained from Robert Shiller's website, with details of the data construction are being described on Shiller's website[8]. The estimated result for Equation (13) is presented in Table 8.

[Insert Tables 8 about here]

We used the target rate in Equation (13) to estimate the impact of monetary policy deviation on bank's profitability, and the SGMM results indicated that policy deviation has negative influence on banks' profitability at 1% significant level (Table 9). The results implied that 1% deviation of monetary policy decisions from a policy rule reduces profitability by 0.082%.

[Insert Tables 9 about here]

[6] visit http://www.federalreserve.gov/releases/h15/data.htm#fn14
[7] https://research.stlouisfed.org/fred2/series/USSTHPI/

The above results indicate that asset prices play a significant role in forward monetary policy rules as well as in deviations of monetary policy from forward optimal commitments as providing extra forward-looking information (Siklos et al., 2004; Semmler and Zhang, 2007). Their role as leading economic indicators tends to enhance not only the information provided to the banking sector in case that actual monetary policy decisions differ from their optimal commitments, but also their inclusion contributes more uncertainty, which could lead to lower liquidity levels in the economy. In either case, higher uncertainty prevails in the economy, and banks are forced to further cut their lending activity, which has a negative impact on their profitability. At the same time, higher uncertainty and lower liquidity could also lead to lower aggregate demand, resulting in lower demand for loans, thus, leading to the same conclusions in terms of bank profitability.

5. Conclusions

This paper attempted to examine the role of deviations of the FOMC monetary policy decision making process from a benchmark monetary policy (Taylor type) rule on back profitability. We utilised a novel dataset to examine the effectiveness of those decisions, controlling for a number of specific bank control characteristics, on the largest U.S. commercial banks through the employment of different linear and non-linear monetary policy rules, spanning the period 1990-2013.

The empirical findings documented that such deviations of FOMC monetary policy decisions from all types of monetary policy rules that have been employed in the empirical analysis are highly important in understanding the FOMC decision-making process. Taken together, the results suggest that such deviations may question established central bank's credibility to fight inflation; in that respect, it is possible to target other objectives for monetary policy, as set out in the Federal Reserve Act, for example, 'maximum employment'. The implications associated with our empirical results could be that the banking sector can increase its capacity to more accurately utilize the information disseminated from the central bank, at least in the case of the U.S. banks. This would significantly reduce the uncertainty associated with monetary policy decisions enabling commercial banks to attach the correct weight to the information emanating from monetary policy decisions. This is important since the presence of uncertainty about the merit and the drivers of FOMC's decisions is welfare reducing. Building on the results of this paper, a key direction for future research would be to explore how our modelling approach can be extended to other central banks, such as the Bank of England and the European Central Bank monetary policy committees.

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Appendix

Description of the variables and respective sources

ROA	Return on Asset is calculated as the ratio of its net income in a given period to the total value of its assets.
ROE	Return on Equity net income returned is defined as the ratio of shareholders equity.
NIM	Net interest margin is a performance metric that examines how successful a firm's investment decisions are compared to its debt situations in percentage. A negative value denotes that the firm did not make an optimal decision, because interest expenses were greater than the amount of returns generated by investments. Calculated by-((Trailing 12M Net Interest Income + Trailing 12M Other Investments and Assets Sale) / (Earning Assets + Prior Year Earning Assets) / 2)*100
NET_INCOME	Earnings after deducting normal operating expenses, but before taking gains or losses from sale of securities, other losses and charge-offs, and additions to the reserve account for possible loan losses. It refers to earnings before federal income taxes are paid.
HERF	Market concentration (the Herfindahl-Hirschman index)
NIETA	Ratio of non-interest expenses to total assets
CAP	The ratio of total assets to equity
QUA	The ratio of loan loss reserves to gross loans.
LA	Logarithm of total assets
LIQ	Ratio of short term borrowings to the sum of short and long term borrowings, total deposits and repurchase agreements, expressed in percentage. Calculated as: [ST Borrowings / (Customer Deposits + Short and Long Term Debt)]*100

where:

ST Borrowings is BS047, BS_ST_BORROW

Customer Deposits is BS041, BS_CUSTOMER_DEPOSITS

Short and Long Term Debt is RR251, SHORT_AND_LONG_TERM_DEBT

EFFR	Efficiency Ratio (also known as Cost to Income Ratio) is an efficiency measure commonly used in the financial sector. The Efficiency Ratio measures costs compared to revenues. Unit: Actual. Calculated as: (Operating Expenses / ((Net Interest Income + Commissions & Fees Earned + Other Operating Income (Losses) + Trading Account Profits (Losses) - Commissions & Fees Paid) + Taxable Equivalent Adjustment or Net Revenue - Net of Commissions Paid) * 100 where: Operating Expenses is IS032, IS_OPERATING_EXPN Net Interest Income is RR016, NET_INT_INC Commissions & Fees Earned is IS019, IS_COMM_AND_FEE_EARN_INC_REO Other Operating Income (Losses) is IS020, IS_OTHER_OPER_INC_LOSSES Trading Account Profits (Losses) is IS017, IS_TRADING_ACCT_PROF Commissions & Fees Paid is IS024, IS_COMM_FEE_PAID Taxable Equivalent Adjustment is IS100, IS_TAX_EQV_ADJ Net Revenue - Net of Commissions Paid is IS954, NET_REV_EXCL_COMMISSIONS_PAID
FLVRG	Financial Levergage is defined as the ratio of total debt to total assets

Table 1

Variable description, descriptive statistics and expected impact on the bank interest margin

Variable	Notation	Mean	Standard deviation	Maximum	Minimum	Jarque-Bera Statistics (prob.)	Expected Sign	Obs.
Net interest margin	NIM	4.002	0.904	12.000	0.520	0.000		3362
Herfindahl index	HERF	0.031	0.283	4.499	0.000	0.000	+	3362
Ratio of non-interest expenses to total assets	OEM	2.880	0.939	9.760	0.198	0.000	+	3362
The ratio of total assets to equity	CAP	9.930	3.403	60.606	0.586	0.000	+	3362
The ratio of loan loss reserves to gross loans.	CRR	0.600	0.909	13.710	-1.970	0.000	+	3362
Logarithm of total assets	TA	8.272	1.561	14.698	3.952	0.000	?	3362
Ratio of liquid assets to customer and short-term funding	LIQ	7.248	7.858	89.290	0.000	0.000	-	3362
Cost to Income Ratio	CEF	61.352	17.770	552.350	11.670	0.000	+	3362
Financial Leverage Ratio	FLVRG	11.524	4.935	134.690	1.530	0.000	?	3362
Monetary policy deviation (original Taylor rule)	DEV	-0.990	1.303	1.275	-3.638	0.000	?	3362
Monetary policy deviation (original Taylor rule: absolute value)	ABSDEV	1.295	1.000	3.638	0.041	0.000	?	3362

Table 2

Estimated results on Net Interest Margin: orignal Taylor rule

VARIABLES	(1) Control variables	(2) Original Rule	(3) Original Rule: SGMM
HERF	0.0391	0.0301	0.184**
	(0.112)	(0.113)	(0.088)
NIETA	0.355***	0.351***	0.947***
	(0.073)	(0.073)	(0.108)
CAP	0.0114	0.0102	0.0733**
	(0.008)	(0.008)	(0.033)
QUA	-0.0471**	-0.0506***	0.0555*
	(0.019)	(0.019)	(0.030)
LA	-0.388***	-0.383***	-0.210***
	(0.031)	(0.031)	(0.027)
LIQ	-0.00351	-0.00296	0.00727
	(0.003)	(0.003)	(0.005)
EFFR	-0.0134**	-0.0136**	-0.0455***
	(0.005)	(0.006)	(0.007)
FLVRG	-0.0185***	-0.0188***	0.0125
	(0.004)	(0.004)	(0.014)
ABSDEV		-0.0399***	-0.0317**
		(0.010)	(0.015)
Constant	7.160***	7.211***	3.888***
	(0.315)	(0.310)	(0.562)
P-value for Hausmen test	0	0	
Z-value for Hensen test			0.583
Observations	3,362	3,362	3,157
R-squared	0.386	0.391	
Number of id	195	195	192
Bank FE	YES	YES	

Notes: This table presents both fixed-effects and SGMM estimates for the model with only control variables without interest rate deviation (i.e. model 1), and the model that incorporated interest rate deviation given by Eq. (2) from 1990 to 2013 for the 195 selected U.S. banks. In particular, Eq.(2) incorporated the original Taylor rule (OTR) of Taylor (1993): $i_t = 1.0 + 1.5\pi_t + 0.5y_t$. ABSDEV denotes the absolute deviations of the Notes: The first two models in this table presents fixed-effect estimates for the model with only control variables without interest rate deviation (i.e. model 1), and the model that incorporated interest rate deviation given by Eq. (2) from 1990 to 2013 for the 195 selected U.S. banks. In particular, Eq.(2) incorporated the original Taylor rule (OTR) of Taylor (1993): $i_t = 1.0 + 1.5\pi_t + 0.5y_t$. ABSDEV denotes the absolute deviations of the actual Fed Fund rate from the target rate (i.e. derived from OTR). A Hausman test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects, the p-value for Hausmen test is smaller than 0.05 for all models, suggesting that fixed-effect model is more appropriate for our data set. NIM, HERF, NIETA CAP, QUA, LA, LIQ, EFFR, FLVRG, ABSDEV denote Net interest margin, Herfindahl index, Ratio of non-interest expenses to total assets, The ratio of total assets to equity, The ratio of loan loss reserves to gross loans, Logarithm of total assets, Ratio of liquid assets to customer and short-term funding, Cost to Income Ratio, Financial Leverage Ratio, and Monetary policy deviation in absolute value respectively. Model (3) incorporates the original Taylor rule (OTR) with system GMM estimators. **, *** denote statistical significance at the 5% and 1% levels, respectively

Table 3. Estimated results on Net Interest Margin: Modified and estimated Taylor rule

VARIABLES	(1) Modified model	(2) Estimated model	(3) Modified model: SGMM	(4) Estimated model: SGMM
HERF	0.0265	0.0380	0.129	0.186**
	(0.111)	(0.112)	(0.330)	(0.0881)
NIETA	0.359***	0.355***	1.045*	0.954***
	(0.0733)	(0.0725)	(0.581)	(0.108)
CAP	0.00944	0.0114	0.0697	0.0771**
	(0.00813)	(0.00831)	(0.247)	(0.0314)
QUA	-0.0541***	-0.0473**	-0.0124	0.0597*
	(0.0191)	(0.0192)	(0.210)	(0.0315)
LA	-0.352***	-0.388***	0.0602	-0.215***
	(0.0316)	(0.0313)	(0.331)	(0.0282)
LIQ	-0.00338	-0.00341	-0.00608	0.00873
	(0.00291)	(0.00300)	(0.0284)	(0.00546)
EFFR	-0.0137**	-0.0134**	-0.0517	-0.0456***
	(0.00552)	(0.00546)	(0.0372)	(0.00735)
FLVRG	-0.0187***	-0.0185***	0.0705	0.0134
	(0.00401)	(0.00420)	(0.142)	(0.0142)
ABSDEV_M	-0.0468***		-0.0354	
	(0.00884)		(0.158)	
ABSDEV_E		-0.00525		-0.0333*
		(0.0124)		(0.0169)
Constant	7.004***	7.173***	…	3.828***
	(0.305)	(0.316)	…	(0.544)
P-value for Hausmen test	0	0		
Z-value for Hensen test			0.05	0.518
Observations	3,362	3,362	3,157	3,157
R-squared	0.396	0.386		
Number of id	195	195	192	192
Bank FE	YES	YES		

Notes: This table presents fixed-effect and SGMM estimates for the models that incorporated interest rate deviation given by Eq. (3) and Eq. (4) from 1990 to 2013 for the 195 selected U.S. banks. In particular, Eq.(3) incorporated the modified Taylor rule (MTR) of Taylor (1993) that increases the size of the coefficient on the output gap from 0.5 to 1.0: $i_t = 1.0 + 1.5\pi_t + 1.0y_t$. Eq.(4) incorporated the estimated Taylor rule (ETR) where data was obtained from Nikolsko-Rzhevskyy et al. (2014): $i_t = 0.37 + 1.49\pi_t + 0.47y_t$. The ETR estimates document that the coefficients on both the inflation and the output gap are close to those in the original Taylor rule Eq.(2). ABSDEV_M and ABSDEV_E denote the absolute deviations of the actual Fed Fund rate from the target rate (i.e.as derived from MTR), and the absolute deviations of the actual Fed Fund rate from the target rate (i.e. as from ETR) respectively. A Hausman test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects, the p-value for Hausmen test is smaller than 0.05 for all models, suggesting that fixed-effect model is more appropriate for our data set. Mode(3) and model(4) provide system GMM estimates.**Indicates statistical significance at the 5% level. ***Indicates statistical significance at the 1% level.

Table 4
Interest rate rule estimates

	Φ_0	Φ_1	Φ_2	A	β	γ	ρ	J-statistic probability	R-squared
FLR	-0.0177	0.1287***	0.0633***	-0.2156	1.5641	0.7702	0.9170***	0.99	0.944

The key results for forward-looking rule given by Eq.(8): $i_t = \Phi_0 + \Phi_1 \pi_{t+1} + \Phi_2 y_{t+1} + \rho\, i_{t-1} + \varepsilon_t$, where $\Phi_0 = (1-\rho)\alpha$, $\Phi_1 = (1-\rho)\beta$, and $\Phi_2 = (1-\rho)\gamma$. Under the Taylor rule principle (i.e., the β coefficient should be greater than unity), and given that β is equal to 1.564, the Fed manages to raise nominal as well as real rates. The coefficient of the output gap is positive as well, albeit smaller when compared to the coefficient of the inflation gap. The interest rate smoothing parameter, ρ, is quite large, indicating that the central bank puts a significant weight to past values of interest rates. The J-statistic in the case of the Taylor-type and the forward-looking rule indicates that the employed instruments are valid. *** denotes statistical significance at the 1% level.

Table 5. Estimated results on Net Interest Margin: Estimated forward-looking Taylor rule

VARIABLES	(1) Forward-Looking Rule	(2) Forward-Looking Rule: SGMM
HERF	0.0458	0.183**
	(0.110)	(0.087)
NIETA	0.363***	0.970***
	(0.071)	(0.103)
CAP	0.0127	0.0837***
	(0.008)	(0.030)
QUA	-0.0480**	0.0389
	(0.019)	(0.028)
LA	-0.356***	-0.188***
	(0.031)	(0.027)
LIQ	-0.00525*	0.00130
	(0.003)	(0.006)
EFFR	-0.0133**	-0.0435***
	(0.005)	(0.007)
FLVRG	-0.0182***	0.0154
	(0.004)	(0.014)
absdev_flr	-0.106***	-0.0930**
	(0.029)	(0.045)
Constant	6.920***	3.440***
	(0.319)	(0.479)
P-value for Hausmen test	0	
Z-value for Hensen test		0.518
Observations	3,362	3,157
R-squared	0.391	
Number of id	195	192
Bank FE	YES	

Notes: This table presents both fixed-effects and SGMM estimates for the models that incorporated interest rate deviation given by Eq. (8) from 1990 to 2013 for the 195 selected U.S. banks. In particular, Eq.(8) incorporated the forward-looking rules (FLR): $i_t = \Phi_0 + \Phi_1\pi_{t+1} + \Phi_2 y_{t+1} + \rho\, i_{t-1} + \varepsilon_t$, where Φ0 = (1-ρ) α, Φ1 = (1-ρ) β, and Φ2 = (1-ρ) γ. ABSDEV_FLR denotes the absolute deviations of the actual Fed Fund rate from the target rate (i.e.as derived from FLR). A Hausman test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects, the p-value for Hausmen test is smaller than 0.05 for all models, suggesting that fixed-effect model is more appropriate for our data set. Model (2) provides system GMM estimates.***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

Table 6
Fıxed effect results on net interest margin: Non-linear rule

VARIABLES	(1) Zero lower bound:0%	(2) Zero lower bound:0.1%	(3) Zero lower bound:0.2%	(4) Zero lower bound:0.3%	(5) Zero lower bound:0.4%
HERF	0.0337	0.0348	0.0343	0.0344	0.0345
	(0.113)	(0.112)	(0.112)	(0.112)	(0.112)
OEM	0.3530***	0.3530***	0.3540***	0.3540***	0.3540***
	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)
CAP	0.0110	0.0111	0.0114	0.0113	0.0113
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
CRR	-0.0486**	-0.0481**	-0.0478**	-0.0478**	-0.0479**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
TA	-0.3870***	-0.3880***	-0.3830***	-0.3840***	-0.3840***
	(0.031)	(0.031)	(0.032)	(0.031)	(0.031)
LIQ	-0.0032	-0.0032	-0.0034	-0.0033	-0.0033
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
CEF	-0.0135**	-0.0135**	-0.0135**	-0.0135**	-0.0135**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
FLVRG	-0.0187***	-0.0187***	-0.0186***	-0.0186***	-0.0186***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
ABSDEV_0	-0.0270**				
	(0.011)				
ABSDEV_1		-0.0204*			
		(0.011)			
ABSDEV_2			-0.0249**		
			(0.012)		
ABSDEV_3				-0.0243**	
				(0.011)	
ABSDEV_4					-0.0236**
					(0.011)
Constant	7.2040***	7.2010***	7.1630***	7.1670***	7.1700***
	(0.313)	(0.314)	(0.312)	(0.312)	(0.312)
P-value for Hausmen test	0.000	0.000	0.000	0.000	0.000
Observations	3,362	3,362	3,362	3,362	3,362
R-squared	0.388	0.387	0.387	0.387	0.387
Number of id	195	195	195	195	195
Firm FE	YES	YES	YES	YES	YES

This table presents fixed-effect estimates for the models that incorporated interest rate deviation given by Equation (12) from 1990 to 2013 for the 195 selected U.S. banks. In particular, Equation (12) considers several lower bound interest rate by setting the floor of the Fed policy target rate (i.e. i_f) to 0%, 0.1%, 0.2%, 0.3% and 0.4% respectively. ABSDEV_0, ABSDEV_1, ABSDEV_2, ABSDEV_3 and ABSDEV_4 denote the absolute deviations of the actual Fed Fund rate from the 0% lower bound policy, 0.1% lower bound policy, 0.2% lower bound policy, 0.3% lower bound policy and 0.4% lower bound policy, respectively. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Table 7. SGMM Estimated results on Net Interest Margin: Non-linear rule

VARIABLES	(1) Zero lower bound:0%	(2) Zero lower bound:0.1%	(3) Zero lower bound:0.2%	(4) Zero lower bound:0.3%	(5) Zero lower bound:0.4%
HERF	0.185**	0.185**	0.185**	0.185**	0.185**
	(0.088)	(0.088)	(0.088)	(0.088)	(0.087)
NIETA	0.952***	0.953***	0.953***	0.953***	0.953***
	(0.107)	(0.108)	(0.108)	(0.108)	(0.109)
CAP	0.0753**	0.0757**	0.0788**	0.0786**	0.0784**
	(0.032)	(0.032)	(0.031)	(0.031)	(0.031)
QUA	0.0572*	0.0588*	0.0609*	0.0608*	0.0606*
	(0.030)	(0.031)	(0.031)	(0.031)	(0.031)
LA	-0.211***	-0.212***	-0.209***	-0.209***	-0.210***
	(0.028)	(0.023)	(0.027)	(0.027)	(0.027)
LIQ	0.00776	0.00801	0.00679	0.00692	0.00705
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
EFFR	-0.0453***	-0.0455***	-0.0463***	-0.0463***	-0.0463***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
FLVRG	0.0123	0.0128	0.0141	0.0141	0.0141
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
ABSDEV_0	-0.0323**				
	(0.015)				
ABSDEV_1		-0.0318**			
		(0.015)			
ABSDEV_2			-0.0464***		
			(0.014)		
ABSDEV_3				-0.0457***	
				(0.014)	
ABSDEV_4					-0.0450***
					(0.014)
Constant	3.831***	3.841***	3.861***	3.864***	3.866***
	(0.539)	(0.546)	(0.525)	(0.527)	(0.529)
Z-value for Hensen test	0.544	0.533	0.504	0.507	0.508
Observations	3,157	3,157	3,157	3,157	3,157
Number of id	192	192	192	192	192

Notes: This table presents SGMM estimates for the models that incorporated interest rate deviation given by Eq. (12) from 1990 to 2013 for the 195 selected U.S. banks. In particular, Eq.(12) considers several lower bound interest rate by setting the floor of the Fed policy target rate (i.e. i_f) to 0%, 0.1%, 0.2%, 0.3% and 0.4% respectively. ABSDEV_0, ABSDEV_1, ABSDEV_2, ABSDEV_3 and ABSDEV_4 denote the absolute deviations of the actual Fed Fund rate from the 0% lower bound policy, 0.1% lower bound policy, 0.2% lower bound policy, 0.3% lower bound policy and 0.4% lower bound policy respectively. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

Table 8
Interest rate rule estimates with asset prices

	Φ_0	Φ_1	Φ_2	A	β	γ	ρ	J-statistic probability	R-squared
FLR	-4.957	0.6334	0.2350	-11.1890	1.4291	0.5319	0.4430	0.99	0.824

Notes: The key results for forward-looking rule given by Eq.(13): $\mathrm{i_t} = \Phi_0 + \Phi_1 \pi_{t+1} + \Phi_2 y_{t+1} + \rho\, \mathrm{i}_{t-1} + \theta_1 CB_t + \theta_2 HI_t + \theta_3 SP_t + \varepsilon_t$, where Φ_0 = (1-ρ)α, Φ_1 = (1-ρ)β, and Φ_2 = (1-ρ)γ. Under the Taylor principle (i.e., the β coefficient is greater than unity), and given that β is equal to 1.429, the Federal Reserve accomplishes to raise nominal as well as real rates. The coefficient of the output gap is positive as well, albeit smaller when compared to the coefficient of inflation gap. The J-statistic in the case of the Taylor-type and the forward-looking rule indicates that used instruments are valid.

Table 9.

Estimated results on Net Interest Margins: with asset prices

VARIABLES	(1) Forward-Looking Rule with asset prices	(2) Forward-Looking Rule with asset prices: SGMM
HERF	0.0296	0.171**
	(0.112)	(0.084)
NIETA	0.355***	0.944***
	(0.073)	(0.106)
CAP	0.0114	0.0741**
	(0.008)	(0.031)
QUA	-0.0359*	0.0943***
	(0.020)	(0.032)
LA	-0.368***	-0.204***
	(0.031)	(0.027)
LIQ	-0.00393	0.00504
	(0.003)	(0.005)
EFFR	-0.0134**	-0.0451***
	(0.005)	(0.007)
FLVRG	-0.0185***	0.00877
	(0.004)	(0.014)
ABSDEV_AP	-0.0691***	-0.0816***
	(0.016)	(0.017)
Constant	7.086***	3.932***
	(0.310)	(0.490)
P-value for Hausmen test	0	
Z-value for Hensen test		0.557
Observations	3,362	3,157
R-squared	0.392	
Number of id	195	192
Bank FE	YES	

Notes: This table presents fixed-effect and SGMM estimates for the models that incorporated interest rate deviation given by Eq. (13) from 1990 to 2013 for the 195 selected U.S. banks. In particular, Eq.(13) incorporated the forward-looking rules that augmented with asset prices: $i_t = \Phi_0 + \Phi_1 \pi_{t+1} + \Phi_2 y_{t+1} + \rho\, i_{t-1} + \theta_1 CB_t + \theta_2 HI_t + \theta_3 SP_t + \varepsilon_t$, where CB, HI, and SP denote 10-year corporate bond, housing index, and stock prices respectively. ABSDEV_AP denotes the absolute deviations of the actual Fed Fund rate from the target rate as obtained from Eq.(13). A Hausman test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects, the p-value for Hausmen test is smaller than 0.05 for all models, suggesting that fixed-effect model is more appropriate for our data set. Model (2) is estimated using system GMM estimator. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.