Testing monetary policy: Rules versus discretion

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February 29, 2016

Abstract

In the paper we apply to a time series version of the heteroscedastic model, to measure the strength of commitment versus discretion in the monetary policy framework. Deviations from the committed rule, in form of volatility of a policy shock, are regressed on the key determinants of the policy rule, disclosing the nature and strength of discretion of a central banker. Today's discretion may partially by explained by the previous period discretion, as a consequence of deprived credibility of the central bank, making commitment more costly. We estimate the U.S. monetary policy rule for Alan Greenspan's era (1987Q1 - 2005Q4) using the FOMC Greenbook projections.

The degree of discretion is decreasing in the supply shock, suggesting that monetary policy has been more tied to the rule in times of positive supply shocks and more flexible in times of negative shocks. Also, monetary policy tended to deviate from the rule in times of positive GDP gap, and follow the rule in times of negative gap. Finally, policy discretion is increasing in past monetary policy shocks.

1 Introduction

Time consistency in the economic policy literature is analyzed in the context of committed versus discretionary policies. Central banks earn credibility from the public, being consistent in their promises on future policy choices, and the gain is in the form of minimized losses that Central bank authorities incur to bring back the economy to its long run development path. The loss of confidence from the public's side can be associated to a single event, while its recovery may take years and along that path

Central banks put much resources to sustain desired levels of inflation and output gap. As any long term relationship, the interaction between Central banks and economic agents is fairly complex, and this complexity is transformed into the policy research, whenever estimating the extent of commitment (time consistency) versus discretion (time inconsistency) in certain economic policies.

The literature on estimation of monetary policy rules builds on the seminal contribution of Taylor (1993), proposing various modifications of the latter.

Depending on the lag and lead structure of the rule, different econometric techniques, mainly OLS and GMM have been used for estimation. However those methods do not take into account the time-series properties, mainly nonstationarity, of the interest rate. Meanwhile, the problems related to the autoregressive and heteroskedastic structure of disturbances (policy shocks) are being addressed using Heteroskedasticity and Autocorrelation consistent standard errors.

Although heteroskedasticity is mostly an undesirable property of data for the researcher, when estimating monetary policy rules it turns out to be a very useful property, because it represents the discretionary actions of central banks and can be used to evaluate the degree of commitment of policymakers.

In this paper we suggest a methodology to answer the following question: Does a Central Bank follow to a policy course that is rather described by the committed rule, or it deviates from that rule in a regular manner so that deviations have some covariation with the key macroeconomic indicators? To answer the question, I apply to the time series version of heteroscedastic regression models, introduced by Harvey (1976). Recently, Cerqueiro et al. (2007) use this model to estimate deviations from the rule on the provision of loans, thus measuring the extent of discretion in this conduct. This type of cross sectional analysis can be extended to a time series dimension and checked for persistence of processes. In our context, an interesting question is to study how discretion is linked to the dynamics of an economy. For instance, whenever there is an inflationary pressure in an economy, will it lead to more deviation from the rule, or the Central bank will even tighten the errors, realizing that the committed rule ensures the most effective reversion to the long term path. The method does not anyhow restrict the functional form of the monetary policy rule - it can be a Taylor type rule or more general, in order to capture certain characteristics of an economy.

Within this framework we also can study whether discretion in past has lasting effect on current discretion. This will be interpreted as discretion in past not only deprives credibility at that time, but also induces further discretion and deepens distrust of private sector towards the Central bank. Given the loss of confidence in past, policy makers find optimal to be further inconsistent with the policy rule, as following to the policy will be too costly due to deprived credibility.

The empirical literature on the policy rule takes the model by Clarida et al. (2001) as a benchmark. The authors estimate the forward looking type of Taylor rule for the U.S. economy. They allow for only expectational errors and do not assume a policy shock. It is however more general to have policy shocks in the model and, if useful, to identify the size and the direction of these shocks, separating them from expectational errors. The main concern of this paper is to explain the dynamics of the policy shocks, and identification of these shocks becomes crucial. In order to deal with this issue, for the Taylor rule estimation we extend the benchmark model by Clarida et al. (2001). Also, due to separation of expectational errors from policy shocks, I slightly modify the framework by Harvey (1976).

The basic idea of Harvey (1976) is to explain heteroskedasticity in the regression model. Strong heteroskedasticity is associated with much discrepancy of the actual values of the left hand side variable with its fitted values. Then, Harvey (1976) suggests to explore whether heteroskedasticity has a regular part, to be explained by the same (or larger) set of variables entering the mean equation. If in the left hand side we have a choice variable set by a policy maker, then heteroskedastic errors can be interpreted as systematic deviations from the policy rule, specified as regression model (mean equation). Cerqueiro et al. (2007) measure the extent of commitment to the rule by the R^2 statistics, so that policies from different policymakers can be compared in terms of how strong commitments are. I transfer this novelty to the monetary policy rule, with proper modifications in order to disentangle policy shocks from expectational errors.

The paper has the following structure. We start from the literature review. In Section 2 the basic methodology is provided. The monetary policy model and estimation procedure are discussed in Section 3. Estimation results and concluding remarks are in Sections 4 an 5, respectively.

2 Literature review

Since early 2000s most developed countries have switched to inflation targeting policy rules and the New Keynesian DSGE framework is used to fit the policy to the actual data. The concept of time inconsistency pioneered by Kydland and Prescott

(1977) lies at the heart of the nature of monetary policy rule, and much efforts have been put to come out with identification restrictions on the optimal policy rule, in order to extract the actual pattern of that rule. In the inflation targeting framework there is common consensus that optimal monetary policy follows to the Taylor (1993) rule, and empirical studies are aimed at estimating that rule under different institutional constraints, determining discretionary and commitment policies. The lifetime objective function of the Central bank and the constraints that are derived from private agents' optimal behavior in the supply and demand sides are sufficient to endogenously derive the link between the policy and main macroeconomic variables.

The classical assumptions on frictions present in the model economy are monopolistic competition *a la* Dixit and Stiglitz (1977) and price rigidity (Calvo (1983)), as well as frictions in the financial sector due to asymmetric information between the lender and the borrower that leads to CSV type contracts (Bernanke et al. (1998)) or monopolistic competition among banks (Gerali et al. (2010)), which breaks neutrality of financial system (the Modiglani-Miller theorem). These are the fundamental assumptions for the most DSGE models, and the implied optimal policy rules in different regimes (commitment versus discretion) are estimated[1]. Relatively early literature estimates only backward looking type of policy rules (e.g., Ozlale (2003) and Favero and Rovelli (2003)), in which the issue of time incostistency is not relevant, since the policy is not a function of variables that have ex post realization. The recent literature examines monetary policy rule in the forward looking framework. Discretionary policy rules in different time intervals for the U.S. economy has been estimated by e.g. Dennis (2003) and Soederstroem et al. (2002), and Salemi (2006) examines the case of commitment.

There are however few papers that test the policy rule, which type of policy (commitment or discretion) is empirically relevant. Givens (2009) estimates a new-Keynesian model of the US economy, in which the forward-looking behavior enables to distinguish two modes of optimization, namely, commitment and discretion. Coroneo at al (2010) provide a new procedure for testing the degree of commitment to time inconsistent optimal plans, relying on set-identification on the basis of the first order conditions.

All these studies have sound theory supported structural base and address the policy issues in developed economies, in which market structure and policy transmission

[1]Cochrane (2007) analyzes the main forms of monetary policy rules discussed in DSGE literature, and demonstrates that most of the cases the policy parameters are not identified in these models.

channels are well developed. Such issues as consequent stages of decision making and implied timing of information between monetary and fiscal authorities, as well as policies towards financial stability are essentially neglected. The other dimension is weakness of traditional channels of the monetary transmission mechanism, which induce monetary authorities to make use of policy tools, different from the classical once.

For emerging market economies (but not only) with many institutional constraints it is more rational to simplify identification sets for testing nature of conducted policy rule. The major step is to reduce the term "commitment" to a "rule" and refer "discretion" to any deviation from the rule. This is a rather classical approach and still used in empirical works.

Despite the term "discretion" presumes a certain rule in the recent literature[2], it has initially been perceived as deviation from the rule, which is systematic and hence time consistent component of the conducted policy. According to the original contributions by Kydland and Prescott (1977) and Barro and Gordon (1983) a policy rule is considered as "optimal" or "precommitted", and discretionary policy is referred to as "inconsistent" or "shortsighted" solution. Taylor (1993) uses these concepts and treats discretion as deviation from the rule. That is, one way to test the rule versus discretion, is directly to test the policy rule of the Taylor type.

Using Non-linear Least squares method Orphanides (2004) estimated a monetary policy rule using real-time FOMC Greenbook projections on inflation and output gap as regressors. The estimation done for the periods before and after Paul Volker's appointment as FED chairman provided evidence against the hypothesis that the Great inflation of 1970s was a result of inappropriate policy actions.

There are numerous papers that test how well the Taylor rule implied policy can explain actual data. For the early literature, see Clarida et al. (1999b) and the references herein. There are some papers estimating monetary policy rules for sets of emerging economies and these are implicit tests of Taylor rules. Fendel et al (2009) test perceived Central Bank consistency for emerging markets, looking at the magnitude of estimated coefficient of the inflation rate[3].

All the papers that test the relevance of Taylor rule in practice, they interpret the mean equation, in the sense that the regression errors are out of their scope of analysis. The monetary policy rule is potentially very complex, especially for emerging

[2]For analytical derivation of policy rules under discretion and commitment, see Clarida et al. (1999a) and Clarida et al. (2001)

[3]The policy is consistent if the coefficient of inflation is higher than 1.

markets, and instead of interpreting the magnitudes of parameters in the context of rule versus discretion, it seems reasonable to consider the mean equation as the "rule" component of the policy, while the variance (generated by errors, unrestricted to be heteroscedastic) equation refers to the discretionary component.

Different to the volumnuous literature, we propose to use heteroscedastic regression model, going back to Harvey (1976), and recently applied by Cerqueiro et al. (2007), to identify the rule itself and the prediction power in terms of adjusted R^2 statistic, accruing the unexplained component to a discretionary policy. This approach has at least two advantages: there are no identification restrictions for the monetary policy rule and (ii) deviations from that rule, fairly interpreted as discretion, are subject to explanation through the relevant covariates. In particular, one can identify the rule of Taylor type, to see its prediction power for the interest rate setting by the Central bank, and to use at least the same set of covariates to estimate the dynamics of discretion.

We describe the econometric model in the next section.

3 The model and methodology

In this section we briefly describe the heteroscedastic model by Harvey (1976). The primary interest of this paper is to estimate the monetary policy rule for the U.S. and Armenian economies, and so the estimated regression models will only have time dimension. One can construct a panel that comprise set of economies that are sufficiently homogeneous in terms of conducting monetary policy rule. This could be the set of post communist countries, European economies or OECD countries. The use of heteroscedastic model to disentangle rule and discretion components has been initiated by Cerqueiro et al. (2007), who identify the determinants of loan granting policy and interpret explained deviation from the loan granting policy rule as evidence of the banks' discretionary use of market power. They have only cross section dimension, and in particular, running rolling regression on loans sorted in ascended order, they find that discretion decreases in the loan size.

The general form of the linear heteroscedastic model is the following:

$$y_i = X_i'\beta + u_i, \tag{1}$$

$$\log \sigma_i^2 = Z_i'\gamma \tag{2}$$

The identification restrictions are

$$E[u_i|X_i] = 0, \tag{3}$$

$$Var[u_i|Z_i] = 0 \tag{4}$$

Assuming normal distribution for u_i, the conditional distribution of y_i is

$$y_i|\{X_i, Z_i\} \xrightarrow{d} N(X_i'\beta, exp(Z_i'\gamma)). \tag{5}$$

We follow to the previous authors and refer to (1) as mean equation and (2) as variance equation. The parameters in the mean and variance equations, β and γ are not correlated, which effectively enables to decompose the policy into the rule and discretion components.

The interpretation of the parameters of interest γ is as follows. For any variable in Z, say Z_k, a positive γ indicates that the precision of the model (the rule component of the policy) decreases in Z_k. Cerqueiro et al. (2007) interpret this result as evidence of a positive correlation between the variable and the weight of "discretion" in the loan rate setting process. There is no restriction on selecting explanatory variables in the mean and variance equations and in particular they can coincide, $X_i = Z_i$.

Now, consider time series structure of y, X and Z, instead of cross section. Also, in order to motivate complete discussion on the topic, we include lags of variables in both equations, as well as past errors and variances in the variance equation. The latter results in GARCH[4] structure for the variance equation and enables to capture persistence in the policy, if there is. For the sake of compact notation, we include only one lag, but in general it can be more.

The resulting equations are

$$y_t = X_t'\beta_0 + X_{t-1}'\beta_1 + u_t,$$

$$\log \sigma_t^2 = Z_t'\gamma_0 + Z_{t-1}'\gamma_1 + \theta_u u_{t-1} + \theta_\sigma \log \sigma_{t-1}^2$$

The lagged variables are predetermined and the identification restrictions are counterparts of (3) and (4), lagged variables as covariates included. These variables enter the vector Z in the baseline model (1) - (2). The two stage estimation is readily available, although it potentially suffers from asymptotically inefficient estimates, as in the

[4] GARCH-generalized autoregressive conditional heteroscedasticity.

cross section (baseline) case. The full information maximum likelihood is a natural candidate as it produces the most efficient estimates.

I am going to decompose the error term, and the resulting several variance equations can be regressed using the two stage estimation technique. In the first stage, the OLS yields the estimated heteroscedastic errors, $\hat{u}_t, t = 1, ..., T$, which serve as estimates for $\sigma_t^2, t = 1, ..., T$. In the second stage we estimate the following equation:

$$\log \hat{u}_t^2 = Z_t'\gamma_0 + Z_{t-1}'\gamma_1 + \theta_u \hat{u}_{t-1} + \theta_\sigma \log \hat{u}_{t-1}^2 + \eta_t \tag{6}$$

In this model, in addition to the variables in Z_t, we have lagged variables that contribute to the variance and provide a source of persistence in discretionary policy. If θ_σ is positive, then higher discretion in the past positively contributes to the current discretion, thus reducing the precision on the rule, identified in the mean equation. It might be that $\theta_u < 0$ and $\theta_\sigma > 0$, which can be interpreted as too large deviation from the rule in the past should be corrected in the current period, while the fact that discretion was strong, it positively affects on the extent of the current discretion. The interpretation of γ_1 is the same as that of γ_0 or γ in the baseline model.

4 Application to the monetary policy rule

A natural candidate for the mean equation is the Taylor rule, which can be extended in order to account for financial and real frictions, as well as lags and leads of the relevant variables to capture persistent and forward looking nature of the policy. For sake of simplicity we state the Taylor rule in its basic form and add the vector of covariates that are taken into consideration by policymakers, when setting the interest rate.

Whenever applicable, I follow to the notation by Clarida et al. (2001), as a baseline model, for which I introduce a monetary policy shock.

General form for the monetary policy will be

$$r_t^* = r^* + \beta(\mathbf{E}\{\pi_{t+k}|\Omega_t\} - \pi^*) + \gamma\mathbf{E}\{x_{t+q}|\Omega_t\} + W_t + \xi_t, \tag{7}$$

where r_t^* is the target rate for the Central bank time t, π_t is the percent change in price level, x_t is the GDP gap, Ω_t is the information set at time t, $\mathbf{E}\{\pi_{t+k}|\Omega_t\}$ and $\mathbf{E}\{x_{t+q}|\Omega_t\}$ are expected values of percent change in the price level between periods t and $t+k$ and the output gap at time $t+q$, respectively[5]. In addition to the Taylor rule specification, we have W_t, a vector of variables, which are taken into consideration by the policymaker when setting the interest rate. It may include variables with expectations, e.g., the expected foreign exchange rate, which is one of the key determinant for the monetary policy rule in emerging market economies.

In what to follows, the rule, represented by the mean equation, should be fairly well defined, in order to capture the real process of decision making. On the other side, the same set of variables will potentially serve as covariates for the variance equation, and each variable will have some impact on the volatility of the rule. The simplest strategy is to put all relevant variables on the mean equation disregarding the problem of multicollinearity and try to extract the rule, which will have the highest adjusted R^2. Nevertheless, one should be cautious with such an unconditional strategy, as some variables might be endogenous to the model.

Different Clarida et al. (2001)'s specification, we introduce a monetary policy shock, identified as difference between the actual target rate and and policy implied rate (fitted values). We also assume a smooth process for interest rates, so that the realized rate is partially explained by its lagged values:

$$r_t = \rho(L) r_{t-1} + (1-\rho) r^*. \tag{8}$$

For simplicity, we take lag length equal to 1, but it is straightforward to extend our analysis for higher lags. Importantly, if there is an expectational variable in W_t, then the corresponding expectational errors should be properly treated.[6] Extracting the actual monetary policy rule is very important for policy makers. Despite the volumnuous literature on the topic, sketched in Section 1, to our knowledge, there is no paper that uses the approach described above, in order to identify the actual rule of the policy interest rate setting and decompose the policy into the rule and discretion components. The policy makers, through the communication within and outside the Central bank with competent bodies, agree to follow to a certain model, and the extent of actual implementation of that model forms the level of credibility for the central bank. Implementing the rule, which is (by definition) committed at some time point, means to follow to a time consistent policy, while deviations from the rule deprives credibility of the Central bank, since the public perceives these deviations as discretionary actions

[5] We will use more compact notation for the expectation operator, $\mathbf{E}_t(.) = \mathbf{E}\{.|\Omega_t\}$.

[6] In the application part, I take $L = 2$ for the U.S. data and $L = 1$ for Armenia. Also, expected exchange rate enters the Armenian monetary policy rule.

from the policy maker, incompatible with consistency in drawing policy.

The first research question is of positive nature - identify the monetary policy rule and observe how credibility evolves over time. Increasing volatility in our setting is consistent with increasing discretion in policy. This will lead to a rather time inconsistent nature of the policy and Central bank will lose its credibility towards the public. In contrast, a higher explanatory power of the policy rule will enable Central bank to earn credibility, since the policy will be characterized as time consistent. The level of time (in)consistency is subject to continuous variation and we provide only qualitative judgment (increasing or decreasing pattern over time) for it.

The other issue is to identify the impact of variables on the variance of the policy rate. From the theory we know that both inflation rate and GDP gap have positive coefficient in the Taylor rule, so that the Central bank responds to deviations of these variables from their steady state values positively, which may also lead to an increase of variance. In this case, such policy contains a source of increasing discretion, which will be perpetuated over time, if there will be persistence in the process (positive coefficients of u_{t-1} and σ^2_{t-1}). We note that the above variables *may* or *may not* have a positive impact on the variance, that is, the sign of the coefficient of a variable in the mean equation *per se* does not determine the sign of the coefficient of that variable in the variance equation.

The effectiveness of the policy can be reconsidered examining the weights of those variables, which contribute to the variance most. Due to the persistence of discretion (if there is), current policy choices might be harmful in terms of losing credibility in the future, and this is a serious reason to reconsider ongoing policies. To be precise, consider the following situation. Suppose, there is too high inflation due to the cost push shock entering the Phillips curve equation. Then the optimal monetary policy implies that the policy rate should respond to the deviation from the targeted inflation rate more than one to one. We know that the loss function accounts for excessive fluctuations, since it minimizes the infinite sum of squared deviations inflation and GDP gap from their steady state values, assuming some (typically ad hoc) weights for these variables (see e.g. Clarida, Gali and Gertler, 1999). In our context, if the inflation rate has a significant positive contribution to the variance of the policy rate, it will be interpreted as stronger deviation from the rule and hence will lead to a loss of credibility. Thus, a policy that is optimal within the standard DSGE framework, may have certain distortionary effects that may potentially persist for several periods.

5 Estimation

For the estimation of the heteroskedastic version of the Taylor rule, we use an ARIMA-GARCH model with exogenous variance regressors. Different to Clarida et al. (1999b) using expectations based on GMM estimation, we use data on inflation and GDP gap from the FOMC Greenbook projections, which represent the expected(ex-ante) values of macroeconomic variables, that were available for the policymakers at the time of setting interest rates.

The data spans the Alan Greenspan's era from 1987Q1 to 2005Q4.

We estimate the following from of Taylor rule

$$\begin{aligned} r_t &= \rho r_{t-1} + (1-\rho)\left[rr^* + \pi^* + \beta(\pi_{t+i} - \pi^*) + \gamma x_t\right] + \varepsilon_t \\ \ln \sigma^2_{\varepsilon,t} &= \alpha_0 + \alpha_1 \varepsilon_{t-1} + \alpha_2 \ln \sigma^2_{\varepsilon,t-1} + \alpha_3 \pi^s_{t+i} + \alpha_4 x_t \end{aligned} \tag{9}$$

where r_t is the federal funds rate, rr^* is the neutral real interest rate, pi^* is the target inflation rate, π_{t+i} is the i periods ahead projection of core CPI inflation, x_t is the GDP gap and π^s_{t+1} is the supply shock defined as the difference between headline inflation and core inflation.

Because of non-stationarity of the federal funds rate data we employ a 2-step estimation procedure in which we separately estimate the smoothing parameter ρ in the Taylor rule and use it to extract the target interest rate which is then used to estimate the policy response parameters and the parameters in the variance equation.

First we express Equation (9) in differences to estimate the autocorrelation coefficient ρ.

$$\begin{aligned} r_t - r_{t-1} = \rho r_{t-1} - \rho r_{t-2} &+ (1-\rho)\left[rr^* + \pi^* + \beta(\pi_{t+i} - \pi^*) + \gamma x_t\right] \\ &- (1-\rho)\left[rr^* + \pi^* + \beta(\pi_{t+i-1} - \pi^*) + \gamma x_{t-1}\right] + \varepsilon_t - \varepsilon_{t-1} \end{aligned}$$

$$\Delta r_t = \rho \Delta r_{t-1} + (1-\rho)\left[\beta(\pi_{t+i} - \pi_{t+i-1}) + \gamma(x_t - x_{t-1})\right] + u_t \tag{10}$$

Where $u_t = \varepsilon_t - \varepsilon_{t-1}$.

Table 1: Estimation results : Differenced equation

Variable	Coefficient	Std. Err.	P-value
Mean equation : Δr_t			
Δr_{t-1}	0.676***	(0.095)	0.000
$\Delta \pi_{t+2}$	0.274***	(0.093)	0.003
Δx_t	0.224***	(0.058)	0.000
Varialce equation : $\ln \sigma^2_{\varepsilon,t}$			
α_0	-3.864***	(0.668)	0.000
x_t	0.272**	(0.107)	0.011
ϵ_{t-1}	-0.071	(0.057)	0.210
$\sigma^2_{\varepsilon,t-1}$	0.838***	(0.147)	0.000

$*p < .1$; $**\ p < .05$; $***\ p < .01$

The resulting equation represents the change of the policy rate as a stationary ARMA(1,1) process with exogenous covariates and potentially unstable moving average part. This specification can be consistently estimated using Maximum-likelihood procedure, regardless of the unstable MA part ().

Then, using the estimated coefficient, we separate the interest rate smoothing part ρr_{t-1} from the target interest rate and estimate the following equation

$$\begin{aligned} \widetilde{r_t} &= (1-\rho)\left[rr^* + \pi^* + \beta(\pi_{t+i} - \pi^*) + \gamma x_t\right] + \varepsilon_t \\ \ln \sigma^2_{\varepsilon,t} &= \alpha_0 + \alpha_1 \varepsilon_{t-1} + \alpha_2 \ln \sigma^2_{\varepsilon,t-1} + \alpha_3 \pi_{t+i} + \alpha_4 x_t \end{aligned} \tag{11}$$

Where $\widetilde{r_t} = r_t - \hat{\rho} r_{t-1}$

The coefficients β and γ in Equation (11) are identified using the interest rate smoothing parameter estimated in the differenced version of the Taylor rule (see Equation (10))

Table 2: Estimation results : Transformed equation

Variable	Coefficient	Std. Err.	P-value
Mean equation : $\widetilde{r}_t$			
π_{t+2}	1.595***	(0.126)	0.000
x_t	0.708***	(0.049)	0.000
$rr^* + (1-\beta)\pi^*$	0.304	(0.377)	0.420
Variance equation $\ln \sigma^2_{\varepsilon,t}$			
α_0	-3.814***	(0.704)	0.000
π^s_{t+1}	-1.890**	(0.898)	0.035
x_t	0.242	(0.198)	0.221
ϵ_{t-1}	0.239	(0.240)	0.320
$\sigma^2_{\varepsilon,t-1}$	0.332	(0.309)	0.282

*$p < .1$; ** $p < .05$; *** $p < .01$

The estimates of policy response parameters are in line with the previous estimates in Clarida et al. (1999b). The estimates of the coefficients in variance equation reveal a relationship between supply shock, GDP gap and the degree of monetary policy discretion during the considered period. The degree of discretion is decreasing in the supply shock, which means that monetary policy has been more tied to the rule in times of positive supply shocks and more flexible in times of negative shocks. More flexible monetary policy has been conducted in times of negative shocks due to the temporary nature of supply shocks. Still, in case of positive shocks monetary policy tends to strictly follow the rule, disclosing the commitment to its price stability mission.

The coefficient on GDP gap shows some connection between GDP gap and policy discretion. It shows that the policy tended to deviate from the rule in times of positive GDP gap, but followed the rule in times of negative gap. This result can be explained by the increased freedom of monetary policy when the economy did well, so that the expected high economic growth gave the policymakers more room to deviate from the rule. On the other hand monetary policy had to follow the rule when economic conditions deteriorated and an adequate response of monetary policy was needed.

As for the impact of the conditional heteroskedasticity terms on the policy discretion, the latter is increasing in past monetary policy shocks, both in magnitude and dispersion. Also, there is a some evidence about persistence of policy discretion.

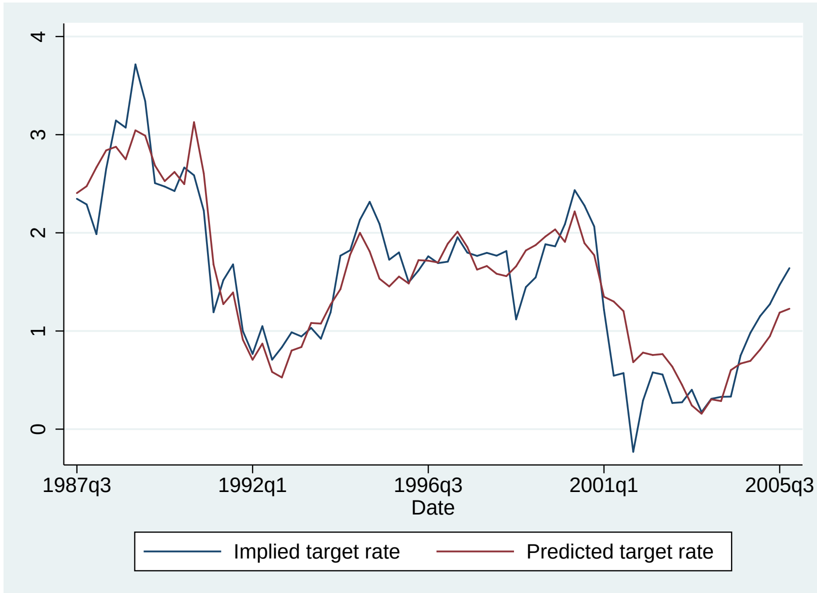

Figure 1: Implied federal funds target rate $\tilde{r}_t$ and the rate predicted by the estimated rule (11)

6 Conclusion

In the paper we use ARIMA-GARCH model to measure the strength of commitment versus discretion in the monetary policy framework. Deviations from the committed rule, in form of volatility of a policy shock, are regressed on the key determinants of the policy rule, disclosing the nature and strength of discretion of a central banker. Today's discretion may partially by explained by the previous period discretion, as a consequence of deprived credibility of the central bank, making commitment more costly. We estimate the U.S. monetary policy rule for Alan Greenspan's era (1987Q1 - 2005Q4). The degree of discretion is decreasing in the supply shock, suggesting that monetary policy has been more tied to the rule in times of positive supply shocks and more flexible in times of negative shocks. Also, monetary policy tended to deviate from the rule in times of positive GDP gap, and follow the rule in times of negative gap. Finally, policy discretion is increasing in past monetary policy shocks.

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