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Risk Management-Driven Policy Rate Gap

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Abstract

We employ real-time data available to the US monetary policy makers to estimate a Taylor rule augmented with a measure of financial uncertainty over the period 1969-2008. We find evidence in favor of a systematic response to financial uncertainty over and above that to expected inflation, output gap, and output growth. However, this evidence regards the Greenspan-Bernanke period only. Focusing on this period, the "risk-management" approach is found to be responsible for monetary policy easings for up to 75 basis points of the federal funds rate.

JEL-Codes: C200, E400, E500.

Keywords: risk management-driven policy rate gap, uncertainty, monetary policy, Taylor rules, real-time data.

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1 Introduction

"[...] The Federal Reserve's experiences over the past two decades make it clear that uncertainty is not just a pervasive feature of the monetary policy landscape; it is the defining characteristic of that landscape. [...] the conduct of monetary policy in the United States has come to involve, at its core, crucial elements of risk management."

Alan Greenspan (2004)

Does the Federal Reserve act as a risk-manager? The quote by Former Federal Reserve's chairman Alan Greenspan points to a positive answer. This paper provides empirical support to this view by quantifying the implications of this "risk management" approach for the federal funds rate. We do so by estimating a Taylor rule augmented with a measure of financial uncertainty over the period 1969M1-2008M10, and by computing the "risk-management-driven policy rate gap". This gap measures the difference between the actual policy rate and the counterfactual policy rate that would have been observed had the Federal Reserve not acted as a "risk manager", i.e., had it not reacted to fluctuations in financial uncertainty. Our estimates focus on the entire sample as well as on subsamples identified by changes of the Federal Reserve's chairman to take into account possible breaks in policymakers' preferences both over risk management and over inflation and output stabilization (Clarida, Galí, and Gertler (2000), Lubik and Schorfheide (2004), Castelnuovo and Fanelli (2015), Boivin and Giannoni (2006), Castelnuovo and Surico (2010)). Importantly, we employ data available in real-time to the Federal Open Market Committee, which is crucial to correctly characterize monetary policy decisions by the Federal Reserve (Orphanides (2001, 2002), Coibion and Gorodnichenko (2011, 2012), Gnabo and Moccero (2015)).

We find significant evidence in favor of a systematic monetary policy response to movements in financial uncertainty. However, this evidence is limited to the Great Moderation period characterized by the lead of Greenspan and Bernanke. The Greenspan-Bernanke risk management approach is associated to a looser monetary policy with respect to the one the Federal Reserve would have implemented had it not reacted to financial uncertainty directly. The estimated median value of the "risk-management-driven" policy rate gap is 30 basis points, which is approximately a standard policy rate move. However, in correspondence to well-identified historical events (Black Monday, 2008 credit crunch), such a gap is estimated to be three times as large due to the higher realizations of financial uncertainty.

Many empirical proxies of uncertainty have recently been proposed by the literature (for a survey, see Bloom (2014)). We focus on financial uncertainty for three reasons.

First, Angelini, Bacchiocchi, Caggiano, and Fanelli (2017) and Ludvigson, Ma, and Ng (2018) find that financial uncertainty shocks - as opposed to macroeconomic uncertainty disturbances - are drivers of the business cycle. Second, and related to the previous point, several papers have recently documented the contribution of financial uncertainty shocks to the US business cycle (Bloom (2009), Caggiano, Castelnuovo, and Groshenny (2014), Leduc and Liu (2016), Basu and Bundick (2017), Caggiano, Castelnuovo, and Nodari (2017), Caggiano, Castelnuovo, and Pellegrino (2017)). Third, financial uncertainty is likely to have strong connections with the uncertainty characterizing the future evolution of the US economy, above all as far as output growth is concerned (Evans, Fisher, Gourio, and Krane (2015)).

The closest papers to ours are Evans, Fisher, Gourio, and Krane (2015) and Fernández-Villaverde, Guerrón-Quintana, Kuester, and Rubio-Ramírez (2015). The first paper presents theoretical motivations for a risk management approach by monetary policymakers (one example being asymmetric loss functions, which imply the presence of second-order elements in the optimal monetary policy feedback function), and document a systematic response to different measures of uncertainty during Greenspan's regime (which is the only regime they investigate). The second paper shows that a nonlinear DSGE framework matches the data better when a systematic monetary policy response to fiscal uncertainty is modeled. We complement these papers by i) showing that the Federal Reserve's risk management-type of response to macroeconomic shocks is monetary policy regime-specific, and ii) defining and quantifying the risk-management driven policy rate gap.[1]

The rest of the paper is organized as follows. Section 2 offers details on the empirical strategy. Section 3 documents our estimates and proposes the risk-management driven policy rate gap. Section 4 concludes.

2 Empirical strategy

Taylor rule. We consider the following Taylor rule:

$$R_t^* = R^* + \phi_\pi(E_t\pi_{t,k} - \pi^*) + \phi_x E_t x_{t,q} + \phi_{\Delta y} E_t(\Delta y_{t,p} - \Delta y^*) + \phi_{unc} unc_t \quad (1)$$

$$R_t = (1 - A(L))R^* + A(L)R_{t-1} + v_t \quad (2)$$

[1] Another strand of the literature looks at uncertainty induces by monetary policy. For recent contributions, see Istrefi and Mouabbi (2017) and Husted, Rogers, and Sun (2018).

Eq. (1) describes the evolution of the Taylor rate in absence of interest rate persistence. In this equation, $\pi_{t,k}$ stands for the average annualized inflation rate from t to $t+k$, π^* is the inflation target, $x_{t,q}$ is the average output gap from t to $t+q$, $\Delta y_{t,p}$ is the average output growth from t to $t+p$, Δy^* is the output growth target, unc_t stands for financial uncertainty, E_t denotes expectations conditional on information available to the FOMC at time t, and R^* is the Taylor rate conditional on inflation and output growth being at the target, a zero output gap, and a concern by policymakers for uncertainty equal to zero.[2] Given that the FOMC has a preference for implementing variations in the policy rate in a smooth manner (English, Nelson, and Sack (2003), Castelnuovo (2003)), the polynomial $A(L) = \Sigma_{j=0}^{N-1} a_{j+1} L^j$ in eq. (2) is modeled, where L is the lag operator, and N denotes the number of federal funds rate lags. Finally, we allow for the presence of monetary policy shocks via the zero-mean, constant variance error term v_t.

Combining equations (1) and (2) yields to the following linear equation:

$$R_t = b_0 + b_\pi E_t \pi_{t,k} + b_x E_t x_{t,q} + b_{\Delta y} E_t \Delta y_{t,p} + b_{unc} unc_t + A(L) R_{t-1} + v_t \tag{3}$$

where $b_i, i = 0, \pi, x, \Delta y$, and unc are nonlinear functions of the structural parameters ϕ_π, ϕ_x, $\phi_{\Delta y}$, $\Delta y_{t,p}$, R^*, and π^*.

Data. We estimate eq. (3) with real-time data. In particular, we employ the Greenbook forecasts of current and future inflation, output gap, and output growth. The interest rate is the federal funds rate set at each FOMC meeting. The measure of financial volatility is the VXO of the "Greenbook day", which is the day in which the Greenbook is finalized (typically, a few days before each FOMC meeting). Given that before 1986 the VXO is not available, we proxy it with the volatility of S&P500 returns computed over a 30-day window before the Greenbook day.[3]

Estimation. We estimate the Taylor rule (3) via ordinary least squares, which delivers consistent estimates of the Taylor rule coefficients given the real-time nature of the data.[4] We account for heteroskedasticity by using the Newey-West correction

[2] As in Evans, Fisher, Gourio, and Krane (2015), we assume the implicit target for uncertainty to be equal to zero. This implies that also moderate, below-mean levels of uncertainty are interpreted as economically harmful by monetary policymakers. This view is corroborated by models à la Bloom (2009) and Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2018), which assume a non-zero inaction region for whatever positive level of uncertainty, and Basu and Bundick (2017), which deliver negative effects of uncertainty independently of the size of the uncertainty shock.

[3] Our results are robust to employing the volatility of S&P500 returns over the whole sample.

[4] See Coibion and Gorodnichenko (2011) (page 355, foonote 17) for an in-depth discussion on the properties of OLS in this context.

of the variance of the estimated coefficients. As in Coibion and Gorodnichenko (2011, 2012), we set $k = 2$, $q = p = 0$, and $N = 2$. The choice of two lags of the policy rate is in line with Clarida, Galí, and Gertler (2000), which is the seminal paper regarding Taylor rules for the United States, Coibion and Gorodnichenko (2011) and Coibion and Gorodnichenko (2012), who also work with real time data, and Ascari, Castelnuovo, and Rossi (2011), who find a Taylor rule with two lags of the policy rate to be associated to a higher marginal likelihood in the context of a battery of estimated DSGE models.

We estimate eq. (3) over the full sample 1969M1-2008M10. The beginning of the sample is justified by data availability, while the end in October 2008 is the last FOMC meeting before the beginning of the ZLB period, which can hardly be described by a standard Taylor rule modeling conventional monetary policy. As anticipated, we also estimate eq. (3) over different subsamples. Due to sample numerosity, we bundle the regimes characterized by Martin's, Burns', and Miller's chairmanships on the one hand, and Greenspan's and Bernanke's on the other hand, under (respectively) the "Great Inflation" regime and the "Great Moderation" one (although, as regards the latter, we check our results by focusing on Greenspan's regime only). We also consider a third regime, which is the one characterized by Volcker's lead of the Federal Reserve.

3 Empirical results

Evidence of risk management. Table 1 collects our estimates, which - as for output and inflation - confirm previous findings in the literature, in particular those by Coibion and Gorodnichenko (2011, 2012).[5] Relevant for our study is the systematic response to financial uncertainty. The regimes of Greenspan and Bernanke are associated to a significant response of the policy rate to financial uncertainty. It is important to stress that this response is found to be significant in spite of the presence of inflation, output gap, output growth, and two lags of the policy rate in the Taylor rule. Our evidence points to a negative reaction of the policy rate to financial uncertainty, i.e., to a looser monetary policy than the one described by inflation and real activity only. Differently, evidence consistent with risk management is found neither during the Great Inflation

[5] These estimates represent the on-impact systematic response of the federal funds rate to movements in the macroeconomic aggregates on the right-hand side of the Taylor rule. We focus on the on-impact coefficients because we will use them later to construct the risk management-driven policy rate gap. The implied long-run Taylor rule coefficients, which are often documented in the Taylor rule context, and which take into account the impact of interest rate smoothing for the long-run monetary policy response to inflation, output, and financial uncertainty, are documented in our Appendix for the sake of brevity.

period nor during Volcker's regime.

Risk management-driven policy rate gap. What is the impact of risk management on the policy rate? We quantify it by computing the difference between the actual policy rate R_t and the fitted policy rate conditional on setting the response to financial uncertainty to zero $\widehat{R}_t^{no\_unc}$. We label this object "risk management-driven policy rate gap". Formally, this gap is computed as $\widehat{R}_t^{gap} = R_t - \widehat{R}_t^{no\_unc} = \widehat{b}_{unc} unc_t$.[6]

Figure 1 plots the risk management-driven policy rate gap. A few observations are in order. First, the gap is negative. This evidence, which is a direct implication of $\widehat{b}_{unc} < 0$, suggests a cautious behavior by the Federal Reserve in presence of uncertainty, i.e., a looser monetary policy than the one the Federal Reserve would have implemented in a world without uncertainty. Second, the median realization of this gap is 30 basis points, i.e., about the size of a standard policy move. Third, the largest realizations (in absolute value) of this gap occur in correspondence of well-identified historical events, e.g., the Black Monday (84 basis points) and the 2008 credit crunch (80 basis points), which are roughly equivalent to three standard policy moves. Other historical events, such as the two Gulf wards, the Asian crisis, the Worldcom/Enron scandals, the Russian and LTCM defaults, and 9/11 are also associated with peaks of the policy rate gap.

4 Conclusions

We estimate augmented Taylor rules with real time data which feature a measure of financial uncertainty among the explanatory variables. We find evidence of a significant policy response to financial uncertainty during the Greenspan-Bernanke period. We then propose an estimate of the "risk management-driven policy rate gap", which is the gap between the actual rate and a counterfactual policy rate implemented in absence of risk management. Such a gap is negative, an evidence consistent with a cautious approach (i.e., a loose monetary policy) by the Federal Reserve in presence of financial uncertainty The median value of the policy rate gap is 30 basis points, i.e., close to one standard policy move by the Federal Reserve, but larger values are detected in correspondence of large jumps in financial uncertainty, in particular those occurred in correspondence of the Black Monday and the 2008 credit crunch. Our findings point to the need of understanding how optimal monetary policy should be conducted in

[6]This way of constructing the policy rate gap neglects the dynamic feedback effect of changes in the policy rate on inflation, output, and financial uncertainty. As shown in our Appendix, an exercise conducted with a VAR modeling all these variables delivers a very similar estimates of the policy rate gap.

presence of uncertainty shocks. Recent attempts along this line are Basu and Bundick (2015) and Seneca (2018).

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	FULL	GRINFL	VOLCKER	GREENSP.	GRMODER
ϕ_π	0.19^{***} (3.76)	0.14^{***} (3.34)	0.47^{***} (3.69)	0.38^{***} (4.84)	0.26^{***} (3.25)
$\phi_{\Delta y}$	0.07^{**} (2.58)	0.04^{**} (2.28)	0.18 (1.55)	0.08^{**} (3.51)	0.11^{***} (4.96)
ϕ_x	0.06^{***} (3.98)	0.07^{***} (2.98)	-0.03 (-0.52)	0.15^{***} (5.32)	0.11^{***} (4.58)
ϕ_{unc}	-0.01^{*} (-1.67)	-0.01 (-0.16)	-0.03 (-0.54)	-0.01^{**} (-2.44)	-0.02^{***} (-2.83)
a_1	0.91^{***} (32.85)	0.88^{***} (17.80)	0.70^{***} (8.87)	0.64^{***} (7.60)	0.68^{***} (7.92)
a_2	–	–	–	0.18^{**} (2.13)	0.20^{***} (2.23)
$\overline{R}^2$	0.93	0.91	0.79	0.98	0.97
Obs.	365	127	67	149	171

Table 1: **Estimated Taylor rules: Short-run responses.** FULL: Full sample, 1969M1-2008M10. GRINFL: Martins-Burns-Miller's sample, 1969M1-1979M7. VOLCKER: Volcker's sample, 1979M8-1987M7. GREENSP.: Greenspan-only sample: 1987M8-2006M1. GRMODER: Greenspan-Bernanke' sample:1987M8-2008M10. Responses to inflation, the output growth, the output gap, and financial uncertainty are collected from top to bottom in the Table, along with the estimated interest rate smoothing. Figures in the Table are point estimates and t-stats (in brackets). One, two, and three stars correspond to p-values < 0.10, 0.05, and 0.01, respectively. Newey-West standard errors computed to account for heteroskedasticity. Rules estimated with an interest rate smoothing structure of order 2 first; in presence of an insignificant lag of order 2, rules estimated with one lag of the policy rate only.

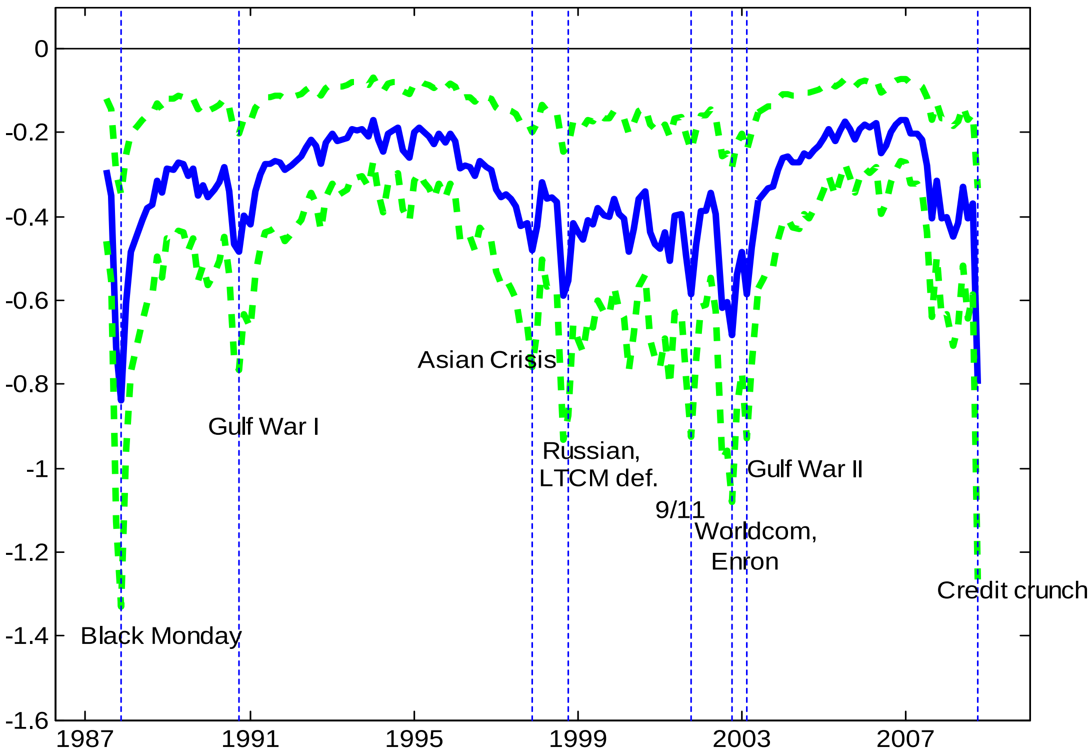

Figure 1: **Risk management-driven policy rate gap**. Blue line: Policy rate gap constructed by computed the fitted value of the policy rate conditional on the estimated response to financial uncertainty. Green lines: 90% confidence bands. Blue vertical dotted lines: Historical events associated to peaks of the policy rate gap.

Appendix of the paper: "Risk Management-Driven Policy Rate Gap" by Giovanni Caggiano, Efrem Castelnuovo, and Gabriela Nodari

This Appendix documents extra results which, for the sake of brevity, we decided not to include in the main text.

- **Taylor rule estimates: Long-run parameters**. Table A1 collects the long-run estimates computed by translating the short-run estimates reported in the text into long-run one by accounting for the role of interest rate smoothing. Formally, $\phi_j = (1 - a_1 - a_2)^{-1} b_j$, with $j = \pi, x, \Delta y$, and unc. To be sure, the estimated parameters a_1 and a_2 are the same as those already documented in the text.

- **Dating of the policy rate gap peaks**. Table A2 reports the dating of the policy rate gap peaks documented in the paper.

- **Extra notes on the data**. After building up the series of the federal funds rate used in this analysis, we confronted it with the target federal funds rate set at each meeting produced by Romer and Romer (2004) and updated by Mu-Jeung Yang and Wieland (2007). The correlation between these two policy rates in the sample 1969M1-2007M12 is 0.99.

- **Risk management-driven policy rate gap: VAR evidence.** The risk management-driven policy rate gap proposed in the text is computed conditional on a Taylor rule framework, which does not acknowledge the dynamic feedback effect going from changes in the policy rate to inflation, real activity, and financial uncertainty. We check our estimate of the policy rate gap by running an alternative exercise in which all variables of our analysis are modeled as endogenous. We do so by estimating a reduced-form VAR(2) model modeling the vector $[E_t\pi_{t,k}, E_t x_{t,q}, E_t\Delta y_{t,p}, unc_t, R_t]'$, where - as for our Taylor rule exercise documented in the text - we set $k = 2$ and $q = p = 0$. We compute the policy rate gap by taking the difference between the actual policy rate and the policy rate simulated by switching off the systematic response of the rate to financial uncertainty at all lags. We employ the period 1984M1-1987M7 as a "burn in" period to initialize the endogenous variables, and consider the period 1987M8-2008M10 for the computation of the policy rate gap. Figure A1 depicts the policy rate gap conditional on the VAR model and compares it with the one constructed with the

Taylor rule and documented in the text. The policy rate gap constructed with the VAR turns out to be somewhat closer to zero, with a median absolute value equal to 22 basis points (vs. 30 basis points according to the Taylor rule model) and a maximum realization in absolute value equal to 59 basis points in correspondence of the Black Monday (vs. 84 basis points according to the Taylor rule model). However, as shown by the Figure, the VAR-related policy rate gap is statistically equivalent to the Taylor rule one.

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	FULL	GRINFL	VOLCKER	GREENSP.	GRMODER
ϕ_π	2.05*** (4.77)	1.19*** (2.87)	1.56*** (6.05)	2.08 *** (10.37)	2.25*** (6.73)
$\phi_{\Delta y}$	0.73** (2.10)	0.30 (1.50)	0.60 (1.65)	0.44** (2.59)	0.95** (2.33)
$\phi_{\widetilde{y}}$	0.61*** (3.59)	0.61*** (3.82)	−0.09 (−0.51)	0.82*** (8.69)	0.93*** (5.18)
α_{unc}	−0.13 (−1.44)	−0.01 (−0.17)	−0.10 (−0.52)	−0.07** (−2.15)	−0.14* (−1.79)
a_1	0.91 *** (32.85)	0.88 *** (17.80)	0.70*** (8.87)	0.64*** (7.60)	0.68*** (7.92)
a_2	–	–	–	0.18** (2.13)	0.20*** (2.23)
$\overline{R}^2$	0.93	0.91	0.79	0.98	0.97
Obs.	365	127	67	149	171

Table A1: **Estimated Taylor rules: Long-run responses.** FULL: Full sample, 1969M1-2008M10. GRINFL: Martins-Burns-Miller's sample, 1969M1-1979M7. VOLCKER: Volcker's sample, 1979M8-1987M7. GREENSP.: Greenspan-only sample: 1987M8-2006M1. GRMODER: Greenspan-Bernanke' sample:1987M8-2008M10. Responses to inflation, the output growth, the output gap, and financial uncertainty are collected from top to bottom in the Table, along with the estimated interest rate smoothing. Figures in the Table are point estimates and t-stats (in brackets). One, two, and three stars correspond to p-values < 0.10, 0.05, and 0.01, respectively. Newey-West standard errors computed to account for heteroskedasticity. Rules estimated with an interest rate smoothing structure of order 2 first; in presence of an insignificant lag of order 2, rules estimated with one lag of the policy rate only.

Date	Event
Oct. 1987	Black Monday
Oct. 1990	Gulf War I
Nov. 1997	Asian crisis
Sep. 1998	Russian, LTMC default
Sep. 2001	9/11
Sep. 2002	Worldcom, Enron
Feb. 2003	Gulf War II
Oct. 2008	Credit crunch

Table A2: **Major peaks of the policy rate gap.** Dates corresponding to peaks of the policy rate gap associated with identified historical events.

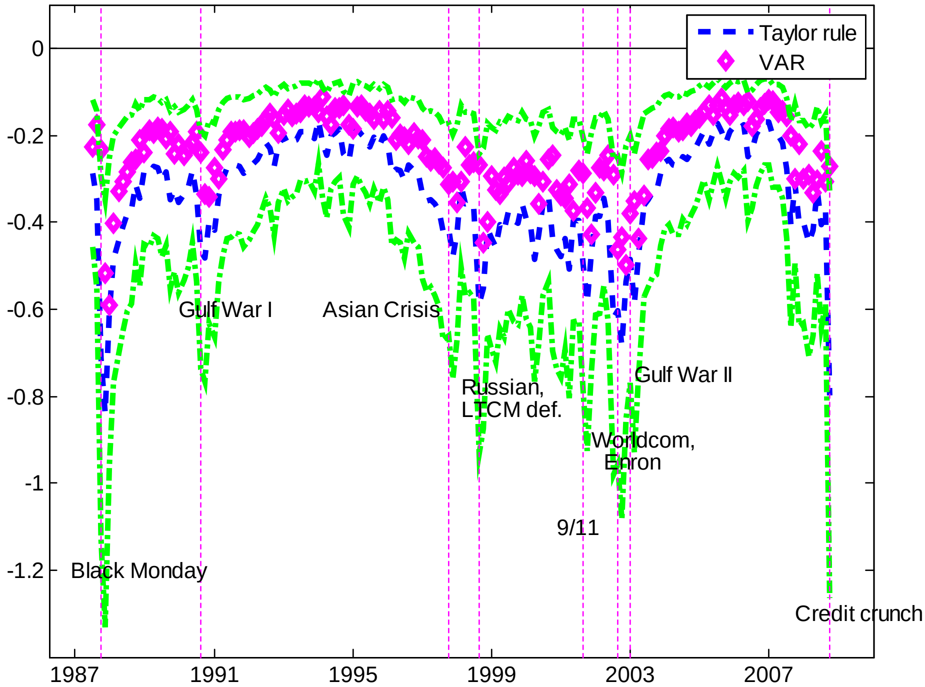

Figure A1: **Risk management-driven policy rate gap**: **VAR evidence**. Magenda diamonds: Policy rate gap conditional on the VAR model. Blue line: Policy rate gap conditional on the Taylor rule model. Green lines: 90% confidence bands conditional on the Taylor rule model. Magenta vertical dotted lines: Historical events associated to peaks of the policy rate gap.