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Forecast uncertainty and the Bank of England interest rate decisions

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Abstract:

To assess the Bank of England Monetary Policy Committee decisions about the Official Bank Rate under forecast uncertainty, I estimate simple forecast-based interest rate rules augmented by the forecast standard deviations recovered directly from the Inflation Report fan charts. I find that interest rate decisions react to deviations of the medium-term forecasts for inflation from target in order to pursue the inflation target. Forecast inflation uncertainty has a strongly intensifying effect on this reaction. Information from output growth is utilized in the form of near-term forecasts. The associated forecast uncertainty of output growth has an attenuating effect on the interest rate reaction. When accounting for asymmetries in forecast uncertainty I find that forecast upward risks to inflation contribute to the intensifying effect of forecast inflation uncertainty. The corresponding downward risks have no significant impact. As regards output growth, asymmetries in the forecast uncertainty have no significant impact on the interest rate reaction at all. Moreover, I find that forecast risks to inflation have a direct effect on the interest rate decisions, in particular when inflation is forecast close to target.

Keywords: Forecast Uncertainty, Forecast Risk,
Bank of England, Monetary Policy Committee,
Forecast-based Interest Rate Rules

JEL classification: C53, E43, E47

Non-technical summary

Monetary policy decisions on the level of a central bank's key interest rate bank are typically the result of a complex process. This starts with the analysis of macroeconomic and financial data using mathematical and statistical tools and ends with decision-making by a committee such as the Governing Council of the ECB or the Bank of England Monetary Policy Committee (MPC). Despite the complexity of this process, historical monetary policy decisions can often be described fairly well by a single equation model, known as an interest rate reaction function. An interest rate reaction function models an interest rate controlled by the central bank subject to information on the state of the economy. Such information may be the observed growth rates of a well-defined consumer price index (CPI), for example, or the growth rate of real gross domestic product (GDP). It is usually assumed, however, that central banks take into consideration future developments in CPI inflation and real GDP growth, which then have to be forecast.

In this study, forecast-based interest rate reaction functions for the Bank of England are estimated by econometric methods. Since forecasts are uncertain and the uncertainties might affect the interest rate decisions, they should be incorporated into the estimation model. This study therefore focuses on the impact of forecast uncertainty on the strength of the relationship between the MPC's own forecasts and the interest rate decisions of the MPC on the official Bank Rate. The data used are the historical forecasts for British CPI inflation and for the annual growth rates of real GDP published by the Bank of England in its quarterly Inflation Report. A feature of the Bank of England Inflation Reports is that they show not only point forecasts but also entire probability distributions, known as the fan charts. From the fan charts, the exact forecast standard deviation for CPI inflation and for real GDP growth are calculated and used as the genuine measure of forecast uncertainty in the estimation model.

The results suggest that the MPC projections for CPI inflation and real GDP growth explain the official Bank Rate quite well. Forecast inflation uncertainty has a strongly intensifying effect on the interest rate reaction in response to a forecast deviation of inflation from target. Forecast output growth uncertainty, by contrast, has an attenuating effect on the interest rate reaction in response to a forecast deviation of output growth from its long-run mean. When accounting for asymmetries in the forecast uncertainty, i.e. if likely alternatives are seen to exceed or to fall short of the point forecast, forecast exceedings contribute to the intensifying effect of forecast inflation uncertainty. Likely shortfalls, however, have no significant effect. For forecast output growth, asymmetries in the forecast uncertainty have no significant impact at all.

Nicht-technische Zusammenfassung

Geldpolitische Entscheidungen über die Höhe des Leitzinssatzes einer Zentralbank sind typischerweise das Ergebnis eines komplexen Verfahrens. Dieses beginnt mit der Analyse von realwirtschaftlichen und Finanzmarktdaten mittels mathematisch-statistischer Modelle und endet mit der Entscheidungsfindung innerhalb von Gremien wie zum Beispiel dem EZB-Rat oder dem Geldpolitischen Kommittee der Bank von England, dem MPC. Dennoch lassen sich historische geldpolitische Entscheidungen häufig recht genau mit einer einfachen Gleichung, einer sogenannten Zinsreaktionsfunktion nachbilden. Eine Zinsreaktionsfunktion modelliert einen von der Notenbank kontrollierten Zins in Abhängigkeit von Informationen über den Zustand einer Volkswirtschaft. Diese Informationen können zum Beispiel die vergangenen oder gegenwärtigen Veränderungsraten eines wohldefinierten Preisindexes und des realen Bruttoinlandsprodukts (BIP) sein. Üblicherweise wird jedoch angenommen, dass Notenbanken bei ihren Entscheidungen vor allem zukünftige Inflations- und BIP-Entwicklungen berücksichtigen, welche zunächst prognostiziert werden müssen.

In dieser Studie werden prognosebasierte Zinsreaktionsfunktionen für die Bank von England mit ökonometrischen Methoden geschätzt. Da Prognosen mit Unsicherheit behaftet sind und das Ausmaß der Unsicherheit sich auf die Zinsentscheidungen auswirken könnte, sollten diese Unsicherheiten auch in die Schätzgleichungen aufgenommen werden. In dieser Arbeit wird daher vor allem darauf eingegangen, welche Auswirkungen die Prognoseunsicherheit auf die Stärke des Zusammenhanges zwischen den Vorhersagen des MPC und dem Leitzins, der official Bank Rate, hat. Die verwendeten Vorhersage-Daten sind dabei die historischen Prognosen für die Inflation des britischen Verbraucherpreisindexes (CPI) und für die Jahreswachstumsraten des britischen realen BIP, die die Bank von England in ihren Quartalsberichten, den Inflation Reports, veröffentlicht. Die Bank von England beschränkt sich in den Inflation Reports nicht nur auf Punktprognosen, sondern veröffentlicht für jedes Quartal gesamte Verteilungen der Prognosen mit ihren entsprechenden Unsicherheitsmargen. Daraus kann die exakte prognostizierte Standardabweichung für die CPI-Inflationsprognose und für die BIP-Wachstumsprognose ermittelt und als genuines Unsicherheitsmaß in den Schätzungen verwendet werden.

Die Ergebnisse zeigen, dass der Leitzinsatz der Bank von England gut durch die eigenen Prognosen für CPI-Inflation und BIP-Wachstum erklärt werden kann. Je höher die prognostizierte Unsicherheit der Inflationspunktprognose ist, umso stärker ist die Zinsreaktion auf eine prognostizierte Abweichung vom Inflationsziel. Die Reaktion des Leitzinssatzes auf eine prognostizierte Abweichung des realen BIP-Wachstums vom langfristigen durchschnittlichen Wachstum wird hingegen durch einen Anstieg der entsprechenden Prognoseunsicherheit abgeschwächt. Berücksichtigt man zusätzlich Asymmetrien in den Unsicherheitsprognosen (es wird erwartet, dass die Punktprognose übertroffen oder unterschritten wird), so tragen prognostizierte Überschreitungen der Punktprognose zum verstärkenden Effekt der Prognoseunsicherheit der Inflation bei. Prognostizierte Unterschreitungen hingegen spielen keine Rolle. Asymmetrien in den Unsicherheitsprognosen für das BIP-Wachstum haben generell keinen nachweisbaren Einfluss auf die Zinsreaktionen.

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Forecast Uncertainty and the Bank of England Interest Rate Decisions*

1 Introduction

Adequate monetary policy is widely recognized to be forward-looking, owing to the lags in monetary policy transmission. It is a common view that interest rate decisions critically hinge on a proper assessment of future developments of inflation and output growth. As the future is unknown, practical central banking has to forecast forecast inflation and output growth. Since 1997Q4, the Bank of England has published its quarterly forecasts both for inflation and for output growth made conditional on constant interest rates and for up to two years ahead in its quarterly Inflation Report.[1] This was following the introduction of a Monetary Policy Committee in June 1997 and an explicit inflation target formulation of currently 2% annual CPI growth. The communicated medium-term objective is to have inflation two years ahead back on target, which makes the Bank of England an inflation forecast targeting institution. I use the considerable record of interest rate decisions and quarterly forecasts to estimate simple forecast-based interest rate rules to assess to what extent the Bank of England MPC decisions on the Official Bank Rate react to the MPC forecasts for both inflation and output growth.

Forecast-based rules encompass the lags of monetary policy transmission, and the forecast data are already conditioned on the relevant information set about future economic develop-

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[1] Although constant rate inflation forecasts have been available since 1993Q1, uncertainty forecasts for real GDP growth have been published since 1997Q4.

ments, as put by Batini & Haldane (1999). Thus, forecast-based rules can be a fairly precise and yet compact tool to characterize historical monetary policy decisions, as shown by Kuttner (2004) who evaluates forecast-based rules for New Zealand, Sweden, the United Kingdom and the United States. Gorter, Jacobs & de Haan (2008, 2009) provide evidence for the performance of interest rate rules for the European Central Bank, based on expectations data constructed from Consensus Economics forecasts. Orphanides & Wieland (2008) explain the Federal Open Market Committee decisions by its own projections for inflation and unemployment. Besley, Meads & Surico (2008) investigate heterogeneity in the members' interest rate decisions of the Bank of England MPC in response to its forecasts.

Forecasts, however, are inherently subject to uncertainty. Therefore, the Bank of England publishes not only point forecasts but rather entire probability distributions of the forecasts known as the fan charts and thereby explicitly quantifies forecast uncertainty. As it might affect the interest rate decisions, forecast uncertainty should be included into the estimation model. Bhattacharjee & Holly (2010) have used a mix of observed and forecast data, including the Bank of England fan chart one-year-ahead input standard deviations for inflation and output growth, when analyzing the Bank of England Monetary Policy Commitee members decisions in a panel interest rate reaction function. Despite the fact that most of their coefficient estimates on uncertainty measures are insignificant, inflation uncertainty is positively correlated with the change of interest rates while output uncertainty is negatively correlated. Kim & Nelson (2006) use standardized prediction errors for inflation and output as a bias correction in their forecast-based interest rules for the Federal Reserve. Their findings differ over subsamples, but basically they show that the probability of a interest rate reaction to a change in inflation that is sufficiently strong to stabilize the economy deteriorates when accounting for inflation uncertainty. Accounting for output uncertainty rather improves the probability of a sufficiently strong reaction. Noteworthy are the studies of Martin & Milas (2005a, 2005b, 2006, 2009) who investigate UK and US monetary policy in forward-looking policy rules. They use observed inflation and output data and control for the impact of inflation and output volatility derived from GARCH processes. Their basic result is that inflation uncertainty dampens the policy response to inflation, favoring the attenuation principle of Brainard (1967).

Although the uncertainty measures mentioned above are already good approximations, they do not reflect the forecast uncertainty that the Bank of England MPC was facing when deciding upon the official Bank Rate. Therefore I recover the exact forecast standard deviation for inflation and for output growth directly from the forecast densities published by the Bank of England as proposed by Wallis (2004). These forecast standard deviations *originally associated* with the forecast location parameters reflect the *genuine and thus relevant measure* of uncertainty about future economic developments the MPC has available at the time the interest rate decision is made. I include the forecast standard deviations directly in reaction functions to estimate the strength and the direction of the impact of forecast uncertainty on the MPC interest rate responses to forecast deviations of inflation from target and output growth from long-run mean. Since the Bank of England emphasizes its use of the two-piece normal distribution, potential asymmetries in forecast uncertainty have to be taken into consideration. Forecast uncertainty is asymmetric when an average of likely alternative outcomes for one variable is seen to exceed or to fall short of the central projection for that variable. The MPC defines such a difference between mean and mode forecast as forecast risk to the central projection. I control for these risks by including their normalized values, the exact forecast Pearson mode skewness for inflation and for output growth, into the regression model.

I find that the MPC interest rate decisions react to deviations of forecast inflation from target in the medium term. When accounting for the forecast inflation uncertainty I find a strongly intensifying effect on interest rate reactions. The partial effect of the forecast standard deviation implies a very aggressive MPC behavior in order to pursue the inflation target. Forecasts for current and near-term inflation have no significant impact nor do their associated forecast uncertainty measures have. On the other hand, information from forecast demeaned output growth steps in for the near term, and its associated forecast uncertainty has an attenuating effect on the interest rate decision response. Contrary to inflation, output growth medium-term forecasts have no explanatory power for the interest rate decisions. When accounting for asymmetries in forecast uncertainty I find that forecast upward risks to inflation contribute to the intensifying effect of forecast inflation uncertainty. This contradicts the Bank of England statement that the inflation target is symmetric. The corresponding downward risks to inflation and forecast risks of either direction to forecast output growth have no significant effect. Moreover, I find that the forecast risk for inflation has a direct effect on interest rate decisions, in particular when the central projection for inflation is close to target.

The paper is organized as follows: Section two explains the data set used. Section three shows the regression model and estimation results for a forecast-based interest rate reaction function augmented by forecast uncertainty. Section four assesses asymmetries in the forecast uncertainty. Section five concludes.

2 Data

The interest rate data for this study have been collected from the interest rate voting spreadsheet published on the Bank of England website. They refer to the decision of the MPC about the level of the key interest rate, the Official Bank Rate, from 1997Q3 to 2009Q4.[2] Though available on a monthly basis, I select the values of March, June, September and December, which are the decisions in light of the most recent forecast results presented in the Inflation Report.[3] The reports and thus the forecasts are published only quarterly, in the middle of the mid-quarter months February, May, August and November. With the timing of the dependent variable I aim to circumvent the undesired introduction of endogeneity between interest rate decisions and forecasts for inflation and output growth.

The Inflation Reports comprise the forecast location parameters mean, mode and median, together with a measure of uncertainty and a measure of the skew of the distribution. The Bank of England has popularized presenting its forecasts as fan charts, a bird's-eye view on the probability distributions of the forecasts made for the two-year forecast horizon. These *"fan charts [...] encompass the views of all members"* with respect to the medium-term outlook for the UK economy, as stated in the Inflation Report from February 1998.[4] The forecast

[2]The Bank of England key interest rate was named repo rate from 1997 to 2006.

[3]The observation resulting from the extra meeting after September 11 is dropped. It was unanimously decided to lower interest rates by 25 basis points.

[4]The entire forecast history is provided as "Numerical Parameters for [...] Probability Distributions"

data sample ranges from 1997Q4 to 2009Q4, and I use the available constant-rate nowcasts and forecasts, made for up to eight quarters ahead. The inflation forecasts are indexed by $h = 0, \ldots, 8$ and the output growth forecasts are indexed by $k = 0, \ldots, 8$.[5] Using constant-rate forecasts only should drain another source of endogeneity that may arise from forecasts conditioned on interest rates that in turn depend on market expectations about the Official Bank Rate.

From the location parameter forecasts I concentrate on the mode, since it is highlighted as the central projection of the Bank of England.[6] The Bank used to forecast RPIX inflation until the end of 2003, targeted at 2.5%. Since the Inflation Report of February 2004, the target remained at an annual CPI inflation of 2%.[7] As inflation measure for the interest rate rules I calculate the deviation of forecast inflation from target for time $t+h$, made at time t, denoted by $\hat{\pi}_{t+h|t} \equiv \pi_{t+h|t} - \pi^*$. Since the Bank of England potential output or trend output measure data are not published, I instead use the deviation of forecast output growth from its mean as output measure. It is denoted by $\hat{y}_{t+k|t} \equiv y_{t+k|t} - \bar{y}_k$. Using data as deviations from target and mean, respectively, imposes an expected value of zero for the exogenous regressors.

The Bank of England forecasts have a two-piece normal distribution potentially skewed, as described in Britton, Fisher & Whitley (1998). The measure of uncertainty mentioned above corresponds to the forecast standard deviation of this two-piece normal distribution only if its forecast density is symmetric (see Wallis (2004)). Whenever forecast mode and forecast mean do not coincide, the forecast variance and hence the forecast standard deviation have to be calculated from the reported uncertainty measure. For a two-piece normal distributed variable X, the variance is given by

$$\sigma^2(X) = \left(1 - \frac{2}{\pi}\right)(\sigma_2 - \sigma_1)^2 + \sigma_1\sigma_2. \tag{1}$$

on the Bank of England website.

[5] The Bank of England presents fixed-horizon forecasts for up to two years ahead, although market-rate forecasts for up to three years ahead are available from 2004Q3 onwards. The history of forecasts conditional on market interest rates, however, starts in 1998Q1.

[6] I rechecked using the forecast mean instead of the forecast mode as baseline data for forecast inflation and output growth. To tackle potential endogeneity issues when using market-rates data, I instrumented the forecast data by lagged forecast data. The efforts, however, did not result in further insights beyond the results shown here.

[7] Actually, every twelve months the Chancellor of the Exchequer, the British cabinet minister responsible for economic and financial matters, announces the inflation target.

Table 1: Numbers of forecast risks

h	0	1	2	3	4	5	6	7	8
$\pi^e_{t+h\|t} - \pi_{t+h\|t} > 0$	16	16	16	16	16	22	22	21	18
$\pi^e_{t+h\|t} - \pi_{t+h\|t} = 0$	26	26	26	26	26	15	16	15	18
$\pi^e_{t+h\|t} - \pi_{t+h\|t} < 0$	7	7	7	7	7	12	11	13	13
k	0	1	2	3	4	5	6	7	8
$y^e_{t+h\|t} - y_{t+h\|t} > 0$	4	4	4	4	4	4	3	3	2
$y^e_{t+h\|t} - y_{t+h\|t} = 0$	18	17	17	17	17	14	13	15	15
$y^e_{t+h\|t} - y_{t+h\|t} < 0$	27	28	28	28	28	31	33	31	32

Sample range: 1997Q4 to 2009Q4.

A two-piece normal distribution has parameters μ, σ_1 and σ_2, where σ_1 is the dispersion of its left half, σ_2 of its right half; see for instance Novo & Pinheiro (2005). Moreover, σ_1 and σ_2 are a transformation of the forecast mean, the forecast mode and the reported measure of forecast uncertainty, as described by Wallis (2004). Following his manual yields the forecast standard deviation series of forecast inflation and of forecast output growth. The demeaned series are henceforth denoted by $\hat{\sigma}_{\pi,t+h|t}$ for inflation and by $\hat{\sigma}_{y,t+k|t}$ for output growth, and serve as the measure for forecast uncertainty in the regression models presented in the following.

The Bank of England uses the functional form of the two-piece normal distribution also to communicate forecast risks to its central projection, which is the mode forecast. If an average of considered alternatives is likely to exceed [fall short of] the central projection, then the forecast mean is larger [smaller] than the mode forecast. In that case, the Bank of England speaks of an upward [downward] risk. The reported measure of skew, i.e. the difference between the mean and mode forecast, is the quantification of that risk. I normalize the risk figures with the respective forecast standard deviation and obtain a simple and scale-free measure of skewness known as Pearson mode skewness:

$$\kappa_{\pi,t+h|t} = \frac{\pi^e_{t+h|t} - \pi_{t+h|t}}{\sigma_{\pi,t+h|t}}, \tag{2}$$

$$\kappa_{y,t+h|t} = \frac{y^e_{t+h|t} - y_{t+h|t}}{\sigma_{y,t+h|t}}. \tag{3}$$

The terms $\pi^e_{t+h|t}$ and $y^e_{t+h|t}$ denote the forecast mean for inflation and output growth, respectively. Table 1 shows the number of forecast upward risks by forecast horizon h and k. Where the Bank of England has been concerned with upward risks to inflation as well as downward risks, it appears that forecast output growth has rather been subject to balanced risks and even more downward risks over the sample period. Only the early forecast history shows upward risks to forecast output growth, and there has been no forecast upward risk after 2001Q1.[8]

The Pearson mode skewness is used to account for the asymmetries of forecast uncertainty in the following regression analysis. In addition, I separate the interest rate reactions under forecast uncertainty into the cases where alternative outcomes of inflation and output growth are likely to either exceed or to drop below the respective central projection, thereby condensing the information to the direction of risk. A simple indicator variable shows if the forecast period considered is marked by an upward risk and accordingly by a positive Pearson mode skewness:

$$I^{+}_{\pi,t+h} = \begin{cases} 1 & \text{if} \quad \kappa_{\pi,t+h|t} > 0 \\ 0 & \text{if} \quad \kappa_{\pi,t+h|t} \leq 0 \end{cases}, \tag{4}$$

$$I^{+}_{y,t+h} = \begin{cases} 1 & \text{if} \quad \kappa_{y,t+h|t} > 0 \\ 0 & \text{if} \quad \kappa_{y,t+h|t} \leq 0 \end{cases}. \tag{5}$$

An indicator variable for downward risks is obtained by simply inverting those for upward risks:[9]

$$I^{-}_{\pi,t+h} = -(I^{+}_{\pi,t+h} - 1), \tag{6}$$

$$I^{-}_{y,t+h} = -(I^{+}_{y,t+h} - 1). \tag{7}$$

The panels 2 to 5 in Figure 1 contrast the nowcasts for the inflation gap, demeaned output growth and corresponding demeaned standard deviations with the corresponding forecasts for $h = k = 8$. With increasing horizon, the forecast standard deviations become larger, but the demeaned figures are smoother in the two-year perspective. Bhattacharjee & Holly (2010)

[8]See also Knüppel & Schultefrankenfeld (2008) for a comprehensive study of the Bank of England inflation risk forecasts.

[9]I recognize that the indicator variables are measures for the direction of risk that separate somewhat roughly into "upward risk and rest" and "downward risk and rest", respectively.

argue that the inflation mean forecasts for two-year-ahead inflation are lacking in information content, as they are set to match the target in expectation. This seems to be plausible for market-rate forecasts, where the inflation gap two years ahead is usually smaller than with constant rate forecasts. Market participants expect the Bank of England to meet the inflation target at the policy horizon, so the Bank of England has to incorporate these expectations into a market interest rate path. Thus, the constant-rate forecasts I use here might be less distorted and gaps communicated via the Inflation Reports, in particular at the policy horizon, might be more informative.

The Official Bank Rate has been lowered massively since the financial turmoil following the Lehman collapse, from a 2008Q3 value of 5% to a 2009Q1 value of 0.5%. Since then it has remained at that level. As a consequence, a decreasing time trend might indeed be eye-balled out in the MPC interest rate decisions, plotted in the top panel of Figure 1. To this extent, I conduct unit root tests as proposed by Ng & Perron (2001). The four alternative test results indicate twice a rejection of the null hypothesis that the interest rate decisions have a unit root at the 10% level, once a rejection at the 5% level, close to the 1% level and once no rejection.[10] In the following I treat interest rates as stationary.

3 Forecast-based Interest Rate Rules augmented by Forecast Uncertainty

3.1 The Regression Model

The starting point for the regression analysis are forecast-based interest rate rules as proposed by Batini & Haldane (1998, 1999) and analyzed by e.g. Levin, Wieland & Williams (2003) or Kuttner (2004). The functional forward-looking specification is also known from Clarida, Galí & Gertler (1998, 2000). Since forecast are inherently subject to uncertainty, the question arises if (and if so, in which direction and to what extent) the responses to forecast inflation and forecast output growth are affected when forecast uncertainty is included in a forecast-

[10]The test routines with a spectral GLS-detrended autoregression based on Modified AIC with automatic lag length selection are utilized.

based rule. The Bank of England has emphasized the role of forecast uncertainty by reporting entire probability distributions for inflation and for output growth in its Inflation Reports. The important role of forecast uncertainty is underlined by the construction of the Inflation Report fan charts which visualize ranges of possible future developments of prices and output. When the MPC decides on the level of interest rates in response to economic prospects, then these measures of uncertainty should also play a significant role in the decision process.

To this extent, I augment a forecast-based rule by an interaction term of the forecast inflation gap with the demeaned forecast standard deviation for inflation and one of demeaned forecast real GDP growth with the corresponding demeaned forecast standard deviation. Since demeaned uncertainty measures enter the specification it is assumed that the MPC in general recognizes forecasts to be subject to uncertainty. Only deviations from the "usual level" of uncertainty play a role. The resulting model is written as

$$i_t = c + \rho i_{t-1} + \alpha_\pi \hat{\pi}_{t+h|t} + \alpha_y \hat{y}_{t+k|t} + \alpha_{\pi\pi} \hat{\pi}_{t+h|t} \hat{\sigma}_{\pi,t+h|t} + \alpha_{yy} \hat{y}_{t+k|t} \hat{\sigma}_{y,t+k|t} + \varepsilon_t, \tag{8}$$

where ε_t is a zero-mean error term.[11] The parameters α_π and α_y represent the reaction to a change in the forecast inflation gap and forecast demeaned output growth when forecast uncertainty is on track, i.e. equals the long-run mean. Whenever the forecast standard deviations deviate from their mean, $\alpha_{\pi\pi}$ and α_{yy} capture the response of the MPC decisions to forecast uncertainty. The partial effects of inflation gap and demeaned output growth thus are linear transformations of the respective forecast standard deviations:

$$\frac{\partial i_t}{\partial \hat{\pi}_{t+h|t}} = \alpha_\pi + \alpha_{\pi\pi} \hat{\sigma}_{\pi,t+h|t}, \tag{9}$$

$$\frac{\partial i_t}{\partial \hat{y}_{t+h|t}} = \alpha_y + \alpha_{yy} \hat{\sigma}_{y,t+h|t}. \tag{10}$$

The reaction function given by equation 8 is estimated for all 81 combinations of the forecast horizons h for inflation and k for output growth. This is to check, without preconceived notions, which combination of forecast data has the greatest explanatory power for interest

[11] In the following, ε_t always denotes a zero-mean error term.

rate decisions. Moreover, this is to detect the degree of forward-looking of the MPC, since the forecasts might not be equally informative to the decision makers. To account for the sluggish adjustment of output, it is likely that the MPC considers current or very near-term output developments for today's interest rate decisions. These developments can be evaluated and the interest rate can be set such that a desired growth path in the future is more likely to be achieved. Yet, output data as provided by the Office for National Statistics (ONS) are at best available with a lag of one quarter. Furthermore, GDP figures are usually subject to extensive revision after their first release. If the MPC responds to current and very-near term output developments, it is ultimately forced to forecast. As regards the inflation forecasts, inflation today cannot be affected by monetary policy action, so the inflation nowcast might not be important for the interest rate decision. The Bank of England medium-term objective, though, is to have two-year-ahead inflation back on target. This two-year policy horizon is highlighted in every Inflation Report inflation prospects section and was referred to in a recent speech by former MPC member Barker (2010). Thus, the inflation forecasts for one and a half years up to two years ahead, i.e. for $h = 6, 7, 8$, should be highly informative. If the Bank forecasts a deviation from target for the medium-term perspective, today's interest rate decisions should respond to them.

3.2 Estimation Results

Tables 5 to 7 show the results for estimation of equation 8 for all combinations of forecast horizons h and k using OLS. When going carefully through the results, there is clear econometric evidence that the MPC interest rate decisions respond to forecasts for output growth for up to one and a half years ahead. Farther forecasts, i.e. horizons $k = 6, 7, 8$, are not taken into account. On the contrary, the responses to the inflation gap almost vanish for $h = 0, \ldots, 6$. Inflation gap forecasts for $h = 7, 8$, however, seem to provide the relevant information content required to set interest rates in response to forecasts. For $h = 0, \ldots, 6$, the forecast inflation gap is insignificant. To carve out this pattern more clearly I present six estimation results in Table 2 which are the best in terms of the log-likelihood. These are the coefficient estimates

Table 2: Selected OLS estimation results

	c	ρ	α_π	α_y	$\alpha_{\pi\pi}$	α_{yy}	ℓ
$h=7,k=1$	-0.03	0.98	0.82	0.20	3.70	-0.95	-7.71
	(0.92)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	
$h=7,k=2$	-0.08	0.99	0.68	0.20	3.51	-0.75	-5.97
	(0.76)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	
$h=7,k=3$	0.19	0.95	0.70	0.16	3.18	-0.51	-10.49
	(0.45)	(0.00)	(0.12)	(0.10)	(0.00)	(0.00)	
$h=8,k=1$	-0.20	1.00	1.04	0.24	0.98	-0.70	-13.64
	(0.46)	(0.00)	(0.00)	(0.00)	(0.23)	(0.01)	
$h=8,k=2$	-0.46	1.05	0.71	0.27	1.64	-0.68	-10.61
	(0.04)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	
$h=8,k=3$	-0.35	1.04	0.72	0.23	1.95	-0.55	-12.48
	(0.08)	(0.00)	(0.06)	(0.01)	(0.01)	(0.00)	

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ.
Sample range: 1997Q4 to 2009Q4.

for $h = 7, 8$ and $k = 1, 2, 3$. The results based on inflation forecasts for $h = 7$ have an even higher log-likelihood than for $h = 8$. This might partly support the argument of Bhattacharjee & Holly (2010) that the two-years ahead forecasts are set to meet the inflation target in a policy-consistent manner. The forecast deviations from target for one period earlier, however, seem to be sufficiently informative.

The immediate implication of the results in Table 2 is that the MPC is very forward-looking with respect to inflation, but considers the very near term with respect to output growth. In terms of log-likelihood, the horizon combination ($h = 7, k = 2$) yields the best description of monetary policy for the period 1997Q4 to 2009Q4. The autoregressive parameter, however, reflects quite inertial interest rates, with $\rho = 0.99$. The MPC seems to have a strong desire to smooth interest rates, with only a few additional information from the forecasts utilized, given the degree of forward-looking implied by this horizon combination. The reaction to a change in forecast inflation seven quarters ahead is relatively weak, implied by $\alpha_\pi = 0.68$, significant at the 5% level. Hence, this estimate does not satisfy the principle coined by Taylor (1993) whereby the coefficient should exceed unity, implying an overproportional reaction of interest rates to a change in inflation to stabilize the economy. Highly significant is the fairly weak reaction to a change in output growth, as reflected by $\alpha_y = 0.20$.

The findings of the optimal degree of forward-looking implied by $(h = 7, k = 2)$ partly contradict the results of the theoretical literature on optimal monetary policy rules, for instance by Svensson (2001) and by Giannoni & Woodford (2003), where optimal policy should rather depend on forecasts for the current period or the very near term. Levin et al. (2003) come to similar conclusions. Their benchmark rule for US data, however, depends on the current output gap forecast and the one-year-ahead inflation gap forecast, with interest rates being very persistent. Longer horizons are advocated by Batini & Nelson (2001), who provide UK data VAR evidence that the optimal feedback horizon of monetary policy is between two and four years.

The significant coefficient estimates for $\alpha_{\pi\pi}$ and α_{yy}, which capture the interest rate reactions in response to a change in forecast uncertainty, are remarkable. In particular for the tuple $(h = 7, k = 2)$, the high value of $\alpha_{\pi\pi} = 3.51$ is significant at the 1% level, implying a very aggressive reaction by the MPC when forecast inflation in almost two years ahead becomes very uncertain. The positive sign of the estimate is particularly sensible when reminding that the Bank of England seeks to have two-year-ahead inflation back on target. Any uncertainty about reaching this target results in increased efforts to finally succeed. This is very much in line with the idea of *"preventing particularly costly outcomes"*, as Bernanke (2007) puts it. When the MPC forecasts that two-year-ahead inflation will be off target, it will today change interest rates. If forecast uncertainty becomes larger and confidence bands widen so to give a certain probability to values that are even more off target, the MPC will increase efforts to ultimately meet its two-year-ahead objective. Such aggressive behavior is in line with the robust control theory of Hansen & Sargent (2008). In the context of a New-Keynesian model, Soederstroem (2002) finds that *"when the central bank attaches some weight to stabilizing output in addition to inflation"*, uncertainty about the inflation (persistence) increases the policy response, while *"uncertainty about other parameters, in contrast, always dampens the policy response"*.

That finding is supported by the highly significant coefficient estimate $\alpha_{yy} = -0.75$ for $(h = 7, k = 2)$. Forecast uncertainty of output growth can be considered as a proxy for the uncertainty about the current state of the economy. If forecast uncertainty is high such that positive point estimates are surrounded by confidence bands that reach well into negative territory, the MPC might be better off with a cautious interest rate change. The intention is to avoid the danger of having changed interest rates too much when output growth indeed materializes below zero. The cautious MPC dampens its response to a change in forecast output growth when the forecast standard deviation of output growth increases, in favor of the attenuation principle of Brainard (1967). Another explanation for the dampened response could be based on a certain trade-off between forecast uncertainty and data uncertainty the MPC might have. Estimates of current real GDP are subject to forecast uncertainty, as early releases of GDP are subject to revisions. Any change in forecast uncertainty also affects the forecast uncertainty/data uncertainty trade-off. As the reliability of forecast output growth deteriorates with increasing forecast uncertainty, the response of interest rates to a change in forecast output growth becomes muted.

4 Accounting for asymmetric Uncertainty Forecasts

4.1 The Regression Model

In every forecasting period there is a certain probability that inflation exceeds the inflation target. In particular for $h = 7$, the best horizon in terms of the log-likelihood, and for $h = 8$, the policy horizon, the inflation forecasts are close to the inflation target. Given that forecast uncertainty is higher than with a nearer forecast horizon, outcomes well above the target are to be taken into account. The Bank of England explains in its monetary policy framework statements that *"[...] Inflation below the target of 2% is judged to be just as bad as inflation above the target. The inflation target is therefore symmetrical. [...]"*. This implies a symmetric loss function and either concern about forecast upward and forecast downward risks.

However, a development of prices towards high inflation is in general a stronger issue than a development towards low inflation. Consequently, if the central projection is forecast close to the target, a forecast upward risk is likely to cause a stronger reaction than a forecast downward risk, even if the central projection is still below target. To account for forecast risks and to assess whether the MPC loss function is asymmetric, I include the Pearson mode skewness into the regression model introduced by equation 8. The resulting reaction function is written as

$$\begin{aligned} i_t = & c + \rho i_{t-1} + \alpha_\pi \hat{\pi}_{t+h|t} + \alpha_y \hat{y}_{t+k|t} + \alpha_{\pi\pi} \hat{\pi}_{t+h|t} \hat{\sigma}_{\pi,t+h|t} + \alpha_{yy} \hat{y}_{t+k|t} \hat{\sigma}_{y,t+k|t} \cdots \\ & + \gamma_\pi \kappa_{\pi,t+h|t} + \gamma_y \kappa_{y,t+h|t} + \varepsilon_t. \end{aligned} \tag{11}$$

Estimates for γ_π and γ_y measure the response of the interest rate decisions to forecast risk and are expected to be positive. If the MPC has a symmetric loss function, however, they should be insignificant. As a robustness check for the impact of the direction of risk I estimate a reaction function that incorporates interactions of the indicator variables for a forecast upward risk to inflation and to output growth with the respective demeaned standard deviations:

$$\begin{aligned} i_t = & c + \rho i_{t-1} + \alpha_\pi \hat{\pi}_{t+h|t} + \alpha_y \hat{y}_{t+k|t} + \alpha_{\pi\pi} \hat{\pi}_{t+h|t} \hat{\sigma}_{\pi,t+h|t} + \alpha_{yy} \hat{y}_{t+k|t} \hat{\sigma}_{y,t+k|t} \cdots \\ & + \gamma^+_{\pi\pi} I^+_{\pi,t+h} \hat{\sigma}_{\pi,t+h|t} + \gamma^+_{yy} I^+_{y,t+h} \hat{\sigma}_{y,t+h|t} + \varepsilon_t. \end{aligned} \tag{12}$$

The parameters $\gamma^+_{\pi\pi}$ and γ^+_{yy} capture the response to a forecast upward risk to forecast inflation and to forecast output growth. The partial effects of forecast uncertainty are given by

$$\left. \frac{\partial i_t}{\partial \hat{\sigma}_{\pi,t+h|t}} \right|_{\pi^e_{t+h|t} > \pi_{t+h|t}} = \alpha_{\pi\pi} \hat{\pi}_{t+k|t} + \gamma^+_{\pi\pi}, \tag{13}$$

$$\left. \frac{\partial i_t}{\partial \hat{\sigma}_{y,t+h|t}} \right|_{y^e_{t+h|t} > y_{t+h|t}} = \alpha_{yy} \hat{y}_{t+k|t} + \gamma^+_{yy}. \tag{14}$$

For completeness I reestimate equation (12) after replacing $I^+_{j,t+h}$ with $I^-_{j,t+h}$, where $j \in \{\pi, y\}$. The parameters $\gamma^-_{\pi\pi}$ and γ^-_{yy} then capture the response to a forecast downward risk to forecast inflation and forecast output growth, respectively, and the partial effects of forecast uncertainty are written analogously to equations 13 and 14.

Table 3: Selected OLS estimation results - Accounting for forecast risk

	c	ρ	α_π	α_y	$\alpha_{\pi\pi}$	α_{yy}	γ_π	γ_y	ℓ
$h=7, k=1$	-0.05	0.98	0.84	0.22	3.46	-0.99	0.60	-0.08	-4.73
	(0.84)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.03)	(0.90)	
$h=7, k=2$	-0.21	1.00	0.65	0.25	3.07	-0.73	0.69	-0.49	-2.72
	(0.42)	(0.00)	(0.06)	(0.00)	(0.00)	(0.00)	(0.00)	(0.22)	
$h=7, k=3$	-0.12	0.99	0.64	0.23	2.80	-0.48	0.71	-0.70	-7.28
	(0.65)	(0.00)	(0.23)	(0.02)	(0.03)	(0.00)	(0.05)	(0.12)	
$h=8, k=1$	-0.27	0.99	1.19	0.27	0.40	-0.71	0.82	-0.61	-9.64
	(0.26)	(0.00)	(0.00)	(0.00)	(0.60)	(0.00)	(0.04)	(0.62)	
$h=8, k=2$	-0.57	1.06	0.85	0.31	0.92	-0.65	0.78	-0.59	-6.49
	(0.01)	(0.00)	(0.01)	(0.00)	(0.15)	(0.00)	(0.01)	(0.36)	
$h=8, k=3$	-0.51	1.06	0.88	0.27	1.18	-0.51	0.69	-0.48	-9.40
	(0.06)	(0.00)	(0.02)	(0.00)	(0.15)	(0.00)	(0.02)	(0.29)	

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ.
Sample range: 1997Q4 to 2009Q4.

4.2 Estimation Results

Tables 8 to 10 show the results for estimation of equation 11 for all combinations of forecast horizons h and k using OLS. Except for slight variations, the same findings apply as for the interest rate reaction function without accounting for forecast risk. The best six specifications selected by the log-likehood are presented in table 3, and the horizon combination ($h = 7, k = 2$) again provides the best description of MPC interest rate decisions. Coefficient estimates for $\alpha_{\pi\pi}$ and α_{yy} are significant at the 1% level. As before, the impact of forecast inflation uncertainty strengthens the response to a change in forecast inflation while the response to output growth is attenuated by forecast output growth uncertainty.

As the results show, asymmetries in the uncertainty forecast have a direct impact on interest rate decisions. An upward risk to the central projection for inflation causes an interest rate increase as reflected by $\gamma_\pi = 0.69$, significant at the 1% level. If inflation is forecast to exceed the central projection at the policy horizon, the MPC reacts with a stronger interest rate step compared to a situation of balanced risks. As the inflation forecasts for $h = 7$ are close to the inflation target, upward risks to the central projection imply that inflation is seen

Table 4: Selected OLS estimation results - Separating the direction of forecast risk

	c	ρ	α_π	α_y	$\alpha_{\pi\pi}$	α_{yy}	$\gamma^+_{\pi\pi}$	γ^+_{yy}	ℓ
$h=7, k=2$	0.08	0.95	0.56	0.29	2.27	-0.55	1.94	0.69	-1.32
	(0.79)	(0.00)	(0.06)	(0.00)	(0.04)	(0.01)	(0.09)	(0.88)	
$h=8, k=2$	-0.20	0.99	0.67	0.35	1.08	-0.68	2.46	-0.27	-2.80
	(0.33)	(0.00)	(0.01)	(0.00)	(0.11)	(0.00)	(0.00)	(0.95)	
	c	ρ	α_π	α_y	$\alpha_{\pi\pi}$	α_{yy}	$\gamma^-_{\pi\pi}$	γ^-_{yy}	ℓ
$h=7, k=2$	-0.15	1.01	0.67	0.23	3.62	-0.78	0.19	0.12	-5.55
	(0.66)	(0.00)	(0.11)	(0.01)	(0.00)	(0.00)	(0.59)	(0.78)	
$h=8, k=2$	-0.43	1.05	0.62	0.22	2.12	-0.65	-0.65	0.20	-9.31
	(0.11)	(0.00)	(0.01)	(0.02)	(0.00)	(0.00)	(0.11)	(0.53)	

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ.
Sample range: 1997Q4 to 2009Q4.

more likely to realize above target than below. The significant risk term casts doubt on the statement of a symmetric loss function as cited above. Asymmetries in the forecast uncertainty of output growth, however, seem to carry no information content, as the insignificant estimates show.

Estimation of equation 12 makes it possible to assess whether and how the direction of risks contributes to the effect of forecast uncertainty. Tables 11 to 16 show detailed estimation results when controlling for the impact of upward risks and downward risks separately. Table 4 picks out the best two models from these results, and the model for horizon combination $(h = 7, k = 2)$ has the largest log-likelihood value of all models estimated.

The effect of asymmetric forecast uncertainty is captured by $\gamma^+_{\pi\pi} = 1.94$, which is significant at the 10% level. This underlines the previous findings that forecast risk matters in explaining the MPC interest rate decisions. Moreover, upward risks to inflation contribute to the intensifying effect of forecast uncertainty on the responses to a change in forecast inflation. Given the width of the fan charts, with every quarterly forecast for inflation there is a certain probability that inflation exceeds the target. However, the forecasts for seven quarters ahead are in general close to the inflation target. If the MPC forecasts an upward risk in seven quarters ahead and is serious about its medium-term objective to have two-year-ahead inflation back on target, an alternative outcome that, a.), is forecast to exceed the central projection for inflation and thus, b.), is more likely to exceed the inflation target than the central projection is, must be undesirable.

On the contrary, forecast downward risks to inflation do not provide the MPC with information, as the results from Table 4 show. While all other coefficients are basically in line with the previous findings, the estimates for $\gamma_{\pi\pi}^{-}$ and γ_{yy}^{-} are insignificant. Thus, there are no additional concerns about a situation where inflation is forecast to be close to target, but an average of alternative outcomes is likely to fall short of the central projection. If inflation is more likely to materialize within the band between zero and two percent, the MPC seems to be fine with that. Forecast upward risks to output growth have no significant impact on the interest rate decisions. However, the number of forecast upward risks is very small, as already shown in Table 1. On the other hand, since the Bank of England has seen more downward risks than balanced risks, it is surprising that these forecast downward risks carry no information content for the interest rate decision making. Forecast output growth, however, is lacking a clear benchmark value compared to the inflation target. Thus, there is no explicit number or implicit interval on which to base a discussion about the importance of the direction of forecast risks to output growth.

Overall, the findings cast doubt on the statement that the Bank of England Monetary Policy Committee considers the inflation target to be symmetrical and imply an asymmetric loss function that lends great weight to upward risks.

4.3 Remarks on Robustness Checks

From the interest rate voting spreadsheet I also calculate a member-specific interest rate i_t^m, which is the previous month' level of the Official Bank Rate plus the basis point change the individual MPC member voted for in the current month.[12] For every month, the resulting rates are averaged across the total M members. This yields $\bar{i}_t = \sum_{m=1}^{M} i_t^m$, the average member

[12]Before November 1998, for some members only the direction of the preferred interest rate change but not the number of basis points is available. I assume the change then to be 25 basis points in line with Besley et al. (2008).

interest rate, which is similarly used by Gerlach-Kristen (2004). As an example, I consider February 2006 with January 2006 interest rates of 5%. Incidentally, only one member (Stephen Nickell) voted for a 25 basis point decrease. The MPC decision in February was to maintain interest rates at 5%, but for nine board members the resulting member average is roughly 4.97%. The average member interest rate can be motivated to be closer to the optimal rate, since in case of positive [negative] dissent it incorporates a minority belief that optimal interest rates should be higher [lower] than the aggregate MPC sets them.[13] However, using the members' interest rate average as dependent variable when estimating equations 8, 11 and both variations of 12 basically yielded about the same coefficient estimates as presented up to now. Although there where minor variations in the responsiveness there were no significant differences in the partial effects of forecast uncertainty and forecast risk.

As regards the estimation technique, recent work by e.g. Chevapatrakul, Kim & Mizen (2009) for the Fed and the Bank of Japan and Wolters (2009) for the Fed has featured LAD quantile regressions. In these works it is shown that across the conditional distribution of interest rates, central banks deviate significantly from their reactions evaluated at the conditional mean, and the interest rate reactions are significantly different at the various quantiles. The Bank of England, however, does not deviate from its conditional mean reaction function by means of a reasonable significance level. Despite variations of the responses across the conditional distribution of both the MPC interest rate decisions and the member interest rate average, these interest rate reactions are not significantly different from the OLS estimates in terms of a 10% confidence band. Although the results are not shown here, tables with detailed estimation results from quantiles regression for both dependent variables for all models and horizon combinations are available upon request.

5 Conclusion

The historical Bank of England Monetary Policy Committee decisions about the Official Bank Rate can be described fairly well by a simple forecast-based interest rate rule. In terms of log-

[13]For the average member interest rate as plotted in the top panel of Figure 1, the same results for tests of stationarity apply as for the decisions about the official Bank Rate.

likelihood, the combination of forecast inflation gap for seven quarters ahead and demeaned output growth for the very near term of two quarters ahead has the greatest explanatory power.

The MPC is very forward-looking with respect to inflation, but less forward-looking with respect to output. An estimated interest rate rule for this best horizon combination displays a fairly high degree of interest rate smoothing. Nonetheless, the MPC utilizes the information content of the forecast inflation gap and of forecast demeaned output growth. Estimates show greater weights on inflation forecasts that on output growth, although the coefficient on the forecast deviation of inflation from target is estimated below unity, implying an insufficiently strong interest rate reaction by means of the Taylor principle. Forecast uncertainty measures are found to be highly significant. In particular, forecast inflation leads to very aggressive interest rate reactions whereas the forecast uncertainty of forecast output growth leads to attenuation in decision making.

The aggressive reaction under inflation uncertainty and the attenuated reaction under output growth uncertainty is confirmed when assessing the asymmetries of forecast uncertainty. It is shown that forecast upward risks to inflation have a direct and positive impact on MPC interest rate decisions. Moreover, there is econometric evidence that the asymmetry of forecast uncertainty contributes to the intensifying effect of forecast uncertainty on the reaction of interest rates to a change in forecast inflation. When inflation is forecast to be close to target, but an average of alternative outcomes is forecast to exceed this central projection, the partial effect of the forecast standard deviation of inflation is stronger than without controlling for upward risk. Despite the statement of the Bank of England that the inflation target is symmetrical, the MPC is found to be concerned about upward risks to inflation, while downward risks have no significant effect.

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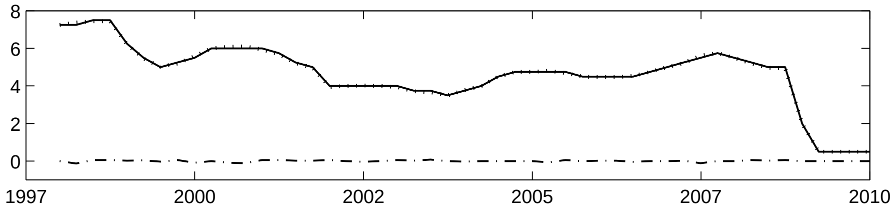
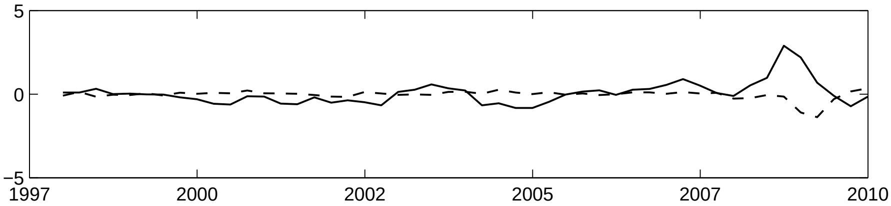
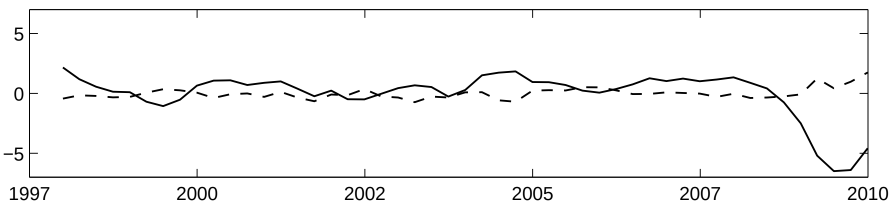
Figure 1: Interest rate decisions, nowcasts and two-year-ahead forecast data



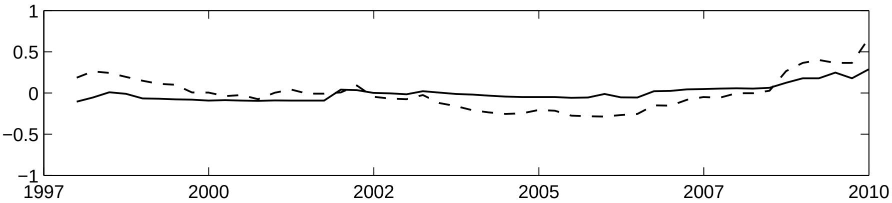
Interest rates: i_t (solid), $\bar{i}_t$ (dotted), $i_t - \bar{i}_t$ (dashed dotted)



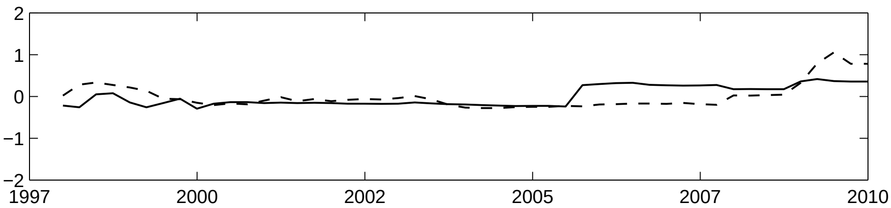
Forecast deviation of inflation from target: $\hat{\pi}_{t+0|t}$ (solid), $\hat{\pi}_{t+8|t}$ (dashed)



Demeaned forecast real output growth : $\hat{y}_{t+0|t}$ (solid), $\hat{y}_{t+8|t}$ (dashed)



Demeaned forecast standard deviation of inflation: $\hat{\sigma}_{\pi,t+0|t}$ (solid), $\hat{\sigma}_{\pi,t+8|t}$ (dashed)



Demeaned forecast standard deviation of real output growth: $\hat{\sigma}_{y,t+0|t}$ (solid), $\hat{\sigma}_{y,t+8|t}$ (dashed)

Table 5: OLS estimates of interest rate reaction function parameters for $h = 0, 1, 2$

h	k	0	1	2	3	4	5	6	7	8
0	c	0.67	0.22	-0.18	-0.31	-0.49	-0.60	-0.22	0.14	0.34
		(0.02)	(0.37)	(0.37)	(0.08)	(0.04)	(0.07)	(0.44)	(0.66)	(0.33)
	ρ	0.84	0.93	1.00	1.04	1.08	1.11	1.04	0.97	0.93
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.13	0.16	0.18	0.17	0.14	0.11	0.03	-0.01	0.00
		(0.25)	(0.20)	(0.17)	(0.20)	(0.34)	(0.49)	(0.89)	(0.98)	(0.98)
	α_y	0.25	0.31	0.38	0.40	0.46	0.50	0.23	-0.07	-0.24
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.13)	(0.60)	(0.15)
	$\alpha_{\pi\pi}$	-3.88	-3.26	-2.29	-1.93	-2.13	-2.55	-3.49	-3.86	-3.87
		(0.00)	(0.01)	(0.05)	(0.10)	(0.13)	(0.12)	(0.07)	(0.04)	(0.03)
	α_{yy}	-0.18	-0.39	-0.45	-0.25	-0.15	-0.15	-0.27	-0.29	-0.37
		(0.18)	(0.01)	(0.00)	(0.04)	(0.25)	(0.57)	(0.24)	(0.24)	(0.14)
1	c	0.82	0.47	0.00	-0.22	-0.50	-0.84	-0.65	-0.17	0.19
		(0.02)	(0.17)	(1.00)	(0.20)	(0.00)	(0.02)	(0.35)	(0.83)	(0.72)
	ρ	0.81	0.88	0.97	1.02	1.09	1.16	1.12	1.02	0.94
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	-0.01	0.06	0.12	0.15	0.16	0.15	0.01	-0.09	-0.12
		(0.93)	(0.54)	(0.27)	(0.23)	(0.29)	(0.40)	(0.95)	(0.60)	(0.40)
	α_y	0.25	0.30	0.36	0.38	0.45	0.58	0.42	0.07	-0.18
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)	(0.67)	(0.18)
	$\alpha_{\pi\pi}$	-1.58	-1.82	-1.45	-1.55	-1.90	-1.87	-1.49	-1.12	-0.97
		(0.01)	(0.01)	(0.03)	(0.03)	(0.02)	(0.05)	(0.25)	(0.44)	(0.45)
	α_{yy}	-0.02	-0.12	-0.25	-0.07	0.12	0.15	0.01	-0.10	-0.31
		(0.93)	(0.69)	(0.19)	(0.66)	(0.41)	(0.62)	(0.98)	(0.81)	(0.55)
2	c	0.86	0.44	-0.11	-0.32	-0.60	-0.88	-0.59	-0.04	0.32
		(0.05)	(0.24)	(0.71)	(0.11)	(0.03)	(0.08)	(0.47)	(0.96)	(0.57)
	ρ	0.79	0.88	0.98	1.04	1.10	1.16	1.10	0.98	0.91
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.01	0.09	0.18	0.22	0.22	0.20	0.03	-0.10	-0.13
		(0.95)	(0.43)	(0.15)	(0.13)	(0.18)	(0.29)	(0.89)	(0.49)	(0.31)
	α_y	0.26	0.33	0.42	0.45	0.54	0.69	0.51	0.10	-0.18
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.12)	(0.61)	(0.20)
	$\alpha_{\pi\pi}$	-0.74	-1.13	-0.85	-0.92	-1.24	-1.01	-0.38	0.02	0.01
		(0.17)	(0.10)	(0.21)	(0.20)	(0.11)	(0.21)	(0.70)	(0.98)	(0.99)
	α_{yy}	-0.03	-0.20	-0.40	-0.21	0.00	-0.04	-0.20	-0.27	-0.43
		(0.90)	(0.54)	(0.20)	(0.32)	(0.99)	(0.86)	(0.51)	(0.53)	(0.39)

h	k	0	1	2	3	4	5	6	7	8
0	ℓ	-24.66	-22.02	-19.20	-20.98	-24.78	-28.96	-33.20	-33.35	-31.93
1	ℓ	-27.55	-21.70	-19.27	-20.17	-22.91	-27.94	-35.88	-38.48	-37.53
2	ℓ	-31.30	-25.23	-20.35	-20.86	-24.45	-29.87	-38.39	-41.08	-40.04

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ.
Sample range: 1997Q4 to 2009Q4.

Table 6: OLS estimates of interest rate reaction function parameters for $h = 3, 4, 5$

h	k	0	1	2	3	4	5	6	7	8
3	c	0.88	0.35	-0.25	-0.29	-0.44	-0.54	-0.21	0.20	0.43
		(0.08)	(0.24)	(0.36)	(0.31)	(0.07)	(0.13)	(0.64)	(0.62)	(0.37)
	ρ	0.79	0.88	1.00	1.02	1.06	1.09	1.02	0.93	0.89
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.02	0.12	0.24	0.29	0.25	0.21	0.02	-0.10	-0.12
		(0.83)	(0.32)	(0.07)	(0.10)	(0.15)	(0.25)	(0.89)	(0.47)	(0.42)
	α_y	0.25	0.35	0.46	0.48	0.56	0.68	0.50	0.14	-0.12
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.11)	(0.40)	(0.29)
	$\alpha_{\pi\pi}$	0.28	0.01	0.57	0.36	0.07	0.38	1.25	1.62	1.45
		(0.55)	(0.98)	(0.39)	(0.61)	(0.92)	(0.56)	(0.07)	(0.01)	(0.00)
	α_{yy}	-0.11	-0.46	-0.77	-0.52	-0.31	-0.28	-0.31	-0.22	-0.24
		(0.53)	(0.03)	(0.01)	(0.02)	(0.06)	(0.16)	(0.24)	(0.46)	(0.49)
4	c	0.88	0.37	-0.14	-0.32	-0.61	-0.69	-0.26	0.20	0.43
		(0.07)	(0.32)	(0.58)	(0.35)	(0.13)	(0.13)	(0.58)	(0.67)	(0.45)
	ρ	0.79	0.89	0.99	1.04	1.11	1.13	1.03	0.93	0.89
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.03	0.14	0.34	0.43	0.38	0.33	0.11	-0.04	-0.06
		(0.88)	(0.54)	(0.17)	(0.15)	(0.16)	(0.18)	(0.59)	(0.84)	(0.78)
	α_y	0.27	0.36	0.44	0.48	0.59	0.70	0.48	0.10	-0.15
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.11)	(0.53)	(0.26)
	$\alpha_{\pi\pi}$	-0.89	-1.32	-0.87	-0.99	-1.15	-0.50	0.77	1.38	1.19
		(0.26)	(0.29)	(0.56)	(0.49)	(0.36)	(0.64)	(0.42)	(0.08)	(0.09)
	α_{yy}	-0.01	-0.26	-0.50	-0.31	-0.18	-0.21	-0.26	-0.17	-0.24
		(0.96)	(0.38)	(0.03)	(0.02)	(0.16)	(0.25)	(0.37)	(0.65)	(0.60)
5	c	0.93	0.51	0.04	-0.05	-0.11	-0.05	0.23	0.41	0.45
		(0.09)	(0.22)	(0.92)	(0.91)	(0.75)	(0.89)	(0.54)	(0.32)	(0.35)
	ρ	0.78	0.86	0.96	0.99	1.01	1.00	0.95	0.91	0.89
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.31	0.39	0.51	0.52	0.44	0.40	0.30	0.24	0.23
		(0.30)	(0.18)	(0.20)	(0.21)	(0.19)	(0.13)	(0.17)	(0.31)	(0.40)
	α_y	0.22	0.32	0.41	0.42	0.47	0.51	0.36	0.14	0.02
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.34)	(0.89)
	$\alpha_{\pi\pi}$	1.40	0.80	0.18	-0.06	0.33	1.30	2.73	3.60	3.77
		(0.31)	(0.47)	(0.93)	(0.97)	(0.71)	(0.17)	(0.02)	(0.01)	(0.02)
	α_{yy}	-0.30	-0.57	-0.61	-0.35	-0.19	0.01	0.31	0.70	0.86
		(0.06)	(0.03)	(0.01)	(0.01)	(0.24)	(0.97)	(0.38)	(0.08)	(0.12)

h	k	0	1	2	3	4	5	6	7	8
3	ℓ	-32.42	-26.97	-18.64	-18.87	-24.25	-29.00	-36.35	-39.19	-38.99
4	ℓ	-32.15	-26.33	-19.95	-20.03	-24.64	-30.13	-37.77	-40.30	-39.87
5	ℓ	-30.48	-24.98	-18.22	-19.26	-23.57	-26.05	-30.21	-32.00	-32.95

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ.
Sample range: 1997Q4 to 2009Q4.

Table 7: OLS estimates of interest rate reaction function parameters for $h = 6, 7, 8$

h	k	0	1	2	3	4	5	6	7	8
6	c	0.71	0.46	0.25	0.26	0.30	0.36	0.53	0.57	0.49
		(0.06)	(0.24)	(0.55)	(0.61)	(0.57)	(0.48)	(0.24)	(0.16)	(0.23)
	ρ	0.84	0.89	0.93	0.94	0.94	0.93	0.89	0.88	0.90
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.65	0.76	0.64	0.55	0.48	0.44	0.39	0.36	0.35
		(0.11)	(0.04)	(0.06)	(0.16)	(0.19)	(0.17)	(0.21)	(0.30)	(0.34)
	α_y	0.11	0.23	0.29	0.29	0.30	0.30	0.18	0.06	0.05
		(0.09)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.24)	(0.63)	(0.67)
	$\alpha_{\pi\pi}$	4.04	3.14	1.60	1.23	1.64	2.39	3.53	4.28	4.85
		(0.03)	(0.07)	(0.43)	(0.46)	(0.17)	(0.01)	(0.00)	(0.00)	(0.00)
	α_{yy}	-0.62	-0.91	-0.60	-0.31	-0.15	0.05	0.33	0.69	0.99
		(0.01)	(0.01)	(0.00)	(0.03)	(0.16)	(0.73)	(0.04)	(0.00)	(0.00)
7	c	0.51	-0.03	-0.08	0.19	0.39	0.45	0.58	0.61	0.56
		(0.10)	(0.92)	(0.76)	(0.45)	(0.29)	(0.29)	(0.12)	(0.12)	(0.22)
	ρ	0.88	0.98	0.99	0.95	0.92	0.91	0.89	0.88	0.89
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.81	0.82	0.68	0.70	0.79	0.91	1.01	1.00	0.96
		(0.06)	(0.01)	(0.05)	(0.12)	(0.10)	(0.05)	(0.02)	(0.02)	(0.05)
	α_y	0.14	0.20	0.20	0.16	0.15	0.17	0.10	-0.01	-0.06
		(0.02)	(0.00)	(0.00)	(0.10)	(0.19)	(0.15)	(0.45)	(0.95)	(0.69)
	$\alpha_{\pi\pi}$	2.78	3.70	3.51	3.18	2.70	2.10	2.04	2.18	2.33
		(0.04)	(0.00)	(0.00)	(0.00)	(0.03)	(0.06)	(0.06)	(0.17)	(0.25)
	α_{yy}	-0.44	-0.95	-0.75	-0.51	-0.41	-0.32	-0.20	-0.02	0.13
		(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.31)	(0.98)	(0.90)
8	c	0.39	-0.20	-0.46	-0.35	-0.16	0.03	0.18	0.21	0.20
		(0.31)	(0.46)	(0.04)	(0.08)	(0.40)	(0.90)	(0.69)	(0.73)	(0.70)
	ρ	0.89	1.00	1.05	1.04	1.01	0.98	0.95	0.94	0.94
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	1.19	1.04	0.71	0.72	0.88	1.13	1.51	1.65	1.62
		(0.00)	(0.00)	(0.01)	(0.06)	(0.03)	(0.00)	(0.06)	(0.01)	(0.00)
	α_y	0.17	0.24	0.27	0.23	0.22	0.20	0.07	-0.05	-0.11
		(0.00)	(0.00)	(0.00)	(0.01)	(0.07)	(0.13)	(0.82)	(0.79)	(0.34)
	$\alpha_{\pi\pi}$	0.37	0.98	1.64	1.95	1.87	1.02	0.07	-0.36	-0.38
		(0.64)	(0.23)	(0.00)	(0.01)	(0.03)	(0.23)	(0.98)	(0.78)	(0.65)
	α_{yy}	-0.25	-0.70	-0.68	-0.55	-0.55	-0.48	-0.31	-0.12	-0.05
		(0.06)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.82)	(0.93)	(0.95)

h	k	0	1	2	3	4	5	6	7	8
6	ℓ	-19.94	-15.57	-14.44	-17.44	-20.72	-21.45	-22.21	-21.82	-21.21
7	ℓ	-15.59	-7.71	-5.97	-10.49	-15.25	-17.82	-19.36	-19.81	-19.71
8	ℓ	-17.61	-13.64	-10.61	-12.48	-15.91	-19.12	-21.04	-21.50	-21.42

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ.
Sample range: 1997Q4 to 2009Q4.

Table 8: OLS estimates of interest rate reaction function parameters for $h = 0, 1, 2$ - Accounting for forecast risk

h	k	0	1	2	3	4	5	6	7	8
0	c	0.65	0.23	-0.34	-0.63	-0.74	-0.40	0.17	0.33	0.40
		(0.06)	(0.37)	(0.29)	(0.24)	(0.32)	(0.59)	(0.70)	(0.39)	(0.29)
	ρ	0.86	0.92	1.01	1.08	1.12	1.08	0.98	0.94	0.93
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.11	0.15	0.20	0.19	0.15	0.08	-0.01	-0.01	0.01
		(0.44)	(0.30)	(0.18)	(0.28)	(0.44)	(0.65)	(0.97)	(0.95)	(0.96)
	α_y	0.24	0.32	0.44	0.50	0.58	0.51	0.14	-0.10	-0.25
		(0.00)	(0.00)	(0.00)	(0.01)	(0.04)	(0.09)	(0.40)	(0.46)	(0.17)
	$\alpha_{\pi\pi}$	-3.87	-3.11	-1.72	-1.13	-1.37	-2.20	-3.31	-3.79	-3.91
		(0.01)	(0.03)	(0.18)	(0.43)	(0.42)	(0.17)	(0.08)	(0.06)	(0.05)
	α_{yy}	-0.21	-0.38	-0.41	-0.24	-0.17	-0.11	-0.04	-0.07	-0.20
		(0.22)	(0.08)	(0.00)	(0.02)	(0.17)	(0.60)	(0.80)	(0.73)	(0.44)
	$\gamma_{\pi\pi}$	-0.14	0.20	0.47	0.57	0.64	0.36	-0.11	-0.29	-0.31
		(0.76)	(0.70)	(0.37)	(0.29)	(0.34)	(0.53)	(0.78)	(0.39)	(0.32)
	γ_{yy}	0.75	-0.09	-0.78	-0.77	-0.33	0.53	1.02	0.72	0.40
		(0.39)	(0.94)	(0.50)	(0.47)	(0.73)	(0.49)	(0.08)	(0.26)	(0.58)
1	c	0.81	0.45	-0.24	-0.58	-0.61	-0.37	-0.04	0.14	0.30
		(0.08)	(0.17)	(0.47)	(0.22)	(0.32)	(0.56)	(0.94)	(0.80)	(0.57)
	ρ	0.83	0.88	0.99	1.07	1.10	1.08	1.03	0.99	0.94
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	-0.05	0.07	0.17	0.21	0.16	0.09	-0.02	-0.08	-0.10
		(0.67)	(0.59)	(0.20)	(0.27)	(0.44)	(0.62)	(0.90)	(0.56)	(0.45)
	α_y	0.23	0.31	0.43	0.48	0.52	0.46	0.23	0.03	-0.16
		(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.05)	(0.17)	(0.85)	(0.27)
	$\alpha_{\pi\pi}$	-1.55	-1.77	-1.28	-1.23	-1.62	-1.99	-1.95	-1.59	-1.31
		(0.01)	(0.01)	(0.03)	(0.07)	(0.06)	(0.01)	(0.04)	(0.18)	(0.28)
	α_{yy}	-0.06	-0.11	-0.27	-0.14	0.06	0.33	0.48	0.39	0.11
		(0.87)	(0.73)	(0.15)	(0.25)	(0.76)	(0.22)	(0.08)	(0.36)	(0.85)
	$\gamma_{\pi\pi}$	-0.19	0.22	0.45	0.47	0.41	0.08	-0.22	-0.33	-0.37
		(0.78)	(0.67)	(0.29)	(0.27)	(0.47)	(0.87)	(0.53)	(0.30)	(0.23)
	γ_{yy}	1.00	-0.36	-0.91	-0.78	-0.13	1.00	1.71	1.48	1.04
		(0.48)	(0.79)	(0.33)	(0.39)	(0.88)	(0.17)	(0.03)	(0.14)	(0.27)
2	c	0.87	0.40	-0.41	-0.83	-0.98	-0.74	-0.15	0.21	0.41
		(0.10)	(0.19)	(0.31)	(0.14)	(0.23)	(0.46)	(0.85)	(0.78)	(0.48)
	ρ	0.80	0.87	1.02	1.11	1.15	1.13	1.04	0.96	0.91
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	-0.02	0.11	0.23	0.29	0.27	0.19	0.02	-0.08	-0.11
		(0.85)	(0.50)	(0.11)	(0.16)	(0.30)	(0.45)	(0.88)	(0.51)	(0.34)
	α_y	0.25	0.36	0.49	0.58	0.70	0.71	0.41	0.09	-0.16
		(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.12)	(0.22)	(0.66)	(0.25)
	$\alpha_{\pi\pi}$	-0.70	-1.04	-0.63	-0.37	-0.62	-0.93	-0.80	-0.37	-0.21
		(0.16)	(0.11)	(0.30)	(0.59)	(0.54)	(0.27)	(0.32)	(0.63)	(0.77)
	α_{yy}	-0.04	-0.19	-0.44	-0.38	-0.23	-0.04	0.17	0.12	-0.13
		(0.88)	(0.59)	(0.13)	(0.10)	(0.57)	(0.94)	(0.62)	(0.76)	(0.81)
	$\gamma_{\pi\pi}$	-0.01	0.38	0.60	0.69	0.81	0.53	0.08	-0.13	-0.22
		(0.99)	(0.57)	(0.22)	(0.19)	(0.33)	(0.52)	(0.87)	(0.69)	(0.44)
	γ_{yy}	0.70	-0.58	-1.10	-1.11	-0.68	0.44	1.45	1.29	0.83
		(0.61)	(0.72)	(0.28)	(0.28)	(0.60)	(0.75)	(0.16)	(0.13)	(0.24)

h	k	0	1	2	3	4	5	6	7	8
0	ℓ	-24.20	-21.87	-18.12	-19.51	-23.58	-27.88	-31.65	-32.29	-31.36
1	ℓ	-26.86	-21.48	-17.85	-18.86	-22.40	-26.26	-32.25	-35.65	-36.03
2	ℓ	-30.93	-24.69	-18.04	-18.07	-22.69	-28.41	-36.13	-39.44	-39.29

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ, the Schwarz information criterion values are denoted by SBC.
Sample range: 1997Q4 to 2009Q4.

Table 9: OLS estimates of interest rate reaction function parameters for $h = 3, 4, 5$ - Accounting for forecast risk

h	k	0	1	2	3	4	5	6	7	8
3	c	0.91	0.31	-0.49	-0.74	-0.93	-0.79	-0.12	0.33	0.50
		(0.13)	(0.35)	(0.18)	(0.07)	(0.03)	(0.18)	(0.85)	(0.47)	(0.31)
	ρ	0.78	0.87	1.02	1.08	1.13	1.12	1.01	0.92	0.88
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.00	0.13	0.27	0.34	0.31	0.24	0.03	-0.09	-0.11
		(0.99)	(0.39)	(0.05)	(0.08)	(0.13)	(0.28)	(0.87)	(0.48)	(0.43)
	α_y	0.25	0.39	0.52	0.57	0.73	0.85	0.58	0.19	-0.08
		(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.21)	(0.40)	(0.42)
	$\alpha_{\pi\pi}$	0.38	0.17	0.79	0.88	0.80	0.82	1.21	1.49	1.41
		(0.51)	(0.73)	(0.16)	(0.16)	(0.26)	(0.32)	(0.16)	(0.07)	(0.05)
	α_{yy}	-0.10	-0.42	-0.74	-0.57	-0.48	-0.47	-0.27	-0.06	-0.08
		(0.72)	(0.05)	(0.00)	(0.00)	(0.02)	(0.20)	(0.52)	(0.85)	(0.83)
	$\gamma_{\pi\pi}$	0.27	0.61	0.70	0.78	1.06	1.02	0.59	0.25	0.09
		(0.74)	(0.42)	(0.13)	(0.08)	(0.11)	(0.24)	(0.49)	(0.67)	(0.83)
	γ_{yy}	0.22	-0.83	-1.16	-1.28	-1.14	-0.48	0.53	0.75	0.58
		(0.89)	(0.63)	(0.22)	(0.12)	(0.16)	(0.63)	(0.50)	(0.20)	(0.39)
4	c	0.90	0.35	-0.31	-0.57	-0.79	-0.67	-0.09	0.34	0.51
		(0.13)	(0.27)	(0.34)	(0.12)	(0.06)	(0.26)	(0.89)	(0.52)	(0.39)
	ρ	0.78	0.88	1.00	1.07	1.12	1.12	1.01	0.92	0.88
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.01	0.16	0.38	0.49	0.43	0.36	0.13	-0.01	-0.05
		(0.97)	(0.53)	(0.13)	(0.15)	(0.19)	(0.25)	(0.54)	(0.93)	(0.80)
	α_y	0.27	0.38	0.49	0.54	0.67	0.78	0.54	0.15	-0.11
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.21)	(0.48)	(0.34)
	$\alpha_{\pi\pi}$	-0.73	-1.06	-0.28	-0.13	-0.32	-0.10	0.62	1.15	1.10
		(0.40)	(0.44)	(0.86)	(0.93)	(0.85)	(0.95)	(0.69)	(0.41)	(0.36)
	α_{yy}	-0.02	-0.23	-0.51	-0.37	-0.27	-0.28	-0.16	-0.02	-0.08
		(0.95)	(0.48)	(0.02)	(0.04)	(0.15)	(0.33)	(0.63)	(0.96)	(0.85)
	$\gamma_{\pi\pi}$	0.15	0.45	0.64	0.73	0.87	0.84	0.52	0.24	0.09
		(0.86)	(0.56)	(0.26)	(0.24)	(0.26)	(0.35)	(0.55)	(0.71)	(0.86)
	γ_{yy}	0.30	-0.69	-0.98	-0.98	-0.63	0.05	0.79	0.81	0.57
		(0.85)	(0.69)	(0.30)	(0.30)	(0.53)	(0.97)	(0.44)	(0.27)	(0.47)
5	c	0.99	0.46	-0.17	-0.37	-0.52	-0.39	0.13	0.45	0.53
		(0.10)	(0.26)	(0.58)	(0.25)	(0.05)	(0.19)	(0.73)	(0.28)	(0.27)
	ρ	0.76	0.84	0.97	1.03	1.06	1.05	0.96	0.90	0.88
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.27	0.36	0.48	0.50	0.43	0.39	0.28	0.22	0.22
		(0.42)	(0.25)	(0.22)	(0.23)	(0.23)	(0.20)	(0.25)	(0.36)	(0.41)
	α_y	0.23	0.37	0.45	0.47	0.58	0.66	0.48	0.24	0.12
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)	(0.21)	(0.35)
	$\alpha_{\pi\pi}$	1.47	1.12	0.74	0.76	1.21	1.88	3.00	3.78	4.06
		(0.29)	(0.31)	(0.61)	(0.54)	(0.27)	(0.10)	(0.03)	(0.01)	(0.02)
	α_{yy}	-0.27	-0.49	-0.51	-0.29	-0.18	-0.08	0.25	0.75	1.06
		(0.12)	(0.02)	(0.00)	(0.00)	(0.08)	(0.72)	(0.53)	(0.07)	(0.04)
	$\gamma_{\pi\pi}$	0.59	1.11	1.09	1.07	1.28	1.24	0.94	0.72	0.57
		(0.48)	(0.16)	(0.03)	(0.04)	(0.06)	(0.14)	(0.29)	(0.34)	(0.34)
	γ_{yy}	-0.10	-1.33	-1.46	-1.36	-1.23	-0.79	-0.07	0.35	0.60
		(0.95)	(0.38)	(0.12)	(0.10)	(0.09)	(0.32)	(0.92)	(0.62)	(0.40)
h	k	0	1	2	3	4	5	6	7	8
3	ℓ	-32.08	-25.65	-15.25	-13.90	-19.47	-26.07	-35.11	-38.50	-38.66
4	ℓ	-31.96	-25.59	-17.68	-17.22	-22.26	-28.05	-36.32	-39.55	-39.56
5	ℓ	-29.63	-21.64	-12.79	-13.60	-17.79	-21.73	-28.03	-30.56	-31.67

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ, the Schwarz information criterion values are denoted by SBC.
Sample range: 1997Q4 to 2009Q4.

Table 10: OLS estimates of interest rate reaction function parameters for $h = 6, 7, 8$ - Accounting for forecast risk

h	k	0	1	2	3	4	5	6	7	8
6	c	0.73	0.36	-0.09	-0.21	-0.25	-0.10	0.31	0.51	0.50
		(0.05)	(0.32)	(0.76)	(0.52)	(0.48)	(0.79)	(0.39)	(0.19)	(0.25)
	ρ	0.84	0.88	0.96	1.00	1.01	0.99	0.92	0.89	0.90
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.60	0.62	0.46	0.38	0.31	0.32	0.30	0.30	0.31
		(0.14)	(0.12)	(0.26)	(0.38)	(0.49)	(0.45)	(0.44)	(0.45)	(0.44)
	α_y	0.12	0.28	0.35	0.35	0.40	0.43	0.27	0.12	0.11
		(0.10)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.16)	(0.37)	(0.33)
	$\alpha_{\pi\pi}$	4.00	3.08	1.89	1.93	2.49	3.00	3.88	4.44	4.95
		(0.02)	(0.05)	(0.23)	(0.20)	(0.08)	(0.03)	(0.01)	(0.00)	(0.00)
	α_{yy}	-0.62	-0.84	-0.51	-0.27	-0.16	-0.08	0.21	0.64	1.03
		(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.55)	(0.36)	(0.00)	(0.00)
	$\gamma_{\pi\pi}$	0.36	0.92	1.07	1.04	1.12	1.00	0.69	0.51	0.44
		(0.43)	(0.02)	(0.00)	(0.03)	(0.06)	(0.13)	(0.21)	(0.20)	(0.19)
	γ_{yy}	0.16	-0.99	-1.45	-1.39	-1.33	-1.02	-0.50	-0.11	0.22
		(0.89)	(0.36)	(0.04)	(0.04)	(0.06)	(0.23)	(0.59)	(0.88)	(0.75)
7	c	0.53	-0.05	-0.21	-0.12	-0.05	0.08	0.41	0.56	0.56
		(0.07)	(0.84)	(0.42)	(0.65)	(0.86)	(0.80)	(0.25)	(0.15)	(0.21)
	ρ	0.87	0.98	1.00	0.99	0.99	0.96	0.91	0.88	0.89
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.84	0.84	0.65	0.64	0.73	0.91	1.07	1.06	1.01
		(0.09)	(0.02)	(0.06)	(0.23)	(0.22)	(0.12)	(0.04)	(0.03)	(0.06)
	α_y	0.16	0.22	0.25	0.23	0.25	0.28	0.17	0.04	-0.02
		(0.01)	(0.00)	(0.00)	(0.02)	(0.04)	(0.04)	(0.31)	(0.83)	(0.91)
	$\alpha_{\pi\pi}$	2.58	3.46	3.07	2.80	2.68	2.15	1.92	1.97	2.13
		(0.09)	(0.00)	(0.00)	(0.03)	(0.06)	(0.15)	(0.17)	(0.27)	(0.33)
	α_{yy}	-0.46	-0.99	-0.73	-0.48	-0.44	-0.46	-0.33	-0.09	0.11
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.22)	(0.93)	(0.93)
	$\gamma_{\pi\pi}$	0.54	0.60	0.69	0.71	0.78	0.76	0.56	0.42	0.36
		(0.17)	(0.03)	(0.00)	(0.05)	(0.07)	(0.10)	(0.17)	(0.20)	(0.20)
	γ_{yy}	-0.13	-0.08	-0.49	-0.70	-0.84	-0.80	-0.44	-0.13	0.06
		(0.87)	(0.90)	(0.22)	(0.12)	(0.11)	(0.34)	(0.68)	(0.88)	(0.94)
8	c	0.36	-0.27	-0.57	-0.51	-0.45	-0.29	0.01	0.13	0.16
		(0.17)	(0.26)	(0.01)	(0.06)	(0.15)	(0.50)	(0.97)	(0.79)	(0.78)
	ρ	0.88	0.99	1.06	1.06	1.05	1.02	0.97	0.95	0.94
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	1.33	1.19	0.85	0.88	1.07	1.33	1.70	1.82	1.80
		(0.00)	(0.00)	(0.01)	(0.02)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)
	α_y	0.19	0.27	0.31	0.27	0.27	0.27	0.13	0.00	-0.04
		(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.07)	(0.77)	(0.98)	(0.75)
	$\alpha_{\pi\pi}$	-0.06	0.40	0.92	1.18	1.11	0.45	-0.49	-0.92	-0.93
		(0.95)	(0.60)	(0.15)	(0.15)	(0.24)	(0.65)	(0.86)	(0.48)	(0.36)
	α_{yy}	-0.30	-0.71	-0.65	-0.51	-0.53	-0.55	-0.38	-0.14	-0.06
		(0.03)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.84)	(0.93)	(0.94)
	$\gamma_{\pi\pi}$	0.74	0.82	0.78	0.69	0.74	0.75	0.64	0.55	0.52
		(0.04)	(0.04)	(0.01)	(0.02)	(0.03)	(0.04)	(0.16)	(0.07)	(0.04)
	γ_{yy}	-0.47	-0.61	-0.59	-0.48	-0.62	-0.67	-0.39	-0.12	0.00
		(0.64)	(0.62)	(0.36)	(0.29)	(0.26)	(0.45)	(0.83)	(0.91)	(1.00)

h	k	0	1	2	3	4	5	6	7	8
6	ℓ	-19.18	-12.65	-8.61	-11.45	-15.02	-17.63	-20.49	-20.86	-20.25
7	ℓ	-13.96	-4.73	-2.72	-7.28	-11.66	-14.89	-17.89	-18.98	-19.01
8	ℓ	-14.83	-9.64	-6.49	-9.40	-12.73	-16.17	-19.02	-19.93	-19.97

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ, the Schwarz information criterion values are denoted by SBC.
Sample range: 1997Q4 to 2009Q4.

Table 11: OLS estimates of interest rate reaction function parameters for $h = 0, 1, 2$ - Accounting for forecast upward risk

h	k	0	1	2	3	4	5	6	7	8
0	c	0.54	0.06	-0.25	-0.41	-0.78	-1.24	-0.64	0.00	0.32
		(0.12)	(0.84)	(0.32)	(0.02)	(0.00)	(0.00)	(0.42)	(1.00)	(0.54)
	ρ	0.87	0.96	1.02	1.06	1.14	1.23	1.13	1.00	0.93
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.06	0.11	0.12	0.09	0.06	0.07	-0.02	-0.04	-0.03
		(0.62)	(0.27)	(0.20)	(0.44)	(0.60)	(0.49)	(0.91)	(0.84)	(0.86)
	α_y	0.24	0.31	0.37	0.39	0.54	0.75	0.32	-0.05	-0.23
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.20)	(0.74)	(0.14)
	$\alpha_{\pi\pi}$	-3.86	-3.37	-2.32	-1.79	-1.61	-1.96	-3.36	-3.81	-3.71
		(0.01)	(0.01)	(0.03)	(0.11)	(0.17)	(0.06)	(0.05)	(0.05)	(0.06)
	α_{yy}	-0.11	-0.35	-0.35	-0.12	-0.05	-0.06	-0.12	-0.23	-0.38
		(0.70)	(0.23)	(0.14)	(0.52)	(0.75)	(0.74)	(0.72)	(0.52)	(0.24)
	$\gamma^+_{\pi\pi}$	3.05	2.78	2.09	3.04	4.21	5.64	2.74	1.10	0.63
		(0.16)	(0.16)	(0.33)	(0.18)	(0.06)	(0.01)	(0.47)	(0.73)	(0.80)
	γ^+_{yy}	-2.82	-3.13	0.08	-4.65	-5.88	-9.12	-0.70	0.97	1.20
		(0.05)	(0.59)	(0.99)	(0.04)	(0.00)	(0.00)	(0.73)	(0.47)	(0.21)
1	c	0.89	0.43	-0.02	-0.28	-0.77	-1.34	-0.80	0.01	0.44
		(0.02)	(0.32)	(0.95)	(0.10)	(0.00)	(0.00)	(0.51)	(0.99)	(0.54)
	ρ	0.79	0.89	0.98	1.03	1.13	1.24	1.15	0.98	0.89
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	-0.06	0.00	0.05	0.07	0.09	0.13	-0.01	-0.05	-0.07
		(0.64)	(0.97)	(0.53)	(0.51)	(0.47)	(0.41)	(0.96)	(0.70)	(0.58)
	α_y	0.24	0.31	0.36	0.40	0.59	0.90	0.47	0.02	-0.22
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.24)	(0.93)	(0.15)
	$\alpha_{\pi\pi}$	-1.28	-1.53	-1.20	-1.21	-1.22	-1.10	-1.36	-1.30	-1.19
		(0.02)	(0.01)	(0.06)	(0.05)	(0.07)	(0.20)	(0.20)	(0.27)	(0.31)
	α_{yy}	0.07	-0.10	-0.15	0.05	0.12	0.03	0.03	-0.14	-0.39
		(0.86)	(0.84)	(0.59)	(0.77)	(0.46)	(0.91)	(0.94)	(0.79)	(0.52)
	$\gamma^+_{\pi\pi}$	1.30	1.73	1.81	2.53	3.33	4.09	0.84	-1.09	-1.38
		(0.57)	(0.34)	(0.30)	(0.14)	(0.04)	(0.03)	(0.79)	(0.64)	(0.37)
	γ^+_{yy}	-2.56	-2.63	0.07	-4.53	-5.43	-8.77	-0.37	1.43	1.55
		(0.12)	(0.59)	(0.99)	(0.02)	(0.00)	(0.00)	(0.85)	(0.29)	(0.08)
2	c	0.94	0.42	-0.07	-0.36	-0.88	-1.37	-0.88	0.03	0.49
		(0.06)	(0.22)	(0.80)	(0.05)	(0.00)	(0.01)	(0.49)	(0.98)	(0.50)
	ρ	0.77	0.88	0.98	1.04	1.15	1.24	1.15	0.97	0.88
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	-0.07	-0.01	0.06	0.09	0.12	0.18	-0.03	-0.10	-0.10
		(0.60)	(0.89)	(0.54)	(0.43)	(0.36)	(0.27)	(0.88)	(0.53)	(0.44)
	α_y	0.25	0.35	0.40	0.45	0.67	1.03	0.63	0.08	-0.20
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.24)	(0.75)	(0.19)
	$\alpha_{\pi\pi}$	-0.33	-0.66	-0.62	-0.67	-0.53	-0.23	-0.03	-0.01	-0.09
		(0.47)	(0.30)	(0.29)	(0.29)	(0.38)	(0.74)	(0.97)	(0.99)	(0.90)
	α_{yy}	0.09	-0.13	-0.19	0.00	0.01	-0.20	-0.17	-0.29	-0.50
		(0.80)	(0.71)	(0.32)	(0.99)	(0.95)	(0.36)	(0.62)	(0.57)	(0.41)
	$\gamma^+_{\pi\pi}$	1.64	2.16	2.20	2.65	3.36	3.96	1.67	-0.23	-0.62
		(0.37)	(0.15)	(0.09)	(0.03)	(0.00)	(0.00)	(0.53)	(0.89)	(0.58)
	γ^+_{yy}	-2.63	-2.54	0.41	-3.90	-5.25	-8.78	-0.62	1.40	1.79
		(0.04)	(0.58)	(0.94)	(0.04)	(0.00)	(0.00)	(0.75)	(0.18)	(0.03)
h	k	0	1	2	3	4	5	6	7	8
0	ℓ	-21.49	-19.30	-17.79	-17.62	-17.47	-19.25	-32.12	-32.91	-31.45
1	ℓ	-26.00	-20.10	-17.69	-16.33	-15.64	-19.48	-35.73	-38.07	-36.66
2	ℓ	-29.22	-22.65	-17.66	-15.81	-14.76	-18.53	-37.69	-40.87	-39.41

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ, the Schwarz information criterion values are denoted by SBC.
Sample range: 1997Q4 to 2009Q4.

Table 12: OLS estimates of interest rate reaction function parameters for $h = 3, 4, 5$ - Accounting for forecast upward risk

h	k	0	1	2	3	4	5	6	7	8
3	c	0.96	0.37	-0.18	-0.36	-0.74	-1.03	-0.66	0.09	0.49
		(0.08)	(0.28)	(0.53)	(0.21)	(0.03)	(0.02)	(0.41)	(0.87)	(0.36)
	ρ	0.76	0.88	0.99	1.04	1.12	1.17	1.11	0.95	0.87
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	-0.06	-0.03	0.11	0.17	0.17	0.21	-0.08	-0.17	-0.15
		(0.64)	(0.83)	(0.36)	(0.28)	(0.30)	(0.19)	(0.67)	(0.37)	(0.38)
	α_y	0.26	0.37	0.45	0.49	0.69	0.98	0.69	0.19	-0.10
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.15)	(0.41)	(0.28)
	$\alpha_{\pi\pi}$	0.57	0.24	0.29	0.23	0.27	0.73	1.76	1.98	1.71
		(0.48)	(0.71)	(0.74)	(0.71)	(0.68)	(0.25)	(0.03)	(0.02)	(0.01)
	α_{yy}	0.01	-0.28	-0.46	-0.26	-0.18	-0.32	-0.21	-0.17	-0.28
		(0.97)	(0.32)	(0.03)	(0.08)	(0.22)	(0.09)	(0.33)	(0.55)	(0.48)
	$\gamma^+_{\pi\pi}$	1.86	2.58	2.06	2.32	3.13	3.48	2.50	1.03	0.47
		(0.11)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)	(0.17)	(0.38)	(0.53)
	γ^+_{yy}	-2.25	-2.07	0.61	-3.35	-4.89	-7.69	-0.09	1.76	2.13
		(0.05)	(0.57)	(0.90)	(0.10)	(0.00)	(0.00)	(0.96)	(0.03)	(0.00)
4	c	0.97	0.39	-0.10	-0.32	-0.69	-0.92	-0.64	0.08	0.49
		(0.08)	(0.29)	(0.73)	(0.32)	(0.06)	(0.05)	(0.42)	(0.90)	(0.52)
	ρ	0.76	0.87	0.98	1.03	1.11	1.16	1.10	0.95	0.87
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	-0.01	0.03	0.24	0.31	0.31	0.36	0.01	-0.12	-0.10
		(0.95)	(0.87)	(0.22)	(0.19)	(0.20)	(0.07)	(0.97)	(0.64)	(0.70)
	α_y	0.27	0.37	0.44	0.49	0.69	0.96	0.70	0.19	-0.12
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.14)	(0.42)	(0.29)
	$\alpha_{\pi\pi}$	-0.15	-0.37	-0.30	-0.14	0.10	0.90	2.25	2.45	1.94
		(0.85)	(0.81)	(0.86)	(0.90)	(0.93)	(0.29)	(0.02)	(0.03)	(0.04)
	α_{yy}	0.04	-0.23	-0.37	-0.20	-0.14	-0.25	-0.12	-0.06	-0.20
		(0.88)	(0.31)	(0.03)	(0.11)	(0.28)	(0.14)	(0.60)	(0.86)	(0.69)
	$\gamma^+_{\pi\pi}$	1.35	2.09	2.03	2.42	3.13	3.64	3.28	1.80	0.99
		(0.35)	(0.10)	(0.04)	(0.01)	(0.00)	(0.01)	(0.09)	(0.17)	(0.26)
	γ^+_{yy}	-1.81	-1.48	1.19	-1.44	-3.26	-5.81	0.73	1.95	2.12
		(0.08)	(0.70)	(0.80)	(0.54)	(0.05)	(0.00)	(0.55)	(0.01)	(0.02)
5	c	1.13	0.63	0.11	-0.05	-0.26	-0.31	-0.05	0.34	0.55
		(0.05)	(0.14)	(0.75)	(0.91)	(0.49)	(0.41)	(0.90)	(0.36)	(0.27)
	ρ	0.74	0.83	0.94	0.98	1.03	1.04	0.99	0.91	0.87
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.22	0.17	0.34	0.32	0.30	0.35	0.15	0.12	0.18
		(0.62)	(0.48)	(0.11)	(0.21)	(0.21)	(0.08)	(0.48)	(0.67)	(0.56)
	α_y	0.22	0.36	0.43	0.46	0.62	0.79	0.55	0.23	0.05
		(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)	(0.22)	(0.61)
	$\alpha_{\pi\pi}$	1.48	0.87	0.12	0.30	0.85	1.87	3.82	4.72	4.69
		(0.35)	(0.37)	(0.88)	(0.70)	(0.23)	(0.00)	(0.00)	(0.00)	(0.00)
	α_{yy}	-0.15	-0.37	-0.39	-0.17	-0.09	-0.02	0.47	0.91	0.99
		(0.67)	(0.20)	(0.03)	(0.16)	(0.35)	(0.89)	(0.05)	(0.00)	(0.05)
	$\gamma^+_{\pi\pi}$	1.37	2.29	2.20	2.52	2.98	3.14	2.85	1.99	1.30
		(0.17)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.08)	(0.09)
	γ^+_{yy}	-2.23	-1.51	1.44	-1.97	-3.77	-5.95	1.34	2.58	2.80
		(0.09)	(0.60)	(0.74)	(0.41)	(0.00)	(0.00)	(0.45)	(0.03)	(0.00)

h	k	0	1	2	3	4	5	6	7	8
3	ℓ	-29.58	-22.84	-16.20	-13.87	-12.40	-15.11	-34.15	-38.45	-38.06
4	ℓ	-30.26	-23.30	-16.43	-14.40	-13.81	-17.38	-34.31	-39.01	-38.76
5	ℓ	-27.84	-20.92	-13.73	-12.07	-10.64	-10.99	-25.21	-28.79	-30.02

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ, the Schwarz information criterion values are denoted by SBC.
Sample range: 1997Q4 to 2009Q4.

Table 13: OLS estimates of interest rate reaction function parameters for $h = 6, 7, 8$ - Accounting for forecast upward risk

h	k	0	1	2	3	4	5	6	7	8
6	c	0.89	0.61	0.28	0.13	-0.04	0.04	0.36	0.58	0.64
		(0.02)	(0.05)	(0.33)	(0.74)	(0.92)	(0.92)	(0.15)	(0.12)	(0.15)
	ρ	0.80	0.84	0.91	0.95	0.98	0.97	0.92	0.88	0.86
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.61	0.54	0.42	0.32	0.29	0.36	0.27	0.28	0.35
		(0.12)	(0.10)	(0.12)	(0.27)	(0.33)	(0.21)	(0.39)	(0.45)	(0.35)
	α_y	0.12	0.28	0.39	0.41	0.53	0.60	0.33	0.12	0.06
		(0.14)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.13)	(0.41)	(0.61)
	$\alpha_{\pi\pi}$	3.78	2.46	0.62	0.83	1.38	2.33	4.03	4.85	5.22
		(0.04)	(0.10)	(0.57)	(0.46)	(0.12)	(0.00)	(0.00)	(0.00)	(0.00)
	α_{yy}	-0.49	-0.68	-0.37	-0.15	-0.12	-0.10	0.32	0.72	0.96
		(0.07)	(0.05)	(0.07)	(0.21)	(0.14)	(0.40)	(0.17)	(0.01)	(0.01)
	$\gamma^+_{\pi\pi}$	0.57	1.62	2.53	2.70	2.89	2.62	1.98	1.34	0.81
		(0.59)	(0.05)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.16)
	γ^+_{yy}	-2.25	-1.13	1.02	-2.39	-3.96	-5.87	0.66	2.10	2.64
		(0.00)	(0.71)	(0.83)	(0.35)	(0.00)	(0.00)	(0.68)	(0.05)	(0.00)
7	c	0.89	0.25	0.08	0.11	0.03	0.12	0.46	0.66	0.73
		(0.02)	(0.40)	(0.79)	(0.65)	(0.95)	(0.74)	(0.01)	(0.02)	(0.02)
	ρ	0.80	0.92	0.95	0.95	0.97	0.96	0.91	0.87	0.85
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.79	0.70	0.56	0.52	0.55	0.81	1.04	1.08	1.10
		(0.07)	(0.01)	(0.06)	(0.23)	(0.25)	(0.06)	(0.02)	(0.01)	(0.02)
	α_y	0.17	0.25	0.29	0.30	0.41	0.48	0.23	0.03	-0.05
		(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.24)	(0.78)	(0.68)
	$\alpha_{\pi\pi}$	2.34	2.98	2.27	2.06	1.91	1.79	2.10	2.29	2.26
		(0.06)	(0.00)	(0.04)	(0.14)	(0.12)	(0.11)	(0.05)	(0.08)	(0.13)
	α_{yy}	-0.24	-0.75	-0.55	-0.34	-0.33	-0.44	-0.26	-0.07	0.01
		(0.09)	(0.00)	(0.01)	(0.02)	(0.00)	(0.00)	(0.16)	(0.88)	(0.98)
	$\gamma^+_{\pi\pi}$	1.85	1.76	1.94	2.08	2.40	2.33	1.78	1.35	1.11
		(0.01)	(0.01)	(0.09)	(0.06)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
	γ^+_{yy}	-1.47	-0.54	0.69	-2.47	-3.83	-5.45	0.84	2.07	2.31
		(0.05)	(0.89)	(0.88)	(0.23)	(0.00)	(0.00)	(0.52)	(0.01)	(0.00)
8	c	0.83	0.14	-0.20	-0.20	-0.12	0.10	0.31	0.38	0.43
		(0.01)	(0.62)	(0.33)	(0.21)	(0.44)	(0.60)	(0.76)	(0.56)	(0.35)
	ρ	0.79	0.92	0.99	1.00	0.99	0.94	0.91	0.90	0.88
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	1.33	1.12	0.67	0.66	0.69	0.90	1.61	1.80	1.79
		(0.00)	(0.00)	(0.01)	(0.08)	(0.08)	(0.03)	(0.36)	(0.00)	(0.00)
	α_y	0.18	0.27	0.35	0.33	0.41	0.46	0.17	-0.02	-0.11
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.86)	(0.90)	(0.30)
	$\alpha_{\pi\pi}$	-0.25	0.34	1.08	1.40	1.75	1.35	-0.15	-0.66	-0.74
		(0.78)	(0.72)	(0.11)	(0.10)	(0.09)	(0.23)	(0.98)	(0.60)	(0.48)
	α_{yy}	-0.09	-0.61	-0.68	-0.55	-0.68	-0.83	-0.47	-0.24	-0.19
		(0.57)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.88)	(0.86)	(0.80)
	$\gamma^+_{\pi\pi}$	2.01	2.01	2.46	2.40	2.54	2.48	1.83	1.36	1.13
		(0.02)	(0.01)	(0.00)	(0.01)	(0.01)	(0.02)	(0.52)	(0.22)	(0.18)
	γ^+_{yy}	-1.47	-1.38	-0.27	-1.63	-3.79	-5.46	0.47	1.59	1.82
		(0.10)	(0.73)	(0.95)	(0.37)	(0.00)	(0.00)	(0.88)	(0.00)	(0.00)
h	k	0	1	2	3	4	5	6	7	8
6	ℓ	-17.84	-13.69	-9.17	-8.89	-7.57	-8.04	-18.32	-18.43	-16.97
7	ℓ	-10.17	-3.45	-1.32	-3.48	-3.21	-4.60	-15.09	-15.63	-14.62
8	ℓ	-12.78	-9.12	-2.80	-4.50	-4.34	-8.38	-18.13	-18.88	-18.18

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ, the Schwarz information criterion values are denoted by SBC.
Sample range: 1997Q4 to 2009Q4.

Table 14: OLS estimates of interest rate reaction function parameters for $h = 0, 1, 2$ - Accounting for forecast downward risk

h	k	0	1	2	3	4	5	6	7	8
0	c	0.67	0.34	-0.13	-0.44	-0.49	-0.16	0.29	0.22	0.06
		(0.09)	(0.31)	(0.72)	(0.33)	(0.17)	(0.69)	(0.47)	(0.60)	(0.91)
	ρ	0.84	0.90	1.00	1.07	1.08	1.02	0.93	0.94	0.97
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.14	0.19	0.23	0.27	0.28	0.23	0.21	0.24	0.24
		(0.56)	(0.23)	(0.12)	(0.17)	(0.25)	(0.36)	(0.42)	(0.41)	(0.45)
	α_y	0.24	0.30	0.39	0.45	0.50	0.35	-0.03	-0.14	-0.15
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)	(0.85)	(0.37)	(0.38)
	$\alpha_{\pi\pi}$	-3.88	-3.23	-2.05	-1.61	-1.97	-2.75	-3.78	-4.18	-4.40
		(0.01)	(0.01)	(0.06)	(0.16)	(0.16)	(0.07)	(0.01)	(0.01)	(0.00)
	α_{yy}	-0.24	-0.37	-0.34	-0.18	0.02	0.35	0.77	0.98	1.04
		(0.10)	(0.15)	(0.06)	(0.38)	(0.93)	(0.44)	(0.22)	(0.28)	(0.39)
	$\gamma^-_{\pi\pi}$	-2.15	-2.31	-1.98	-1.98	-2.95	-3.83	-3.76	-3.31	-2.83
		(0.47)	(0.30)	(0.30)	(0.36)	(0.27)	(0.25)	(0.32)	(0.44)	(0.55)
	γ^-_{yy}	0.38	0.53	0.80	0.70	0.53	-0.02	-0.74	-0.94	-0.97
		(0.38)	(0.33)	(0.25)	(0.20)	(0.26)	(0.96)	(0.03)	(0.00)	(0.01)
1	c	0.81	0.45	-0.14	-0.51	-0.57	-0.34	-0.06	-0.19	-0.34
		(0.02)	(0.23)	(0.67)	(0.29)	(0.12)	(0.39)	(0.90)	(0.72)	(0.69)
	ρ	0.81	0.88	1.00	1.08	1.10	1.05	0.99	1.01	1.03
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	-0.05	0.03	0.14	0.25	0.26	0.20	0.20	0.25	0.21
		(0.78)	(0.82)	(0.25)	(0.14)	(0.22)	(0.38)	(0.35)	(0.33)	(0.59)
	α_y	0.25	0.30	0.39	0.45	0.49	0.32	-0.06	-0.12	-0.10
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.12)	(0.76)	(0.48)	(0.62)
	$\alpha_{\pi\pi}$	-1.43	-1.66	-1.26	-1.24	-1.64	-2.15	-2.80	-2.83	-2.53
		(0.23)	(0.05)	(0.05)	(0.05)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)
	α_{yy}	-0.02	-0.11	-0.23	-0.12	0.19	0.78	1.47	1.69	1.62
		(0.83)	(0.74)	(0.24)	(0.64)	(0.34)	(0.04)	(0.00)	(0.07)	(0.40)
	$\gamma^-_{\pi\pi}$	-0.07	-0.32	-0.80	-1.17	-2.01	-2.65	-2.54	-2.12	-1.58
		(0.99)	(0.89)	(0.62)	(0.43)	(0.27)	(0.28)	(0.43)	(0.64)	(0.83)
	γ^-_{yy}	0.21	0.43	0.81	0.76	0.56	-0.15	-1.15	-1.44	-1.46
		(0.77)	(0.52)	(0.23)	(0.18)	(0.31)	(0.80)	(0.03)	(0.01)	(0.00)
2	c	0.80	0.42	-0.27	-0.77	-0.96	-0.70	-0.27	-0.27	-0.36
		(0.05)	(0.34)	(0.48)	(0.12)	(0.03)	(0.08)	(0.56)	(0.67)	(0.72)
	ρ	0.80	0.88	1.02	1.12	1.17	1.12	1.02	1.01	1.02
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	-0.01	0.06	0.18	0.30	0.33	0.25	0.21	0.24	0.21
		(0.97)	(0.64)	(0.14)	(0.05)	(0.10)	(0.22)	(0.26)	(0.20)	(0.40)
	α_y	0.24	0.32	0.44	0.54	0.65	0.52	0.06	-0.06	-0.07
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.72)	(0.69)	(0.71)
	$\alpha_{\pi\pi}$	-0.56	-0.89	-0.61	-0.39	-0.57	-1.01	-1.65	-1.55	-1.18
		(0.36)	(0.20)	(0.37)	(0.54)	(0.36)	(0.16)	(0.00)	(0.00)	(0.01)
	α_{yy}	-0.07	-0.20	-0.37	-0.34	-0.09	0.55	1.43	1.67	1.64
		(0.57)	(0.53)	(0.20)	(0.26)	(0.65)	(0.09)	(0.01)	(0.09)	(0.36)
	$\gamma^-_{\pi\pi}$	-0.58	-0.56	-0.80	-1.03	-1.91	-2.82	-2.85	-2.51	-2.20
		(0.76)	(0.69)	(0.53)	(0.31)	(0.12)	(0.12)	(0.26)	(0.44)	(0.62)
	γ^-_{yy}	0.14	0.41	0.95	1.00	1.06	0.42	-0.83	-1.19	-1.19
		(0.78)	(0.52)	(0.27)	(0.09)	(0.15)	(0.56)	(0.20)	(0.01)	(0.00)

h	k	0	1	2	3	4	5	6	7	8
0	ℓ	-22.71	-19.65	-17.19	-18.43	-21.40	-24.18	-25.05	-24.71	-25.06
1	ℓ	-27.39	-21.39	-18.07	-18.19	-20.32	-22.37	-23.44	-25.10	-28.02
2	ℓ	-31.06	-24.90	-18.81	-17.50	-19.89	-23.51	-26.78	-28.82	-31.36

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ, the Schwarz information criterion values are denoted by SBC.
Sample range: 1997Q4 to 2009Q4.

Table 15: OLS estimates of interest rate reaction function parameters for $h = 3, 4, 5$ - Accounting for forecast downward risk

h	k	0	1	2	3	4	5	6	7	8
3	c	0.70	0.30	-0.47	-0.90	-1.06	-0.88	-0.46	-0.32	-0.37
		(0.11)	(0.43)	(0.06)	(0.00)	(0.00)	(0.01)	(0.27)	(0.53)	(0.66)
	ρ	0.81	0.89	1.05	1.15	1.19	1.15	1.05	1.02	1.02
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.01	0.06	0.21	0.36	0.36	0.26	0.14	0.16	0.16
		(0.97)	(0.63)	(0.10)	(0.03)	(0.03)	(0.14)	(0.37)	(0.24)	(0.30)
	α_y	0.21	0.33	0.49	0.60	0.74	0.71	0.25	0.02	-0.03
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.17)	(0.85)	(0.85)
	$\alpha_{\pi\pi}$	0.52	0.35	1.00	1.43	1.21	0.83	0.05	0.00	0.29
		(0.54)	(0.53)	(0.19)	(0.06)	(0.05)	(0.22)	(0.94)	(1.00)	(0.74)
	α_{yy}	-0.20	-0.44	-0.73	-0.73	-0.48	0.06	1.08	1.56	1.71
		(0.27)	(0.05)	(0.00)	(0.00)	(0.00)	(0.85)	(0.04)	(0.06)	(0.19)
	$\gamma^-_{\pi\pi}$	-0.99	-0.93	-0.61	-0.29	-1.28	-2.64	-3.42	-3.17	-2.85
		(0.48)	(0.41)	(0.49)	(0.58)	(0.05)	(0.04)	(0.12)	(0.19)	(0.30)
	γ^-_{yy}	0.23	0.65	1.18	1.24	1.51	1.27	0.13	-0.44	-0.60
		(0.58)	(0.26)	(0.09)	(0.00)	(0.00)	(0.04)	(0.87)	(0.54)	(0.29)
4	c	0.75	0.35	-0.26	-0.64	-0.77	-0.74	-0.52	-0.44	-0.46
		(0.09)	(0.45)	(0.33)	(0.02)	(0.01)	(0.01)	(0.21)	(0.47)	(0.65)
	ρ	0.81	0.89	1.02	1.11	1.14	1.13	1.06	1.04	1.04
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.07	0.12	0.29	0.50	0.46	0.34	0.23	0.28	0.27
		(0.84)	(0.61)	(0.26)	(0.13)	(0.10)	(0.14)	(0.27)	(0.22)	(0.31)
	α_y	0.23	0.33	0.44	0.52	0.59	0.53	0.13	-0.03	-0.06
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.39)	(0.81)	(0.73)
	$\alpha_{\pi\pi}$	-0.74	-1.16	-0.07	0.93	0.31	-0.16	-1.61	-1.66	-1.09
		(0.32)	(0.45)	(0.97)	(0.59)	(0.84)	(0.91)	(0.16)	(0.08)	(0.26)
	α_{yy}	-0.09	-0.25	-0.46	-0.43	-0.05	0.49	1.41	1.73	1.74
		(0.61)	(0.52)	(0.04)	(0.01)	(0.76)	(0.09)	(0.01)	(0.08)	(0.29)
	$\gamma^-_{\pi\pi}$	-0.77	-0.74	-0.73	-0.92	-1.96	-2.99	-3.34	-2.93	-2.55
		(0.55)	(0.38)	(0.52)	(0.30)	(0.06)	(0.05)	(0.10)	(0.23)	(0.43)
	γ^-_{yy}	0.04	0.29	1.02	1.37	1.35	0.93	-0.44	-0.96	-0.97
		(0.93)	(0.61)	(0.32)	(0.10)	(0.09)	(0.27)	(0.62)	(0.17)	(0.08)
5	c	0.85	0.46	-0.11	-0.32	-0.46	-0.47	-0.26	-0.08	-0.07
		(0.16)	(0.27)	(0.71)	(0.40)	(0.19)	(0.10)	(0.48)	(0.87)	(0.93)
	ρ	0.80	0.87	0.99	1.06	1.09	1.09	1.03	0.98	0.98
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.29	0.29	0.41	0.51	0.46	0.38	0.25	0.26	0.30
		(0.48)	(0.36)	(0.24)	(0.16)	(0.12)	(0.13)	(0.25)	(0.27)	(0.26)
	α_y	0.21	0.33	0.45	0.47	0.53	0.55	0.29	0.06	-0.00
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)	(0.65)	(0.98)
	$\alpha_{\pi\pi}$	1.21	1.02	1.81	1.85	1.65	2.14	2.07	1.99	2.05
		(0.16)	(0.23)	(0.39)	(0.34)	(0.20)	(0.03)	(0.01)	(0.02)	(0.03)
	α_{yy}	-0.31	-0.54	-0.66	-0.40	-0.04	0.36	1.02	1.54	1.71
		(0.03)	(0.04)	(0.02)	(0.04)	(0.79)	(0.22)	(0.03)	(0.04)	(0.14)
	$\gamma^-_{\pi\pi}$	-0.42	-0.27	0.29	0.08	-1.12	-2.06	-2.67	-2.43	-2.01
		(0.77)	(0.78)	(0.76)	(0.92)	(0.11)	(0.02)	(0.11)	(0.20)	(0.39)
	γ^-_{yy}	0.12	0.48	1.07	1.16	1.39	1.42	0.73	0.08	-0.23
		(0.81)	(0.20)	(0.19)	(0.02)	(0.00)	(0.00)	(0.32)	(0.90)	(0.65)

h	k	0	1	2	3	4	5	6	7	8
3	ℓ	-31.41	-25.72	-16.06	-11.78	-15.50	-20.65	-27.01	-28.90	-30.59
4	ℓ	-31.48	-25.46	-18.59	-15.78	-18.32	-21.47	-25.74	-27.91	-30.52
5	ℓ	-30.22	-24.60	-15.53	-13.87	-15.79	-17.27	-23.94	-26.61	-28.57

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ, the Schwarz information criterion values are denoted by SBC.
Sample range: 1997Q4 to 2009Q4.

Table 16: OLS estimates of interest rate reaction function parameters for $h = 6, 7, 8$ - Accounting for forecast downward risk

h	k	0	1	2	3	4	5	6	7	8
6	c	0.64	0.34	0.06	0.00	-0.12	-0.10	0.07	0.19	0.17
		(0.04)	(0.25)	(0.85)	(1.00)	(0.77)	(0.76)	(0.84)	(0.63)	(0.66)
	ρ	0.85	0.91	0.98	1.00	1.02	1.02	0.98	0.95	0.95
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.35	0.51	0.50	0.47	0.41	0.35	0.28	0.28	0.32
		(0.39)	(0.13)	(0.12)	(0.20)	(0.26)	(0.32)	(0.42)	(0.43)	(0.38)
	α_y	0.15	0.28	0.35	0.34	0.38	0.38	0.20	0.05	0.03
		(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.30)	(0.74)	(0.82)
	$\alpha_{\pi\pi}$	6.22	6.30	4.54	3.57	2.75	3.02	3.40	3.78	4.26
		(0.00)	(0.00)	(0.00)	(0.05)	(0.07)	(0.02)	(0.02)	(0.00)	(0.00)
	α_{yy}	-0.79	-1.18	-0.85	-0.48	-0.12	0.18	0.70	1.19	1.46
		(0.00)	(0.00)	(0.00)	(0.00)	(0.51)	(0.58)	(0.17)	(0.01)	(0.00)
	$\gamma^-_{\pi\pi}$	0.49	1.08	1.26	0.78	-0.51	-1.22	-1.67	-1.56	-1.26
		(0.15)	(0.01)	(0.02)	(0.23)	(0.47)	(0.20)	(0.17)	(0.12)	(0.08)
	γ^-_{yy}	0.73	0.98	0.72	0.76	1.05	1.10	0.76	0.40	0.18
		(0.06)	(0.01)	(0.10)	(0.01)	(0.00)	(0.00)	(0.17)	(0.49)	(0.74)
7	c	0.29	-0.10	-0.15	0.02	-0.06	-0.08	0.10	0.11	-0.00
		(0.36)	(0.69)	(0.66)	(0.96)	(0.90)	(0.82)	(0.74)	(0.78)	(1.00)
	ρ	0.92	0.99	1.01	0.99	1.01	1.01	0.97	0.96	0.98
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	0.51	0.58	0.67	0.71	0.69	0.74	0.69	0.51	0.41
		(0.26)	(0.08)	(0.11)	(0.18)	(0.21)	(0.16)	(0.21)	(0.42)	(0.53)
	α_y	0.13	0.20	0.23	0.20	0.24	0.25	0.08	-0.07	-0.11
		(0.02)	(0.00)	(0.01)	(0.11)	(0.13)	(0.09)	(0.55)	(0.64)	(0.51)
	$\alpha_{\pi\pi}$	3.85	4.29	3.62	3.48	2.47	1.96	2.04	2.59	3.08
		(0.00)	(0.00)	(0.00)	(0.01)	(0.09)	(0.09)	(0.05)	(0.03)	(0.03)
	α_{yy}	-0.57	-0.94	-0.78	-0.60	-0.30	-0.06	0.37	0.84	1.13
		(0.00)	(0.00)	(0.00)	(0.00)	(0.31)	(0.88)	(0.34)	(0.15)	(0.06)
	$\gamma^-_{\pi\pi}$	-0.68	-0.42	0.19	0.36	-0.59	-1.27	-1.64	-1.77	-1.72
		(0.14)	(0.10)	(0.59)	(0.59)	(0.51)	(0.19)	(0.11)	(0.09)	(0.04)
	γ^-_{yy}	0.52	0.63	0.12	0.15	0.67	0.83	0.57	0.34	0.19
		(0.07)	(0.02)	(0.78)	(0.72)	(0.04)	(0.00)	(0.19)	(0.48)	(0.66)
8	c	0.13	-0.35	-0.43	-0.26	-0.32	-0.31	-0.10	-0.07	-0.13
		(0.70)	(0.17)	(0.11)	(0.55)	(0.43)	(0.29)	(0.77)	(0.93)	(0.86)
	ρ	0.94	1.02	1.05	1.03	1.04	1.04	0.99	0.98	0.99
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	α_π	1.14	0.88	0.62	0.66	0.70	0.94	1.24	1.21	1.03
		(0.00)	(0.00)	(0.01)	(0.10)	(0.08)	(0.01)	(0.00)	(0.02)	(0.05)
	α_y	0.14	0.20	0.22	0.18	0.21	0.19	0.01	-0.11	-0.16
		(0.01)	(0.00)	(0.02)	(0.22)	(0.23)	(0.32)	(0.97)	(0.79)	(0.40)
	$\alpha_{\pi\pi}$	0.83	1.78	2.12	2.22	1.60	0.72	0.16	0.30	0.79
		(0.28)	(0.03)	(0.00)	(0.02)	(0.06)	(0.36)	(0.92)	(0.59)	(0.55)
	α_{yy}	-0.38	-0.76	-0.65	-0.52	-0.33	-0.09	0.21	0.55	0.80
		(0.00)	(0.00)	(0.00)	(0.00)	(0.06)	(0.81)	(0.91)	(0.83)	(0.66)
	$\gamma^-_{\pi\pi}$	-0.72	-0.92	-0.65	-0.41	-1.08	-1.72	-1.77	-1.79	-1.75
		(0.11)	(0.04)	(0.11)	(0.42)	(0.18)	(0.13)	(0.35)	(0.37)	(0.26)
	γ^-_{yy}	0.47	0.57	0.20	0.05	0.61	0.92	0.71	0.53	0.33
		(0.02)	(0.06)	(0.53)	(0.93)	(0.20)	(0.10)	(0.31)	(0.47)	(0.58)

h	k	0	1	2	3	4	5	6	7	8
6	ℓ	-17.13	-10.64	-8.14	-11.75	-14.52	-15.19	-18.34	-18.97	-19.12
7	ℓ	-12.15	-5.79	-5.55	-9.33	-12.72	-13.72	-16.03	-15.51	-14.80
8	ℓ	-14.79	-10.32	-9.31	-11.92	-14.49	-15.73	-17.44	-16.97	-16.65

Note: Figures in parentheses are p-values for t test statistics based on Newey-West (1987) standard errors. The bandwidth parameter is chosen based on the procedure proposed by Andrews (1991). The log-likelihood values are denoted by ℓ, the Schwarz information criterion values are denoted by SBC.
Sample range: 1997Q4 to 2009Q4.

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