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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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The Dynamic Voting Patterns of the Bank of England's MPC

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Abstract: The literature on the behavior of the Bank of England's Monetary Policy Committee (MPC) has focused on static voting patterns. We find statistical support for a dynamic pattern using a panel reaction function to analyze MPC votes over the 1997-2008 period. We find that internal and external members do not behave differently in their first year on the MPC. In their third year of tenure, internal members prefer higher policy rates, placing a higher weight on price stability and a lower weight on the output gap than external members.

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1. Introduction

The deliberation of monetary policy committees is a topic addressed in a small but growing literature on the internal functioning of central banks. Much of the genesis of this literature owes to Alan Blinder who, in two prominent monographs (1998, 2004), posed many important questions. The bulk of the research so far has examined the Bank of England's Monetary Policy Committee (MPC) or the Federal Reserve's Federal Open Market Committee (FOMC) because these central banks publish detailed information about their decision-making procedures. In particular, the Bank of England publishes not only minutes of its MPC meetings, but also votes by individual (including preferred settings for the policy rate in the event of dissent) and macroeconomic forecasts that accompany the policy decision taken at each meeting.

In this paper, we examine the dynamic voting behavior of the MPC. Most prior studies of the MPC consider the average voting patterns of monetary policymakers over time, not the dynamics of the votes. Gerlach-Kristen (2003) and Spencer (2006), for example, provided evidence that the votes cast by the five internal members of the MPC differ significantly from those cast by the four external members who are not career central bankers. A close look at the time pattern of the votes reveals that internal members dissent little initially and then increase their dissents over their tenure, whereas external members dissent about one-quarter of the time during each year on the MPC. Our estimation of a pooled voting panel over the 1997-2008 period provides statistical support for dynamics in voting and for differences by type of member. When dynamics and member type are interacted, the estimation results suggest that internal and external members behave similarly during their first year on the MPC. However, by their third year as a policymaker, internal

members are substantially more hawkish, and place a greater weight on inflation and a lower weight on output relative to external members.

In the next section, we review the literature on MPC voting and provide some stylized facts about the time pattern of voting. In section 3, we discuss our empirical framework and data. We present estimation results and robustness checks in section 4. Section 5 concludes.

2. Literature review and stylized facts of MPC voting

Much of the literature on the Bank of England's MPC has analyzed the voting behavior of policymakers, and focused on the differences between the votes cast by the five internal members (who are career central bankers) and those cast by the four external members (who come from diverse backgrounds, generally serve part-time, and do not have administrative responsibilities). Internal members serve terms that range from 3 to 5 years in duration, as the Governor and two Deputy Governors are appointed to a term of 5 years, while the two other internal members are appointed for 3 years. External members are appointed to a 3-year term. Both types of members can be re-appointed, although in actual fact, re-appointment is relatively rare for both types of members.¹ The average tenure is around 41 months for an internal member and 25 months for an external member.

Gerlach-Kristen (2003), Spencer (2006), and Harris and Spencer (2008) documented the differences in voting behavior between internal and external members, and showed that external members are more likely to dissent for lower interest rates. This is important because Gerlach-Kristen (2009) demonstrated that the dissents cast by external MPC members are helpful in predicting future changes in policy interest rates.

¹ Internal and external members can be appointed initially to complete the unfinished term of a prior member.

What lies behind the different voting patterns of internal and external members? The possible sources investigated in the literature include differences in career backgrounds or skills, information sets, incentives (reputation effects), and/or models of the economy. Some studies have examined this question using a pooled panel of MPC votes, where the dependent variable has generally been either the member's preferred level for the policy rate or a discrete indicator of it;² in this framework, differences between internal and external members are detected with a dummy variable. Other studies have estimated individual monetary policy reaction functions in order to look directly at the member-specific weights placed on inflation and output gaps; in this framework, differences between internal and external members are detected by comparing reaction function parameters.

Harris and Spencer (2008), paralleling the work of Havrilesky and Schweitzer (1990) for the FOMC, examined whether background characteristics, such as years spent in academia, finance, government, and so on, could account for the differences in voting patterns. In a panel setting, they found that such characteristics could not fully explain voting differences, and that a dummy variable for the type of member remained a large and highly significant determinant of dissents despite the inclusion of background effects. Using a simulation approach, Gerlach-Kristen (2009) was able to re-produce the pattern of MPC votes by employing an asymmetric reaction function in which external members place a higher weight on output deviations when output is below (rather than above) potential.

While Goodhart (2005) discussed a monetary policy reaction function for the MPC policy rate, several recent papers have presented reaction functions for individual policymakers. Bhattacharjee and Holly (2006) found significant heterogeneity in the parameters on inflation and output in MPC members' reaction functions. In contrast, Riboni

² A binomial indicator represents agreement or dissent with the policy proposal, whereas a multinomial indicator captures in addition the direction of the dissent.

and Ruge-Murcia (2008) found that members were homogeneous with respect to policy preferences but heterogeneous with respect to their type of membership and career backgrounds. Besley, Meads, and Surico (2008) also found no heterogeneity in policy preferences; however, they did find differences in the sensitivity to the lagged interest rate (usually interpreted to represent interest rate smoothing) and in the intercept term, which they construed as a measure of experience. Due to the absence of heterogeneity in policy preferences, Besley and his co-authors concluded that the type of membership (internal versus external) does not explain the differences in voting patterns.³

Because some policymakers serve on the MPC for only a short time, studies that estimate individual reaction functions typically only examine a subset of the membership. Bhattacharjee and Holly (2006) estimated reaction functions for five MPC members. Riboni and Ruge-Murcia (2008) dropped six officials; Besley *et al* (2008) made a less restrictive assumption and examined members with tenure on the MPC of at least two years.⁴

To date, the dynamic pattern of MPC member voting has not received much attention. The explanation for the source of the dynamics differs from study to study; some papers attribute it to experience or tenure, while other papers attribute it to learning. Groth and Wheeler (2008) looked at dynamics in a study of interest rate activism, and found no support for “learning” or the degree of gradualism in MPC policy. In their study, learning was represented as a dummy variable equal to unity when tenure was 36 months or more. Because external members are appointed to three-year terms that are typically not renewed, the change detected by this learning proxy was primarily determined by the behavior of the internal members.

³ They also found no support for background experience in academia or the UK Treasury.

⁴ This restriction resulted in the elimination of three members (Alan Budd, Howard Davies, and David Walton).

Hansen and McMahon (2008) examined whether MPC members' experience on the committee was important for preferred changes in the policy interest rate. In a panel setting, the authors found that experienced external members preferred lower interest rates relative to other MPC members – internal members and inexperienced external members – who were statistically indistinguishable from one another. While the threshold level for experience reported in the paper was the first 12 months on the MPC, Hanson and McMahon report that their results were robust to alternative measures of experience.

Table 1 provides information on MPC votes by member type for non-overlapping 12-month tenure intervals based upon MPC meetings from June 1997 through December 2008 (1228 votes, 140 meetings, and 26 policymakers). Based on dissent rates, inexperienced external members behave very differently from their internal brethren: external members dissented nearly 23 percent in their first 12 months of policymaking, compared with only 5.5 percent for internal members. As tenure on the MPC rises, the percentage of dissents cast by internal and external members becomes somewhat more similar, but this is *not* because external members become more like internal members; rather, it is because the frequency of dissent by internal members rises sharply. However, the dissent rate is still very different for the two types: in the third year of tenure, dissents are 13.5 percent for internal members and almost 26 percent for external members. Therefore, it is no wonder that studies using discrete indicators of agreement/dissent find that member type is an important determinant of voting behavior.

The table also provides information on the mean difference (in basis points) between the policy rate (the outcome of the MPC meeting) and the policymaker's preferred rate by tenure year. This difference is statistically significant for both internal and external members in their first 3 years of tenure on the MPC. Internal members prefer rates that are higher

than the policy rate outcome in their first 3 years on the committee, whereas external members generally prefer rates that are lower than the policy rate (in several cases, the difference is as large as 4 or more basis points). However, in their first year on the MPC, external members are similar to internal members in that – taking the average rate preference across all policymakers in each group – they would prefer somewhat higher interest rates. But, without question, using the preferred level of the policy rate to examine differences between the member types tends to make internal and external members appear more similar than does an examination of their dissenting votes.

Nearly all external members remain on the MPC for only one term or less (that is, 36 or fewer months). Only 5 individuals cast the 35 votes and 8 dissents registered by external members during their fourth year of tenure shown on table 1⁵. Because re-appointment is infrequent and we are investigating the voting dynamics for both types of members, we focus our empirical analysis of dynamics on the first 36 months of tenure – a sample of 784 votes cast between August 1997 and December 2008. By truncating the sample for each policymaker after their first 36 months on the MPC, we avoid the possibility that the results about dynamics are influenced by the behavior of a few long-standing internal members.⁶

3. Empirical framework and data

Our basic empirical model relies upon the conventional monetary policy reaction function first suggested by Taylor (1993) and refined in Svensson (1997) and other studies:

$$i_t = \alpha_1 + \alpha_2 i_{t-1} + \alpha_3 E_t(\pi_{t+h} - \pi^*) + \alpha_4 E_t(y_{t+k} - y^*) + \varepsilon_t \quad (1)$$

⁵ These members were Christopher Allsopp, Kate Barker, DeAnne Julius, Steve Nickell, and Sushil Wadhvani. Allsopp and Wadhvani left after 37 months. Only Barker and Nickell were formally re-appointed and served for more than 4 years.

⁶ Although re-appointment is rare, several internal members have been re-appointed repeatedly. In our sample, Charles Bean, Eddie George, Mervyn King, and Paul Tucker have tenure of 100, 74, 140, and 79 meetings, respectively.

The (nominal) policy interest rate (i_t) is the outcome of the monetary policy decision taken at time t , and is a function of the forecast made at time t for the gap of inflation from its target $E_t(\pi_{t+j} - \pi^*)$ at time $(t + j)$ and the time t forecast for the gap of output from potential $E_t(y_{t+k} - y^*)$ at time $(t + k)$. A lagged value of the policy rate is included to correct for serial correlation, and typically has been justified in the literature as capturing central bank efforts to smooth interest rates.

We estimate the conventional reaction function for the Bank of England in a pooled regression framework, as follows:

$$R_{it} = \beta_1 + \beta_2 \text{repo}_{t-1} + \beta_3 E_t(\pi_{\text{BOE}, t+2} - \pi^*) + \beta_4 E_t(y_{\text{BOE}, t+1} - y^*) + \beta_5 E_t(\pi_{\text{CF}, t+1} - \pi^*) + \beta_6 E_t(y_{\text{CF}, t}) + \beta_7 E_t(y_{\text{CF}, t+1}) + \beta_8 \text{internal}_i + \varepsilon_{it} \quad (2)$$

The dependent variable (R_{it}) is a panel of each individual member's preferred policy rate at time t . Data on the policy rate (repo) as well as the votes cast at each meeting and the interest rate preferred by dissenters are available on the Bank of England's web site.⁷

For real-time forecasts of inflation and output, we rely upon two sources: the MPC itself and Consensus Economics. Since August 1997, the Bank of England has published (in its quarterly *Inflation Report*) MPC forecasts for the 4-quarter growth rates of inflation and real output for the current and subsequent 8 quarters.⁸ Because the *Inflation Report* is published in the middle month of each quarter (February, May, August, and November), we use the forecast from each report beginning in the month it is published and for the following 2 months.⁹ As in Goodhart (2005), we use the forecasts formulated on an assumption of a

⁷ Before June 1998, the Bank of England only provided the preferred direction for the policy rate in the event of a dissent and did not provide the level of the dissenter's preferred rate. The convention in the literature on MPC voting has been to assume that the preferred interest rate was 0.25 basis points different from the policy outcome (in the direction indicated by the dissent). We follow that convention in this paper.

⁸ Because the MPC forecasts begin in August 1997, our estimation sample period comprises the 138 meetings from August 1997 through December 2008.

⁹ For example, we use the forecasts from the August report when the dependent variable is members' preferred rates from meetings held in August, September, and October.

constant interest rate, and like other studies, we use the forecast mode (as opposed to the median or mean).

The MPC aims to achieve its inflation target over 2 years; thus, we use the 8-quarter-ahead forecast for inflation and subtract the target value to compute the inflation gap, which we denote $E_t (\pi_{\text{BOE}, t+2} - \pi^*)$ (thus, the time subscript (j) in equation (2) is set to 2 years). The MPC's inflation target was moved from 2.5 to 2 percent in January 2004 when the targeted inflation index was changed from the retail price index excluding mortgage interest payments (RPIX) to the index of consumer prices (CPI).¹⁰

Because the transmission lag from output to inflation is about 1 year, we use a 4-quarter-ahead forecast of the output gap, which we denote $E_t (y_{\text{BOE}, t+1} - y^*)$ (thus, the time subscript (k) in equation (2) is set to 1 year).¹¹ We construct a real-time measure of the output gap by extending each vintage of real-time historical data for the level of real GDP first with the preliminary estimate of real GDP growth¹² in the quarter prior to the publication quarter of the *Inflation Report* and then with the growth rates projected in the *Inflation Report*. We apply a Hodrick-Prescott filter (with a smoothing parameter set equal to 1600) to each vintage of data to estimate the level of real-time potential GDP. Then we construct the real-time output gap as the percentage deviation of the level of output from its potential consistent with each *Inflation Report*.

Because we use contemporaneous forecasts (ones from the most recent *Inflation Report*), we have a potential endogeneity problem as the individual rate preferences for the

¹⁰ For a discussion of the Bank of England's history with inflation targeting, see King (2007). For the January 2004 MPC meeting, because we use the inflation forecast from the *Inflation Report* published in November 2003, we subtract off the old target to compute the inflation gap.

¹¹ The 2-year and 1-year forecast horizons for inflation and output, respectively, are also used in Besley *et al* (2008) and Harris and Spencer (2006), and are consistent with the Bank of England's views on the monetary transmission mechanism. See "The transmission mechanism of monetary policy," www.bankofengland.co.uk/publications/other/monetary/montrans.pdf.

¹² The real-time historical data and the preliminary estimate of growth are taken from the UK's Office of National Statistics (www.statistics.gov.uk).

MPC meeting in the middle month of each quarter are based upon these forecasts or, are at least in principle, consistent with it. Most studies in this literature have not used the Bank's forecasts. Besley *et al* (2008) used forecasts from the previous *Inflation Report* and not the contemporaneous forecasts due to concerns about endogeneity. We discuss this issue further below.

In addition to the MPC forecasts, we include real-time forecasts published by Consensus Economics as additional explanatory variables (denoted with the subscript "CF" in equation (2)). Each month, Consensus Economics surveys a large number of private-sector forecasters to obtain individual predictions of major economic indicators in the UK and other countries. We use their mean forecast for inflation (the relevant index less the inflation target) and real output growth in the subsequent calendar year.¹³ These forecasts are readily available to policymakers and may provide useful information, particularly in the months when the *Inflation Report* is not published. Because MPC meetings are usually convened during the first 10 days of the month, whereas Consensus Economics publishes its UK forecasts toward the middle of each month, we used the Consensus forecasts published in the month prior to the month in which an MPC meeting was held.¹⁴

We also included the dummy variable $internal_i$ equal to unity when the policymaker is an internal MPC member.

In order to investigate the role played by experience, we estimated four alternative versions of the baseline specification (equation (2)), including in each alternative variables

¹³ The forecasts are unconditional and, thus, are based implicitly upon each individual forecaster's expected path for policy interest rates. We experimented with the Consensus forecasts for the current year, but these variables were rarely significant.

¹⁴ The horizon of the MPC and Consensus forecasts are different, which is not reflected in the time subscripts used in equation (2). MPC forecasts are for 1- and 2-years ahead, while the Consensus forecasts are always made on a calendar-year basis (for the current and subsequent calendar years). Thus, the horizon of the Consensus forecast is longest for the forecasts made early in a given year and shortest for forecasts made at the end of a year.

related to the year of tenure on the MPC. In the first alternative specification, we include dummy variables equal to unity for the second and third years of tenure on the MPC (exp2_{it} , exp3_{it}). The second alternative includes the experience terms as well as terms that interact experience with the MPC forecasts for the inflation and output gaps: (expj_p) and (expj_y), respectively, and j equal to 2 or 3. In the third alternative, we replace the pure experience terms with terms that interact experience with the type of membership on the MPC (expj_{int}) where j takes on the value of 2 or 3. In the final alternative, we augment the previous specification with terms that interact experience, the MPC forecast, and the type of membership: (expj_p_{int}) and (expj_y_{int}) where j equals 2 or 3.

4. Results and robustness checks

Estimation results are presented in table 2. Our baseline specification is shown in column (1) and the alternative specifications that include experience effects are shown in columns (2) through (5).

All of the panel equations were estimated using ordinary least squares. We clustered errors by MPC member when computing standard errors under the assumption that each individual's error is not necessarily independently and identically distributed over time. Standard errors were obtained from heteroskedasticity-consistent covariances using White's procedure.

As shown in table 2 for all equations, the policy rate is highly persistent. In addition, the Bank's own forecasts are highly significant – inflation above target and output above potential are associated with higher interest rates. The magnitude of these estimates and their statistical significance is quite similar across the specifications. In addition, the Consensus Economics projections for the inflation gap and output growth appear to provide useful supplementary information. The baseline results in column (1) indicate that internal

members prefer higher interest rates (5 basis points) than external members, as the coefficient on the dummy variable is significant at the 5 percent level.

The addition of two experience dummy variables in column (2) for the second and third years on the MPC provides no support for dynamics in the voting patterns, and the dummy variable for member type remains significant. When we add in experience terms interacted with the Bank's projected inflation and output gaps (shown in column (3)), some interesting dynamics emerge. The reaction of MPC members to the macroeconomic outlook varies with tenure: members place twice as high a weight on the price gap projected in the *Inflation Report* and almost no weight on the output gap during their third year of tenure. Once again member type is important – the internal dummy is positive and significant at the 5 percent level. According to these results, internal and external members vote differently from each other in all years. Furthermore, both types of members become more hawkish in their third tenure year with internal members remaining relatively more hawkish.

Now that we have identified some role for dynamics, we want to explore further possible differences by member type. In column (4), we include the experience dummies interacted with the internal dummy; the results suggest that internal members prefer interest rates that are 6-8 basis points higher in years 2 and 3 relative to external members. In this specification, the internal dummy variable is no longer statistically significant, indicating that there is no difference by member type in the first year on the MPC.

The final alternative, shown in column (5), again suggests that internal members prefer higher interest rates (on the order of 4 to 6 basis points) in tenure years 2 and 3. More important, in their third year, internal members once again place nearly twice as high a weight on the price gap projected in the *Inflation Report* and almost no weight on the output gap relative to external members in their third year of tenure. Since the internal dummy is

not statistically significant in this specification, these results again suggest that significant differences in voting behavior between the two member types emerge after the first year on the MPC. These results also point to a puzzling effect in the second year of tenure – internal members appear to place a lower weight on the projected inflation gap relative to year 1 (and relative to external members in their second year of tenure).

One potential problem already noted is the endogeneity of the policy rate and *Inflation Report* forecasts for the middle month of each quarter. We addressed this issue in two ways. First, we examined the correlation between the *Inflation Report* forecasts and the residuals for all of the estimated specifications and found them to be uncorrelated. Second, we re-estimated all of the equations without the *Inflation Report* forecasts; the results from these regressions were very similar to those shown in table 2.

Another potential issue concerns the appropriate definition of the lagged policy rate. When a policymaker decides his preferred policy rate at an MPC meeting, does he use as a reference point the policy rate at the previous meeting or his own preferred rate at that meeting? In order to control for the possibility that the lagged individual rate preference is important, we re-estimated all of the equations including an additional dummy variable defined as +1, 0, -1 if the member preferred higher, unchanged, or lower interest rates, respectively, at the previous meeting. This additional variable was positive and highly significant in all of the equations, while the results for member type and tenure effects were virtually identical to those reported in table 2.

Finally, we examined the sensitivity of our estimation results to uncertainty by including a proxy for uncertainty constructed from the Consensus forecasts. As these forecasts are unconditional, they implicitly incorporate private-sector forecasters' judgments on all relevant factors, including monetary policy. Our measure of uncertainty is the standard

deviation of the Consensus forecasts for inflation in the subsequent calendar year (lagged one month, due to the timing of publication and the MPC meeting, as noted previously). Furthermore, we allowed for the possibility of asymmetric voting with respect to uncertainty, by interacting the standard deviation of the inflation forecast with a directional indicator based upon the decision at the previous MPC meeting (unc_{up} , unc_{noch} , unc_{down}).

Estimation results, presented in table 3, indicate no difference with respect to member type or tenure effects from the results presented in table 2. Estimated parameters and their statistical significance are remarkably similar to those in table 2. The uncertainty proxies suggest that when the MPC is reducing the policy rate, greater uncertainty leads to additional easing.

Finally, our estimation results remained virtually unchanged when we dropped the votes cast by the two Governors (Eddie George and Mervyn King) from our sample. Moreover, our estimates were robust to different definitions of the tenure interval (9 and 18 months) and to the elimination of observations associated with the recent financial crisis (we ended the sample in July 2007).

5. Concluding remarks

In this paper, we have used a panel reaction function framework to examine the dynamics of votes cast by the Bank of England's monetary policy committee. Our results support the general finding in the literature that external and internal MPC members behave differently. While some of our results suggest that there is a fundamental difference in voting behavior by member type for the first three years on the committee, other results from more detailed specifications point to a similarity between internals and externals in their first year on the MPC and to a deviation in voting behavior thereafter. If it is indeed the case that all MPC members initially vote similarly, then background characteristics such as education and

prior employment would not be expected to explain differences in voting behavior. In an earlier study, Harris and Spencer (2008) found no direct support for background characteristics using a discrete indicator of voting, and this finding is implicit in our panel estimation of preferred policy rates. Finally, our results indicate that internal members become decidedly more hawkish (in absolute terms and relative to external members) by their third year on the MPC. While our results cannot be compared directly with those of Gerlach-Kristen (2009), like her we find support for a policy reaction function in which the weight placed on output differs by member type.

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Table 1. MPC voting by tenure, 1997-2008 (140 meetings, 26 officials)¹

	Internal				External ²			
	Voters (#)	Total votes	Dissents (percent)	Policy rate less mean vote (basis points) ³	Voters (#)	Total votes	Dissents (percent)	Policy rate less mean vote (basis points) ³
1 st year (1-12 months)	12	127	5.5	-1.0*	14	168	22.6	-1.8*
2 nd year (13-24 months)	10	120	10.0	-1.3*	13	150	23.3	4.3***
3 rd year (25-36 months)	10	111	13.5	-2.9***	12	120	25.8	5.0***
4 th year (37-48 months)	8	88	10.2	-0.9	5	35	10.2	4.3**
5 th year (49-60 months)	7	84	9.5	0.0	2	24	4.2	1.0
6 th year (61-72 months)	6	51	3.9	-1.0	2	24	25.0	6.3**
7 th year (73-84 months)	4	33	6.1	1.5	2	13	7.7	1.9
8 th year (85-96 months)	2	24	0.0	0.0	1	8	0.0	0.0
9 th year (97-108 months)	2	16	6.3	-1.6				
10 th year (109-120 months)	1	12	0.0	0.0				
11 th year (121-132 months)	1	12	8.3	-2.1				
12 th year (133-144 months)	1	8	0.0	0.0				

¹ Internal and external members are appointed for 5 and 3 years, respectively; both internal and external members can be re-appointed.

² The horizontal underscoring indicates the term of appointment for external members (3 years).

³ A ***/**/* indicates that the difference between the policy rate and the mean of policymakers' votes (i.e., their preferred rates) was significant at the 1/5/10 percent level, respectively. Note that calendar year and tenure year are different concepts and, therefore, the policy rate differs for each member type in every tenure year.

Table 2. Estimation results for panel regression, member tenure 1-3 years, August 1997 – December 2008 (robust standard errors in parentheses, 784 observations)¹

Equation:	(1)	(2)	(3)	(4)	(5)
Dependent variable:	R_{it}	R_{it}	R_{it}	R_{it}	R_{it}
repo _{t-1}	1.03 (0.008)***	1.03 (0.009)***	1.02 (0.010)***	1.03 (0.008)***	1.02 (0.009)***
$E_t(\pi_{BOE, t+2} - \pi^*)$	0.51 (0.060)***	0.51 (0.058)***	0.44 (0.111)***	0.51 (0.059)***	0.50 (0.058)***
$E_t(y_{BOE, t+1} - y^*)$	0.23 (0.037)***	0.23 (0.037)***	0.30 (0.057)***	0.24 (0.037)***	0.26 (0.044)***
$E_t(\pi_{CF, t+1} - \pi^*)$	0.24 (0.039)***	0.24 (0.044)***	0.23 (0.049)***	0.26 (0.044)***	0.26 (0.047)***
$E_t(y_{CF, t})$	-0.03 (0.013)**	-0.03 (0.013)**	-0.02 (0.013)*	-0.04 (0.013)***	-0.03 (0.013)**
$E_t(y_{CF, t+1})$	0.15 (0.027)***	0.15 (0.026)***	0.13 (0.026)***	0.16 (0.026)***	0.15 (0.027)***
internal	0.05 (0.022)**	0.05 (0.022)**	0.05 (0.020)**	0.01 (0.027)	0.01 (0.027)
exp2		0.01 (0.021)	-0.00 (0.021)		
exp3		0.01 (0.024)	-0.02 (0.022)		
exp2_int				0.06 (0.018)***	0.06 (0.019)***
exp3_int				0.08 (0.019)***	0.04 (0.016)**
exp2_p			-0.27 (0.167)		
exp3_p			0.49 (0.112)***		
exp2_y			-0.04 (0.062)		
exp3_y			-0.29 (0.062)***		
exp2_p_int					-0.30 (0.124)**
exp3_p_int					0.45 (0.060)***
exp2_y_int					0.01 (0.044)
exp3_y_int					-0.25 (0.051)***
R-squared	0.9813	0.9813	0.9824	0.9816	0.9821

¹ Year 1 is omitted category; all equations estimated by OLS; constant terms included but not reported; equations estimated with robust errors clustered by individual; ***/**/* represents significance at the 1/5/10 percent levels, respectively.

Table 3. Estimation results for panel regressions with uncertainty, August 1997 – December 2008 (robust standard errors in parentheses, 784 observations)¹

Equation:	(1)'	(2)'	(3)'	(4)'	(5)'
Dependent variable:	R_{it}	R_{it}	R_{it}	R_{it}	R_{it}
repo _{t-1}	1.03 (0.008)***	1.03 (0.009)***	1.02 (0.011)***	1.03 (0.008)***	1.02 (0.009)***
$E_t(\pi_{BOE, t+2} - \pi^*)$	0.45 (0.063)***	0.45 (0.061)***	0.39 (0.111)***	0.46 (0.061)***	0.45 (0.059)***
$E_t(y_{BOE, t+1} - y^*)$	0.20 (0.033)***	0.19 (0.034)***	0.26 (0.058)***	0.21 (0.034)***	0.23 (0.042)***
$E_t(\pi_{CF, t+1} - \pi^*)$	0.24 (0.068)***	0.24 (0.071)***	0.23 (0.077)***	0.25 (0.069)***	0.25 (0.072)***
$E_t(y_{CF, t})$	-0.04 (0.016)***	-0.04 (0.016)***	-0.03 (0.015)**	-0.04 (0.015)***	-0.04 (0.015)**
$E_t(y_{CF, t+1})$	0.15 (0.029)***	0.15 (0.029)***	0.13 (0.029)***	0.15 (0.029)***	0.14 (0.030)***
internal	0.05 (0.021)**	0.05 (0.021)**	0.05 (0.019)**	0.01 (0.027)	0.01 (0.027)
unc _{up}	-0.21 (0.193)	-0.22 (0.198)	-0.18 (0.200)	-0.16 (0.191)	-0.14 (0.193)
unc _{noch}	-0.24 (0.182)	-0.24 (0.185)	-0.19 (0.192)	-0.19 (0.175)	-0.17 (0.180)
unc _{down}	-0.44 (0.179)**	-0.45 (0.189)**	-0.38 (0.196)*	-0.38 (0.181)**	-0.34 (0.189)*
exp2		0.00 (0.020)	-0.00 (0.020)		
exp3		-0.00 (0.023)	-0.03 (0.021)		
exp2_int				0.05 (0.017)**	0.05 (0.018)***
exp3_int				0.06 (0.017)***	0.03 (0.016)*
exp2_p			-0.27 (0.167)		
exp3_p			0.44 (0.112)***		
exp2_y			-0.04 (0.057)		
exp3_y			-0.25 (0.060)***		
exp2_p_int					-0.27 (0.123)**
exp3_p_int					0.41 (0.057)***
exp2_y_int					-0.00 (0.043)
exp3_y_int					-0.23 (0.052)***
R-squared	0.9819	0.9819	0.9828	0.9821	0.9824

¹ Year 1 is omitted category; all equations estimated by OLS; constant terms included but not reported; equations estimated with robust errors clustered by individual; ***/**/* represents significance at the 1/5/10 percent levels, respectively.

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