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MONETARY POLICY DECISIONS BY THE WORLD'S CENTRAL BANKS USING REAL-TIME DATA

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Monetary Policy Decisions by the World's Central Banks using Real-Time Data*

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Abstract

This paper contributes to the empirical understanding of monetary policy in five dimensions. First, specifiying a generalized Taylor equation that nests backward and forward-looking inflation and activity variables in setting policy rates. Second, using real-time data. Third, estimating the model on a world panel of monthly 1994-2011 data for 28 advanced and emerging economies. Fourth, using alternative panel data estimators to test for robustness. Fifth, testing for differences in monetary policy over time and across country groups. The findings are very supportive of the nested model and generally show that the Taylor principle is satisfied by the world's central banks.

Keywords: monetary policy, Taylor rule, Taylor principle, heterogeneous panels

JEL: E50, E52, E58

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Optimal monetary policy is predicated on forward-looking actions based on real-time forecasts for future variables. This approach is reflected in central bank (CB) policy statements and documents in both advanced and emerging economies. For example, Ben Bernanke has declared that "... it's a true real-time rule - that is, it estimates reaction functions given actual forecasts available at the time the policy decision was taken" (cited in Aso et al., 2010). Another example is the CB of Chile, which states that "the actions of monetary policy are based on the evolution of expected inflation over a horizon of 12 to 24 months and not necessarily on its current behavior" (Central Bank of Chile, 2000).

However, in opposition to the latter statements, monetary policy actions could also respond to real-time data on current and past variables. Uncertainty about forecast accuracy and the predictive power of current and past information for future data realizations could lead CBs to use backward-looking data in taking policy decisions. In addition, actual policy making could simply contradict CB statements committed to forward-looking behavior.

So, do deeds follow words? This paper tests for the role of real-time information on both past data and forecasts about future data in setting monetary policy rates in the world. We contribute to the literature on the conduct of monetary policy in five novel dimensions. First, we specify a generalized Taylor equation that nests backward-looking and forward-looking determinants of policy actions. This set-up allows identifying the weights placed by CBs on past information and forecasts about future variables in taking their policy decisions. To our best knowledge, such a nested model has not been tested yet. Second, we test our model on real-time data (Orphanides, 2001), that is, information about past realizations and forecasts on future variables available to CBs at the time they take their policy decisions. Third, we estimate our model using a world panel of monthly data extending from 1994 through 2011 and comprising 28 advanced and emerging economies. The latter countries represent approximately 80% of the world's 2011 GDP and our sample size exceeds 4,000 observations.

Fourth, we estimate this model using a battery of appropriate estimators, for alternative assumptions on and features of the underlying data-generating process. We start by using the Fixed Effects Instrumental Variables estimator, which assumes homogeneity in slope coefficients. Then we extend this model by considering possible common shocks, using the Pooled Common Correlated Effects estimator. Subsequently we relax the homogeneity assumption across countries by using three alternative estimators for heterogeneous panels: the Mean Group, Common Correlated Effects Mean Group, and Augmented Mean Group estimators. Then we test for error-corection models that allow for differences between short and long-run coefficients: the Dynamic Fixed Effects, Pooled Mean Group, and Mean Group estimators. Finally, we apply the Conditional Pooled Mean Group estimator for possible common shocks. To our knowledge, most of the latter estimators have not been used in empirical studies of monetary policy yet.

We find that both past inflation and the inflation forecast are very significant and robust determinants of monetary policy - robust to heterogeneity across countries and controlling for common shocks in CB behavior. We find that the weight of the inflation forecast is nearly ten times as large as the weight on past inflation in setting monetary policy rates. While the results on the role of activity variables are less robust to the use of different econometric techniques, we also find strong evidence on the role of past unemployment and the GDP growth forecast in setting monetary policy rates. When separating between short and long-run dynamics, we find that all short-run variables are highly significant in all error-correction models. All long-run coefficients are also highly significant using the Pooled Mean Group estimator, which dominates other error-correction estimators in our data sample.

Finally, we identify behavioral differences in the conduct of monetary policy over time and across monetary regimes. We test for changes in monetary policy since 2001 (when monetary policy is predicated on a forward-looking behavior and inflation reached low levels in most sample countries) and since the onset of the global financial crisis in 2008. We find that monetary policy shows less inertia and reacts more strongly to activity variables. Separately, we find that when policy rates are close to the zero lower bound, CBs lessen their reaction to changes in inflation and activity. We also find that inflation targeting countries exhibit stronger reactions to inflation variables than non-inflation targeting economies.

Most empirical studies assess if CB behavior is consistent with the Taylor principle, i.e., if CBs can stabilize the economy by raising interest rates in response to higher inflation by more than one-to-one. We verify that the Taylor principle is generally satisfied in our panel data results.

This paper is laid out as follows. We start in section 1 reviewing briefly the relevant literature. In section 2 we discuss our empirical methods and describe the estimators we use for our world panel data regressions. Then we describe our data. Our empirical findings are reported in section 4. Section 5 concludes.

I Literature Review

John Taylor shows in his seminal paper (Taylor, 1993) that a simple monetary policy rule - the one that subsequently carries his name - fits appropriately the conduct of policy by the US Federal Reserve. The Fed raises its policy rate when inflation exceeds a 2% implicit inflation target or when real GDP exceeds potential GDP. This result led to a large line of research focused on interest rule models and CB behavior. Most studies were applied to individual industrial countries and many assess if monetary policy satisfies the Taylor principle.

The literature on Taylor rules is wide. It has been surveyed by Orphanides (2007), focusing on the development and characteristics of Taylor rules in comparison to alternative monetary policy guides, and by Carare and Tchaidze (2008), who review the key empirical issues in the estimation of Taylor rules.

Here we review selectively some key issues on empirical Taylor rule research that are relevant to this paper. Forward-looking rules (based on forecasts or expectations of future policy determinants) are preferable to backward-looking rules due to lags in monetary transmission. This would be consistent with CB statements about their forward-looking reaction to expected future economic conditions (e.g., Clarida et al., 2000, Orphanides, 2004). Yet the evidence is mixed. On one hand, Rudebusch and Svensson (1999) find that forecast-based rules marginally outperform rules based on contemporaneous (i.e., backward-looking) information. On the other hand, Smets (1998) finds that contemporaneous rules are similar, and marginally superior, to forecast rules. Taylor (1999) concludes that there is not much difference between the performance of inflation forecasts and actual inflation in his policy rule.

Policy interest rate paths followed by CBs tend to be fairly smooth, moving slowly in the same direction rather than exhibiting frequent reversion of direction. Therefore, Taylor rules are commonly extended to encompass interest rate smoothing (e.g., Judd and Rudebusch, 1999, Clarida et al., 2000). One explanation for interest rate smoothing is that CBs are averse to frequent reversal in the direction of interest rates to avoid their interpretation as policy mistakes (Williams, 1999). Smoothing can also be rationalized as reflecting CBs' lack of accurate economic information and uncertainty about monetary policy transmission mechanisms (Sack and Wieland, 2000).

Empirical Taylor rules were initially estimated on data not available at the time of the corresponding CB policy decision - like contemporaneous data or data subject to future revision. Orphanides (1997) correctly criticized such methods, which led to several subsequent estimations based on real-time data and forecasts (e.g., Orphanides, 2001,Tchaidze, 2001).

Most empirical Taylor rules have been estimated on time-series data for individual countries, initially for the U.S. and subsequently for a growing number of countries. To our knowledge, international panel data studies are non-existent, except Aizenman et al. (2010), an empirical panel data study of a backward-looking Taylor rule for 17 emerging economies.

In sum, there are few country studies of empirical Taylor based on a specification that nests backward and forward-looking policy determinants and/or are restricted to using only real-time data in their empirical implementation. International panel estimations of such Taylor rules are not available.

II Methodology

Our proposed model can be rationalized as an extended Taylor that nests backward and forward-looking measures of inflation and activity in the following form:

$$mpr_{it} = \alpha_1 \pi_{it} + \alpha_2 \pi_{it+1|t} + \beta_1 y_{it} + \beta_2 y_{it+1|t} \tag{1}$$

where mpr_{it} is the monetary policy rate in country i, π_{it} is a past inflation measure available at time t in country i, $\pi_{it+1|t}$ is an inflation forecast measure available at time t in country i, y_{it} is a past activity measure available at time t in country i, and $y_{it+1|t}$ is an activity forecast measure available at time t in country i.

This monetary policy rule nests reactions to both past realizations and forecasts about future variables when setting policy rates.

Our empirical strategy is based on combining two alternative specifications (in levels and first differences, each associated to different estimation techniques), combined with three different estimation methods. This implies using a wide battery of estimation models, to allow for different assumptions on the data generating process to test for robustness of our results.

Regarding the three estimation methods, we start by assuming parameter homogeneity across countries, then turning to parameter heterogeneity, and finally allowing for possible correlation across countries arising from common shocks.

We start by introducing our model in levels, specifying a dynamic form that generalizes (1):

$$mpr_{it} = \rho_i mpr_{it-1} + \alpha_{i1}\pi_t + \beta_{i1}\pi_{it+j|t} + \alpha_{i2}y_{it} + \beta_{i2}y_{it+j|t} + \theta_i + \nu_t + \epsilon_{it} \tag{2}$$

where i, t, and j stand for country, current period, and future period, respectively. Following standard specifications, we include the lagged dependent variable (mpr_{it-1}), reflecting interest-rate smoothing. Generalizing the one-period forecasting horizon in equation (1), here we allow for a j-period horizon. The terms θ_i and ν_t are country and period fixed effects, respectively, and ϵ_{it} is a random noise.

We first estimate equation (2) using the Instrumental-Variable Fixed-Effect (*IV-FE*) estimator. A key assumption of this estimator is that all parameters are common for all countries ($\rho_i = \rho$, $\alpha_{i1} = \alpha_1$, $\beta_{i1} = \beta_1$, $\alpha_{i2} = \alpha_2$, and $\beta_{i2} = \beta_2$). The IV procedure corrects for possible endogeneity in the smoothing term, due to possible autocorrelation in the error term. We use two lags of the interest rate and of the backward-looking variables as instruments for the smoothing term. In addition, this estimator corrects for country unobservable variables that are constant over time. Finally, we also include a time fixed effect, which controls for time shocks that affect all countries in the same way.

Our second estimation technique allows to control for possible common shocks that could affect each country in a different way. We use Pesaran's (2006) Pooled Common Correlated

Effects (*Pooled-CCE*) estimator, which includes the interaction of cross-section means of each independent variable with a country dummy. This estimator is more flexible in considering the impact of unobserved common factors, which can differ across countries and change over time, even exhibiting non-linear or non-stationary behavior (Kapetanios et al., 2011).

Then we relax the assumption of parameter homogeneity, applying recent estimation models (e.g., Eberhardt and Teal, 2012, Eberhardt et al., 2012). These models estimate individual country coefficients separately and then report average country coefficients. Since our sample is comprised by 28 countries with an average of 124 observations per country, we can fully exploit country heterogeneity.

We present three different estimators that consider country heterogeneity. First we use Pesaran and Smith's (1995) Mean Group (*MG*) estimator, which allows for heterogeneous slope coefficients and reports the average as the coefficient of interest. Then we correct for possible correlations across countries due to common shocks. First we apply Pesaran's (2006) Common Correlated Effects Mean Group (*CCE-MG*) estimator. This method is similar to the Mean Group estimator but includes cross-section means of the independent variables as regressors, capturing cross-section dependence. Then we use Eberhart and Teal's (2012) Augmented Mean Group (*AUG-MG*) estimator that accounts for cross-section dependence by including a "common dynamic process" in the country regression (see our Appendix for more details on the two previous estimators). In our three methodologies we use a linear average and, for robustness, a Huber-weighted average that corrects for the presence of outliers. As in the case of the *IV-FE* estimator, we instrument the smoothing term by using two lags of the interest rate and the backward-looking variables.

Now we turn to the error-correction specification in order to differentiate between short-run and long-run reactions of monetary policy to its determinants. We rewrite equation (2) as follows:

$$\begin{aligned}\Delta mpr_{it} =& \theta + \gamma(mpr_{it-1} - \alpha_1\pi_{it-1} - \beta_1\pi_{it+j-1|t} - \alpha_2 y_{it-1} - \beta_2 y_{it+j-1|t}) \\ & + \delta_1\Delta\pi_{it} + \phi_1\Delta\pi_{it+j|t} + \delta_2\Delta y_{it} + \phi_2\Delta y_{it+j|t} + \epsilon_{it}\end{aligned} \quad (3)$$

where Δx_{it} operator for variable x_i is defined as $x_{it} - x_{it-1}$. Parameters α_1, α_2, β_1, and β_2

represent the coefficients of the long-run equation, while δ_1, δ_2, ϕ_1, and ϕ_2 are the coefficients of the short-run dynamics.

To estimate equation (3) we use three different methods that allow for varying degrees of heterogeneity. First we estimate a Dynamic Fixed Effects (*Dynamic FE*) model, which restricts all parameters to be homogeneous across countries. Then we estimate a Pooled Mean Group (*PMG*) estimator, proposed by Pesaran et al. (1999), which allows for heterogeneity in short-run dynamics but constrains long-run dynamics to be common to all countries. Finally, we estimate Pesaran and Smith's (1995) Mean Group (*MG*) estimator, which allows for heterogeneity in all parameters. As Pesaran et al. (1999) have argued, these error-correction models can be applied to stationary and non-stationary samples.

As we did in the previous model, we estimate the latter models controlling for possible common shocks. To do this we use Binder and Offermanns' (2008) estimator that extends the *Dynamic FE* and *PMG* methods by including means of the independent variables in the short and long-run dynamics (see Appendix on Econometric Methods for details).

III Data

We have collected a unique panel database that comprises 28 countries with monthly data ranging from January 1994 to December 2011, comprising approximately 4,100 observations. This panel was constructed using data from the OECD and Consensus Forecast databases, completed by information from national CBs. Our dependent variable is the monetary policy rate (mpr_t) set by the central bank.

Our forward-looking variables are the CPI inflation forecast ($\text{Inflation Forec.}_{t,t+11}$) and the GDP growth forecast ($\text{GDP growth Forec.}_{t,t+11}$). The horizon for both forecasts extends over a twelve-month period starting with the current month (t) and ending eleven months into the future ($t + 11$).[1] Our forecasts are calculated using Consensus Forecast data. Since

[1] CB real-time information (available at the time of CB policy decisions) on future expectations and forecasts about inflation and activity variables is comprises market-based implicit inflation expectations (derived from spreads between indexed and non-indexed Treasury or CB bonds for different maturities), survey-based forecasts (like Consensus Forecast data or data from surveys conducted by CBs or other sources), and internal CB forecasts. For reasons of availability and data consistency across time and countries, we use forecasts from Consensus Forecast.

the latter are published for calendar years we construct a weighted average of two calendar-year forecasts, relevant for month m. Our monthly inflation forecast is defined as:

$$\text{Inflation Forec.}_{m,m+11} = \frac{(12-m+1)}{12} * \text{CPI Inflation Forecast for year t} + \frac{(m-1)}{12} * \text{CPI Inflation Forecast for year t+1}.$$

where m is the corresponding month.

The same procedure is applied to calculate the GDP growth $\text{forecast}_{t,t+11}$.

We use annualized three-month CPI inflation ($\text{Inflation}_{t-3,t-1}$) as our backward-looking measure of inflation.[2] In the case of activity we use the average unemployment rate for the three-month period ending at $t-2$ ($\text{Unemployment}_{t-4,t-2}$). As opposed to the unobservable output gap, this variable is observable and is correlated with estimated measures of the output gap (Okun's Law).[3]

We select the starting month for each country sample adopting two criteria: data availability (i.e., the monetary policy rate is published and is used as the main monetary policy instrument) and trend inflation at single digit levels. Sample starting dates are reported for each country in Table 1. Accordingly, our panel data sample is unbalanced. Figure 1 depicts the average monetary policy rate across countries.

Table 2 reports summary statistics for the main variables in our full sample (1994-2011) and shorter 2002-2011 sample. We report separate results for the latter shorter sample, because roughly since 2002 monetary policy has been predicated in most sample countries on a modern policy framework, which generally is consistent with a floating exchange rate and low inflation.

The average mpr is 5.4% in the full sample, its standard deviation is 4.3% and the large range between the maximum and minimum monthly observations reflect the differences in monetary policy stance across countries and over time. The annualized three-month inflation

[2]To use real-time data we use inflation with one lag to be sure that CB have this information available in the time of the decision.

[3]In the regressions we include this variable lagged by two periods, to make sure that this information is available at the moment of CB decisions. For some countries, like Australia and New Zealand, only quarterly data is published. In the latter case we use quarterly information that is available for the corresponding CB at the moment of its policy decision.

rate is 3.3% in the full sample and the large range between extreme points reflects the influence of exceptional idiosyncratic inflation and deflation shocks. Average unemployment is 7.5%, the average inflation forecast is identical to actual average inflation (3.3%), and the average GDP growth forecast is 3.2% in the full sample. Summary statistics for the shorter sample are similar to those for the full sample.

Table 3 summarizes bi-variate correlations of all variables for the full sample. Simple correlations of the monetary policy rate with its potential determinants exhibit expected signs, except for unemployment.

Before conducting our empirical analysis, we test for unit roots in our sample. Since we are working with panel time-series data we perform panel data unit root tests.[4] First we apply a Fisher-type test proposed by Choi (2001), which is based on a combination of p-values of the test statistic for a unit root in each cross sectional unit (we perform an Augmented Dickey-Fuller test with two lags for each unit). We test for the null hypothesis that all time series have a unit root, while the alternative hypothesis is that a fraction of the sample is stationary. We reject the null hypothesis for all our variables. We also apply a test proposed by Pesaran (2007), which corrects for cross-sectional dependence and serially correlated errors; the conclusion is the same as for the previous test. Thus we do not find evidence of integrated processes in our panel sample.

We also test for the presence of common shocks in our data. We run Pesaran's (2004) test for cross-section dependence in panel time-series data; we reject the null hypothesis of cross-section independence. Hence we have to be careful in our specifications to take into account possible common shocks.

IV Results

We start by applying the *IV-FE* estimator. The results, reported in Table 4, are based on the full 1994-2011 sample and the shorter 2002-2011 sample, with country fixed effects (all columns) and time effects (columns 5-8). For the full sample we report a backward-

[4]For a detailed discussion of panel time series tests and estimation techniques see Barbieri (2009) and Smith and Fuertes (2010).

looking Taylor rule (columns 1 and 5): coefficients display expected signs and are highly significant, except for unemployment when not including monthly fixed effects. The size of the our past inflation coefficient is similar to the coefficient for Germany and half the size of the coefficient for the U.S coefficient, both reported by Molodtsova et al. (2008) for a backward-looking Taylor rule estimated on real-time data. We also report for the full sample a forward-looking Taylor rule (columns 2 and 6): coefficients show expected signs and are highly significant except for the GDP growth forecast when including monthly fixed effects. The size of our inflation forecast coefficient is similar to the coefficient for the U.S. reported by Boivin (2006) for a forward-looking Taylor rule based on real-time U.S. Greenbook data.

Our previous results are potentially biased due to specification (omission) bias; hence we report results for our more general specification reflected by equation (2), nesting both past variables and forward-looking forecasts. The results for the full 1994-2011 sample (in columns 3 and 7) are similar to those of the 2002-2011 sample (in columns 4 and 8). All coefficients display expected signs and are highly significant (at 1% or 5% significance levels), except unemployment (when not including time FE) or except the growth forecast (when including time FE).

Monetary policy exhibits significant inertia, as reflected by the large coefficient estimates of the lagged dependent variable, which range from 0.90 to 0.96 and are significant at the 1% level. This feature - a very large and highly significant coefficient associated to the previous month's monetary policy rate - is common to all our subsequent results, and robust to different specifications and estimators. The range of point estimates for this variable - from 0.77 to 0.96 across all our results - implies that the size of the long-term effect of a change in any other right-hand side variable ranges from 4 to 25 times the size of the reported coefficient.

Both inflation and the inflation forecast are highly significant in all results. A key result is that the coefficient estimate on the inflation forecast is several times as large as the one on inflation: 10 times in the 1994-2011 sample and 3.5 times in the 2002-2011 sample. Central banks attach a much larger weight to inflation forecasts than to actual (past) inflation when taking monetary policy decisions. This novel result on the strongly and highly-significant forward-looking behavior of central bankers regarding inflation will be shown to be robust in our subsequent results. This stands in contrast to the absolute and relative weights attached to activity variables (past unemployment and growth forecasts), which are shown below to be less robust to alternative estimators.

The non-significance of the GDP forecast when including time effects in Table 4 (columns 7-8) suggests that this variable partly reflects common time shocks that affect all economies, when not including time effects and when it is significant (columns 3-4). To explore this issue further, now we apply the pooled CCE estimator that allows for unobserved common factors that can differ across countries. The results in Table 5 confirm the absolute and relative weights of inflation and the inflation forecast, and the weight attached to unemployment. However, the growth forecast is rejected here to be a significant determinant of monetary policy decisions.

Now we turn to additional results obtained from heterogeneous panel techniques based on different variants of the *MG* estimator (Table 6). The first three columns report *MG* estimation results, the next three report *CCE-MG* results, and the final three show *AUG-MG* results. For each set we report two columns of results based on the robustness procedure based on Huber-weighted averages that correct for the presence of outliers, which therefore are preferable to those reported in the first column of each set.

Both the *CCE-MG* and the *AUG-MG* estimators control for unobserved common shocks. The GDP forecast is not significant when using the *CCE-MG* technique but is highly significant when using the *AUG-MG* technique. Moreover, when using the *AUG-MG* estimator all variables turn out to be highly significant for the 2002-2011 sample; only unemployment is not significant in the 1994-2012 sample.

Now we turn to results for our specification (3), which identifies long and short-run dynamics. The results, reported in Table 7, are based on three estimators. The *PMG* estimator dominates the *Dynamic FE* estimator because the former allows for heterogeneity in short-run coefficients. In principle, the *MG* estimator could dominate the *PMG* estimator because the former allows for heterogeneity in both short and long-run coefficients. A Hausman test developed by Pesaran et al. (1999) allows to test for the null hypothesis of homogeneity in long-run coefficients.[5] We report the test results at the bottom of Table 7. At p-values (for

[5]The *MG* estimator is consistent under the null hypothesis of homogeneity and the alternative hypothesis

rejection of the null hypothesis) of 0.07 (full sample) and 0.33 (2002-2011 sample), we are not able to reject the null. Therefore we prefer the *PMG* results reported in columns 3 and 4 to those obtained under *Dynamic FE* and *MG* estimations.

For both samples almost all short and long-run coefficients are significant at the 1% level and exhibit expected signs. Long-run coefficients of the inflation forecast are 4-5 times the size of long-run coefficients of inflation. The magnitudes of the long-run coefficients of the growth forecast are much larger than those of unemployment. Short-term coefficients of the inflation forecast are also many times larger than those associated to inflation. However, short-run coefficients of growth forecasts are smaller than those related to unemployment. In sum the *PMG* results are highly supportive of our nested Taylor rule specification in a dynamic context that distinguishes between short-term and long-term monetary policy reactions to changes in economic conditions.

To test for the robustness of the latter results to unobserved common factors, now we apply the conditional pooled *Dynamic FE* and *MG* estimators, which allow for unobserved common factors that can differ across countries. As above, we focus on the *PMG* results, reported in the two last columns of Table 8. While coefficient estimates and significance levels are different from those reported in Table 7, previous results are generally maintained, except for the growth forecast. The growth forecast is highly significant in the long run but is not significant in the short run in our full sample. However, the opposite result is obtained in our shorter sample. Again, this may reflect that among all variables the growth forecast is the one most related to common shocks across countries.

Next we assess how well our nested monetary policy function fits particular periods of time and country groups. We address three separate questions: (i) has monetary policy changed since the onset of the global financial crisis?, (ii) is monetary policy conducted in a different way when central banks are close to the zero lower bound (ZLB)?, and (iii) does inflation targeting make a difference for the conduct of monetary policy?.

Starting with the first question, we date the beginning of the period comprised by the financial crisis and the subsequent financial turmoil as October 2008 and extend it to the

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of heterogeneity, but it is always inefficient. However, the *PMG* estimator is consistent and efficient under the null, but inconsistent (and efficient) under the alternative.

end of our sample in December 2011. We expand our nested model in levels (equation 2) to include a crisis dummy for the October 2008 - December 2011 period (to identify a possible level effect in setting policy rates) and add new interaction terms for all right-hand side variables with the crisis dummy (to identify possible differences in policy reaction to changes in economic conditions since late 2008). Table 9 reports the corresponding results, without time effects (columns 1-2) and with time effects (columns 3-4) - we focus on the latter next.

While the sign of the crisis dummy is negative - reflecting a reduction in monetary policy rates during the crisis - its statistical significance is not different from zero. However, monetary policy inertia has lessened somewhat during the crisis, as shown by a small but significant negative interaction term between the lagged policy rate and the crisis dummy. This reflects the fact that many CBs have conducted a more aggressive monetary policy during the financial crisis to counter-act its effects (Mishkin, 2009). A similar result was found by Belke and Klose (2010), separetely for the U.S. Federal Reserve and the European Central Bank. We also find weak evidence (and only for the 2002-2011 sample) that the response of monetary policy to inflation has lessened during the crisis. CBs' reactions to inflation forecasts have not changed during the financial crisis. However, CBs are much more reactive to activity variables since late 2008. The coefficient of unemployment has risen very significantly and by half. Moreover, while CBs did not react to growth forecasts before October 2008, since then they do and significantly so.

Now we turn to our crisis interaction results based on the *Dynamic FE* and *PMG* estimators (Table 10), focusing more closely on the latter. We introduce crisis interaction terms with all short-run variables. We do not interact long-run variables with the crisis dummy because it is unlikely that CBs have changed their long-run behavior. The general results reported in Table 9 - less reaction of monetary policy to inflation variables and more reaction to activity variables - is confirmed here.

A variation on the latter theme is the question about differential CB behavior in setting interest rates when rates are close to the ZLB. We would expect less reaction to changes in economic conditions simply because the room for further rate cuts shrinks toward zero as rates converge to the ZLB, taking CBs to use unconventional policy instruments based on aggregates rather than interest rates. In order to test for this possible change in monetary policy behavior, we define a dummy variable for all country-month observations for which the monetary policy rate is below 1%.[6] Like our previous and related results on the financial crisis, we report results based on *IV-FE* estimations for equation (2) (Table 11) and based on *Dynamic FE* and *PMG* models for equation (3). As expected, Table 11 shows that central banks that are close to the ZLB weaken their response to both activity and inflation variables. The results in Table 12 show that that central banks reduce their short-run response to the inflation forecast when they are close to the ZLB.

Finally, in Table 13 we split our sample between countries where CBs conduct their monetary policy under inflation targeting (IT) and countries where they do not. We define the start of IT regimes in each country following Hammond (2011). The results reported in Table 13 are based on the *IV-FE* estimator using time effects, as in Table 4. We observe that IT CBs attach a very significant weight to the inflation forecast and no weight to the growth forecast. Since 2002, IT CBs attach a larger weight to the inflation forecast and a smaller weight to actual (past) inflation, reflecting a shift toward a more forward-looking policy focus, which seems consistent with the maturing of the IT regime. In contrast, non-IT CBs attach a very significant weight to the growth forecast, without reacting to either inflation or unemployment. In conclusion, CB's commitment to an explicit inflation target strengthens their reaction to inflation variables compared to non-IT CBs.

As a final robustness test we have found that all previous results are robust to using alternative measures for our backward-looking variables: a six-month measure of inflation, replacing our three-month measure, and a six-month unemployment average instead of our three-month average. The corresponding results are available on request.

Last but not least, we exploit our results to check if our estimations of the world's extended Taylor rules satisfy the Taylor principle, namely, that the coefficient of the monetary policy rate on inflation exceeds unity. In the context of our nested specification, we focus only on the long-run response of monetary policy to both past inflation and the inflation forecast. Our focus is on the long-run monetary response because monetary policy can satisfy

[6] The countries and time periods with monetary policy rates at levels below 1% are Canada 2009.m4 - 2010.m8, Chile 2009.m4 - 2010.m5, Czech Republic 2010.m5 - 2011.m7, Denmark 2011.m7, Israel 2009.m3 - 2009.m11, Japan 1995.m9 - 2011.m12, Sweden 2009.m4 - 2010.m9, Switzerland 2002.m8 - 2011.m12, United Kingdom 2009.m3 - 2011.m12, and the United States 2008.m10 - 2011.m12.

the Taylor principle in the long run, even while deviating substantially from it in the short run, as shown by Davig and Leeper (2007). In case of the level estimations consistent with equation (2), we divide the sum of the coefficients of inflation and the inflation forecast by one minus the coefficient of the lagged dependent variable. A majority of results reported under the assumption of country heterogeneity, in Tables 4 and 5, satisfy the Taylor principle. However, when assuming country heterogeneity (Table 6), the results do not satisfy the Taylor principle. This may reflect the particular weight attached to those countries that do not satisfy the Taylor principle in a panel that allows for slope heterogeneity. For the error-correction estimations consistent with equation (3), reported in Table 7, the Taylor principle is strongly satisfied regarding long-run coefficients.

V Conclusions

This paper tests for the role of real-time information on both past data and forecasts about future data in setting monetary policy rates in the world. We propose a nested model that encompasses a backward and a forward-looking Taylor rule. While CBs claim that they are forward-looking in setting interest rates based on forecasts for future variables, their policy actions could also be based on past data, due to forecast uncertainty, high predictive power of past information for the future, or policy inconsistency with CB statements.

The paper contributes to the literature on the conduct of monetary policy in five novel dimensions. First, by specifying a generalized Taylor equation that nests backward-looking and forward-looking variables in setting interest rates. Second, by using real-time data available to CBs at the time they take their policy decisions. Third, by estimating the model on a world panel of monthly data extending from 1994 through 2011 and comprising 28 advanced and emerging economies. Fourth, using a large battery of appropriate panel-data estimators to test for robustness of reported results. Finally, by testing for differences in the conduct of monetary policy over time and across country groups.

We find that past inflation and the inflation forecast are very significant and robust determinants of monetary policy - robust to heterogeneity across countries and controlling for common shocks in CB behavior. We find that the weight of the inflation forecast is nearly ten times as large as the weight on past inflation. While the results on the role of activity variables are less robust to the use of different econometric techniques, we also find strong evidence on the role of past unemployment and the GDP growth forecast in the setting of monetary policy rates. When applying error-correction models to separate between short and long-run dynamics, we find that all short-run variables are highly significant using different estimators. Long-run variables are all significant using the Pooled Mean Group estimator, which is shown to be the consistent and most efficient estimator in our data sample.

Then we test for a change in the conduct of monetary policy since the onset of the global financial crisis in late 2008. We find that monetary policy shows less inertia and reacts more strongly to activity variables: the parameter estimate on unemployment has risen by half and the one on the GDP growth forecast has doubled since 2008. We also report changes in short-run reactions to unemployment and the GDP growth forecast in the *PMG* model. Related to the latter findings are our subsequent results on changes in CB behavior when monetary policy rates are close to the zero lower bound. We find that CB reactions to changes in inflation and activity weaken when rates are close to the ZLB.

Next we report separate results for inflation-targeting (IT) and non-IT CBs. We show that IT CBs attach a very significant weight to the inflation forecast and no weight to the growth forecast. Since 2002, IT CBs attach a larger weight to the inflation forecast and a smaller weight to past inflation, reflecting a shift toward a more forward-looking policy outlook, which is consistent with the maturing of the IT regime. In contrast, non-IT CBs attach a very significant weight to the growth forecast, without reacting to either inflation or unemployment. Hence CB's commitment to an explicit inflation target strengthens their reaction to inflation variables, compared to non-IT central banks.

As an additional robustness test we find that all previous results are robust to using alternative measures for our backward-looking variables: a six-month measure of inflation that replaces our standard three-month measure, and a six-month unemployment average instead of our three-month average. The corresponding results are available on request.

Last but not least, we exploit our results to check if our estimations of the world's extended Taylor rules satisfy the Taylor principle. In the context of our nested specification, we focus only on the long-run response of monetary policy to both past inflation and the inflation forecast. Our focus is on the long-run monetary response because monetary policy can satisfy the Taylor principle in the long run, even while deviating substantially from it in the short run. In case of the level estimations consistent with equation (2), we divide the sum of the coefficients of inflation and the inflation forecast by one minus the coefficient of the lagged dependent variable. For the level specification, a majority of results reported for the case of country homogeneity satisfies the Taylor principle. However, when assuming country heterogeneity, the results do not satisfy the Taylor principle. For the error-correction estimations, the Taylor principle is strongly satisfied for long-run coefficients.

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Appendix on Econometric Methods

Pesaran (2006)

This method is similar to the Mean Group estimator (Pesaran and Smith, 1995) but includes cross-section averages, with the aim of capturing the effect of common shocks. The base equation is:

$$y_{it} = a_i + b_i x_{it} + c_i \overline{x}_t + d_i \overline{y}_t + \epsilon_{it}$$

obtaining $b_{CCE-MG} = (1/N) \sum_{i=1}^{N} b_i$.

Teal and Eberhardt (2012)

This estimator accounts for the effect of common shocks by the inclusion of a "common dynamic process" in the country regression. The model is estimated in two steps. First step:

$$\Delta y_{it} = b \Delta x_{it} + \sum_{t=2}^{T} c_t \Delta D_t + \epsilon_{it}$$

obtaining $c_t = \mu_t^*$. This represents a standard First Differences-OLS regression with T - 1 year dummies in first differences, from which the year dummy coefficients are obtained (relabeled as μ_t^*).

Second Step:

$$y_{it} = a_i + b_i x_{it} + d_i \mu_t^* + \epsilon_{it}$$

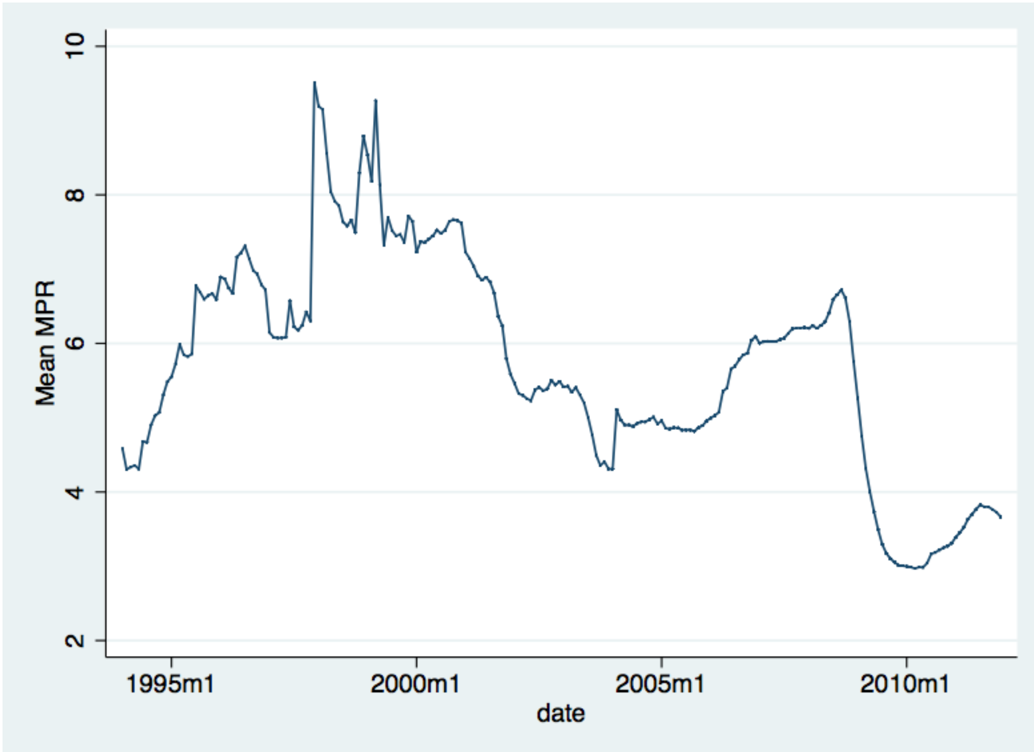
obtaining $b_{AUG-MG} = (1/N) \sum_{i=1}^{N} b_i$.

Binder and Offermanns (2008)

This model is close to the Pooled Mean Group estimator by Pesaran et al. (1999), but it includes cross-section averages (y_t and x_t), with the aim of capturing cross-section dependence. Therefore, this model allows for heterogeneous short-run dynamics and speed of adjustment, but the long-run dynamics are homogeneous across groups. The model is:

$$\begin{aligned}\Delta y_{it} =& \delta_i + \alpha_i(y_{i.t-1} - \beta_i x_{i,t-1}) + \phi_{1i}\bar{x}_t + \phi_{2i}\bar{y}_t + \sum_{j=1}^{p_i} \alpha_{ij}\Delta y_{i,t-j} + \sum_{j=1}^{p_i} \gamma_{ij}\Delta x_{i,t-j} \\ &+ \sum_{j=1}^{p_i} \varphi_{1ij}\Delta\overline{y}_{i,t-j} + \sum_{j=1}^{p_i} \varphi_{2ij}\Delta\overline{x}_{i,t-j} + \epsilon_{it}\end{aligned}$$

Figure 1
Sample Average of Monetary Policy Rates in 28 Countries, 1994.m1-2011.m12



Source: CBs webpages.

Table 1

Sample Starting Dates by Countries

Country	Month	Year	Country	Month	Year
Australia	1	1994	Mexico	1	2008
Brazil	1	1997	New Zealand	4	1999
Canada	11	2001	Norway	1	1994
Chile	1	2002	Peru	9	2003
China	1	2003	Philippines	4	2005
Colombia	6	1999	Poland	1	1999
Czech Rep.	6	1996	Russia	4	2006
Denmark	1	1994	South Africa	11	1999
Euro Zone	1	1999	Sweden	6	1994
Hungary	1	1999	Switzerland	1	2000
Indonesia	11	2006	Thailand	1	2001
Israel	7	1995	Turkey	2	2004
Japan	1	1994	United Kingdom	1	1994
Korea	5	1999	United States	1	1994

Table 2

Summary Statistics

			1994-2011		
Statistics	**mpr**	**Inflation**$_{t-3,t-1}$	**Unemployment**$_{t-4,t-2}$	**Inflation Forec.**$_{t,t+11}$	**GDP Growth Forec.**$_{t,t+11}$
Mean	5.45%	3.29%	7.50%	3.29%	3.19%
Median	4.75%	2.75%	6.67%	2.68%	3.04%
Standard Deviation	4.33%	4.51%	4.66%	2.34%	2.03%
Max.	42.00%	33.80%	31.20%	31.23%	10.89%
Min.	0.00%	-17.88%	0.47%	-1.09%	-7.61%
			2002-2011		
Statistics	**mpr**	**Inflation**$_{t-3,t-1}$	**Unemployment**$_{t-4,t-2}$	**Inflation Forec.**$_{t,t+11}$	**GDP Growth Forec.**$_{t,t+11}$
Mean	4.83%	3.38%	7.59%	3.19%	3.19%
Median	4.25%	2.85%	6.87%	2.70%	3.08%
Standard Deviation	3.89%	4.52%	4.90%	2.16%	2.11%
Max.	26.50%	33.80%	31.20%	31.23%	10.89%
Min.	0.00%	-17.88%	0.47%	-1.09%	-7.61%

Table 3

Bi-variate Correlations, 1994.m1-2011.m12

	mpr_t	Inflation$_{t-3,t-1}$	Unemployment$_{t-4,t-2}$	Inflation Forec.$_{t,t+11}$	GDP Growth Forec.$_{t,t+11}$
mpr_t	1.00	**0.84**	**0.48**	**0.83**	0.38
Inflation$_{t-3,t-1}$	**0.42**	1.00	0.40	**0.99**	0.4
Unemployment$_{t-4,t-2}$	**0.37**	**0.16**	1.00	0.41	0.04
Inflation Forec.$_{t,t+11}$	**0.75**	**0.56**	**0.36**	1.00	0.46
GDP Growth Forec.$_{t,t+11}$	**0.27**	**0.19**	0.04	**0.32**	1.00

Notes: (1) Upper matrix: cross-section simple correlations; Lower matrix: panel simple correlations.
(2) Correlations statistically significant at 1% in bold.

Table 4

Monetary Policy in the World, 1994-2011 and 2002-2011

IV-FE Estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	1994-2011	1994-2011	1994-2011	2002-2011	1994-2011	1994-2011	1994-2011	2002-2011
Dependent Variable				mpr_t				
Variables								
mpr_{t-1}	0.950***	0.921***	0.922***	0.962***	0.930***	0.899***	0.901***	0.957***
	(0.018)	(0.025)	(0.025)	(0.005)	(0.026)	(0.033)	(0.033)	(0.006)
$Inflation_{t-3,t-1}$	0.021***		0.010**	0.014***	0.018***		0.009**	0.012***
	(0.003)		(0.004)	(0.002)	(0.003)		(0.004)	(0.002)
$Unemployment_{t-4,t-2}$	-0.007		0.001	-0.002	-0.016**		-0.012	-0.014***
	(0.006)		(0.007)	(0.004)	(0.007)		(0.008)	(0.004)
Inflation $Forec._{t,t+11}$		0.105***	0.092**	0.043***		0.108***	0.095**	0.042***
		(0.039)	(0.044)	(0.010)		(0.039)	(0.042)	(0.011)
GDP Growth $Forec._{t,t+11}$		0.054***	0.052***	0.051***		0.000	-0.005	0.004
		(0.007)	(0.007)	(0.006)		(0.014)	(0.014)	(0.008)
Observations	4,155	4,155	4,155	3,054	4,155	4,155	4,155	3,054
Number of Countries	28	28	28	28	28	28	28	28
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	No	No	No	No	Yes	Yes	Yes	Yes

We instrument the lag of monetary policy with two lags of monetary policy rate, quarterly inflation, and unemployment.
Heteroscedastic and autocorrelated (AR-1) robust standard errors in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1

Table 5

Monetary Policy in the World, 1994-2011 and 2002-2011

Pooled Common Correlated Effect Estimations

	(1)	(2)	(3)	(4)
Sample	1994-2011	2002-2011	1994-2011	2002-2011
Dependent Variable		mpr_t		
Variables				
mpr_{t-1}	0.872***	0.874***	0.855***	0.874***
	(0.043)	(0.015)	(0.045)	(0.015)
$Inflation_{t-3,t-1}$	0.005	0.009***	0.007*	0.009***
	(0.005)	(0.002)	(0.004)	(0.002)
$Unemployment_{t-4,t-2}$	-0.040**	-0.072***	-0.035**	-0.067***
	(0.016)	(0.013)	(0.015)	(0.012)
Inflation $Forec._{t,t+11}$	0.140*	0.099***	0.148**	0.109***
	(0.075)	(0.018)	(0.074)	(0.019)
GDP Growth $Forec._{t,t+11}$	-0.019	0.002	-0.032	0.001
	(0.028)	(0.010)	(0.027)	(0.010)
Observations	4,155	3,054	4,155	3,054
Number of Countries	28	28	28	28
Country FE	Yes	Yes	Yes	Yes
Month FE	No	No	Yes	Yes

We instrument the lag of monetary policy with two lags of monetary policy rate, quarterly inflation, and unemployment.
Heteroscedastic and autocorrelated (AR-1) robust standard errors in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1

Table 6

Monetary Policy in the World, 1994-2011 and 2002-2011
IV Heterogeneous Panels Estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		MG			**CCE-MG**			**AUG-MG**	
		Pesaran and Smith (1995)			**Pesaran (2006)**			**Eberhart and Teal (2012)**	
		Robust	Robust		Robust	Robust		Robust	Robust
Sample	1994-2011	1994-2011	2002-2011	1994-2011	1994-2011	2002-2011	1994-2011	1994-2011	2002-2011
Dependent Variable					mpr_t				
Variables									
mpr_{t-1}	0.916***	0.936***	0.917***	0.817***	0.848***	0.772***	0.866***	0.878***	0.834***
	(0.014)	(0.010)	(0.015)	(0.028)	(0.027)	(0.027)	(0.022)	(0.019)	(0.025)
$\text{Inflation}_{t-3,t-1}$	0.011***	0.005***	0.006***	0.006*	0.003	0.002	0.010***	0.004***	0.006***
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)
$\text{Unemployment}_{t-4,t-2}$	-0.037	-0.009	-0.041**	-0.076**	-0.035***	-0.095***	-0.019	-0.009	-0.065**
	(0.028)	(0.014)	(0.021)	(0.035)	(0.013)	(0.027)	(0.030)	(0.017)	(0.029)
$\text{Inflation Forec.}_{t,t+11}$	0.056***	0.058***	0.053***	0.115***	0.113***	0.114***	0.077***	0.077***	0.088***
	(0.016)	(0.017)	(0.019)	(0.028)	(0.031)	(0.029)	(0.019)	(0.020)	(0.024)
$\text{GDP Growth Forec.}_{t,t+11}$	0.068***	0.068***	0.067***	0.021	0.033	-0.010	0.043***	0.054***	0.044***
	(0.011)	(0.011)	(0.011)	(0.024)	(0.021)	(0.023)	(0.015)	(0.013)	(0.015)
Observations	4,155	4,155	3,054	4,155	4,155	3,054	4,155	4,155	3,054
Number of Countries	28	28	28	28	28	28	28	28	28

We instrument the lag of monetary policy with two lags of monetary policy rate, quarterly inflation, and unemployment.
Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 7

Monetary Policy in the World, 1994-2011 and 2002-2011
Error-Correction Estimations

	(1)	(2)	(3)	(4)	(5)	(6)
	Dynamic FE		**PMG**		**MG**	
Sample	1994-2011	2002-2011	1994-2011	2002-2011	1994-2011	2002-2011
Dependent Variable			$\Delta\ mpr_t$			
Variables						
Short-Run						
$\Delta\ \text{Inflation}_{t-3,t-1}$	0.016***	0.016***	0.013**	0.009***	0.013**	0.011***
	(0.004)	(0.002)	(0.006)	(0.002)	(0.006)	(0.004)
$\Delta\ \text{Unemployment}_{t-4,t-2}$	-0.233***	-0.144***	-0.261***	-0.190***	-0.217***	-0.185***
	(0.054)	(0.026)	(0.057)	(0.063)	(0.068)	(0.069)
$\Delta\ \text{Inflation Forec.}_{t,t+11}$	0.087***	0.036***	0.208***	0.222***	0.200***	0.208***
	(0.016)	(0.007)	(0.034)	(0.045)	(0.036)	(0.043)
$\Delta\ \text{GDP Growth Forec.}_{t,t+11}$	-0.027*	0.024***	0.083**	0.135***	0.083**	0.122***
	(0.015)	(0.007)	(0.034)	(0.029)	(0.039)	(0.032)
Long-Run						
γ	-0.074***	-0.026***	-0.028***	-0.017***	-0.068***	-0.087***
	(0.005)	(0.003)	(0.004)	(0.002)	(0.012)	(0.016)
$\text{Inflation}_{t-4,t-2}$	0.134***	0.597***	0.230***	0.343***	0.127*	0.184*
	(0.048)	(0.095)	(0.050)	(0.088)	(0.071)	(0.111)
$\text{Unemployment}_{t-5,t-3}$	0.070	-0.028	-0.278***	-0.425***	0.404	0.203
	(0.092)	(0.131)	(0.091)	(0.151)	(0.518)	(0.640)
$\text{Inflation Forec.}_{t-1,t+10}$	1.063***	0.622***	1.199***	1.405***	1.436	-0.209
	(0.127)	(0.237)	(0.145)	(0.322)	(0.880)	(0.610)
$\text{GDP Growth Forec.}_{t-1,t+10}$	0.773***	1.896***	1.967***	3.227***	0.004	1.537
	(0.132)	(0.274)	(0.206)	(0.485)	(0.877)	(1.271)
Observations	4,179	3,062	4,179	3,062	4,179	3,062
Number of Countries	28	28	28	28	28	28
Hausman Test (p-value)			0.07	0.33		

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 8

Monetary Policy in the World, 1994-2011 and 2002-2011
Conditional Error-Correction Estimations

	(1)	(2)	(3)	(4)
	Dynamic FE		**PMG**	
Sample	1994-2011	2002-2011	1994-2011	2002-2011
Dependent Variable	Δ mpr$_t$			
Variables				
Short-Run				
Δ Inflation$_{t-3,t-1}$	0.016***	0.015***	0.010***	0.007***
	(0.004)	(0.002)	(0.004)	(0.003)
Δ Unemployment$_{t-4,t-2}$	-0.211***	-0.125***	-0.189***	-0.106**
	(0.055)	(0.026)	(0.064)	(0.054)
Δ Inflation Forec.$_{t,t+11}$	0.084***	0.032***	0.179***	0.171***
	(0.016)	(0.008)	(0.041)	(0.042)
Δ GDP Growth Forec.$_{t,t+11}$	-0.046***	-0.006	0.025	0.078***
	(0.017)	(0.007)	(0.042)	(0.030)
Long-Run				
γ	-0.081***	-0.026***	-0.077***	-0.090***
	(0.006)	(0.004)	(0.012)	(0.016)
Inflation$_{t-4,t-2}$	0.127***	0.504***	0.079***	0.068***
	(0.044)	(0.102)	(0.016)	(0.014)
Unemployment$_{t-5,t-3}$	-0.068	-0.480***	-0.152***	-0.074*
	(0.094)	(0.166)	(0.057)	(0.044)
Inflation Forec.$_{t-1,t+10}$	0.944***	0.653***	0.881***	0.841***
	(0.123)	(0.252)	(0.081)	(0.071)
GDP Growth Forec.$_{t-1,t+10}$	0.392**	0.452*	0.178***	0.092
	(0.167)	(0.272)	(0.068)	(0.065)
Observations	4,179	3,062	4,179	3,062
Number of Countries	28	28	28	28

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 9

Monetary Policy in the World, 1994-2011 and 2002-2011
IV-FE estimations with Crisis Interactions

	(1)	(2)	(3)	(4)
Sample	1994-2011	2002-2011	1994-2011	2002-2011
Dependent Variable		mpr_t		
Variables				
mpr_{t-1}	0.901***	0.945***	0.896***	0.953***
	(0.034)	(0.006)	(0.035)	(0.007)
mpr_{t-1} X Crisis	-0.035**	-0.045***	-0.029*	-0.038***
	(0.016)	(0.011)	(0.016)	(0.010)
Crisis	-0.154**	-0.110***	-0.067	-0.056
	(0.061)	(0.034)	(0.084)	(0.064)
$\text{Inflation}_{t-3,t-1}$	0.008	0.013***	0.010*	0.015***
	(0.006)	(0.003)	(0.005)	(0.003)
$\text{Inflation}_{t-3,t-1}$ X Crisis	0.001	-0.001	-0.003	-0.007*
	(0.005)	(0.004)	(0.006)	(0.004)
$\text{Unemployment}_{t-4,t-2}$	-0.011*	-0.015***	-0.019**	-0.020***
	(0.006)	(0.004)	(0.008)	(0.005)
$\text{Unemployment}_{t-4,t-2}$ X Crisis	-0.006	-0.002	-0.011***	-0.010***
	(0.005)	(0.003)	(0.004)	(0.003)
Inflation $\text{Forec.}_{t,t+11}$	0.110**	0.050***	0.099**	0.042***
	(0.052)	(0.011)	(0.046)	(0.012)
Inflation $\text{Forec.}_{t,t+11}$ X Crisis	-0.017	0.006	-0.022	0.021
	(0.025)	(0.015)	(0.029)	(0.014)
GDP Growth $\text{Forec.}_{t,t+11}$	-0.004	0.000	-0.024	-0.013
	(0.018)	(0.009)	(0.020)	(0.010)
GDP Growth $\text{Forec.}_{t,t+11}$ X Crisis	0.039***	0.040***	0.030**	0.024***
	(0.011)	(0.008)	(0.012)	(0.008)
Observations	4,155	3,054	4,155	3,054
Number of Countries	28	28	28	28
Country FE	Yes	Yes	Yes	Yes
Month FE	No	No	Yes	Yes

Heteroscedastic and autocorrelated (AR-1) robust standard errors in parenthesis.
We instrument the lag of monetary policy with two lags of monetary policy rate, quarterly inflation, and unemployment

*** p<0.01, ** p<0.05, * p<0.1

Table 10

Monetary Policy in the World, 1994-2011 and 2002-2011
Error-Correction estimation with Crisis Interactions

	(1)	(2)	(3)	(4)
	Dynamic FE		**PMG**	
Sample	1994-2011	2002-2011	1994-2011	2002-2011
Dependent Variable	Δ mpr$_t$			
Variables				
Short-Run				
Δ Inflation$_{t-3,t-1}$	0.015***	0.015***	0.010	0.006**
	(0.005)	(0.002)	(0.007)	(0.003)
Δ Inflation$_{t-3,t-1}$ X Crisis	0.003	0.004	-0.003	0.000
	(0.008)	(0.004)	(0.010)	(0.006)
Δ Unemployment$_{t-4,t-2}$	-0.223***	-0.117***	-0.281***	-0.237***
	(0.054)	(0.024)	(0.056)	(0.070)
Δ Unemployment$_{t-4,t-2}$ X Crisis	-0.029	-0.035***	-0.067***	-0.066***
	(0.019)	(0.008)	(0.021)	(0.022)
Δ Inflation Forec.$_{t,t+11}$	0.088***	0.030***	0.213***	0.227***
	(0.016)	(0.007)	(0.034)	(0.042)
Δ Inflation Forec.$_{t,t+11}$ X Crisis	-0.029	0.013	-0.106**	-0.056
	(0.030)	(0.012)	(0.052)	(0.045)
Δ GDP Growth Forec.$_{t,t+11}$	-0.052***	0.013*	0.038	0.085***
	(0.018)	(0.007)	(0.041)	(0.023)
Δ GDP Growth Forec.$_{t,t+11}$ X Crisis	0.074**	0.021*	0.101**	0.051
	(0.029)	(0.012)	(0.043)	(0.032)
Long-Run				
γ	-0.074***	-0.028***	-0.032***	-0.026***
	(0.005)	(0.003)	(0.005)	(0.004)
Inflation$_{t-4,t-2}$	0.129***	0.593***	0.205***	0.218***
	(0.048)	(0.086)	(0.040)	(0.046)
Unemployment$_{t-5,t-3}$	0.059	-0.076	-0.233***	-0.050
	(0.093)	(0.120)	(0.078)	(0.076)
Inflation Forec.$_{t-1,t+10}$	1.071***	0.191	1.164***	1.262***
	(0.127)	(0.223)	(0.121)	(0.169)
GDP Growth Forec.$_{t-1,t+10}$	0.761***	1.718***	1.507***	1.574***
	(0.133)	(0.232)	(0.149)	(0.178)
Observations	4,155	3,054	4,155	3,054
Number of Countries	28	28	28	28

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 11

Monetary Policy in the World, 1994-2011 and 2002-2011
IV-FE Estimations with Zero Lower Bound Interactions

	(1)	(2)
Sample	1994-2011	2002-2011
Dependent Variable	mpr_t	
Variable		
mpr_{t-1}	0.897***	0.869***
	(0.035)	(0.016)
mpr_{t-1} X ZLB	-0.087	-0.061
	(0.103)	(0.057)
ZLB	0.116**	0.196***
	(0.050)	(0.075)
$Inflation_{t-3,t-1}$	0.009**	0.009***
	(0.004)	(0.002)
$Inflation_{t-3,t-1}$ X ZLB	-0.014	-0.008**
	(0.009)	(0.004)
$Unemployment_{t-4,t-2}$	-0.013	-0.065***
	(0.009)	(0.012)
$Unemployment_{t-4,t-2}$ X ZLB	0.028***	0.022***
	(0.009)	(0.005)
Inflation $Forec._{t,t+11}$	0.100**	0.119***
	(0.044)	(0.021)
Inflation $Forec._{t,t+11}$ X ZLB	-0.136***	-0.139***
	(0.046)	(0.025)
GDP Growth $Forec._{t,t+11}$	-0.007	0.003
	(0.016)	(0.010)
GDP Growth $Forec._{t,t+11}$ X ZLB	-0.018	-0.038**
	(0.018)	(0.019)
Observations	4,155	3,054
Number of Countries	28	28
Country FE	Yes	Yes
Month FE	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12

Monetary Policy in the World, 1994-2011 and 2002-2011

Pooled Mean Group estimation with Zero Lower Bound Interactions

	(1)	(2)
Sample	1994-2011	2002-2011
Dependent Variable	Δ mpr$_t$	
Variables		
Short-Run		
Δ Inflation$_{t-3,t-1}$	0.012**	0.008***
	(0.006)	(0.002)
Δ Inflation$_{t-3,t-1}$ X ZLB	-0.001	-0.002
	(0.002)	(0.002)
Δ Unemployment$_{t-4,t-2}$	-0.267***	-0.231***
	(0.056)	(0.065)
Δ Unemployment$_{t-4,t-2}$ X ZLB	0.004**	0.002
	(0.002)	(0.002)
Δ Inflation Forec.$_{t,t+11}$	0.230***	0.250***
	(0.034)	(0.046)
Δ Inflation Forec.$_{t,t+11}$ X ZLB	-0.076***	-0.057***
	(0.028)	(0.022)
Δ GDP Growth Forec.$_{t,t+11}$	0.089**	0.116***
	(0.036)	(0.026)
Δ GDP Growth Forec.$_{t,t+11}$ X ZLB	0.009	0.000
	(0.025)	(0.010)
Long-Run		
γ	-0.031***	-0.026***
	(0.004)	(0.003)
Inflation$_{t-4,t-2}$	0.195***	0.204***
	(0.043)	(0.049)
Unemployment$_{t-5,t-3}$	-0.242***	-0.092
	(0.083)	(0.082)
Inflation Forec.$_{t-1,t+10}$	1.218***	1.390***
	(0.131)	(0.187)
GDP Growth Forec.$_{t-1,t+10}$	1.702***	1.706***
	(0.172)	(0.200)
Constant	-0.111***	-0.173***
	(0.033)	(0.029)
Observations	4,179	3,062
Number of Countries	28	28

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 13

Monetary Policy in Inflation and Non-Inflation Targeting Countries, 1994-2011 and 2002-2011

IV-FE Estimations

	(1)	(2)	(3)	(4)
	IT Countries		**Non-IT Countries**	
Sample	1994-2011	2002-2011	1994-2011	2002-2011
Dependent Variable	mpr_t			
Variables				
mpr_{t-1}	0.953***	0.956***	0.964***	0.944***
	(0.006)	(0.007)	(0.008)	(0.013)
$Inflation_{t-3,t-1}$	0.018***	0.013***	0.005*	0.003
	(0.003)	(0.003)	(0.003)	(0.002)
$Unemployment_{t-4,t-2}$	-0.024***	-0.024***	-0.005	-0.004
	(0.006)	(0.008)	(0.004)	(0.004)
Inflation $Forec._{t,t+11}$	0.023**	0.050***	0.034**	0.035**
	(0.009)	(0.013)	(0.016)	(0.017)
GDP Growth $Forec._{t,t+11}$	0.001	-0.006	0.029***	0.034***
	(0.009)	(0.010)	(0.010)	(0.011)
Observations	2,668	2,153	1,275	895
Number of Countries	20	20	8	8
Country Fe	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes

We instrument the lag of monetary policy with two lags of monetary policy rate, quarterly inflation, and unemployment.
Heteroscedastic and autocorrelated (AR-1) robust standard errors in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1