

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

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Abstract

Optimal monetary policy is predicated on forward-looking actions based on real-time forecasts for future variables, as reflected in central bank (CB) policy statements. However, monetary policy 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. Do deeds follow words in the real world? This paper tests for the role of real-time information on both past data and forecasts about future variables in setting monetary policy rates in the world. It 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. Fifth, by testing for differences in the conduct of monetary policy over time and across country groups. The empirical findings are very supportive to the nested model for the reaction of monetary policy makers to real-time information on past realizations and forecasts of both inflation and activity variables. The weight attached to inflation forecasts is nearly ten times as large as the weight on past inflation. Central banks also react to past unemployment and GDP growth forecast, and this reaction has grown since the onset of the 2008 financial crisis.

Keywords: monetary policy, Taylor rule, 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 “... its 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 in an horizon between 12 and 24 months and not necessarily on its current behavior” (Central Bank of Chile, 2000).

However, monetary policy could also be based on 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 variables in setting interest rates. This set-up provides information about 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 the 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 Estimator, the Common Correlated Effects Mean Group estimator, and the Augmented Mean Group Estimator. Then we test for dynamic models that allow for differences between short and long-run coefficients: the dynamic fixed effects, pooled mean group, and mean group estimator. Finally we apply the Condi-

tional Pooled Mean Group estimator for possible common shocks. To our knowledge, most of the latter estimators have not been used yet in empirical studies of monetary policy.

Finally, we test for 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 also report separate results for inflation-targeting countries.

The research closest to our work is Aizenman et al. (2010), an empirical panel study of monetary policy decisions using a backward-looking Taylor rule in a sample of 17 emerging economies. They report a significant response running from inflation to policy interest rates in inflation targeting countries, also they found that inflation and real exchange rates are important determinants of policy interest rates, being the first more strong in non-inflation targeting countries.

We find that past inflation and 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 separating between short and long-run dynamics, we find that short-run all variables are highly significant, while in the long-run all are significant using the pooled mean group estimator, which is shown to be the consistent and efficient estimator for our model.

Then we test for a change in monetary policy during the global financial crisis. 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 find changes in short-run reactions to unemployment and GDP growth forecast under the PMG model. We find that CB reduce its reaction to information about inflation and activity during periods when the monetary policy rate has reach the zero lower bound. Finally, and somewhat surprisingly, we observe that inflation targeting countries have been more backward-looking in the conduct of their monetary policy than non-inflation targeting countries.

This paper is laid out as follows. We start in section 1 with a literature review and the motivation of our main research question. In section 2 we discuss our empirical methods and describe the estimators we use for our world panel data regressions. Then we describe our database. Our empirical findings are presented 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 the interest rate when inflation exceeds a 2% implicit inflation target or if real GDP exceeds potential GDP describes quite well the actual path of the federal funds rate. This result led to a large line of research focused on interest rule models and CB behavior. Studies were generally applied to individual industrial countries, and many evaluate monetary policy using the Taylor principle: CB facing higher expected inflation should raise nominal interest rates by more than the rise in expected inflation, in order to stabilize inflation.

The literature on Taylor Rules is very wide; below we discuss some key points on the empirical Taylor Rule research. A first step is to distinguish between backward and forward-looking specifications. The latter is commonly preferred in the literature since it is frequently assumed that authorities make policy decisions based on economic condition expected in the future (see for example Clarida et al., 2000, Orphanides, 2004). However, the evidence is mixed in one side Rudebusch and Svensson (1999) find forecast-based rules outperform marginal to the contemporaneous Taylor-type rule. While in the other, Smets (1998) finds that contemporaneous rules perform similar, and marginally superior, to forecast rules. Taylor (1999) also concludes that forecast-based rules have little advantage over contemporaneous rules after he fails to find much difference between the performance of inflation forecasts and actual inflation in his policy rule.

Second, interest rate paths set by the CB tends to be fairly smooth, moving slowly in the same directions rather than often reversing the direction of the changes. Taylor rules are commonly modified to incorporate interest rate smoothing, (see for example Judd and Rudebusch, 1999 and Clarida et al., 2000). One argument to this practice is that CB would want to avoid frequent reversal in the directions of interest rate movements, because this may appear as mistakes to the public, thus lowering the confidence in CB (Williams, 1999). Interest rate smoothing may also be a response to the unavailability of accurate economics information and the uncertainty associated with monetary policy transmission mechanism, in this way CB prefers to adjust slowly to their economic targets (Sack and Wieland, 1999).

Third, Taylor Rules have proven valuable for historical analysis. Following Taylor (1993) numerous authors have estimated historical monetary policy reaction function in the United States, using calibrated or empirical models. However, a key factor to evaluate monetary policy is to use real-time data and forecast (Orphanides, 2001 and Tchaidze, 2001). The main point is that to evaluate CB actions base on revised or unavailable data is of questionable value (Orphanides, 2007). In this paper we are careful about the timing of data publications and monetary policy decisions,

with the aim of evaluate the monetary decisions using the same information as they had.

II Methodology

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

$$MPR_{it} = \alpha_1\pi_{it} + \alpha_2\pi_{it+1|t} + \beta_1y_{it} + \beta_2y_{it+1|t} \quad (1)$$

where MPR_{it} is the monetary policy rate in country i , π_{it} is the past inflation in country i , $\pi_{it+1|t}$ is the inflation forecast with information until period t in country i , y_{it} is represents the past output-gap in country i , and $y_{it+1|t}$ is the forecast of the output-gap for the next period using information until period t in country i .

This nested monetary policy reaction function allows that CBs could take into account information on both past realizations and forecasts about future variables in setting their policy instrument.

In our empirical strategy we estimate using different estimators, for alternative assumptions on and features of the underlying data-generating process. There are three main differences between our estimators, first the separation between short and long-run dynamics, second the degree of heterogeneity in our parameters, and third the possible correlation across countries due to common shock (e.g. recession) that could exist in monetary policy.

First, we estimate a dynamic equation as the one presented in equation (1):

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

where i , t , and j stands for country, actual month, and future month, respectively. Our dependent variable is the monetary policy rate (MPR) settled by the central bank. We include MPR_{it-1} to control for smoothing in changes of MPR. Our control variables include: π_{it} which is the past CPI inflation rate, $\pi_{it+j|t}$ is the expected inflation from period t through $t + j$, y_{it} is the actual output gap, $y_{it+j|t}$ is the expected output gap from period t through $t + j$, and ϵ_{it} is a random noise. The terms θ_i and ν_t are country and monthly fixed-effects, respectively.

We first estimate equation (2) using fixed effect estimator with instrumental variable (*IV-FE*). One of the main 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 $\beta_{i2} = \beta_2$). This estimator corrects for country unobservable variables that are constant in time and also corrects for possible endogeneity in the

smoothing term, due to autocorrelation in the error term. We use two lags of the interest rate and the backward-looking variables as the set of instruments for the smoothing term. We also include monthly fixed effects, that controls for time shocks that affect all the countries in the same way. We then augment this model to control for possible common shocks that could affect each country in a different way. We do this using Pesaran (2006) Pooled Common Correlated Effects estimator (*Pooled-CCE*), this model includes the interaction of cross section means of each independent variable with a country dummy. This allows for more flexibility as the impact of the unobserved common factors can differ across country while the evolution of these factors may be nonlinear or even non-stationary (Kapetanios et al., 2011).

Then we relax the assumption of homogeneity in our parameters, for this we estimate using the growing literature of heterogeneous panels that it has been used in recent studies with panel time-series data (see for example Eberhardt and Teal, 2012 and Eberhardt et al., 2012). Since we have 28 countries with an average of 124 months per country we can exploit the country heterogeneity. In this way, we don't restrict, for example, that European Central Bank follows the same rule as the Central Bank of Colombia. These models estimate each time series separately and then average the country coefficients.

We present three different estimators, first we estimate using Pesaran and Smith (1995) mean group estimator (*MG*), which allows for heterogeneous slopes and presents the average as the coefficient of interest. Then we correct for the possible correlation across panel members due to common shock. To make this, we first estimate Pesaran (2006) Common Correlated Effects Mean Group (*CCE-MG*). This method is like a Mean Group estimator but includes cross section means of the independent variables as regressors, with the aim of capturing cross section dependence. Finally, we estimate Eberhart and Teal (2012) estimator (*Aug-MG*) that accounts for cross-section dependence by the inclusion of a "common dynamic process" in the country regression (see Appendix: Specific Methodology for details of the two previous estimators). In our three methodologies we use linear average and a Huber weighted average that corrects for the presence of outliers. As in the case of *IV-FE* estimator, we instrument the smoothing term with two lags of the interest rate and the backward-looking variables.

Now, to differentiate between short-run and long-run reactions in the Taylor-rule equation, we can rewrite equation (2). The model is defined as,

$$\begin{aligned} \Delta MPR_{it} = & \theta + \gamma(MPR_{it-1} - \alpha_1\pi_{it-1} - \beta_1\pi_{it+j-1|t} - \alpha_2y_{it-1} - \beta_2y_{it+j-1|t}) \\ & + \delta_1\Delta\pi_{it} + \phi_1\Delta\pi_{it+j|t} + \delta_2\Delta y_{it} + \phi_2\Delta y_{it+j|t} + \epsilon_{it} \end{aligned} \quad (3)$$

where Δ operator is defined as $x_{it} - x_{it-1}$. In this case parameters α_1 , α_2 , β_1 , and β_2 represents the coefficients of the long run equation, while δ_1 , δ_2 , ϕ_1 , and ϕ_2 are the coefficient of the short run dynamics.

To estimate equation (3) we use three different methods that allows for different degrees of heterogeneity. We first estimate a Dynamic Fixed Effect model (*DFE*), which constraints all parameters to be homogeneous between countries. Then, we estimate a Pooled Mean Group estimator (*PMG*) proposed by Pesaran et al. (1999), which allows for heterogeneity in the short-run dynamics but we constraint long-run dynamics to be the same for all countries. Finally, we estimate Pesaran and Smith (1995) Mean Group estimator (*MG*), which allows for heterogeneity in all parameters.

As we did in the previous model, we estimate these kind of models controlling for possible common shocks. To do this we use Binder and Offermanns (2008) estimator that augments the *DFE* and *PMG* including means of the independent variables in the short and long-run dynamics (see Appendix: Specific Methodology for details).

III Data

We have collected a unique panel database that comprises 28 countries with monthly data from 1994 to 2011, approximately 4,100 observations. This panel was constructed using data from OECD database, countries CB information, and Consensus Forecast database. Our dependent variable is the monetary policy rate (MPR_t) settled by the central bank.¹

Our forward-looking variables are forecast about CPI inflation for the current and the next 11 months (Inflation Forec. $_{t,t+11}$) and forecasts about GDP growth for the current and the next 11 months (GDP growth Forec. $_{t,t+11}$).² This forecasts were calculated using Consensus Forecast data, since forecasts are published for calendar year, we construct a weighted average between both forecasts. The formula for the month m at year t in the case of CPI inflation forecast is define as:

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

The same procedure is used to calculate GDP growth Forecast $_{t,t+11}$.

¹In the case that a central bank changes the monetary policy rate twice in a month, we use the first change.

²CB real-time information (available at the time of their policy decisions) on future expectations and forecasts about inflation and activity variables is a combination of 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 data forecasts from Consensus Forecast.

We use annualized-quarter CPI inflation ($\text{Inflation}_{t-3,t-1}$) as our main backward-looking variable for inflation, 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. In the case of activity we use the mean of previously three months unemployment rates as our main variable ($\text{Unemployment}_{t-4,t-2}$), this variable has the advantage that it is observable and is negatively correlated with the idea of output gap (Okuns' Law). In the regressions we include this variable lagged in two periods, so we are sure that this information is available in the moment of the decision. Some countries have only quarterly data like Australia and New Zealand; in these cases we use the available quarterly information that the CB has in the moment of their decisions.

In table 1 we present the initial date for each country, this date depends first on available data; for example, monetary policy rate is not available for all countries at 1994 because their monetary policy was conducted with another instrument. Second, on inflation stability of the country, for this we use 10% of year inflation as our inflation ceiling.

Figure 1 shows the average monetary policy rate across countries, we observe an increasing MPR during 1994-2000, while during 2004-2007 we observe an stable time with low MPR. During 2008-2010 we observe a strong decrease in MPR mainly reflecting the CB's responses to the financial crisis.

In table 2 we present summary statistics for the main variables for all sample (1994-2011) and post 2001 (2002-2011). We split the sample in two, because since 2002 monetary policy has been predicated in most sample countries according to a modern policy framework, consistent with a floating exchange rate and attainment of low inflation. The average in the MPR is 5.45% for the entire sample and it has decrease for the last decade, the standard deviation of 4.33% and the difference between the maximum and minimum shows the differences in the monetary policy rate between countries. The annualized quarterly inflation is 3.3% in the entire sample and it has remained nearly the same in the last decade, in the sample we observe a maximum of 33.8%, which corresponds to Brazil in January 2003, and a minimum of -17.9% ,which corresponds to Thailand in November 2011. The mean of unemployment, inflation forecast, and GDP growth forecast for the entire sample has been 7.5% , 3.3% , and 3.2%, respectively, and it has been mainly the same in the last decade.

The table 3 shows panel correlation and cross-section correlations for our variables. Lower-triangle matrix shows panel correlations, all variables have expected sign, except from unemployment that has a positive correlation with monetary policy rate. This can be due because to the fact that countries with higher monetary policy rate are also countries with a high unemployment rate. Upper-triangle matrix shows cross-section correlations; the results are similar to the panel

correlations.

Before doing our empirical analysis we test for unit roots in our sample. Since we are working with panel time-series data we have to do panel data unit root test.³ We first do a fisher-type test proposed by Choi (2001), which is based on a combination of the 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). This test has the null hypothesis that all time series have a unit root, while the alternative hypothesis is that a fraction of the sample are stationary. We reject the null hypothesis for all of our variables. We also, do a test proposed by Pesaran (2007), which corrects for cross sectional dependence and serially correlated errors; the conclusion is the same as in previous test. Thus, we don't find evidence of integrated process in our panel.

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

IV Results

We first estimate using an *IV-FE* approach, columns (1)-(4) from table 4 include country FE, while columns (5)-(8) include country and monthly FE. Columns (1) and (5) presents a backward-looking Taylor rule estimation, coefficients have the expected sign and are all significant at 5% except from unemployment in the specification without monthly fixed effects. The size of the inflation coefficient is similar to German's coefficient and half of US's coefficient, both estimated by Molodtsova et al. (2008) using real-time data. In columns (2) and (6) we present a forward-looking Taylor rule, coefficients have the expected sign, and are all significant at 5% except from GDP growth forecast when we include monthly fixed effects. The size of the inflation forecast coefficient is similar to Boivin (2006) for the US, which use information from the Greenbook.

Our nested model is presented in columns (3), (4), (7), and (8), we observe that our backward and forward-looking variables for inflation are significant in all columns, the size of both coefficients is reduced compare to the backward and forward-looking specification. These is not a surprise since both variables share common information, expectations are based on past inflation. However, it is interesting to find that both variables are significant, which means that Central Banks take into account past and forecast information about the future in the moment of taking a monetary policy decision. But, the weights are quite different between both, inflation forecasts has always a higher

³For a detail discussion of panel time series tests and estimation techniques see Barbieri (2009) and Smith and Fuertes (2010).

weight which varies between 3 times to 10 times the weight of past inflation. If we compare column (7) to column (8) we observe that the relative weights of inflation forecasts over past inflation has decrease from 10 times to 3.5 times in the last decade. We also find that GDP growth forecast is highly significant only if we don't include monthly FE, this reflects that this variable was capturing part of the time shocks that have affected the economies. In the case of unemployment we find that has the expected sign, but is only significant in backward-looking model and in our nested model since 2002.

We now test the robustness of our results allowing more flexibility in the impact of the unobserved common factors that can differ across country. In table 5 we estimated the *Pooled CCE* estimator for our nested model. We find that past inflation and inflation forecast are significant and that the weights are higher for inflation forecast, near 10 times. We also find that unemployment is highly significant, while GDP growth forecast is not.

In table 6 we present estimations for our nested model using the heterogeneous panel techniques. In the first three columns we estimate using *MG* estimator, we find that past inflation, inflation forecast, and GDP growth forecast are highly significant, while unemployment is significant only after 2001 and using a robust average. From columns (4) to (9) we estimate controlling for common shocks using *CCE-MG* and *Aug-MG* estimators, we find that inflation forecast is always significant, while past inflation is significant in most of the estimations. The relative weight between past and inflation forecast are similar to the ones find before. In the case of employment is significant only using *CCE-MG*, while GDP growth forecast is significant only using *Aug-MG*.

So far we have found evidence that past inflation and inflation forecast are robust components of the monetary policy in the world. In particular, inflation forecast has a higher weights in the monetary policy behavior of CB than past inflation, near 10 times. In the case of unemployment and GDP growth forecast, they have the expected sign and are significant in most of the cases.

In table 7 we present our estimations separating between long and short-run dynamics using three different techniques. We observe that in the short-run all parameters are significant and have the expected sign, except from GDP growth forecast in the *DFE* model. As in the previous cases we observe that short-run central banks reactions are higher for inflation forecast. In the long-run we observe the expected sign and highly significant results for *DFE* and *PMG* estimations, these means that under homogeneity in the long-run CB's monetary policy, all variables are relevant and highly significant under, except for unemployment under *DFE*. We can test for the assumption of homogeneity in the long-run dynamic, as proposed by Pesaran et al. (1999), using a Hausman type test. Where *MG* estimator is consistent under the null hypothesis of homogeneity and the alternative hypothesis of heterogeneity, but it is inefficient. However, *PMG* is inconsistent under

the alternative, but efficient. At the bottom of the table we present the p-value for reject the null hypothesis. We observe that the p-value is 0.07 for all sample and 0.33 for the last decade, thus we don't find significant evidence to reject the null of homogeneity. So, *PMG* estimator is preferred since the long-run parameters are consistent and efficient.

To test if our results are robust to common shocks (e.g. recessions), we estimate Binder and Offermanns (2008) estimator in table 8. As in the previous case *PMG* was preferred over *MG* because of the consistency and efficiency in long-run parameters, we present the *DFE* and *PMG* estimators. Our results are mainly the same as in the previous case, the main difference is that GDP growth forecast is not significant in the short-run, and less significant in the long-run. This might be due to the fact that GDP growth forecast is the variable more related to common shock across countries.

All previous results are robust to use bi-annual annualized inflation and the average of employment for six months as our backward-looking variables.⁴

Now, we test for the possible effect of very well known common shock as it is the global financial crisis. Since the financial crisis most central bank's have been forced to conduct an aggressive monetary policy, reaching in many cases the zero lower bound . We define the beginning of the financial crisis in October of 2008 and the end is the end of our sample December 2011.

In table 9 we estimate our nested model as in table 4, but we include interactions of our main variables with the dummy of crisis. We observe that monetary policy has been less smoothing since the financial crisis, maybe reflecting the fact that many CBs has conducted an aggressive monetary policy during the financial crisis to counteract the effects of it (Mishkin, 2009). The same result was found by Belke and Klose (2010) in the case of the FED and the European Central Bank. We also find that monetary policy behavior has been more aggressive on the activity variables, we observe that the weights to unemployment has augmented in 50% since the financial crisis, when we include time fixed effects. In the case of GDP growth forecast it has at least double since the crisis. In the case of inflation variables we don't find a change but they are still significant for the whole period. This results are quiet interesting, because it shows that CB's move their reaction function to a more activity oriented setting, trying to counteract the negative effect of the crisis on the product.

In table 12 we estimate *DFE* and *PMG* models including interactions of the short-run parameters with the financial crisis dummy. We don't interact the long-run parameters because we don't think that central banks have changed their long-run behavior, and even if it has our sample we don't have too much observations to test it. As in the previous table we observe a significant

⁴Tables are available upon request.

change since the financial crisis, we find that short-run reaction to unemployment has increase at least in 20%. We also find an increase in short-run reaction to GDP growth forecast. In the case of inflation we only observe a decrease in the parameter of inflation forecast using *PMG*. The long-run parameters are mainly the same as in table 7. Thus, we found robust evidence that CB's has been more sensitives to changes in variables related to activity during the financial crisis.

Now we study how it is the monetary policy reaction during times periods where the monetary policy rate has reach the zero lower bound. We define those periods when the monetary policy rate is below 1%.⁵ We first estimate using *FE-IV* including interactions between our main variables and our dummy of zero lower bound (*ZLB*). We find that during *ZLB* periods central banks reduce its reaction to activity and inflation variables, see table 11. In table ?? we estimate a *PMG* including interaction in the short-run, we find evidence that central banks reduce its reaction in the short-run to inflation forecast.

Finally, in table 13 we split our sample between countries with inflation targeting (*IT*) and countries without it.⁶ We estimate using *IV-FE* estimator as in table 4, we observe that in *IT* countries past inflation, unemployment and inflation forecast are highly significant and have the expected sign. In the case of non-*IT* countries only the forward-looking variables are relevant. Thus, we observe some suggesting evidence that inflation countries has been more backward-looking oriented that non inflation countries.

V Conclusion

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, we strongly believe that central banks conduct its monetary policy looking for all the information they have at the time of the decision. Thus this model can give us information about the relative weights that central banks gives to past and future information.

We test our model in a panel time-series dataset with real-time information that includes 28 countries with monthly data from January 1994 through December 2011 (this countries account for about 80% of world GDP). We estimate this nested model using different econometrics techniques that separate long-run and short-run dynamics, that allows for different degrees of heterogeneity in the parameters across countries, and that are robust to common shocks across countries.

⁵The countries and periods with a zero lower bound 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, and United Kingdom 2009 m3 - 2011 m12.

⁶We define the beginning of inflation targeting regime for each country using Hammond (2011).

We find that past inflation and 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 separating between short and long-run dynamics, we find that short-run all variables are highly significant, while in the long-run all are significant using the pooled mean group estimator, which is shown to be the consistent and efficient estimator for our model.

Then we test for a change in monetary policy during the global financial crisis. 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 find changes in short-run reactions to unemployment and GDP growth forecast under the PMG model. We find that CB reduce its reaction to information about inflation and activity during periods when the monetary policy rate has reach the zero lower bound. Finally, and somewhat surprisingly, we observe that inflation targeting countries have been more backward-looking in the conduct of their monetary policy than non-inflation targeting countries.

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Appendix: Specific Methodology

Pesaran (2006)

This method is like a Mean Group estimator (Pesaran and Smith, 1995) but includes cross section means, with the aim of capturing the effect of common shocks. Thus, the base equation should be,

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

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

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:

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

and we obtain $c_t = \mu_t^*$. This represents a standard FD-OLS regression with T - 1 year dummies in first differences, from which we collect the year dummy coefficients (reabeled as μ_t^*).

Second Step:

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

and we obtain $b_{Aug-MG} = (1/N) \sum_{i=1}^N b_i$.

Binder and Offermanns (2008)

This model is the same as the Pooled Mean group proposed by Pesaran et al. (1999), the main difference is that it includes cross section means (y_t and x_t), with the aim of capturing cross section dependence. Thus, this model allows for heterogeneous short run dynamics and speed of adjustment, but the long run dynamics are homogeneous across groups. The model is:

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

Figure 1
Average of Monetary Policy Rates

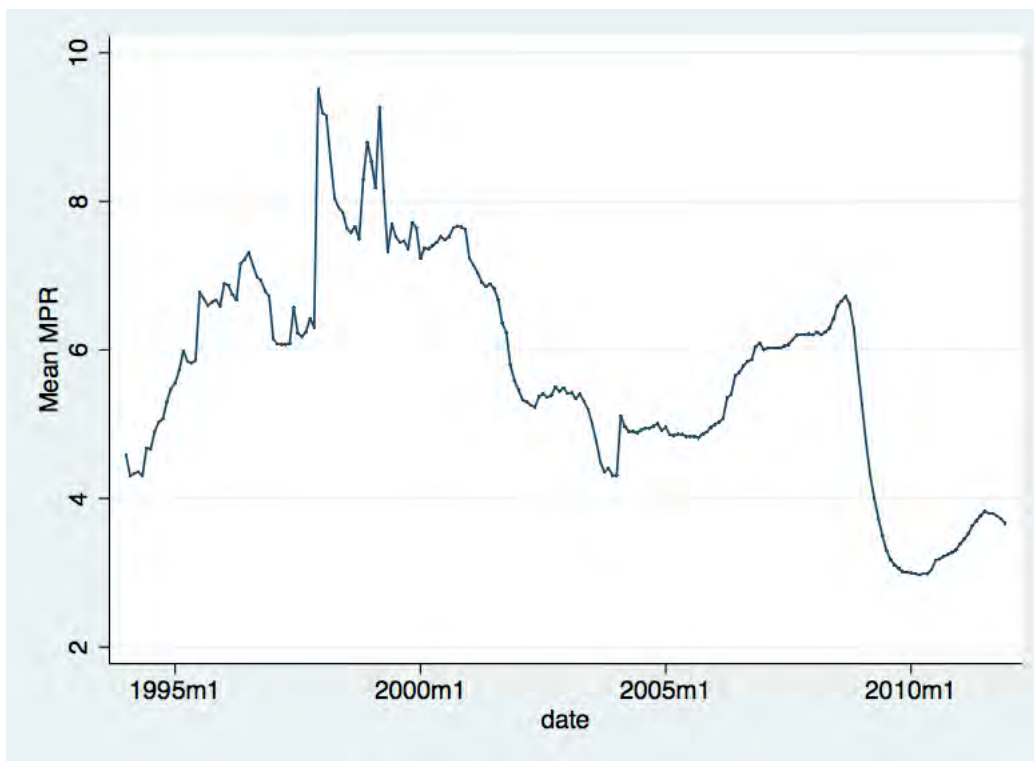


Table 1
Initial Dates by Countries

| 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
Correlation Matrix

| | 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

| Sample Dependent Variable Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------------|
| | 1994-2011 | 1994-2011 | 1994-2011 | 2002-2011 | 1994-2011 | 1994-2011 | 1994-2011 | 2002-2011 |
| | MPR _t | | | | | | | |
| MPR _{t-1} | 0.950*** (0.018) | 0.921*** (0.025) | 0.922*** (0.025) | 0.962*** (0.005) | 0.930*** (0.026) | 0.899*** (0.033) | 0.901*** (0.033) | 0.957*** (0.006) |
| Inflation _{t-3,t-1} | 0.021*** (0.003) | | 0.010** (0.004) | 0.014*** (0.002) | 0.018*** (0.003) | | 0.009** (0.004) | 0.012*** (0.002) |
| Unemployment _{t-4,t-2} | -0.007 (0.006) | | 0.001 (0.007) | -0.002 (0.004) | -0.016** (0.007) | | -0.012 (0.008) | -0.014*** (0.004) |
| Inflation Forec. _{t,t+11} | | 0.105*** (0.039) | 0.092** (0.044) | 0.043*** (0.010) | | 0.108*** (0.039) | 0.095** (0.042) | 0.042*** (0.011) |
| GDP Growth Forec. _{t,t+11} | | 0.054*** (0.007) | 0.052*** (0.007) | 0.051*** (0.006) | | 0.000 (0.014) | -0.005 (0.014) | 0.004 (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

| Sample Dependent Variable Variables | (1) | (2) | (3) | (4) |
|---|---------------------|----------------------|---------------------|----------------------|
| | 1994-2011 | 2002-2011 | 1994-2011 | 2002-2011 |
| | MPR _t | | | |
| MPR _{t-1} | 0.872*** (0.043) | 0.874*** (0.015) | 0.855*** (0.045) | 0.874*** (0.015) |
| Inflation _{t-3,t-1} | 0.005 (0.005) | 0.009*** (0.002) | 0.007* (0.004) | 0.009*** (0.002) |
| Unemployment _{t-4,t-2} | -0.040** (0.016) | -0.072*** (0.013) | -0.035** (0.015) | -0.067*** (0.012) |
| Inflation Forec. _{t,t+11} | 0.140* (0.075) | 0.099*** (0.018) | 0.148** (0.074) | 0.109*** (0.019) |
| GDP Growth Forec. _{t,t+11} | -0.019 (0.028) | 0.002 (0.010) | -0.032 (0.027) | 0.001 (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

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

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

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

| Sample Dependent Variable Variables | (1) 1994-2011 | (2) 2002-2011 | (3) 1994-2011 | (4) 2002-2011 |
|--|---------------------|----------------------|----------------------|----------------------|
| | MPR _t | | | |
| MPR _{t-1} | 0.901*** (0.034) | 0.945*** (0.006) | 0.896*** (0.035) | 0.953*** (0.007) |
| MPR _{t-1} X Crisis | -0.035** (0.016) | -0.045*** (0.011) | -0.029* (0.016) | -0.038*** (0.010) |
| Crisis | -0.154** (0.061) | -0.110*** (0.034) | -0.067 (0.084) | -0.056 (0.064) |
| Inflation _{t-3,t-1} | 0.008 (0.006) | 0.013*** (0.003) | 0.010* (0.005) | 0.015*** (0.003) |
| Inflation _{t-3,t-1} X Crisis | 0.001 (0.005) | -0.001 (0.004) | -0.003 (0.006) | -0.007* (0.004) |
| Unemployment _{t-4,t-2} | -0.011* (0.006) | -0.015*** (0.004) | -0.019** (0.008) | -0.020*** (0.005) |
| Unemployment _{t-4,t-2} X Crisis | -0.006 (0.005) | -0.002 (0.003) | -0.011*** (0.004) | -0.010*** (0.003) |
| Inflation Forec. _{t,t+11} | 0.110** (0.052) | 0.050*** (0.011) | 0.099** (0.046) | 0.042*** (0.012) |
| Inflation Forec. _{t,t+11} X Crisis | -0.017 (0.025) | 0.006 (0.015) | -0.022 (0.029) | 0.021 (0.014) |
| GDP Growth Forec. _{t,t+11} | -0.004 (0.018) | 0.000 (0.009) | -0.024 (0.020) | -0.013 (0.010) |
| GDP Growth Forec. _{t,t+11} X Crisis | 0.039*** (0.011) | 0.040*** (0.008) | 0.030** (0.012) | 0.024*** (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
 Pooled Mean Group estimation with Crisis Interactions

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

| Sample Dependent Variable Variable | (1) 1994-2011 | (2) 2002-2011 MPR _t |
|---|----------------------|--------------------------------------|
| MPR _{t-1} | 0.897*** (0.035) | 0.869*** (0.016) |
| MPR _{t-1} X ZLB | -0.087 (0.103) | -0.061 (0.057) |
| ZLB | 0.116** (0.050) | 0.196*** (0.075) |
| Inflation _{t-3,t-1} | 0.009** (0.004) | 0.009*** (0.002) |
| Inflation _{t-3,t-1} X ZLB | -0.014 (0.009) | -0.008** (0.004) |
| Unemployment _{t-4,t-2} | -0.013 (0.009) | -0.065*** (0.012) |
| Unemployment _{t-4,t-2} X ZLB | 0.028*** (0.009) | 0.022*** (0.005) |
| Inflation Forec. _{t,t+11} | 0.100** (0.044) | 0.119*** (0.021) |
| Inflation Forec. _{t,t+11} X ZLB | -0.136*** (0.046) | -0.139*** (0.025) |
| GDP Growth Forec. _{t,t+11} | -0.007 (0.016) | 0.003 (0.010) |
| GDP Growth Forec. _{t,t+11} X ZLB | -0.018 (0.018) | -0.038** (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

| Sample | (1) | (2) |
|--|-----------------------|-----------|
| Dependent Variable | ΔMPR_t | |
| Variables | | |
| Short-Run | | |
| $\Delta \text{Inflation}_{t-3,t-1}$ | 0.012** | 0.008*** |
| | (0.006) | (0.002) |
| $\Delta \text{Inflation}_{t-3,t-1} \text{ X ZLB}$ | -0.001 | -0.002 |
| | (0.002) | (0.002) |
| $\Delta \text{Unemployment}_{t-4,t-2}$ | -0.267*** | -0.231*** |
| | (0.056) | (0.065) |
| $\Delta \text{Unemployment}_{t-4,t-2} \text{ X ZLB}$ | 0.004** | 0.002 |
| | (0.002) | (0.002) |
| $\Delta \text{Inflation Forec.}_{t,t+11}$ | 0.230*** | 0.250*** |
| | (0.034) | (0.046) |
| $\Delta \text{Inflation Forec.}_{t,t+11} \text{ X ZLB}$ | -0.076*** | -0.057*** |
| | (0.028) | (0.022) |
| $\Delta \text{GDP Growth Forec.}_{t,t+11}$ | 0.089** | 0.116*** |
| | (0.036) | (0.026) |
| $\Delta \text{GDP Growth Forec.}_{t,t+11} \text{ X ZLB}$ | 0.009 | 0.000 |
| | (0.025) | (0.010) |
| Long-Run | | |
| γ | -0.031*** | -0.026*** |
| | (0.004) | (0.003) |
| $\text{Inflation}_{t-4,t-2}$ | 0.195*** | 0.204*** |
| | (0.043) | (0.049) |
| $\text{Unemployment}_{t-5,t-3}$ | -0.242*** | -0.092 |
| | (0.083) | (0.082) |
| $\text{Inflation Forec.}_{t-1,t+10}$ | 1.218*** | 1.390*** |
| | (0.131) | (0.187) |
| $\text{GDP Growth Forec.}_{t-1,t+10}$ | 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

| Sample Dependent Variable Variables | (1) | (2) | (3) | (4) |
|---|----------------------|----------------------|---------------------|---------------------|
| | IT Countries | | Non-IT Countries | |
| | 1994-2011 | 2002-2011 | 1994-2011 | 2002-2011 |
| | MPR _t | | | |
| MPR _{t-1} | 0.953*** (0.006) | 0.956*** (0.007) | 0.964*** (0.008) | 0.944*** (0.013) |
| Inflation _{t-3,t-1} | 0.018*** (0.003) | 0.013*** (0.003) | 0.005* (0.003) | 0.003 (0.002) |
| Unemployment _{t-4,t-2} | -0.024*** (0.006) | -0.024*** (0.008) | -0.005 (0.004) | -0.004 (0.004) |
| Inflation Forec. _{t,t+11} | 0.023** (0.009) | 0.050*** (0.013) | 0.034** (0.016) | 0.035** (0.017) |
| GDP Growth Forec. _{t,t+11} | 0.001 (0.009) | -0.006 (0.010) | 0.029*** (0.010) | 0.034*** (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