Do the World's Central Banks React to Financial Markets?*

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Abstract

We investigate if the world's central banks setting of monetary policy rates is sensitive to financial variables, controlling for conventional monetary policy determinants. We specify and estimate an extended Taylor rule that includes, in addition to real-time backward and forward-looking inflation and activity variables, three financial variables. First, we include exchange-rate devaluation, reflecting possible fear of floating and fear of devaluation-inflation pass-through. Then we include two financial variables that may indicate bubbles and overheating to test for monetary behavior reflecting leaning against the wind: the change in stock market prices and the growth in bank credit to the private sector. We estimate our model using the Pooled Mean Group estimator applied to an unbalanced world panel of monthly 1994-2011 observations for 28 advanced and emerging economies, representing 80% of the world's GDP. We find that central banks react to changes in exchange rates and credit flows, both in the short term and long term. We also find that industrial-country central banks respond to stock-market returns and exchange-rate changes in the long term, while central banks in emerging economies react to credit flows and exchange rates both in the short and the long term. Finally, we find that inflation-targeting countries take into account exchange rates and

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credit flows changes either in the long term or in the short-term. Results are robust to backward and forward-looking inflation and activity variables and to the presence of outliers.

Keywords: monetary policy, Taylor rule, Taylor principle, stock market, exchange rate, credit flows

JEL: E50, E52, E58

Optimal monetary policy is predicated to be based on inflation and activity information. However, in the past two decades many economists have suggested that central banks should take into account more variables to decide their monetary policy. In one side, it have been suggested that CBs should react to exchange rate shock, based on the idea of "Fear of Floating" or to controlling the inflation-to-devaluation passthrough.

In the other side, there are some economists that have suggested that monetary policy must take into account the financial sector. This is known as "Leaning Against the Wind" behavior, where central banks should look at a quantity variable, such as credit flows, or a price variable, such as stock market returns, and raise interest rates to stop asset bubbles.

Pre-2007 there was a general consensus in central banks about most elements of monetary policy strategy, and monetary policy was perceived as being highly successful in OECD countries, with not only low inflation, but also low variability of inflation. However, since 2007 what Alan Greenspan, former Chairman of the Fed, described in Congressional testimony as a "once-in-a-century credit tsunami", the discussion about how monetary policy should be conducted has emerge again (see Mishkin, 2011 for a detailed discussion about monetary policy strategy since 2007).

So, What does the history tell us about the practice in Central Banks? Does CBs only look at inflation and activity information? or CBs has also take into account exchange rate and financial sector information? We investigate if the world's central banks, in setting their monetary policy rates, react to financial variables in addition to conventional monetary policy determinants. As Muñoz and Schmidt-Hebbel (2012), we present an extended Taylor that includes, in addition to real-time backward and forward-looking inflation and activity variables, three financial variables. We include exchange-rate devaluation reflecting possible fear of floating and fear of passthrough. Also, we include two financial variables (one price and one quantity variable) that may indicate bubbles and overheating to test for leaning against the wind behavior: the change in stock market prices and the growth in bank credit to the private sector.

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. Also, 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. We use a dynamic error-correction panel data model: the Pooled Mean Group model, allowing for heterogeneous short-term and homogeneous long-term reactions.

Overall we find that CB reacts to changes in exchange rate and credit flows either in the short and long-term, reflecting a "Fear of Floating" and "Leaning Against the Wind" in a quantitative variable behavior, these results remain mainly the same after 2002. Then we investigate if there is a difference between industrial and emerging economies. We find that the first cares about stock market return and exchange rate in the long-term, while the latter cares about credit flows and exchange rate either in the long and short-term. Finally, we find that inflation-targeting countries take into account exchange rate and credit flows changes either in the long and short-term. All these results are robust to the presence of outliers.

The contribution of this paper lies in presenting robust evidence on the reaction of the world's central banks to real-time financial variables in setting their monetary policy rates, controlling for backward and forward-looking inflation and activity variables. This new evidence for 1994-2011 shows that central banks have reacted for a long time to financial variables, in addition to standard inflation and activity indicators, much before the onset of the world financial crisis.

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. Then we describe our database. 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 using 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.

The relation between exchange rate depreciation and monetary policy, has been an important topic discussion mainly in emerging markets in the last decades. Monetary policy can be sensitive to exchange rate movements by two ways, in a indirectly way because of a pass-through effects on inflation or in a directly way because the exchange rate is an additional argument in central bank objective functions, reflecting their concern for devaluation-induced bank failures and domestic recessions.

This sensitiveness can be higher in emerging economies, as was discussed by Schmidt-Hebbel and Werner (2002), due to low central bank credibility, a high degree of openness, and a history of high inflation. In addition, emerging economies present large mismatches between foreign currency assets and liabilities in their corporate, banking, and public sectors; this raises the likelihood of two undesirable outcomes of adverse shocks: self-fulfilling attacks on the country's assets and the onset of bank failures, corporate bankruptcies, and domestic recession following a large exchange rate depreciation. However, these authors find no significative effect of depreciation rate on monetary policy rate for Brazil, Chile, and Mexico.

More recently Lubik and Schorfheide (2007) estimate a structural general equilibrium model for a small open economy, where monetary policy reacts not only to inflation and output gap, but also to exchange rate. They found that central banks of Australia and New Zealand do not, whereas Canadian and England central banks do include exchange rate in their monetary policy. In the same way Chadha et al. (2004) estimate an "augmented" taylor rule for United States, United Kingdom, and Japan from 1979 to 2000 found that monetary policy makers set interest rates to offset deviations of asset prices or exchange rates from their equilibrium levels.

The clear evidence that asset price bubbles have negative effects on the economy led some economists before the financial crisis,[1] both inside and outside central banks (such as Cecchetti et al., 2000, Borio and Lowe, 2002, Jeanne and Bordo, 2002, Borio, English, and Filardo, 2003, White, 2004) to argue that central banks should at times "lean against the wind" by raising interest rates to stop bubbles from getting out of hand. They argued that raising interest rates to slow a bubble's growth would produce better outcomes because it would either prevent the bubble or would result in a less severe bursting of the bubble, with far less damage to the economy.

In the other side there is the "cleaning up" doctrine based on Greenspan (2002). He strenuously argued that monetary policy should not try to lean against asset price bubbles, but rather should just clean up after they burst. He based his argument on the difficulty of detecting bubbles, market participants expectations,[2] the difficulty of affect just those assets affected by the bubble, and the theoretical uncertainty about the effects of raising interest rate on asset's bubbles. Bernanke and Gertler (1999, 2001) states that central banks should respond to asset prices only to the extent that they affect central bank's forecast of inflation.

II Methodology

Following Muñoz and Schmidt-Hebbel (2012), our proposed model can be rationalized as an extended Taylor that nests backward and forward-looking indicators of inflation and activity in the following form:

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

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

[1] See Dupor (2005) and Kindleberger (1978) for the impact asset prices bubbles on the economy.

[2] See Greenspan (2002) for detailed discussion.

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.

Since we are interested in difference between short and long-run reactions in the Taylor rule equation, we rewrite equation (1). To test if monetary policy has been conducted using other information aside of inflation and activity, we add three variables to the specification in the short and long-run dynamics: the growth of exchange rate (GER), the growth of private credit (GPC), and the stock market return (SMR). The model is defined as,

$$\begin{aligned}\Delta mpr_{it} = \theta + \gamma(&mpr_{it-1} - \alpha_1\pi_{it-1} - \beta_1\pi_{it+j-1|t} - \alpha_2 y_{it-1} - \beta_2 y_{it+j-1|t} \\ &+ \phi_1\Delta GER_{it} + \phi_2\Delta GPC_{it} + \phi_3\Delta SMR_{it}) + \delta_1\Delta\pi_{it} + \phi_1\Delta\pi_{it+j|t} \\ &+ \delta_2\Delta y_{it} + \phi_2\Delta y_{it+j|t} + \varphi_1\Delta GER_{it} + \varphi_2\Delta GPC_{it} + \varphi_3\Delta SMR_{it} + \epsilon_{it}\end{aligned} \tag{2}$$

where Δx_{it} operator for variable x_i is defined as $x_{it} - x_{it-1}$. In this case parameters α_1, α_2, β_1, β_2, ϕ_1, ϕ_2, and ϕ_3 represents the coefficients of the long-run equation, while δ_1, δ_2, ϕ_1, ϕ_2, φ_1, φ_2, and φ_3 are the coefficients of the short-run dynamics.

To estimate equation (2) we use the Pooled Mean Group estimator (PMG) 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.

In the case that central bank's have been conducted it's monetary policy taking into account the "Fear of Floating" and the passthrough effect in the short and long-run, we expect that ϕ_1 and φ_1 are positive and significant. In the case that central bank's have been "Leaning Against the Wind" in quantities and prices, we expect that ϕ_2, ϕ_3, φ_2, and φ_3 are positive and significant.

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 (Inflation $\text{Forec.}_{t,t+11}$) and the GDP growth forecast (GDP growth $\text{Forec.}_{t,t+11}$). The horizon for both forecasts extends over a twelve-month period starting with the current month (t) and ending eleven months into the future ($t + 11$).[3] Our forecasts are calculated using Consensus Forecast data. Since 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.[4] 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).[5] We call the previous group of variables, inflation and activity, as "conventional" variables.

As our "additional" variables we use the growth of nominal exchange rate relative to United States dollar for the past three months (Exchange $\text{Rate}_{t-3,t-1}$). As our financial

[3]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.

[4]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.

[5]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.

variables, we use the stock market return in the previous three months (Stock Market Return$_{t-3,t-1}$) as our price variable. We use the main stock market index in each country as our reference index. As our quantity variable we use the growth in private credit in the past three months (Stock Market Return$_{t-3,t-1}$). This variable was obtain from IFS using the line "Claims on Private Sector" 22D, there are few countries for which this variable is not reported so we use line 22S "Claims on Other Sectors", this variable encompasses line 22D.[6]

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 accord to a modern policy framework, consistent with a floating exchange rate and to 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 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, 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.

We observe an average of three months exchange rate change of 0.1%, with the highest appreciation against the dollar in October 2008 in Japan and the higher depreciation against the dollar in January 1999 in Brazil. The average of credit flow growth in three months is

[6] The countries for which we use line 22S are Czech Republic, Denmark, Euro Zone, Hungary, Poland, and Sweden.

2.7% and the average for stock market return in three months is 2.7% where the highest was in May 2009 in Peru in and the lower in November 2008 in Russia.

Table 3 shows bi-variate panel correlation for our variables for the full sample. Simple correlations of the monetary policy rate with it's potential determinants exhibit expected signs, except for unemployment.

Table 4 summarize bi-variate correlations of all variables for the full sample for industrial and emerging market economies. We split the countries into this categories using IMF's (2012) definition. Upper-triangle matrix shows emerging market economies correlations, while lower-triangle matrix shows industrial economies correlations. The main difference between both is the negative correlation of stock market return with credit flow growth and exchange rate growth in the case of the emerging economies.

In general we observe a high correlation between monetary policy rate and the forward looking variables, also the correlation between the "additional" variables is small, and the correlation of these variables with the monetary policy rate has the expected sign, except for stock market return.

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.[7] 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.

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

IV Results

As an starting point in Table 5 we present our estimations for the parsimonious model as in Muñoz and Schmidt-Hebbel (2012). We estimate using Pooled Mean Group (*PMG*) estimator and the Mean Group (*MG*) estimator, the latter allows for heterogeneity in the long and short-term parameters. 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.[8] We report the test results at the bottom of Table . At p-values (for 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 1 and 2 to those obtained under *MG* estimation.

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 these 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.

Table 6 extend our parsimonious model by adding three main variable to test for "Fear of Floating" and "Leaning Against the Wind" reactions by the CB. In the short-run we find that CBs react to exchange rate and credit flow, raising the monetary policy rate in the case of a depreciation of the exchange rate and in the case of growth in credit flow. However, the weight to these variables is lower than the weights of inflation and activity variables. In the case of the long-run we observe a similar results, exchange rate and credit flow have a positive and significative coefficient, that it's smaller than inflation and activity variables.

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

All the rest of the variables maintain it's significance and are similar to our benchmark model presented in table 5, either in the long and short-run dynamics.

The differences between columns observations is due to the availability of credit flows data and because when we include the exchange rate growth we have to exclude United States, since all the exchange rates are relative to this country.

In table 7 we re-estimate our model for data post-2001. Our results remain practically the same in the case of the short-run dynamics. However, in the long-run we observe a negative coefficient in the exchange rate growth and the stock market return. The first changes to positive when we estimate the model including only this variable, while in the case of stock market, this negative reaction disappears.

Up to this point we find robust evidence that central banks' have conducted monetary policy reacting to the "Fear of Floating" and "Leaning against the wind" in terms of a quantitative variable in the short-term and long-term dynamics. Nevertheless, we find that the weights to this variables are smaller than to the "conventional" variables.

Now we turn to the question whether this reaction have been different between industrial and emerging economies (see tables 8 and 9). We observe that industrial economies' central banks have not react to changes in the short-run. However, they have have react to changes in stock market return and exchange rate. In the other hand, we find that emerging economies CBs reacts to exchange rate movements and credit flows, either in the long and short-run. In the case of the stock market return we find a negative coefficient, as in the table post-2001. Another interesting result is that industrial economies CBs reacts mostly to forecast information, while emerging economies CBs reacts also to past inflation. All these results are robust to an estimation using the sample post 2001.[9]

We also test how inflation-targeting countries have conducted their monetary policy. We define the beginning of inflation targeting regime for each country using Hammond (2011). In table 10 we find that CBs cares about the "conventional" variables either in the short and long-term, except from unemployment in the long-term. In the case of our "additional" variables we find strong evidence that CBs reacts to exchange rate and credit flows in the long-term and to credit flows in the short-term.

[9]Results available upon request.

As a robustness we correct for outliers as in Onahian and Raffo (2012), based on the approach propose by Iglewicz and Hoaglin (1993). We construct the modified Z-score test statistic:

$$M_t = 0.6745 \frac{x_t - \overline{x}}{median(|x_t - \overline{x}_t|)} \tag{3}$$

where x_t is the variable of interest, note that this variable are already in growth rate, $\overline{x}$ is the median growth, and the $median(|x_t - \overline{x}_t|)$ is the median absolute deviation. We then identify as outliers those observations for which $|M_t| > 3.1$ that correspond to a probability of 0.001 in the normal standard distribution, and replace the value as an interpolation of the preceding and following observation. We find an average of 3 outliers per country and variable.

Table 11 present the first column of the main specifications. We find that all the main results remain robust to the correction for outliers.

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 the Taylor principle in the long run, even while deviating from it substantially in the short run, as shown by Davig and Lepper (2007). For the error-corrections estimations consistent with equation (2), the Taylor principle strongly satisfied regarding long-run coefficients.

V Conclusion

In this paper we investigate if the world's central banks, in setting their monetary policy rates, react to financial variables in addition to conventional monetary policy determinants. We present an extended Taylor that includes, in addition to real-time backward and forward-looking inflation and activity variables, three financial variables. We include exchange-rate devaluation reflecting possible fear of floating and fear of passthrough. Also, we include two financial variables (one price and one quantity variable) that may indicate bubbles and overheating to test for leaning against the wind behavior: the change in stock market prices and the growth in bank credit to the private sector. Using real-time data for a world panel of monthly data extending from 1994 through 2011 and comprising 28 advanced and emerging economies (comprising approximately 80% of the world's 2011 GDP), we use a dynamic error-correction panel data model: the pooled mean group model, allowing for both short and long-term effects of all variables.

Overall, we find that CB reacts to changes in exchange rate and credit flows either in the short and long-term, reflecting a "Fear of Floating" and "Leaning Against the Wind" in a quantitative variable behavior. Also, we find that the industrial countries cares about stock market return and exchange rate in the long-term, while the emerging economies cares about credit flows and exchange rate either in the long and short-term. Finally, we find that inflation-targeting countries take into account exchange rate and credit flows changes either in the long and short-term. All these results are robust to the presence of outliers.

This results contribute to the actual discussion about how monetary policy should be conducted after the financial crisis (Mishkin, 2011), by showing how monetary policy in the world was conducted in the last two decades.

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Figure 1

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

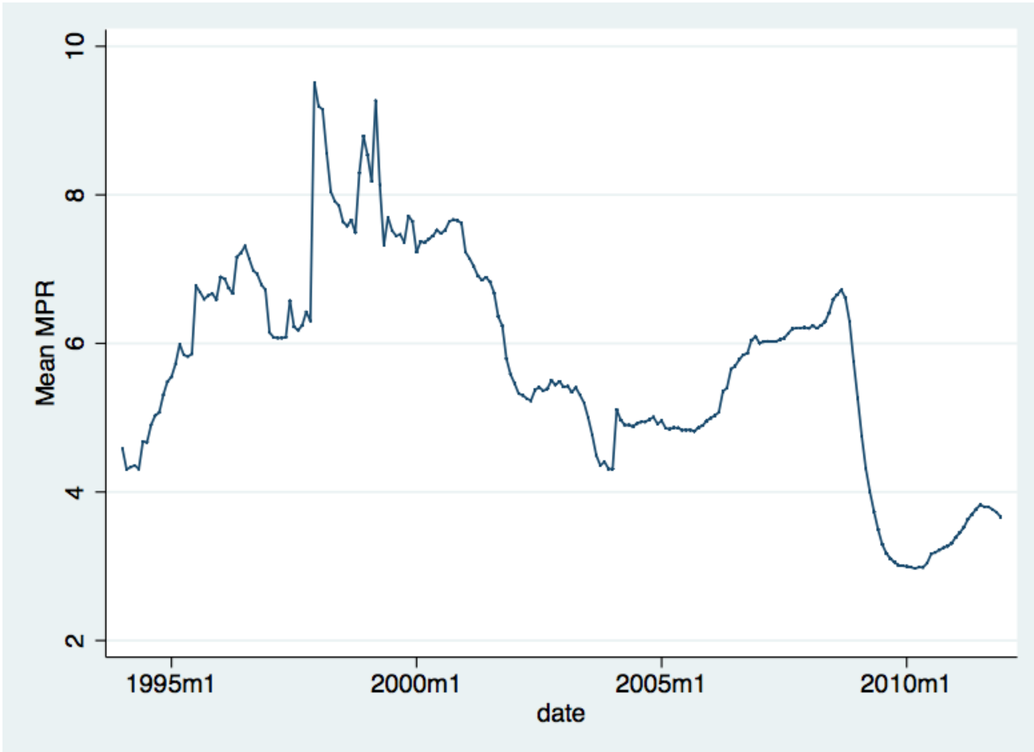

Table 1

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

Variable	Mean	Median	Standard Deviation	Max.	Min.
mpr	5.45%	4.75%	4.33%	42.00%	0.00%
Inflation	3.29%	2.75%	4.51%	33.80%	-17.88%
Unemployment	7.49%	6.67%	4.66%	31.20%	0.47%
Inflation Forec.	3.29%	2.68%	2.34%	31.23%	-1.09%
GDP growth Forec.	3.19%	3.04%	2.03%	10.89%	-7.61%
Exchange Rate Dev.	0.13%	-0.24%	6.82%	71.86%	-35.18%
Stock Market Return	2.72%	2.90%	12.56%	100.73%	-54.68%
Credit Flow	2.67%	2.40%	3.07%	28.84%	-17.74%

Table 3

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

	mpr_t	$Inflation_{t-3,t-1}$	$Unemp._{t-4,t-2}$	Inflation $Forec._{t,t+11}$	GDP growth $Forec._{t,t+11}$	$GER._{t-3,t-1}$	$GCF_{t-3,t-1}$
mpr_t	1						
$Inflation_{t-3,t-1}$	**0.42**	1					
$Unemp._{t-4,t-2}$	**0.37**	**0.16**	1				
Inflation $Forec._{t,t+11}$	**0.75**	**0.56**	**0.36**	1			
GDP growth $Forec._{t,t+11}$	**0.27**	**0.20**	0.04	**0.32**	1		
$GER._{t-3,t-1}$	**0.11**	**0.05**	0.03	**0.09**	**-0.05**	1	
$GCF_{t-3,t-1}$	**0.41**	**0.21**	0.06	**0.37**	**0.39**	**0.15**	1
$SMR_{t-3,t-1}$	0.01	0.03	**0.09**	0.02	**0.06**	**-0.17**	**-0.06**

Notes: Correlations statistically significant at 1% in bold.

Table 4

Bi-variate Correlations, Industrial Countries and Emerging Market Economies, 1994.m1-2011.m12

	mpr_t	$Inflation_{t-3,t-1}$	$Unemp._{t-4,t-2}$	Inflation $Forec._{t,t+11}$	GDP growth $Forec._{t,t+11}$	$GER._{t-3,t-1}$	$GCF_{t-3,t-1}$	$SMR_{t-3,t-1}$
mpr_t	1	**0.33**	**0.26**	**0.61**	**-0.07**	**0.16**	**0.28**	-0.06
$Inflation_{t-3,t-1}$	**0.35**	1	0.04	**0.49**	-0.03	0.06	**0.11**	0.00
$Unemp._{t-4,t-2}$	**0.08**	0.01	1	**0.19**	**-0.26**	0.03	-0.067	0.03
Inflation $Forec._{t,t+11}$	**0.79**	**0.50**	**0.11**	1	**-0.08**	**0.14**	**0.21**	-0.07
GDP growth $Forec._{t,t+11}$	**0.35**	**0.25**	0.03	**0.44**	1	**-0.10**	**0.25**	-0.03
$GER._{t-3,t-1}$	**0.06**	0.03	0.00	0.04	-0.02	1	**0.23**	**-0.37**
$GCF_{t-3,t-1}$	**0.37**	**0.17**	-0.04	**0.30**	**0.35**	**0.07**	1	**-0.18**
$SMR_{t-3,t-1}$	-0.01	-0.01	**0.11**	-0.01	**0.10**	**0.09**	**0.07**4	1

Notes: (1) Lower triangular matrix: Industrial Countries simple correlations; Upper matrix: Emerging Market Economies correlations.
(2)Correlations statistically significant at 1% in bold.

Table 5

Monetary Policy in the World, 1994-2011 and 2002-2011
Pooled Mean Group and Mean Group estimations

	(1)	(2)	(3)	(4)
	PMG		**MG**	
Sample	1994-2011	2002-2011	1994-2011	2002-2011
Variables				
Short-Run				
Δ Inflation$_{t-3,t-1}$	0.013**	0.009***	0.013**	0.011***
	(0.006)	(0.002)	(0.006)	(0.004)
Δ Unemployment$_{t-4,t-2}$	-0.261***	-0.190***	-0.217***	-0.185***
	(0.057)	(0.063)	(0.068)	(0.069)
Δ Inflation Forec.$_{t,t+11}$	0.208***	0.222***	0.200***	0.208***
	(0.034)	(0.045)	(0.036)	(0.043)
Δ GDP growth Forec.$_{t,t+11}$	0.083**	0.135***	0.083**	0.122***
	(0.034)	(0.029)	(0.039)	(0.032)
Long-Run				
γ	-0.028***	-0.017***	-0.068***	-0.087***
	(0.004)	(0.002)	(0.012)	(0.016)
Inflation$_{t-4,t-2}$	0.230***	0.343***	0.127*	0.184*
	(0.050)	(0.088)	(0.071)	(0.111)
Unemployment$_{t-5,t-3}$	-0.278***	-0.425***	0.404	0.203
	(0.091)	(0.151)	(0.518)	(0.640)
Inflation Forec.$_{t-1,t+10}$	1.199***	1.405***	1.436	-0.209
	(0.145)	(0.322)	(0.880)	(0.610)
GDP growth Forec.$_{t-1,t+10}$	1.967***	3.227***	0.004	1.537
	(0.206)	(0.485)	(0.877)	(1.271)
Observations	4,179	3,062	4,179	3,062
Number of Countries	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 6

Extended Taylor Rule in Full Country Sample, 1994-2011
Pooled Mean Group estimations

	(1)	(2)	(3)	(4)
Dependent Variable		Δ mpr_t		
Variables				
Short-Run				
Δ $\text{Inflation}_{t-3,t-1}$	0.008***	0.013**	0.009***	0.011**
	(0.003)	(0.006)	(0.003)	(0.005)
Δ $\text{Unemployment}_{t-4,t-2}$	-0.264***	-0.237***	-0.249***	-0.279***
	(0.064)	(0.056)	(0.061)	(0.058)
Δ GDP growth $\text{Forec.}_{t,t+11}$	0.111***	0.084**	0.119***	0.086**
	(0.028)	(0.033)	(0.029)	(0.033)
Δ Inflation $\text{Forec.}_{t,t+11}$	0.230***	0.207***	0.210***	0.224***
	(0.040)	(0.034)	(0.042)	(0.037)
Δ Exchange Rate $\text{Growth}_{t-3,t-1}$	0.004**	0.006***		
	(0.002)	(0.002)		
Δ Credit $\text{Growth}_{t-3,t-1}$	0.009***		0.011***	
	(0.003)		(0.003)	
Δ Stock Market $\text{Return}_{t-3,t-1}$	-0.001			-0.000
	(0.001)			(0.001)
Long-Run				
γ	-0.024***	-0.026***	-0.024***	-0.030***
	(0.003)	(0.004)	(0.003)	(0.005)
$\text{Inflation}_{t-4,t-2}$	0.258***	0.312***	0.258***	0.183***
	(0.059)	(0.061)	(0.056)	(0.046)
$\text{Unemployment}_{t-5,t-3}$	-0.101	-0.174*	-0.129	-0.210**
	(0.085)	(0.091)	(0.086)	(0.092)
Inflation $\text{Forec.}_{t-1,t+10}$	1.393***	0.973***	1.418***	1.406***
	(0.202)	(0.158)	(0.197)	(0.155)
GDP growth $\text{Forec.}_{t-1,t+10}$	1.993***	2.349***	1.951***	1.666***
	(0.241)	(0.255)	(0.231)	(0.175)
Exchange Rate $\text{Growth}_{t-4,t-2}$	0.065**	0.109***		
	(0.027)	(0.028)		
Credit $\text{Growth}_{t-4,t-2}$	0.196***		0.187***	
	(0.063)		(0.059)	
Stock Market $\text{Return}_{t-4,t-2}$	0.011			-0.003
	(0.013)			(0.010)
Constant	-0.194***	-0.151***	-0.187***	-0.132***
	(0.026)	(0.026)	(0.026)	(0.032)
Observations	3,340	3,963	3,510	4,095
Number of Countries	27	27	28	28

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

Table 7

Extended Taylor Rule in Full Country Sample, 2002-2011
Pooled Mean Group estimations

	(1)	(2)	(3)	(4)
Dependent Variable		Δ mpr$_t$		
Variables				
Short-Run				
Δ Inflation$_{t-3,t-1}$	0.008***	0.008***	0.008***	0.009***
	(0.003)	(0.002)	(0.002)	(0.002)
Δ Unemployment$_{t-4,t-2}$	-0.306***	-0.192***	-0.213***	-0.181***
	(0.068)	(0.069)	(0.064)	(0.063)
Δ Inflation Forec.$_{t,t+11}$	0.242***	0.234***	0.219***	0.220***
	(0.045)	(0.044)	(0.043)	(0.045)
Δ GDP growth Forec.$_{t,t+11}$	0.107***	0.133***	0.144***	0.137***
	(0.027)	(0.027)	(0.030)	(0.029)
Δ Exchange Rate Growth$_{t-3,t-1}$	0.001	0.005***		
	(0.002)	(0.001)		
Δ Credit Growth$_{t-3,t-1}$	0.007**		0.009***	
	(0.003)		(0.003)	
Δ Stock Market Return$_{t-3,t-1}$	-0.001			-0.001
	(0.001)			(0.001)
γ	-0.024***	-0.016***	-0.021***	-0.016***
	(0.004)	(0.002)	(0.002)	(0.002)
Inflation$_{t-4,t-2}$	0.196***	0.398***	0.268***	0.339***
	(0.050)	(0.098)	(0.069)	(0.091)
Unemployment$_{t-5,t-3}$	-0.149	-0.485***	-0.257**	-0.506***
	(0.095)	(0.160)	(0.117)	(0.162)
Inflation Forec.$_{t-1,t+10}$	1.535***	1.145***	1.632***	1.368***
	(0.205)	(0.333)	(0.271)	(0.342)
GDP growth Forec.$_{t-1,t+10}$	1.486***	3.432***	2.450***	3.366***
	(0.187)	(0.517)	(0.336)	(0.514)
Exchange Rate Growth$_{t-4,t-2}$	-0.156***	0.121***		
	(0.032)	(0.041)		
Credit Growth$_{t-4,t-2}$	0.123**		0.158**	
	(0.053)		(0.071)	
Stock Market Return$_{t-4,t-2}$	-0.031**			-0.000
	(0.012)			(0.019)
Constant	-0.152***	-0.146***	-0.189***	-0.149***
	(0.028)	(0.022)	(0.026)	(0.023)
Observations	2,881	2,942	2,997	3,062
Number of Countries	27	27	28	28

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

Table 8

Extended Taylor Rule in Industrial Countries, 1994-2011
Pooled Mean Group estimations

	(1)	(2)	(3)	(4)
Dependent Variable		Δ mpr$_t$		
Variables				
Short-Run				
Δ Inflation$_{t-3,t-1}$	0.006	0.005	0.006	0.004
	(0.005)	(0.005)	(0.005)	(0.005)
Δ Unemployment$_{t-4,t-2}$	-0.135	-0.177*	-0.144	-0.170*
	(0.099)	(0.095)	(0.091)	(0.093)
Δ Inflation Forec.$_{t,t+11}$	0.230***	0.268***	0.201***	0.244***
	(0.046)	(0.061)	(0.056)	(0.059)
Δ GDP growth Forec.$_{t,t+11}$	0.131***	0.135**	0.197***	0.113*
	(0.039)	(0.065)	(0.046)	(0.058)
Δ Exchange Rate Growth$_{t-3,t-1}$	0.002	0.000		
	(0.002)	(0.001)		
Δ Credit Growth$_{t-3,t-1}$	0.003		0.003	
	(0.004)		(0.003)	
Δ Stock Market Return$_{t-3,t-1}$	-0.000			0.001
	(0.002)			(0.001)
Long-Run				
γ	-0.010***	-0.008***	-0.008***	-0.012***
	(0.002)	(0.002)	(0.002)	(0.002)
Inflation$_{t-4,t-2}$	0.242	0.244	0.284	0.161
	(0.183)	(0.204)	(0.213)	(0.143)
Unemployment$_{t-5,t-3}$	-0.596**	-1.119***	-1.201***	-0.949***
	(0.291)	(0.360)	(0.420)	(0.262)
Inflation Forec.$_{t-1,t+10}$	1.561**	1.787**	1.341	1.646***
	(0.736)	(0.794)	(0.842)	(0.586)
GDP growth Forec.$_{t-1,t+10}$	5.636***	7.002***	6.901***	4.589***
	(1.505)	(1.838)	(2.078)	(0.941)
Exchange Rate Growth$_{t-4,t-2}$	0.237**	0.238**		
	(0.096)	(0.099)		
Credit Growth$_{t-4,t-2}$	0.329		0.295	
	(0.247)		(0.269)	
Stock Market Return$_{t-4,t-2}$	0.262***			0.218***
	(0.086)			(0.058)
Constant	-0.127***	-0.113***	-0.097***	-0.092***
	(0.021)	(0.022)	(0.018)	(0.015)
Observations	2,000	2,401	2,170	2,563
Number of Countries	13	13	14	14

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

Table 9

Extended Taylor Rule in Emerging Economies, 1994-2011
Pooled Mean Group estimations

	(1)	(2)	(3)	(4)
Dependent Variable		Δ mpr$_t$		
Variables				
Short-Run				
Δ Inflation$_{t-3,t-1}$	0.010***	0.019*	0.010***	0.016**
	(0.003)	(0.011)	(0.004)	(0.008)
Δ Unemployment$_{t-4,t-2}$	-0.342***	-0.287***	-0.328***	-0.295***
	(0.115)	(0.096)	(0.111)	(0.099)
Δ Inflation Forec.$_{t,t+11}$	0.218***	0.157***	0.221***	0.196***
	(0.070)	(0.036)	(0.068)	(0.049)
Δ GDP growth Forec.$_{t,t+11}$	0.058	0.035	0.047	0.038
	(0.036)	(0.034)	(0.035)	(0.035)
Δ Exchange Rate Growth$_{t-3,t-1}$	0.004	0.010***		
	(0.003)	(0.003)		
Δ Credit Growth$_{t-3,t-1}$	0.014***		0.018***	
	(0.005)		(0.005)	
Δ Stock Market Return$_{t-3,t-1}$	-0.002			-0.001
	(0.001)			(0.002)
Long-Run				
γ	-0.046***	-0.053***	-0.046***	-0.052***
	(0.009)	(0.011)	(0.009)	(0.011)
Inflation$_{t-4,t-2}$	0.172***	0.179***	0.175***	0.138***
	(0.039)	(0.036)	(0.039)	(0.038)
Unemployment$_{t-5,t-3}$	0.023	-0.151*	0.014	-0.043
	(0.052)	(0.079)	(0.052)	(0.092)
Inflation Forec.$_{t-1,t+10}$	1.221***	1.070***	1.328***	1.171***
	(0.144)	(0.112)	(0.142)	(0.134)
GDP growth Forec.$_{t-1,t+10}$	0.969***	0.995***	0.958***	0.987***
	(0.113)	(0.107)	(0.111)	(0.113)
Exchange Rate Growth$_{t-4,t-2}$	-0.020	0.044*		
	(0.022)	(0.023)		
Credit Growth$_{t-4,t-2}$	0.029		0.089**	
	(0.040)		(0.036)	
Stock Market Return$_{t-4,t-2}$	-0.032***			-0.033***
	(0.010)			(0.009)
Constant	-0.221***	-0.073	-0.254***	-0.117
	(0.046)	(0.081)	(0.050)	(0.083)
Observations	1,340	1,562	1,340	1,532
Number of Countries	14	14	14	14

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

Table 10

Extended Taylor Rule in Inflation-Targeting Countries, 1994-2011
Pooled Mean Group estimations

	(1)	(2)	(3)	(4)
Dependent Variable		Δ mpr_t		
Variables				
Short-Run				
Δ $\text{Inflation}_{t-3,t-1}$	0.011***	0.015***	0.012***	0.016***
	(0.004)	(0.005)	(0.004)	(0.005)
Δ $\text{Unemployment}_{t-4,t-2}$	-0.278***	-0.273***	-0.267***	-0.275***
	(0.082)	(0.081)	(0.079)	(0.074)
Δ $\text{Inflation Forec.}_{t,t+11}$	0.237***	0.207***	0.227***	0.217***
	(0.049)	(0.034)	(0.048)	(0.036)
Δ $\text{GDP growth Forec.}_{t,t+11}$	0.117***	0.111***	0.115***	0.107***
	(0.030)	(0.028)	(0.031)	(0.031)
Δ $\text{Exchange Rate Growth}_{t-3,t-1}$	0.003	0.005***		
	(0.002)	(0.002)		
Δ $\text{Credit Growth}_{t-3,t-1}$	0.011***		0.012***	
	(0.003)		(0.004)	
Δ $\text{Stock Market Return}_{t-3,t-1}$	-0.001			-0.002***
	(0.001)			(0.001)
Long-Run				
γ	-0.017***	-0.018***	-0.017***	-0.017***
	(0.002)	(0.002)	(0.002)	(0.002)
$\text{Inflation}_{t-4,t-2}$	0.495***	0.628***	0.549***	0.597***
	(0.115)	(0.122)	(0.120)	(0.124)
$\text{Unemployment}_{t-5,t-3}$	-0.087	-0.095	-0.152	-0.144
	(0.160)	(0.142)	(0.177)	(0.177)
$\text{Inflation Forec.}_{t-1,t+10}$	1.434***	0.438	1.397***	0.830***
	(0.332)	(0.271)	(0.336)	(0.307)
$\text{GDP growth Forec.}_{t-1,t+10}$	3.212***	3.516***	3.330***	3.438***
	(0.518)	(0.521)	(0.541)	(0.543)
$\text{Exchange Rate Growth}_{t-4,t-2}$	0.148***	0.182***		
	(0.048)	(0.047)		
$\text{Credit Growth}_{t-4,t-2}$	0.357***		0.321***	
	(0.111)		(0.106)	
$\text{Stock Market Return}_{t-4,t-2}$	0.015			-0.005
	(0.023)			(0.021)
Constant	-0.243***	-0.188***	-0.240***	-0.198***
	(0.030)	(0.022)	(0.029)	(0.024)
Observations	2,432	2,678	2,457	2,626
Number of Countries	19	19	20	20

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

Table 11

Extended Taylor Rule in Different Country Samples Correcting for Outliers, 1994-2011
Pooled Mean Group estimations

	(1) All Countries	(2) Industrial Countries	(3) Emerging Economies	(4) Inflation Targeting Countries
Dependent Variable		Δ mpr$_t$		
Variables				
Short-Run				
Δ Inflation$_{t-3,t-1}$	0.008***	0.006	0.010***	0.011***
	(0.003)	(0.005)	(0.003)	(0.004)
Δ Unemployment$_{t-4,t-2}$	-0.262***	-0.131	-0.332***	-0.285***
	(0.062)	(0.100)	(0.106)	(0.079)
Δ Inflation Forec.$_{t,t+11}$	0.225***	0.228***	0.213***	0.232***
	(0.040)	(0.047)	(0.069)	(0.048)
Δ GDP growth Forec.$_{t,t+11}$	0.114***	0.132***	0.065*	0.122***
	(0.028)	(0.040)	(0.036)	(0.030)
Δ Exchange Rate Growth$_{t-3,t-1}$	0.000	0.001	-0.002	0.002
	(0.003)	(0.003)	(0.005)	(0.003)
Δ Credit Growth$_{t-3,t-1}$	0.009***	0.002	0.015***	0.011***
	(0.003)	(0.004)	(0.005)	(0.004)
Δ Stock Market Return$_{t-3,t-1}$	-0.001	-0.000	-0.002*	-0.002*
	(0.001)	(0.002)	(0.001)	(0.001)
Long-Run				
γ	-0.025***	-0.010***	-0.045***	-0.019***
	(0.003)	(0.002)	(0.009)	(0.002)
Inflation$_{t-4,t-2}$	0.243***	0.224	0.172***	0.425***
	(0.055)	(0.182)	(0.039)	(0.098)
Unemployment$_{t-5,t-3}$	-0.082	-0.496*	0.032	-0.037
	(0.083)	(0.293)	(0.053)	(0.150)
Inflation Forec.$_{t-1,t+10}$	1.546***	1.617**	1.353***	1.602***
	(0.200)	(0.752)	(0.147)	(0.307)
GDP growth Forec.$_{t-1,t+10}$	1.873***	5.574***	0.982***	2.834***
	(0.223)	(1.521)	(0.116)	(0.436)
Exchange Rate Growth$_{t-4,t-2}$	0.058**	0.235**	-0.025	0.135***
	(0.028)	(0.100)	(0.025)	(0.047)
Credit Growth$_{t-4,t-2}$	0.226***	0.390	0.057	0.388***
	(0.064)	(0.269)	(0.041)	(0.107)
Stock Market Return$_{t-4,t-2}$	0.021	0.270***	-0.022**	0.027
	(0.013)	(0.091)	(0.010)	(0.021)
Constant	-0.212***	-0.134***	-0.258***	-0.264***
	(0.029)	(0.022)	(0.051)	(0.034)
Observations	3,325	1,992	1,333	2,423
Number of Countries	27	13	14	19

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