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Nonlinear impact of the conventional monetary policy: A cross-country evidence [☆]

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ABSTRACT

The possibility of non-linear responses to conventional monetary policy interventions has been a subject of ongoing research for a considerable period. However, the existing body of literature largely concentrates on analyzing individual economies or investigates only specific facets of these non-linearities. This paper aims to contribute to the literature and study the nonlinear impact of the conventional monetary policy, in two dimensions: direction and current monetary condition. This is the monetary policy effects depend on the monetary conditions and shock direction. Using a sample of both advanced and emerging economies, we find consistent evidence of asymmetric effectiveness of monetary policy. Initial movements of the policy rate are expected to have the largest effects, in contrast to the following movements in the same direction. Thus, the effectiveness of monetary policy wanes as the monetary stance tightens (i.e., as the policy interest rate rises). Conversely, the efficacy of expansionary monetary policy weakens as the monetary stance loosens (i.e., as the policy interest rate approaches its lower bound).

0. Introduction

We have seen abrupt changes in monetary policy positions around the world over the last few decades. Recently, following the Covid-19 shock, central banks were forced to reduce policy interest rates abruptly and to historically low levels, to the point where lower bound interest rate limits became binding in some countries. In the post-pandemic period, a persistent rise in inflation as a result of global supply shocks led central banks to normalize their policy stance by beginning to raise policy interest rates at a faster pace to high historical levels.

When the policy interest rate is significantly above normal levels or close to its lower bound, concerns about the effectiveness of the conventional monetary policy are raised. At elevated interest rate levels, the marginal impact of further increases diminishes. Conversely, approaching the lower bound renders the policy rate itself constrained, hindering its ability to stimulate the economy. These contrasting monetary policy stances (or prevailing monetary conditions) motivate the study of potential nonlinearities in the transmission mechanism of monetary policy on the economy.

In this paper we examine the evidence of any nonlinear impact that the policy interest rate might have on economic and financial activity. First, to capture the impact of the monetary policy, we focus on its impact on the GDP and credit cycle. Later, as a robustness exercise, we focus on the GDP and credit growth.

[☆] The opinions expressed in this working paper correspond solely to those of the authors.

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In particular, we seek to determine if the impact of the monetary policy depends on the current stance of the monetary policy (or current monetary conditions). We propose several measures for it, such as the policy interest rate level, the inflation level, the deviations of the policy rate or inflation from its average over time, and the inflation deviation from its target.

To do so, we develop a simple nonlinear empirical model and estimate it with cross-country panel data. We focus on the 2004–2019 period, to avoid the pandemic period, where the economy faced several shocks and the monetary and fiscal authorities implemented several conventional and unconventional policy measures.

We find robust evidence of a nonlinear impact of the monetary policy associated with the monetary conditions in two dimensions of the shock: direction and its dependence on the monetary conditions.¹ The effectiveness of monetary policy is asymmetric. Initial movements of the policy rate are expected to have the largest effects, in contrast to the following movements in the same direction. This holds for all our monetary conditions measures. Our result show that the tighter monetary conditions (e.g., when the policy rate is at very high levels), the less effective the impact of a contractionary monetary policy shock is, than when the monetary conditions are eased (e.g., when the policy rate is low). In other words, the monetary authority requires a stronger policy rate increment to have the same impact as any previous increment. Similarly, the more accommodative monetary conditions (e.g., when the policy rate is close to its lower bound), the less effective an expansionary monetary policy is than when monetary conditions are normal (e.g., when the policy rate is at mid-levels).

We perform different robustness exercises: considering only inflation-targeting countries, splitting our sample by country income level and by regions, using nominal instead of real GDP, using different proxies of monetary conditions and monetary policy shock, and using different time-series filters.

The rest of this document is organized as follows: Section 1 presents the literature review. Section 2 describes the data and presents the empirical model, and we provide a preliminary assessment of the nonlinear impact of the monetary policy (MP). Section 3 reports the regression results. In Section 4 we develop the robustness exercises. Finally, Section 5 concludes.

1. Literature review

This paper is related to the empirical literature that studies the nonlinear impact of monetary policy. In terms of methodology, this work is also related to empirical literature that studies the cycles of key real and financial variables.

One group of papers is related to the nonlinear impact of the conventional monetary policy, or policy interest rate, on real activity as GDP. For example, [Kim et al. \(2005\)](#) find evidence of nonlinearities in the US monetary policy rule up to 1979. They find asymmetries in the reaction to inflation deviations. This partially captures the nonlinearity. Indeed, the interaction between inflation deviations and output gaps characterizes the nonlinear policy rule.

In addition, [Barnichon and Matthes \(2015\)](#) propose a nonlinear generalization of the recursive approach (i.e. SVAR approach) to identify the effects of policy shocks. Using US data they find evidence of nonlinear effects of the monetary policy in two dimensions: the sign of the shocks (asymmetric effects) and the shock size. Regarding the latter, they claim that while expansionary shocks are clearly neutral, large expansionary shocks may have some positive effect on output.

Recently, [Saldías \(2017\)](#) in a Bayesian TVAR model and using monthly data for the 1984–2014 period for four advanced economies (USA, UK, Canada, and Australia) find that the effects on output growth of monetary policy shocks are stronger during normal times (i.e., when the financial system is functioning well); while when the financial sector is stressed, the conventional monetary policy is less effective. This suggests the importance of “leaning against the wind policies”. Similarly, [Alpanda et al. \(2021\)](#) employ state-dependent local projection methods to investigate the influence of cyclical fluctuations in economic activity, credit markets, and interest rates on the transmission mechanism of monetary policy. They find that economic downturns, low debt, and high rates mute monetary policy effects.

In contrast to the previous literature: First, we aim to capture the nonlinearity in a simple nonlinear specification with classical techniques such as the OLS and the [Arellano and Bond \(1991\)](#) methodology. Second, in addition to the GDP growth or credit growth, we focus on the cycle component of GDP and credit to measure the impact of the monetary policy shock. Finally, we focus on all the countries.

In a quantile regression study, [Miles and Schreyer \(2014\)](#) find that four Latin American countries (Brazil, Chile, Mexico and Peru) display nonlinearities, when estimating the Taylor rule. The quantiles are defined by the dependent variable, the interest rate. For Chile, Mexico and Peru, the response of the interest rate to inflation is stronger the higher the level (quartile) of the policy interest rate. For Brazil, this is not true. Clearly, this result suggests, that for a high-interest rate, an increase in the policy rate becomes less effective, so a stronger increase in the policy rate is required for the same increase in inflation, compared to a state of nature with a low-interest rate level.

In contrast to [Miles and Schreyer \(2014\)](#), we do not estimate the Taylor rule, but develop a nonlinear model to capture the impact of the policy rate on real and financial activity. In addition, to measure the nonlinear impact of the shock conditional to the monetary conditions, we also focus on any asymmetric effect. This is, in addition, to distinguish between high and low levels of the policy rate, we distinguish the direction of the policy rate.

Another group of papers is those related to the nonlinear impact of the conventional or unconventional monetary policy, or policy interest rate, on risk-taking. [Brana et al. \(2019\)](#) find for the 2000–2015 period in Europe, that a low policy rate increases

¹ In contrast to [Barnichon and Matthes \(2015\)](#) instead of focusing on the size dimension for the analysis of nonlinearity, we focus on the effects conditional to the current monetary conditions.

bank risk-taking. And the effects of an unconventional monetary policy have a stronger impact on bank risk-taking when the interest rate is below a certain threshold. Recently [Haiwei and Chengqi \(2023\)](#) finds evidence of a nonlinear impact of monetary policy on bank risk-taking in China. When the interest rate is below a threshold value (that is defined as a negative deviation of the policy rate of -199 basis points from the Taylor rule interest rate), the relationship is negative; however, above that threshold value, there is a positive relationship. This is, during the 2008–2010 financial crisis, the expansionary monetary policy had a negative impact.

In contrast to the previous literature, we do not use thresholds to capture the nonlinearity, instead the response of the policy rates depends continuously on the level of the policy rate.

2. Data and model

2.1. Data

We use country-level data from the International Financial Statistics from the IMF. In particular, we use information of real and nominal GDP, nominal credit,² consumer price index (CPI) and policy rates. GDP is available at a quarterly frequency. Credit, CPI and policy rates are available at a monthly frequency. Also, we use information regarding countries' inflation targets from Central Bank News.³

With this information, we are able to compute business cycle indicators used in the regression analysis: credit and GDP cycles, and the annual GDP and credit growth, and indicators of monetary conditions. The time period analyzed spans from January 2004 to December 2019. This is to include periods with central banks having the short-term interest rates as their main tool to perform monetary policy (and the inflation targeting as the monetary policy framework) and to avoid the Covid-19 period, which was exposed to several and large shocks.

[Tables 1 and 2](#) report the descriptive statistics of our variables for country-quarter and country-month observations, respectively. At quarterly frequency, [Table 1](#) reports both the (real and nominal, RGDP and GDPC) GDP cycle and the nominal credit cycle (CREC). Both are computed using the typical (two-sided) HP filter.⁴ This represents the log deviation of the variable from its long-term value. As expected, in all cases the means are close to zero, and the volatility is relatively higher for the credit cycle. This latter is consistent with the literature that reports a relatively more volatile financial cycle than the real business cycle (see, e.g., [Claessens et al. \(2012\)](#) and [Schüler et al. \(2020\)](#)). As a robustness exercise, we compute the real GDP cycle using the one-sided HP filter (RGDPC1S).⁵ In this case, the mean of the one-sided real GDP cycle is much closer to zero and its volatility is similar to that of the two-sided real GDP cycle.

Regarding our measure of monetary policy surprise, according to [Table 1](#) the mean of the quarterly absolute increase of the policy interest rate (ΔMP), is closer to zero, as expected; and its volatility is 0,56%.⁶ When considering only positive increments ($\Delta MP > 0$), the mean yields 0,52% and the volatility is 0,46%; while considering only negative movements ($\Delta MP < 0$), the mean is $-0,68\%$ and the volatility is 0,61%. Also, there are more null movements, followed by negative movements. It is worth noting that the number of observations is large enough to justify a specification with a dummy variable for positive or negative changes. As a robustness exercise, we perform the same analysis but with a measure of monetary policy shock from [Choi et al. \(2024\)](#). Similarly, the mean is virtually zero, and in this case, there is a larger number of positive and negative values to evaluate any asymmetric impact.

Regarding our measures of monetary conditions, the average policy rate (MP) is 5,0% with a volatility of 4,4%. The mean of the policy rate deviation from its average over time (MP^{dev}), is $-0,11\%$ with a volatility of 2,69%. The average inflation is 3,80%. The mean of the inflation deviation from its average is $-0,19\%$ with a volatility of 2,56%. Finally, the mean and volatility of the inflation deviation from the inflation target are 0,67% and 2,84%, respectively. The table also reveals that our chosen proxies for monetary conditions exhibit a noteworthy degree of variation. This characteristic is crucial, as it enables us to utilize these measures as conditional variables within our analysis.

Other indicators that allow us to capture any impact of the monetary policy are the GDP and credit growth. In this case, the annual real GDP growth (RGDPG) has a mean of 3,22% and a volatility of 2,73%. The annual nominal GDP growth (GDPG) has a mean of 7,9% and a relatively larger volatility of 6,18%.⁷

[Table 2](#) reports the variables built at monthly frequency. The annual nominal credit growth (CREG) has a mean of 13,39% and volatility of 13,43%. The policy rate (MP) has a mean of 6,43% and a volatility of 5,25%. The monthly absolute variation of the policy rate as a mean close to zero, $-0,03\%$, and a volatility of 0,34%. This table also reports the policy rate changes, conditional on the direction of the change. For positive changes we have a mean of 0,5% while for negative changes a mean relatively higher in

² Credit is defined as credit to private sector from other depository corporations in units of domestic currency. Nominal GDP is in units of domestic currency.

³ The data is available for 77 countries in <http://www.centralbanknews.info/p/inflation-targets.html>. To account for the modifications of the inflation targets across time we use a database provided for Marco Vega, who built it using the IMF report "Annual Report on Exchange Arrangements and Exchange Restrictions", <https://www.imf.org/en/Publications/Annual-Report-on-Exchange-Arrangements-and-Exchange-Restrictions/Issues/2022/07/19/Annual-Report-on-Exchange-Arrangements-and-Exchange-Restrictions-2021-465689>.

⁴ We set the value of the smooth parameter to 1600 (default value).

⁵ We use the Stata module of [Ohanian \(2019\)](#). It implements the popular two-sided version as well as the one-sided version of the HP filter. The smooth parameter value is set to 1600.

⁶ Notice that for quarterly frequency, we consider the end-of-the quarter policy rate.

⁷ The annual growths are defined as the change of the log variable across 12 months.

Table 1
Descriptive statistics for country-quarter observations.
Source: International Financial Statistics (IFS), IMF.

Variables	Obs	N	Mean	S.D.	Minimum	Maximum
RGDPC _{it} (%)	2587	52	0,22	1,87	-17,74	17,22
GDPC _{it} (%)	3001	58	0,17	3,16	-26,58	24,10
CREC _{it} (%)	4104	79	-0,03	6,32	-72,37	42,70
RGDPC1S _{it} (%)	2558	52	-0,07	1,89	-8,82	22,44
ΔMP_{it} (%)	2587	52	-0,07	0,56	-3,00	2,75
$\Delta MP_{it} > 0$ (%)	535	48	0,52	0,46	0,00	2,75
$\Delta MP_{it} < 0$ (%)	663	51	-0,68	0,61	-3,00	0,00
MPS _{it} (%)	2187	49	0,00	0,04	-0,20	0,19
MPS _{it} > 0 (%)}	977	48	0,03	0,04	0,00	0,19
MPS _{it} < 0 (%)}	945	48	-0,03	0,04	-0,20	0,00
MP _{it} (%)	2587	52	4,98	4,44	-0,75	50,00
MP _{it}^{dev} (%)}	2502	52	-0,11	2,69	-17,17	14,69
π_{it} (%)	2498	50	3,80	3,44	-3,83	41,69
π_{it}^{dev} (%)	2417	50	-0,19	2,56	-10,36	35,76
π_{it}^{tar} (%)	2018	39	0,67	2,84	-6,28	36,69
RGDPG _{it} (%)	2516	50	3,22	2,73	-8,14	15,30
GDPG _{it} (%)	2824	55	7,90	6,18	-18,57	39,81
CREGDP _{it} (%)	1961	40	67,42	46,63	10,03	246,61
XMGDP _{it} (%)	1961	40	82,52	59,06	18,99	442,62

Own elaboration. N: number of countries. S.D.: Standard deviation. We keep countries with GDP/credit cycle observations greater or equal than 12 (3 years) for the two-sided HP, and greater or equal than 20 (5 years). We omit observations with extreme values: we keep of $-3\% \geq \Delta MP_{it} \leq 3\%$. Similarly, when using the policy stance measure we keep, respectively: $MP_{it} \leq 40\%$; $MP_{it}^{dev} \leq 30\%$; $-5\% \geq \pi_{it} \leq 30\%$; $-15\% \geq \pi_{it}^{dev} \leq 15\%$; $-10\% \geq \pi_{it}^{tar} \leq 20\%$; $-13\% \geq RGDPG_{it} \leq 16\%$ and $-19\% \geq GDPG_{it} \leq 40\%$.

Table 2
Descriptive statistics for country-month observations.
Source: IFS, IMF.

Variables	Obs	N	Mean	S.D.	Minimum	Maximum
CREG _{it} (%)	12 681	80	13,39	13,43	-38,93	89,47
ΔMP_{it} (%)	12 681	80	-0,03	0,34	-3,00	3,00
MP _{it} (%)	12 681	80	6,43	5,25	-0,50	40,00
MP _{it} (%) > 0}	1 040	75	0,50	0,51	0,00	3,00
MP _{it} (%) < 0}	1 420	78	-0,60	0,56	-3,00	0,00

Own elaboration. N: number of countries. S.D.: Standard deviation. We omit observations with extreme values: We keep of $-40 \leq CREG_{it} \leq 95$; $-3\% \leq \Delta MP_{it} \leq 3\%$ and $MP_{it} \leq 40\%$.

absolute terms, -0,6%. The volatility is greater for the latter. At monthly frequency, we are supposed to capture better the short-term movement of the policy interest rate. As in the case of quarterly frequency, the average and the volatility of the negative deviation is larger than the positive deviation.

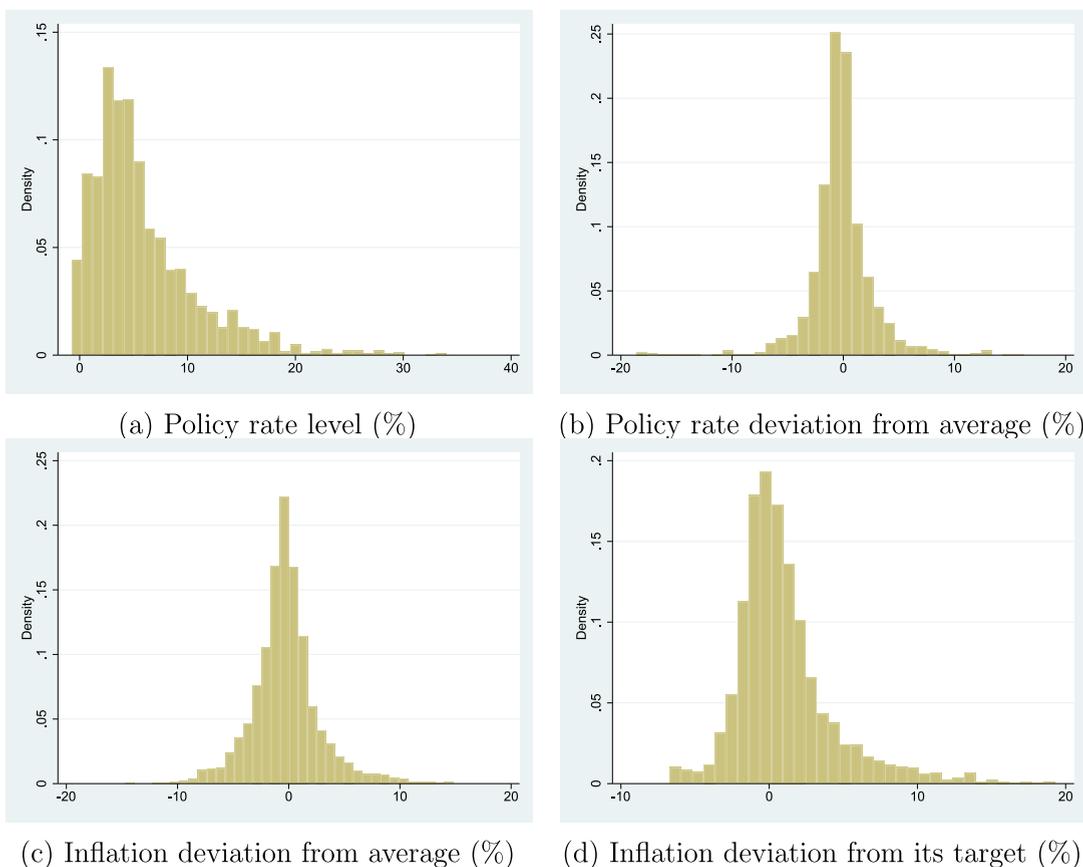
For the quarterly panel data, we perform the Im-Pesaran-Shin unit-root test, with a null hypothesis of all panels contain unit roots, for the GDP and credit cycles, and the monetary policy change. We find in all cases that we reject the null hypothesis. In particular, we propose an Augmented Dickey Fuller (ADF) regression with one lag.

Fig. 1 shows the histogram of some measures of our monetary condition or stance: the policy interest rate level (Fig. 1.a); the deviation of the policy rate and inflation from their corresponding average over time (Fig. 1.b and .c); and the inflation deviation from its inflation target (Fig. 1.d). We observe a large number of policy rate observations between 0 and 10%. And according to panels (b) and (c) of Fig. 1 policy and inflation deviations from average present symmetric distributions.

Fig. 2 shows the histogram of the quarterly change of the policy interest rate, the monetary policy shock (Choi et al., 2024), the annual real GDP and credit growths at the quarterly and monthly frequency, respectively. As expected, we notice that there is more concentration of observation around zero for the policy interest change, and that the monetary policy shock' measure looks more normal than the policy rate change. Also, it seems that distribution of GDP growth is left-skewed, while the credit growth distribution is right-skewed.

2.2. Preliminary assessment and stylized facts of the monetary policy

Before presenting our formal results about the non linearities of monetary policy, in this section we present some stylized facts based on a simple pattern recognition technique to date monetary policy cycles. We consider quarterly information of monetary



It reports the histograms of the (a) policy interest rates, (b) the policy rate deviations from their long-term average, (c) the inflation deviations from their long-term average, and (d) the inflation deviations from their target, for the 2004:Q1 - 2019:Q4 period at quarterly frequency. Source: IFS, IMF. Own elaboration.

Fig. 1. Histograms: monetary condition measures at quarterly frequency. It reports the histograms of the (a) policy interest rates, (b) the policy rate deviations from their long-term average, (c) the inflation deviations from their long-term average, and (d) the inflation deviations from their target, for the 2004:Q1–2019:Q4 period at quarterly frequency. Own elaboration.

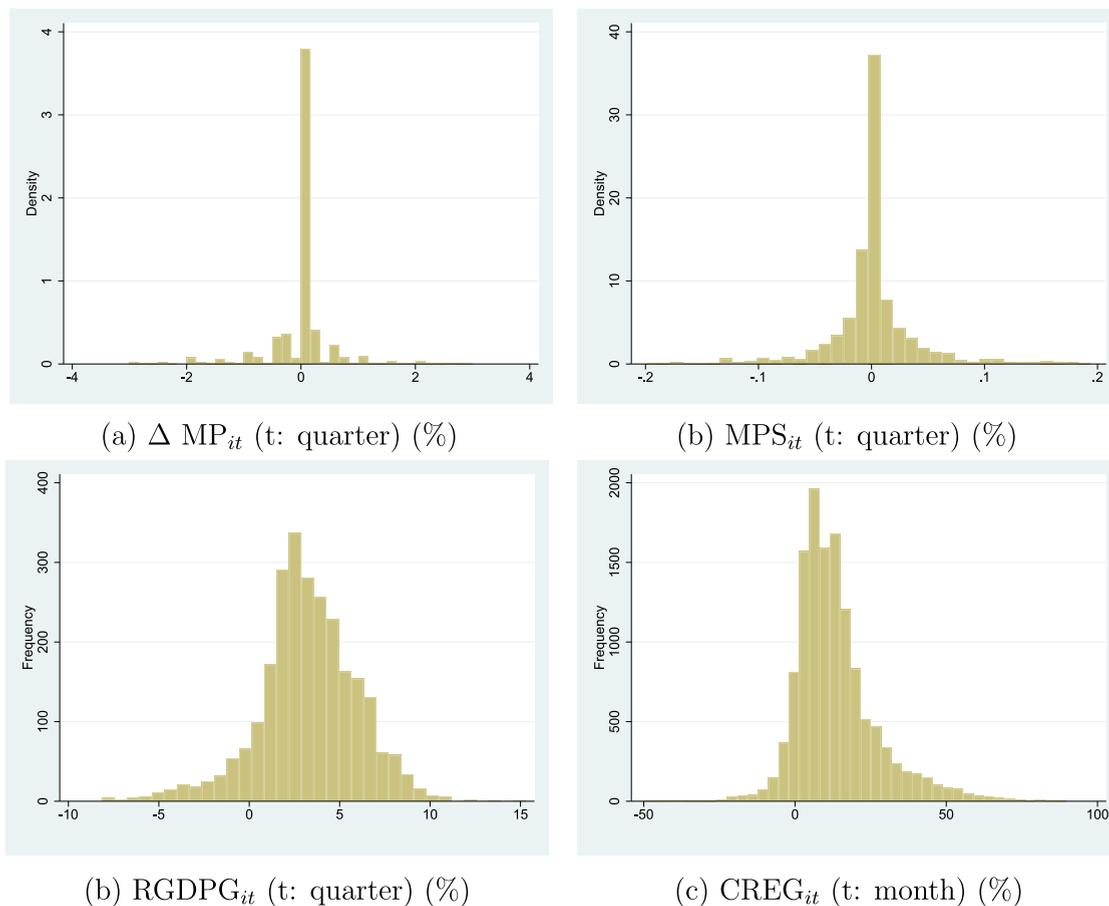
Source: IFS, IMF.

policy rates for our sample. Following the pioneering work of Burns and Mitchell (1946) for each country we think of monetary policy cycles as the sequence of alternating turning points generating expansion/recession phases of some minimum duration. In particular, we modify the turning points identification algorithm of Dupraz et al. (2020) to find dates of monetary policy cycle peaks and troughs. See Appendix A for more details of the algorithm that we use.

Panel (a) of Fig. 3 plots data on the median countries’ MP rates relative to their long-run averages during the 8 quarters before and after a trough, (quarter “0”), after which began a contractionary monetary policy (MP) period. During the 2 quarters preceding this trough, the MP rate was below its long-run average by approximately 1 percentage point, then it rose as MP tightens. After 2 quarters MP rates are above their long run averages.

Panel (b) of Fig. 3 also plots the median policy rate (relative to its long-run average) during periods of MP expansion. Previous to a MP expansion, the median monetary policy rate was above its long run average much by approximately 2 percentage points. After 4 quarters, MP rates are below its median long run average. Thus, during expansion MP rates decline persistently but at a much less steep than rises of MP rates during tightenings. The difference between MP contractions and expansions put under question if nonlinearities of monetary policy rates would be active during periods of extreme changes and during periods of high or low levels of monetary policy rates.

We observe the dynamics of GDP growth and credit growth around the peaks and troughs of MP to determine whether patterns observed in history can help us guide our analysis. Panel (a) and (b) of Fig. 4 show both the median GDP growth and the median credit growth relative to their long run average levels in the quarters around of a MP rate peak or a MP rate trough (quarter “0”).



It reports the histograms of the (a) quarterly change of the policy interest rate, (b) quarterly monetary policy shock, (c) the annual growth of the real GDP, and (d) the annual growth of the nominal credit for the 2004:M1 - 2019:M12 period at quarterly or monthly frequency. Source: IFS, IMF. Own elaboration.

Fig. 2. Histograms: MP surprises' measures and GDP and credit growth. It reports the histograms of the (a) quarterly change of the policy interest rate, (b) quarterly monetary policy shock, (c) the annual growth of the real GDP, and (d) the annual growth of the nominal credit for the 2004:M1-2019:M12 period at quarterly or monthly frequency. Source: IFS, IMF.

This Figure shows that in our sample of countries, the difference in MP rates across phases of monetary policy stance manifests itself in the dynamics of the GDP growth and the credit growth. The pattern followed by the median of GDP differs significantly across MP phases. Following a trough, during a period of MP tightening, GDP remains persistently above its long-run average rate and sharply declines to its long-run level. On the contrary, GDP growth is below trend after a peak, during an expansionary MP phase, but it returns to its long-run trend at a much slower pace after two quarters. This evolution is completely different for credit growth. As shown in panels (c) and (d) credit growth is more stable during MP tightening phases, but with a persistent negative decline during an expansionary MP phase, as it does not revert to its long-run trend.

These basic analyses give some evidence that MP policy actions have different effects across phases of the level of MP rate. Appendix B shows that the differential effects of MP on GDP growth and credit growth are robust to alternative dating of MP cycles.

2.3. Empirical model

To study our research question we propose the following linear model:

$$Y_{it} = \alpha + \beta_0 Y_{it-1} + \beta_1 \Delta MP_{it-k} + \beta_2 D_{it-k} \Delta MP_{it-k} + \beta_3 MC_{it-k-1} \Delta MP_{it-k} + \beta_4 D_{it} MC_{it-k-1} \Delta MP_{it-k} + \epsilon_{it}, \tag{1}$$

Monetary policy rate

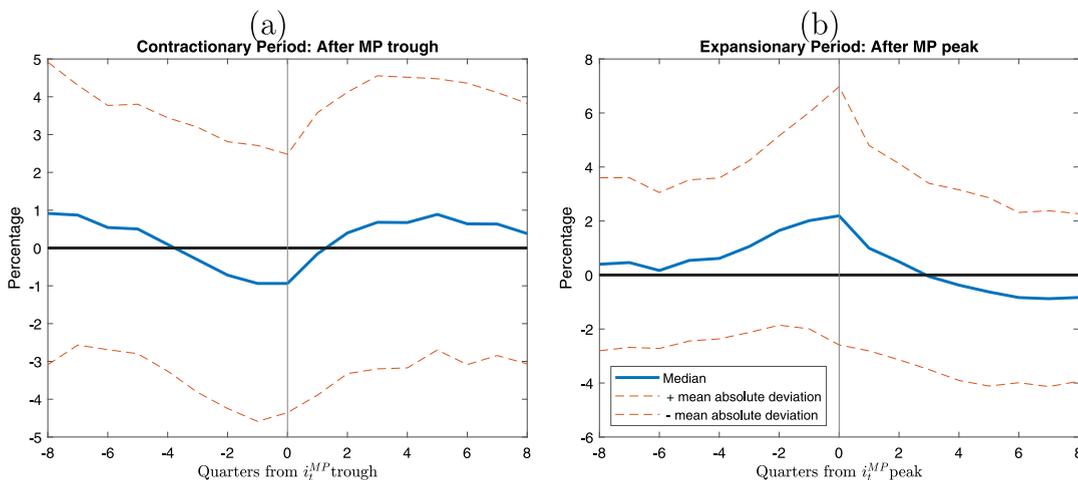


Fig. 3. Monetary policy phases in Latin American countries: Expansionary vs. contractionary periods. Own elaboration. Note: It shows the median of the monetary policy rate relative to its long-run average during the 8 quarters before and after the peak or trough in MP cycle. The bands comprise the median \pm the mean absolute deviation. We identify dates of monetary policy cycle peaks and troughs by looking at turning points for the quarterly policy rate of 50 countries from 2000:Q1–2019:Q4. See Appendix A for more details of the algorithm that we use.

Source: IFS, IMF.

where the i subscript refers to a country, the t subscript refers to a sample quarter and ϵ_{it} is a random error that has a normal distribution,⁸ and k is the lag used for our explanatory variables.⁹ Y_{it} is our endogenous variable. It could be a measure of economic or credit activity. For the former, we use GDP, while for the latter we use credit to private sector. In particular, Y_{it} could be the GDP or credit cycle (measured as the log deviation of the GDP or credit from its long-term value). This latter is computed using the typical two-sided HP filter or the one-sided HP filter. Also Y_{it} could be the GDP or credit annual growth (measured as the deviation of the log of the GDP or credit).

MC_{it} is our measure of monetary conditions or monetary policy stance. For this, we might use the policy interest rate, the inflation rate, or the deviation of any of these with respect to a reference value. This is our measure of the relative ease or tightness of monetary conditions.

ΔMP_{it} is our measure of the “surprise” of the conventional monetary policy, which is the movement of the policy interest rate. D_{it-k} is a dummy variable that takes one if $\Delta MP_{it-k} > 0$; otherwise, it takes zero. This allows for the capture of any asymmetric effect on top of the linear or nonlinear effect of the conventional monetary policy.

We might include country fixed effects, to control for unobservable country characteristics that do not vary across time. For example, country income level could be associated with credit and GDP growth as the economic growth theory suggests. We might include time-fixed effects to control better for common shocks across countries that might correlate with credit and GDP growth, so the results are not driven by synchronized monetary policy shocks but rather by idiosyncratic domestic monetary policy shocks.

Notice that in order to alleviate the endogeneity concerns we include our exogenous variable (monetary policy shock) with some lag $k > 0$. Also, when running the regression with the AR(1) term we use the Arellano and Bond (1991) estimator. And we might include time-varying country characteristics, as controls. It is worth mentioning that in a future research agenda we might include interest rates to disentangle between impacts through the credit supply or credit demand channel. Similarly, we leave the study of MP impact of the GDP’s sub-components, which helps us to better characterize the mechanisms, for further research.

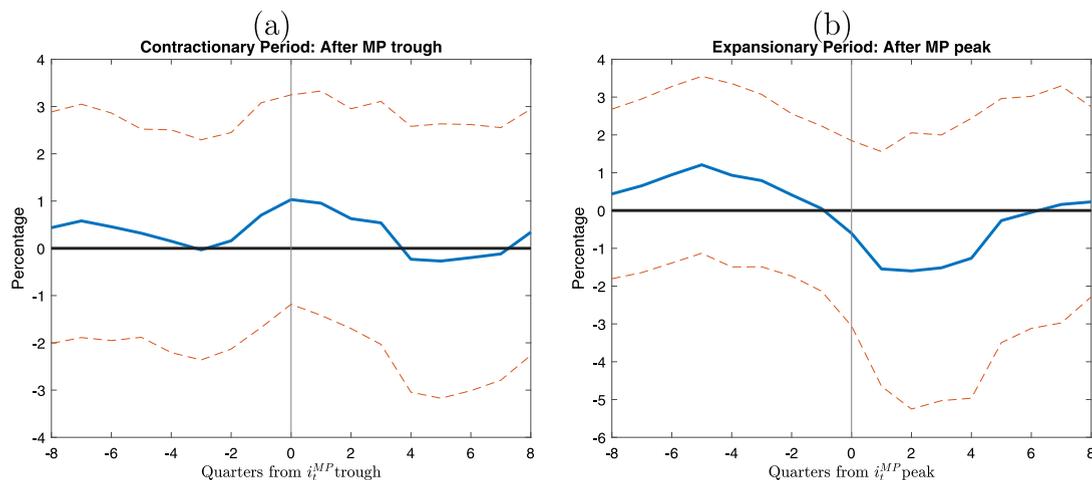
In general, the specification is supported by the literature that suggests that the monetary policy might have an impact on the real economy (see, e.g., Christiano et al. (1999), Bernanke et al. (1999) and Galí and Monacelli (2005)) and by the literature that argues that the monetary policy might have an impact on the credit market (see, e.g., Gertler and Karadi (2015), Kashyap et al. (1993) and Jiménez et al. (2012)).

According to the model the average impact of a unit decrease of the policy interest rate on Y_{it} is $\beta_1 + \beta_3 \overline{MC}$, where \overline{MC} is the average of our measure of monetary conditions or monetary policy stance across time and countries; while the impact of a unit increase of the policy rate is $\beta_1 + \beta_2 + (\beta_3 + \beta_4) \overline{MC}$. And the coefficients β_3 and β_4 capture the linear and nonlinear components of any asymmetric impact. For example, if only β_4 is statistically significant but β_3 is not, the source of any asymmetric effect is due to the nonlinear component.

⁸ The normality assumption for the error is required to perform statistical tests. Otherwise, tests’ results become inaccurate.

⁹ Indeed, we lag one-quarter the exogenous variable to diminish any endogeneity problem. However, we also verify that for $k \leq 1$ the marginal impact is not statistically or economically significant or we stay with the k value that is more statistically significant.

GDP Growth



Credit Growth

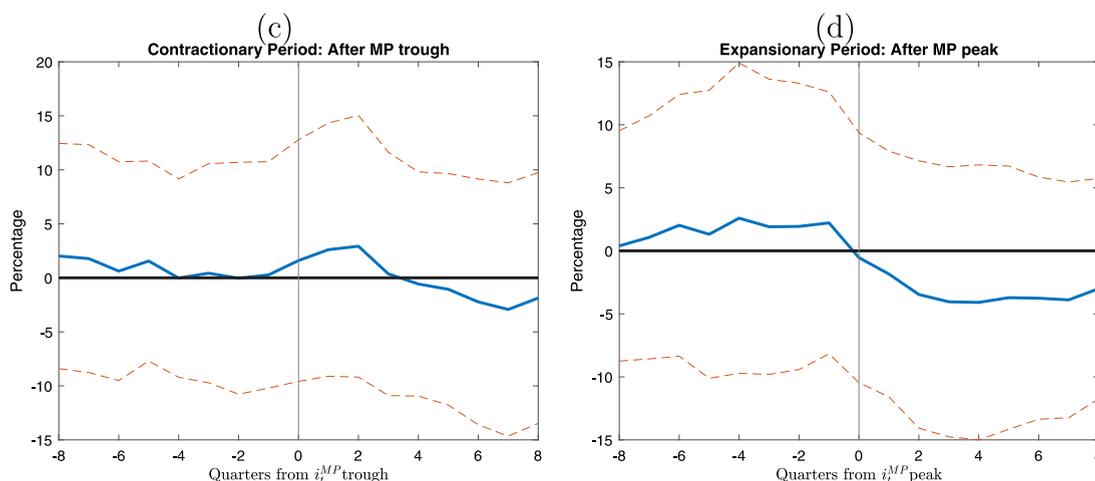


Fig. 4. Macroeconomic dynamics of monetary policy phases in Latin American countries: Expansionary vs. contractionary periods. Own elaboration. Note: It shows the median of the GDP growth and credit growth relative to their long-run average during the 8 quarters before and after the peak or trough in MP cycle. The bands comprise the median \pm the mean absolute deviation. We identify dates of Monetary policy cycle peaks and troughs by looking at turning points for the quarterly policy rates in a sample of 50 countries. We consider quarterly information from 2000:Q1–2019:Q4. See Appendix A for more details of the algorithm that we use.

Source: IFS, IMF.

Notice that if $\beta_3 < 0$, it means that for more restrictive monetary conditions (i.e, the higher policy interest rate or inflation rate, or the larger their deviations from some reference level), the stronger the positive impact on economic or credit activity after a reduction of the policy rate ($\Delta M < 0$). This is, during tough monetary policy conditions, an expansionary monetary policy should be more effective, than for easy monetary conditions. Similarly, it leads to a reduced effectiveness of an expansionary monetary policy when the interest rate is close to its lower bound. Consequently, we argue that we should expect that $\beta_3 < 0$ in order to capture that the effectiveness of the monetary policy might also depend on the “policy space” that the policymaker has to implement it.

Also, if $\beta_4 + \beta_3 > 0$, the higher the tightness of the monetary conditions, the smaller the negative impact on GDP or credit, after an increased policy rate ($\Delta M > 0$). This is, in an economy that has a relatively higher policy rate, (maybe because it has been increasing the interest rate several times before) the additional marginal increase has a weaker expected impact compared to a low-interest rate environment. In that sense, we should expect that $\beta_4 + \beta_3 > 0$.

Consequently, our hypotheses are mainly two: $\beta_3 < 0$ and $\beta_4 + \beta_3 > 0$. Thus, we argue that we should be able to capture a reduced effectiveness of an expansionary monetary policy when the monetary conditions are already easy (and vice versa) and to capture a reduced effectiveness of a contractionary monetary policy when the monetary conditions are already tough (and vice versa). This implicitly implies that β_3 or β_4 are statistically significant, and thus we find evidence of nonlinearity of the monetary

policy shock due to the dependence of monetary conditions, and implies that β_4 is statistically significant, and thus we find evidence of a nonlinear asymmetric effect of the monetary policy shock.

3. Regression results

3.1. Regression results

Table 3 reports the results when working with the real GDP cycle (Panel A) and nominal credit cycle (Panel B) as endogenous variables at quarterly frequency; and with the policy rate as our measure of the monetary conditions.¹⁰ Columns 1 and 2 report a positive and statistically significant relationship between our endogenous variables and the monetary policy surprise. This could be explained by missing explanatory variables. However, the main purpose of the paper is to test the presence and form of the nonlinearity of the monetary policy.

When considering a dummy to capture any asymmetric effect (columns 3 and 4), results are not statistically significant for both cycles. However, we find evidence of nonlinearity related to the policy rate level (our monetary condition measure), in columns 5 and 6. In particular, for both the real GDP and the credit cycles on average the tougher the monetary conditions (i.e., the higher the policy interest rate), the higher the effectiveness of the monetary policy.

More importantly, for both cycles, results in columns 7 and 8 support our hypothesis. This is we find $\beta_3 < 0$ and $\beta_4 + \beta_3 > 0$.¹¹ This is, an expansionary monetary policy becomes less effective when the policy rate is close to its lower bound. And a contractionary monetary policy becomes less effective when the policy rate is already high.¹² For the GDP cycle, results are also robust when including additional controls at bank-time level (credit to GDP ratio, and exports and imports to GDP ratio), see column 1 in Table 16 in Appendix C.

In addition, we see that $|\beta_3| < |\beta_4 + \beta_3|$. This is, the implications of the monetary policy stance (e.g., the policy rate level) on the effectiveness of the monetary policy are relatively more important for policy rate increments than for reductions. In other words, the non-linear impact on the GDP and credit, after a policy rate increase, is economically more significant than after policy rate cuts.

Also, from columns 7–8, we β_2 is statistically significant. As a result, we find evidence of an asymmetric effect of the monetary policy, through both the linear (β_2) and nonlinear channel (β_3).

Table 12 in Appendix C reports the results when splitting the sample by country income level.¹³ In general, we verify our hypothesis, except for lower-middle income (LMI) countries for the real GDP cycle, and for high-income countries for the credit cycle. For the GDP cycle, the results for upper-middle-income countries are more statistically significant. Furthermore, results are robust when using nominal GDP (Panel A), see Table 13 in Appendix C. However, when working with credit cycle at the monthly frequency (Panel B) we find evidence of a non-linear impact but when not splitting the sample by the direction of the policy rate movement (columns 5–6).

Table 14 in Appendix C reports the results when splitting the sample into 7 regions in total for the real GDP cycle as our endogenous variable.¹⁴ In sum, results hold in three regions: Latin America & Caribbean, North America and Sub-Saharan Africa. Results are, in particular, very statistically significant in two regions: Latin America & Caribbean and North America.

Table 4 reports the results when using the annual real GDP growth (columns 1–2), the nominal GDP growth (columns 3–4), and the nominal credit growth (columns 5–6) as our endogenous variable.¹⁵ For the latter, we use monthly frequency data of credit. This time we include an AR(1). When considering the nominal GDP or credit growth (columns 4 and 6), we verify our hypothesis that $\beta_3 < 0$ and $\beta_4 + \beta_3 > 0$. Although this latter does not hold for the nominal credit growth.¹⁶ In contrast to the results with the GDP or credit cycle, β_3 is more economically significant than $\beta_4 + \beta_3$. This is, the non-linearity observed after a policy rate reduction is more economically significant than the one observed after a policy rate increases. In addition, since β_2 is statistically significant, we find evidence of an asymmetric monetary policy shock through the linear component.

In terms of policy implications, results suggest that policy makers using their conventional monetary policy, need to be aware that the initial movements of the policy rate are expected to have the largest effects, in contrast to the following movements in the same direction. Equivalently, policy makers should note that the effectiveness of the conventional monetary policy diminishes the far we are from normal interest rate levels.

¹⁰ Notice that t refers to a sample quarter and that the monetary policy surprise ΔMP_{it} is defined as the absolute increase of the policy rate from quarter $t-1$ to quarter t .

¹¹ Indeed, in a Wald test the F-statistics for the null hypothesis $\beta_4 + \beta_3 = 0$, for real GDP cycle are 15.59 (column 7) and 13.69 (column 8), and for the credit cycle are 16.94 (column 7) and 16.45 (column 8). In all cases, the related p-values are smaller than 1%.

¹² These results are robust if we include time FE, which for example allow us to control for foreign monetary policy shock, see Table 15 in Appendix C.

¹³ We follow the income classification of the World Bank.

¹⁴ We follow the geographic classification of the World Bank.

¹⁵ In all cases, the monetary policy surprise ΔMP_{it} is defined as the last month's absolute change at the end of the quarter t . For example, if t corresponds to 2010Q1 or 2010M3, the ΔMP_{it} corresponds to the monthly increase of the policy rate from 2010M2 to 2010M3. Notice that for the credit growth t refers to a sample month.

¹⁶ Indeed, in a Wald test the F-statistics for the null hypothesis $\beta_4 + \beta_3 = 0$ are 20.75 (column 7) and 3.33 (column 4), 0.14 (column 6), yielding p-values of 0.0%, 6.8% and 71%, respectively.

Table 3
Regression results: GDP and credit cycles.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: $Y = \text{real GDP cycle}$								
ΔMP_{it-1}	0.308*** (0.0839)	0.303*** (0.0829)	0.349*** (0.130)	0.338*** (0.123)	0.453*** (0.123)	0.458*** (0.124)	0.793*** (0.182)	0.792*** (0.182)
$D_{it-1} \Delta MP_{it-1}$			-0.129 (0.163)	-0.111 (0.161)			-0.930** (0.362)	-0.960*** (0.345)
$MP_{it-2} \Delta MP_{it-1}$					-0.00549** (0.00245)	-0.00588** (0.00248)	-0.0126*** (0.00340)	-0.0130*** (0.00346)
$D_{it-1} MP_{it-2} \Delta MP_{it-1}$							0.0475** (0.0230)	0.0518** (0.0215)
Observations	2587	2587	2587	2587	2587	2587	2587	2587
N	52	52	52	52	52	52	52	52
Adj. R-squared	0.032	-0.009	0.033	-0.008	0.036	-0.004	0.048	0.008
F test (ρ -value)	0.000571	0.000602	0.00483	0.00497	9.98e-07	2.12e-07	5.18e-10	1.33e-08
Panel B: $Y = \text{nominal credit cycle}$								
ΔMP_{it-1}	0.638*** (0.149)	0.629*** (0.153)	0.492*** (0.146)	0.443*** (0.142)	0.979*** (0.210)	0.988*** (0.214)	1.010*** (0.269)	0.952*** (0.300)
$D_{it-1} \Delta MP_{it-1}$			0.407 (0.298)	0.504 (0.321)			-0.822 (0.803)	-0.797 (0.835)
$MP_{it-2} \Delta MP_{it-1}$					-0.0143** (0.00576)	-0.0151*** (0.00551)	-0.0160** (0.00679)	-0.0157** (0.00698)
$D_{it-1} MP_{it-2} \Delta MP_{it-1}$							0.0800 (0.0628)	0.0866 (0.0609)
Observations	4104	4104	4104	4104	4104	4104	4104	4104
N	79	79	79	79	79	79	79	79
Adj. R-squared	0.013	-0.003	0.014	-0.002	0.015	-0.001	0.017	-0.000
F test (ρ -value)	5.06e-05	2.62e-05	2.24e-05	1.69e-05	4.11e-08	3.75e-08	1.39e-10	4.75e-10
Country FE	No	Yes	No	Yes	No	Yes	No	Yes
Time FE	No	No	No	No	No	No	No	No

Table reports regression results using information of the full sample (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period. ΔMP_{it} : absolute deviation of the policy interest rate; D_{it} : dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero; and MP_{it} : the policy interest rate level. Standard errors (in parentheses) are clustered at the country level. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

Table 4
Regression results: real GDP and credit growth.

Annual growth:	GDP				Credit	
	Real		Nominal		Nominal	
	(1)	(2)	(3)	(4)	(5)	(6)
Y_{it-1}	0.916*** (0.00469)	0.912*** (0.00448)	0.961*** (0.00381)	0.944*** (0.00368)	0.948*** (0.00388)	0.947*** (0.00352)
ΔMP_{it-1}	0.326*** (0.0390)	0.471*** (0.0705)	0.966*** (0.0645)	1.787*** (0.115)	0.138* (0.0823)	0.427** (0.175)
$D_{it-1} \Delta MP_{it-1}$	-0.439*** (0.0517)	-0.210* (0.114)	-0.670*** (0.0875)	-1.290*** (0.190)	-0.325** (0.135)	-0.577** (0.256)
$MP_{it-4/3} \Delta MP_{it-1}$		-0.0109*** (0.00423)		-0.0595*** (0.000698)		-0.00923** (0.00463)
$D_{it-1} MP_{it-4/3} \Delta MP_{it-1}$		-0.0304*** (0.0101)		0.0309* (0.0172)		0.00553 (0.0111)
Observations	2516	2516	2824	2824	12,681	12,681
N	50	50	55	55	80	80
F test (ρ -value)	0	0	0	0	0	0

Columns 1–4 reports regression results using information of the full sample (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period; while columns 5–6 at monthly frequency for the 2004:M1–2019:M12 period. ΔMP_{it} : absolute deviation of the policy interest rate during the last month of quarter t ; D_{it} : dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero; and MP_{it} : the policy interest rate level. The econometric model for columns 5–6: $Y_{it} = \alpha + \beta_0 Y_{it-1} + \beta_1 \Delta MP_{it-3} + \beta_2 D_{it-3} \Delta MP_{it-3} + \beta_3 MC_{it-4} \Delta MP_{it-3} + \beta_4 D_{it-3} MC_{it-4} \Delta MP_{it-3} + \epsilon_{it}$. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: Generalized Method of Moments (GMM) estimator of Arellano and Bond (1991). This estimation includes country fixed effects.

Table 5
Regression results: Policy rate gap as policy stance.

	All		LMI		UMI		HI	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: $Y = \text{real GDP cycle}$								
ΔMP_{it-1}	1.028*** (0.235)	0.969*** (0.235)	0.467 (0.330)	0.221 (0.342)	1.324*** (0.435)	1.307*** (0.404)	0.681*** (0.222)	0.694*** (0.207)
$D_{it-1} \Delta MP_{it-1}$	-0.659** (0.247)	-0.588** (0.247)	-0.567 (0.403)	-0.363 (0.525)	-1.011** (0.447)	-0.964** (0.417)	-0.365 (0.570)	-0.270 (0.532)
$MP_{it-2}^{dev} \Delta MP_{it-1}$	-0.0995*** (0.0281)	-0.100*** (0.0283)	-0.0603 (0.0369)	-0.00147 (0.0607)	-0.0981* (0.0501)	-0.0948** (0.0417)	-0.0930*** (0.0190)	-0.0970*** (0.0177)
$D_{it-1} MP_{it-2}^{dev} \Delta MP_{it-1}$	0.142*** (0.0343)	0.144*** (0.0335)	0.124 (0.0842)	0.0555 (0.161)	0.132** (0.0545)	0.137** (0.0519)	0.503*** (0.0466)	0.485*** (0.0400)
Observations	2502	2502	213	213	1010	1010	1174	1174
N	52	52	7	7	20	20	22	22
Adj. R-squared	0.069	0.033	0.011	-0.141	0.110	0.102	0.071	0.052
F test (p -value)	3.54e-06	7.53e-06	0.0102	0.897	0.000307	0.00134	8.36e-10	0
Panel B: $Y = \text{nominal credit cycle}$								
ΔMP_{it-1}	0.756*** (0.224)	0.884*** (0.230)	1.139 (0.840)	1.092 (0.885)	0.943*** (0.331)	0.926** (0.355)	-0.285 (0.463)	0.0910 (0.435)
$D_{it-1} \Delta MP_{it-1}$	0.450 (0.306)	0.299 (0.348)	0.0312 (1.012)	-0.0377 (1.086)	0.476 (0.508)	0.504 (0.528)	1.059 (1.398)	0.964 (1.387)
$MP_{it-2}^{dev} \Delta MP_{it-1}$	-0.00544 (0.0148)	-0.00506 (0.0138)	-0.106 (0.197)	-0.134 (0.191)	-0.0205 (0.0400)	-0.00938 (0.0437)	0.114 (0.0779)	0.0337 (0.0686)
$D_{it-1} MP_{it-2}^{dev} \Delta MP_{it-1}$	0.156*** (0.0399)	0.159*** (0.0400)	0.516* (0.255)	0.609** (0.234)	0.183*** (0.0423)	0.173*** (0.0450)	0.573 (0.509)	0.658 (0.505)
Observations	3963	3963	931	931	1559	1559	1044	1044
N	79	79	19	19	29	29	21	21
Adj. R-squared	0.023	0.004	0.028	0.006	0.040	0.029	0.028	-0.006
F test (p -value)	0	0	1.22e-07	1.67e-06	3.46e-07	7.32e-07	0.436	0.186
Country FE	No	Yes	No	Yes	No	Yes	No	Yes
Time FE	No	No	No	No	No	No	No	No

Table reports regression results at quarterly frequency for the 2004:Q1–2019:Q4 period. ΔMP_{it} : absolute deviation of the policy interest rate; D_{it} : dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero; and MP_{it} : the absolute policy interest rate deviation with respect to its average over time. LI: Low Income (no shown since there are zero observations); LMI: Lower Middle Income; UMI: Upper Middle Income; HI: High Income. Standard errors (in parentheses) are clustered at the country level. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

4. Robustness exercises

4.1. Results with others measures of monetary conditions

So far, our proxy of monetary policy condition is the policy rate level. However, it might be argued that a better measure is the distance of the monetary policy rate with respect to a reference value, which could be the long-term interest rate.¹⁷ To have a better proxy for that value we consider the absolute policy interest rate deviation with respect to its average over time. In this case, we find that results are robust, see columns 1–2 in Table 5, when considering the real GDP cycle (Panel A) and the nominal credit cycle (Panel B) as our endogenous variables.

Table 5 also reports that results are, in general, robust when splitting the sample by income level. In contrast to Table 12 (with the policy rate as the measure of monetary conditions), for the case of real GDP cycle (Panel A) results are not only robust for upper-middle income (UMI) countries, but also for high-income (HI) countries.

In Table 6 we perform additional robustness exercises for both the GDP and credit cycles. Columns 1 and 2 report that results are robust when considering only countries with inflation-targeting and the policy rate as our proxy of the monetary conditions. Columns 3–8 report the results when considering more proxies of the monetary conditions: inflation level (columns 3–4), inflation deviation from its long-term average (columns 5–6) and inflation deviation from a target (columns 7–8).

According to Table 6, results are robust for all these proxies. We observe that in the case of the credit cycle, the coefficients associated with the nonlinearity when the policy change is negative are not statistically significant.

4.2. Robustness to filter specification: HP filters (two-sided versus one-sided) and alternative filters

This section presents a comparative analysis of our findings. We revisit the results obtained using the two-sided HP filter (previously presented) and contrast them with those derived from the one-sided HP filter application. Additionally, we benchmark the performance of the HP filter against other established time series filtering techniques employed in the literature.

¹⁷ This can be built with the inflation target and the long-term real natural interest rate, or with its average over time value.

Table 6
Regression results. Robustness.

	MC = MP		MC = π		MC = π^{dev}		MC = π^{tar}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: $Y = \text{real GDP cycle}$								
ΔMP_{it-1}	0.802*** (0.0927)	0.802*** (0.212)	0.705*** (0.0984)	0.705*** (0.215)	0.672*** (0.0771)	0.672*** (0.230)	0.670*** (0.0842)	0.670*** (0.206)
$D_{it-1} \Delta MP_{it-1}$	-0.928*** (0.209)	-0.928* (0.466)	-0.658*** (0.202)	-0.658* (0.374)	-0.376*** (0.121)	-0.376 (0.238)	-0.453*** (0.152)	-0.453 (0.280)
MC $_{it-2} \Delta MP_{it-1}$	-0.0134*** (0.00227)	-0.0134*** (0.00406)	-0.00720 (0.00659)	-0.00720 (0.00693)	-0.0187*** (0.00664)	-0.0187 (0.0205)	-0.0101 (0.00675)	-0.0101 (0.00987)
$D_{it-1} \text{MC}_{it-2} \Delta MP_{it-1}$	0.0468*** (0.0175)	0.0468 (0.0313)	0.0423** (0.0190)	0.0423 (0.0286)	0.0994*** (0.0242)	0.0994** (0.0456)	0.0509** (0.0205)	0.0509 (0.0353)
Observations	2011	2011	2498	2498	2417	2417	2018	2018
N	39	39	50	50	50	50	39	39
Adj. R-squared	0.038	0.038	0.011	0.011	0.015	0.015	0.045	0.045
F test (ρ -value)	0	4.34e-05	0	1.41e-06	0	4.52e-05	0	1.86e-05
Panel B: $Y = \text{nominal credit cycle}$								
ΔMP_{it-1}	1.110*** (0.282)	1.110*** (0.310)	0.906*** (0.255)	0.906*** (0.331)	0.847*** (0.179)	0.847*** (0.217)	0.974*** (0.252)	0.974*** (0.226)
$D_{it-1} \Delta MP_{it-1}$	-0.920* (0.527)	-0.920 (1.031)	-0.489 (0.368)	-0.489 (0.404)	0.381 (0.267)	0.381 (0.356)	-0.108 (0.357)	-0.108 (0.376)
MC $_{it-2} \Delta MP_{it-1}$	-0.0156** (0.00739)	-0.0156* (0.00842)	-0.0152 (0.0174)	-0.0152 (0.0257)	-0.0231 (0.0188)	-0.0231 (0.0341)	-0.0153 (0.0203)	-0.0153 (0.0263)
$D_{it-1} \text{MC}_{it-2} \Delta MP_{it-1}$	0.0773** (0.0368)	0.0773 (0.0842)	0.118*** (0.0280)	0.118*** (0.0306)	0.129*** (0.0295)	0.129*** (0.0398)	0.110*** (0.0316)	0.110*** (0.0368)
Observations	2601	2601	3972	3972	3828	3828	2602	2602
N	49	49	77	77	77	77	49	49
Adj. R-squared	-0.009	-0.009	0.004	0.004	0.000	0.000	-0.018	-0.018
F test (ρ -value)	3.80e-10	3.36e-08	0	2.91e-10	0	7.04e-10	0	0

Table reports regression results with the full sample (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period. Columns 1–2 consider only inflation-targeting countries, MP_{it} : the policy interest rate level. Columns 3–8 report the results when considering more proxies of the monetary conditions: inflation level (columns 3–4), inflation deviation from its long-term average (columns 5–6) and inflation deviation from a target (columns 7–8). ΔMP_{it} : absolute deviation of the policy interest rate; D_{it} : dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero. All regressions include country fixed effects. Standard errors (in parentheses) are clustered at the country level in columns 2, 4, 6 and 8. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

In the baseline results, we compute the cycles using the two-sided Hodrick–Prescott (HP) filter (Hodrick and Prescott, 1997). As a robustness exercise, we perform a similar analysis but using the more recently proposed one-sided HP filter. See Alfaro and Drehmann (2022) for a literature review of the one-sided HP filter, which is also suggested by Basel III framework to compute the credit to GDP gap, BCBS (2010).

Despite its widespread use and popularity, the HP filter is not without limitations and critiques (see Hamilton (2018) and Moura (2022)). In particular, given that the traditional HP-filter is a two-sided, it is not very useful for real time analysis and forecasting. This is where the one-sided HP filter becomes advantageous. It avoids incorporating future values, making it more applicable for real-time scenarios.

Table 7 reports the results when considering the one-sided filter for the GDP cycle and for different measures of the current monetary conditions: policy rate level (column 1), as in column 1 with only IT countries (column 2), policy rate deviation from the long-term average (column 3), as in column 3 with only IT countries (column 4), inflation level (column 5), inflation deviation from its long-term average (column 6), as in column 6 with IT countries (column 7) and inflation deviation from its target (column 8). In general, results are robust in capturing the nonlinear impact of the policy rate after policy rate cuts. This impact is statistically significant when having the policy rate level, inflation level, or inflation deviation from its target as our monetary condition proxy.

In this part of our robustness analysis we consider alternative filters to the HP filter: Band Pass filters and the Butterworth high-pass filter. Each filter makes different assumptions regarding the cycle and trend components of a time series.

The Hodrick and Prescott (1997) filter, which is a high pass filter, considers that the trend is assumed to be stochastic but smooth and uncorrelated with the cycle. The Baxter and King (1999) band-pass filter wipes out variability outside all frequencies in the interval (ω_1, ω_2) that defines the business cycle between 1.5 and 8 years. The Christiano and Fitzgerald (2003) band-pass filter use a non-stationary, asymmetric approximation which is optimal in the sense of making the approximation error as small as possible. Band pass filters are known by having limitation to identification at the beginning and at the end of the sample. Butterworth high-pass filter is very flexible and can eliminate, low frequencies or unit roots without affecting medium frequencies.

Table 8 reports that the results of compute the real GDP cycle for these four different filters: Hodrick and Prescott (1997) filter (columns 1–2), Christiano and Fitzgerald (2003) band-pass filter (columns, 3–4), Baxter and King (1999) band-pass filter (columns 5–6) and Butterworth high-pass filter (columns 7–6) and for two different measures of monetary conditions (the policy interest rate, MP, and its long-term deviation MP^{dev}). The results in this table indicates that our baseline results are robust to filter specification.

Table 7
Regression results: One-sided HP filter.

	MC = MP		MC = MP ^{dev}		MC = π	MC = π ^{dev}		MC = π ^{tar}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y: real GDP cycle								
ΔMP_{it-1}	1.001*** (0.188)	0.873*** (0.194)	0.824*** (0.208)	0.800*** (0.244)	0.908*** (0.151)	0.731*** (0.176)	0.646*** (0.207)	0.683*** (0.164)
$D_{it-1} \Delta MP_{it-1}$	-0.673** (0.322)	-0.565* (0.312)	-0.938*** (0.227)	-0.910*** (0.281)	-0.518* (0.297)	-0.804*** (0.210)	-0.617** (0.254)	-0.498* (0.253)
MC _{it-2} ΔMP_{it-1}	-0.0201*** (0.00417)	-0.0171*** (0.00422)	-0.0444 (0.0368)	-0.0327 (0.0378)	-0.0198*** (0.00514)	-0.00345 (0.0196)	-0.00848 (0.0149)	-0.0177** (0.00699)
$D_{it-1} MC_{it-2} \Delta MP_{it-1}$	-0.0226 (0.0215)	-0.0260 (0.0233)	0.0386 (0.0438)	0.0353 (0.0410)	-0.0360 (0.0296)	-0.0770** (0.0371)	-0.0583 (0.0365)	-0.0498* (0.0292)
Observations	2558	1989	2475	1923	2471	2392	1878	1998
N	52	39	52	39	50	50	38	39
Adj. R-squared	-0.071	-0.017	-0.076	-0.017	-0.090	-0.111	-0.022	0.020
F test (ρ-value)	6.51e-06	0.000925	0.00119	0.00242	8.87e-06	0.000130	0.0132	0.000571

Table reports regression results at quarterly frequency for the 2004:Q1–2019:Q4 period when considering the one-sided filter for the GDP cycle and for different measures of the current monetary conditions: policy rate level (column 1), as column 1 with only IT countries (column 2), policy rate deviation from the average over time (column 3), as in column 3 with only IT countries (column 4), inflation level (column 5), inflation deviation from its average over time (column 6), as in column 6 with IT countries (column 7) and inflation deviation from its inflation target (column 8). MC_{it}: monetary conditions. ΔMP_{it} : absolute deviation of the policy interest rate; D_{it}: dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero. All regressions include country Fixed Effects. N: number of countries. Standard errors (in parentheses) are clustered at the country level. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

Table 8
Regression results. Robustness.

Filter:	Hodrick and Prescott		Christiano and Fitzgerald		Baxter–King		Butterworth	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y = real GDP cycle								
ΔMP_{it-1}	0.792*** (0.182)	0.969*** (0.235)	0.00795*** (0.00163)	0.00922*** (0.00215)	0.00693*** (0.00130)	0.00774*** (0.00106)	0.00733*** (0.00162)	0.00890*** (0.00211)
$D_{it-1} \Delta MP_{it-1}$	-0.960*** (0.345)	-0.588** (0.247)	-0.00943*** (0.00304)	-0.00681*** (0.00226)	-0.00720** (0.00339)	-0.00308* (0.00176)	-0.00885*** (0.00308)	-0.00584*** (0.00215)
MP _{it-2} ΔMP_{it-1}	-0.0130*** (0.00346)		-0.000133*** (3.03e-05)		-0.000116*** (2.70e-05)		-0.000123*** (3.06e-05)	
$D_{it-1} MP_{it-2} \Delta MP_{it-1}$	0.0518** (0.0215)		0.000425** (0.000178)		0.000417* (0.000230)		0.000456** (0.000185)	
MP ^{dev} _{it-2} ΔMP_{it-1}		-0.100*** (0.0283)		-0.000748*** (0.000239)		-0.000740*** (0.000147)		-0.000867*** (0.000252)
$D_{it-1} MP_{it-2}^{dev} \Delta MP_{it-1}$		0.144*** (0.0335)		0.00103*** (0.000264)		0.00119*** (0.000209)		0.00121*** (0.000292)
Observations	2587	2502	2587	2502	2324	2248	2587	2502
N	52	52	52	52	50	50	52	50
Adj. R-squared	0.008	0.033	0.033	0.047	-0.015	0.015	0.025	0.047
F test (ρ-value)	1.33e-08	7.53e-06	1.95e-08	4.93e-07	1.56e-09	0	7.86e-09	4.19e-06

Table reports regression results with the full sample (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period. MP_{it}: the policy interest rate level. MP^{dev}_{it}: the absolute policy interest rate deviation with respect to its average over time. ΔMP_{it} : absolute deviation of the policy interest rate; D_{it}: dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero. All regressions include country fixed effects. Standard errors (in parentheses) are clustered at the country level. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

4.3. An alternative measure of monetary policy shock and a quadratic term

A key challenge in analyzing the role of monetary policy lies in the endogeneity of policy rates. To mitigate this endogeneity concern, in this part we employ a series of identified exogenous monetary policy shocks for each country-year observation in our sample. In particular, we use the estimated series of monetary policy shocks from Choi et al. (2024). Choi et al. (2024) first obtain monetary policy surprises from high-frequency studies; if these estimates are not available for a given country, they proxy the monetary policy shock sequentially based on availability of: the one-day change in swap yields, or bond yields, or based on the expectations of the monetary policy rate reported in surveys, or the residual from a Taylor rule.

As shown in Table 9, given the nature of the series of monetary policy shocks (MPS), our specification considers the contemporaneous impact of the MP shock. As reported in Table 9, our baseline results are robust to endogeneity concerns. Considering the monetary policy shocks of Choi et al. (2024) as our measure of the monetary policy surprise, our previous results

Table 9
Regression results. Robustness — Monetary policy shocks.

	MC = MP		MC = MP ^{dev}		MC = π	MC = π^{dev}		MC = π^{tar}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y = real GDP cycle								
MPS _{it}	1.459 (2.175)	1.680 (2.558)	-0.788 (1.503)	-2.494 (1.633)	-1.558 (1.485)	-0.874 (1.512)	-2.659* (1.611)	-2.128 (1.607)
D _{it} MPS _{it}	-2.594 (3.039)	-4.025 (3.559)	6.748*** (2.165)	7.960*** (2.346)	6.904*** (2.149)	6.385*** (2.208)	7.858*** (2.298)	6.181*** (2.343)
MC _{it-1} MPS _{it}	-0.777** (0.392)	-0.795* (0.456)	0.00252 (0.0111)	0.00446 (0.0111)	0.0621*** (0.00964)	-0.0512*** (0.0175)	-0.0318* (0.0182)	0.0807*** (0.0149)
D _{it} MC _{it-1} MPS _{it}	2.462*** (0.547)	2.319*** (0.630)	0.00812 (0.0132)	0.00855 (0.0135)	-0.00615 (0.0141)	0.174*** (0.0325)	0.162*** (0.0345)	0.0333 (0.0228)
Observations	2187	1738	2145	1703	2132	2090	1648	1726
N	49	38	49	38	49	49	38	38
Adj. R-squared	-0.031	-0.019	-0.018	-0.011	-0.011	-0.018	-0.010	0.025
F test (p-value)	6.20e-08	0.000118	0.000435	0.00182	0	2.07e-09	1.10e-07	0

Table reports regression results with the full sample (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period. The econometric specification is the following: $Y_{it} = \alpha + \beta_1 MPS_{it} + \beta_2 D_{it} MPS_{it} + \beta_3 MC_{it-1} MPS_{it} + \beta_4 D_{it} MC_{it-1} MPS_{it} + \epsilon_{it}$. MPS_{it}: monetary policy shock of Choi et al. (2024). MC_{it}: monetary conditions. We consider different measures of the current monetary conditions: policy rate level (column 1), as column 1 with only IT countries (column 2), policy rate deviation from the average over time (column 3), as in column 3 with only IT countries (column 4), inflation level (column 5), inflation deviation from its average over time (column 6), as in column 6 with IT countries (column 7) and inflation deviation from its inflation target (column 8). D_{it}: dummy variable that takes one if MPS_{it} > 0; otherwise, it takes zero. All regressions include time fixed effects. Standard errors (in parentheses). N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

Table 10
Regression results: Quadratic term.

	Y _{it} : real GDP cycle				Y _{it} : credit cycle			
	X _{it} = MPS _{it}		X _{it} = ΔMP _{it-1}		X _{it} = MPS _{it}		X _{it} = ΔMP _{it-1}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
X _{it}	7.258** (2.936)	4.033 (11.57)	0.529*** (0.0561)	0.627*** (0.144)	0.805 (3.093)	-44.21*** (11.83)	0.780*** (0.113)	0.931*** (0.237)
D _{it} X _{it} ²		29.05* (17.37)		-0.156 (0.195)		53.97*** (17.40)		0.702* (0.373)
X _{it} ²	50.80* (27.01)	61.85 (97.23)	-0.0298*** (0.00548)	-0.00910 (0.0347)	158.1*** (26.22)	-225.9** (101.2)	-0.0131 (0.0107)	0.0211 (0.0224)
D _{it} X _{it}		-223.9* (122.3)		-0.0172 (0.0353)		353.6*** (126.2)		-0.121*** (0.0335)
Observations	4021	4021	2151	2151	4011	4011	3422	3422
Adj. R-squared	-0.001	0.001	-0.022	-0.021	0.004	0.008	-0.016	-0.011
F test (p-value)	0.00524	0.00169	0	0	7.15e-09	8.34e-11	0	0
Country FE	No	Yes	No	Yes	No	Yes	No	Yes
Time FE	No	No	No	No	No	No	No	No

Table reports regression results using information of the full sample (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period. MPS_{it}: monetary policy shock. ΔMP_{it}: absolute deviation of the policy interest rate. D_{it}: dummy variable that takes one if X_{it} > 0; otherwise, it takes zero. Standard errors (in parentheses) are clustered at the country level. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

remain similar for all our measures of monetary condition (the policy interest rate level, columns 1–2, inflation deviation from its long-term, columns 6–7), except for the policy rate deviation (columns 3–4) and the inflation deviation from target, column 8.

Also, we perform an exercise to test the presence of nonlinear impact of the monetary policy, by including a quadratic term. Table 10 reports the results when considering both measures of policy shock, the policy rate change and the monetary policy shock. In general, we find evidence of a second order effect of the monetary policy (columns 1, 3, 5). Also, there is evidence that the direction of the second order effect is conditional on the sign of the monetary policy shock (columns 2, 6, 8). Results are statistically more significant when working with the estimated MP shock rather than the policy rate deviation.

For example, according to column 2, the contractionary monetary policy is more effective, the larger the shock; while an expansionary monetary policy, is less effective the larger the shock. However, the opposite holds when assessing the impact on credit cycle: a contractionary policy is less effective the larger the shock, while an expansionary policy is more effective the larger the shock.

Table 11
Mean descriptive statistics for country-quarter MP cycles.

Number of expansions	222
Number of contractions	231
Duration of expansions (quarters)	13.3
Duration of contractions (quarters)	6.8
Acum. change of expansions	-10.0
Acum. change of contractions	7.6
Speed of expansions (pp/quarter)	-3.1
Speed of contractions (pp/quarter)	2.9

Mean statistics of expansionary or contractionary monetary policy phase across our sample of 50 countries and across the 2001–2019 sample period.

5. Conclusion

In this work, we study the nonlinear impact of the monetary policy, associated with the monetary conditions or the monetary policy stance. Using different measures of monetary conditions, we find evidence of nonlinear impact in two dimensions: the direction of the monetary policy shock and its dependence on the monetary condition. Results suggest that the effectiveness of the monetary policy depends on the monetary conditions and on the shock direction. For example, the effectiveness of a contractionary monetary policy decreases, the harder the monetary conditions (e.g. the higher the policy rate), while the effectiveness of an expansionary monetary policy decreases the more ease the monetary policy (e.g., the closer the policy rate to its lower bound). In general, results are robust to commonly used time series filters and to the monetary policy shock of [Choi et al. \(2024\)](#).

An important caveat of our results is the measure of the monetary policy shock and the relatively small number of countries that we ending up working with. As a future research agenda, we would like to assess the nonlinear impact of the monetary policy on other variables such as inflation or employment, and to verify the results using an alternative measure of the monetary conditions based on the Taylor rule. In addition, as part of our future agenda, in the same spirit as [Alpanda et al. \(2021\)](#), is to study the interaction between the direction of monetary policy and monetary conditions alongside other economic indicators such as the business cycle, credit conditions, and interest rate cycles. Furthermore, is important to investigate the breakdown of conventional monetary policy into ‘news’ and ‘surprise’ shocks or ‘pure’ and ‘information’ shocks, as suggested by [Jarociński and Karadi \(2020\)](#), [Milani and Treadwell \(2012\)](#).

CRedit authorship contribution statement

Jorge Pozo: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Youel Rojas:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

None.

Appendix A. Dating monetary policy cycles

We developed a simple algorithm that defines the MP cycle peak and trough. The basic idea is to find the local minima and maxima of the policy rate. However, we ignore small changes in the monetary policy rate and focus instead on delineating substantial cycles in the policy rate in a similar manner as the peaks and troughs identified by the NBER Business Cycle Dating Committee. In particular, we modify the turning points algorithm developed for [Dupraz et al. \(2020\)](#).

Let i_t denote the MP rate at time t . The algorithm begins by taking the first month of our sample as a candidate for a business cycle peak, c_p . If, in all the following quarters until MP rate becomes X percentage points lower than i_{c_p} , MP rate is lower than i_{c_p} , we confirm that c_p is a business cycle peak. If, instead, the MP rate goes up i_{c_p} before it is confirmed as a peak, the month in which this happens becomes the new candidate peak. Once we have identified a peak, we switch to looking for a trough (in an analogous manner) and so on until we reach the end of the sample. We set $X = 1\%$. The same MP cycles are produced by X values ranging from 0.75 to 1.5 percentage points. Larger or smaller X values result in more cycles of shorter duration, which include small movements of the MP rate, or fewer cycles of longer duration, which sometimes appear implausible.

As an example, [Fig. 5](#) show the dating peaks and troughs of the monetary policy rate for selected countries of Latin American.

[Table 11](#) shows mean statistics of each expansionary or contractionary monetary policy phase across our sample of 50 countries and across the 2001–2019 sample period.

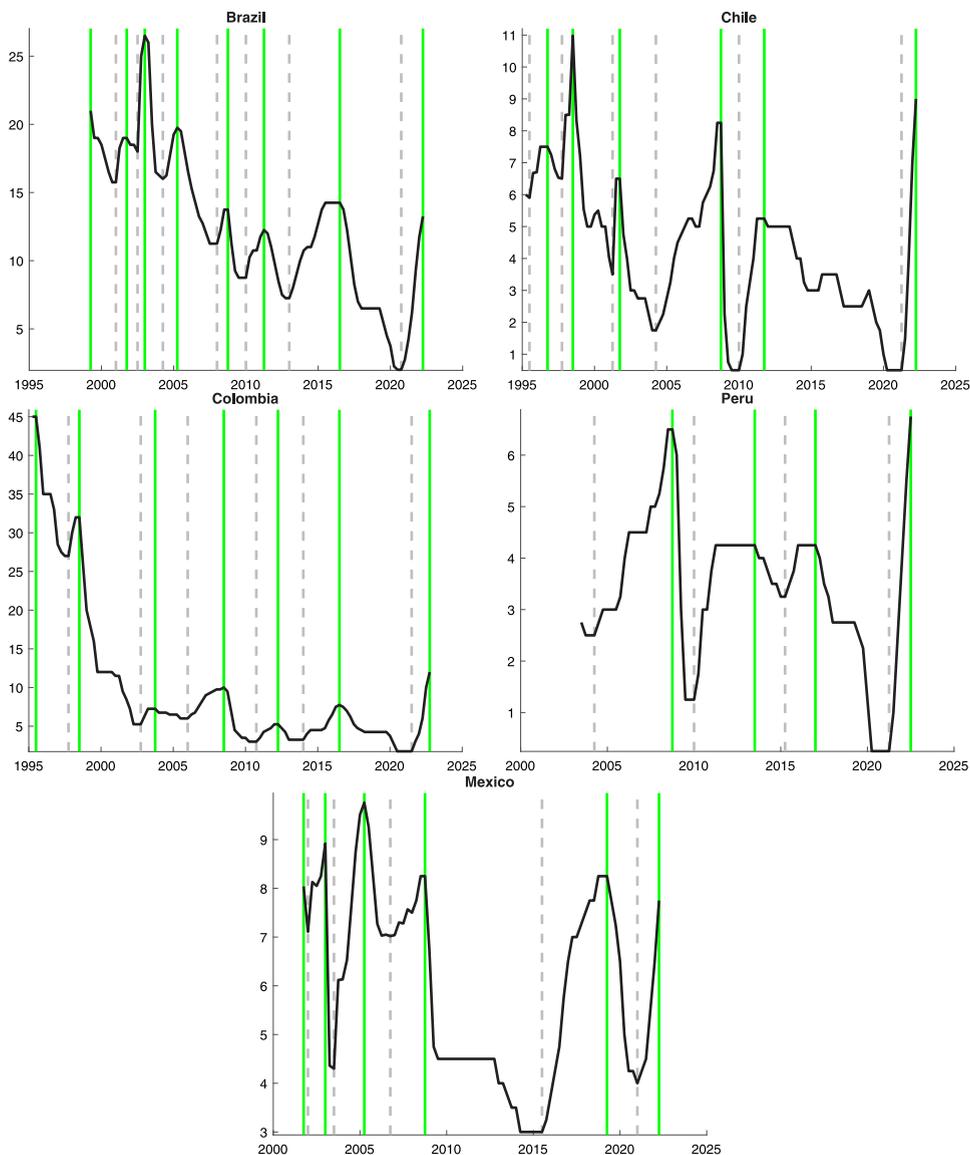


Fig. 5. Monetary policy cycles: Selected countries of Latin America. Own elaboration. Note: MP rate cycles are represented for peaks and troughs. Peaks are denoted by solid vertical lines, while MP rate troughs are denoted by solid vertical lines. Source: IFS, IMF.

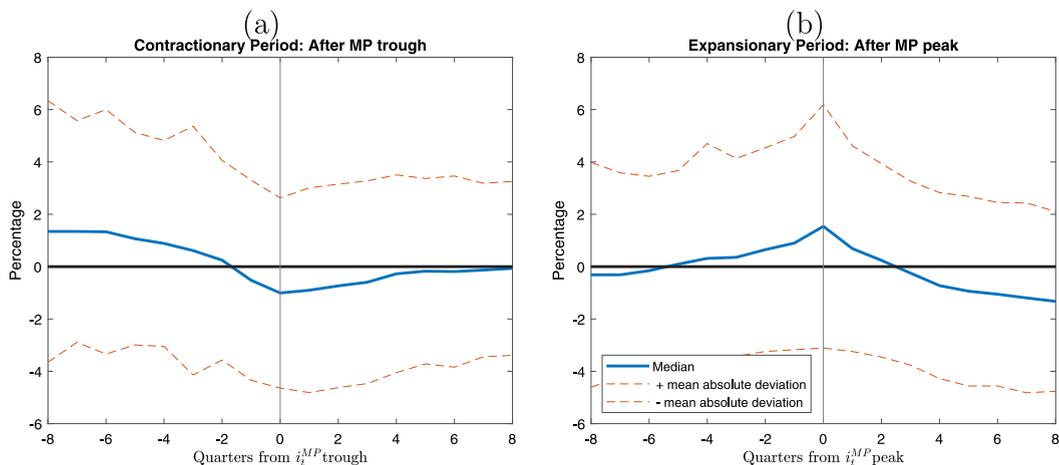
Appendix B. Robustness: Dating monetary policy cycles under phase average trend

In this section presents robustness to the dating algorithm. We consider an alternative algorithm: the Phase Average Trend methodology (Boschan and Ebanks, 1978). This algorithm is less sensitive to the end and the beginning of the sample. Fig. 6 shows that the dynamic behavior of GDP growth and credit growth around peaks and troughs of MP identified under this method is very similar to the one presented in Section 2.2.

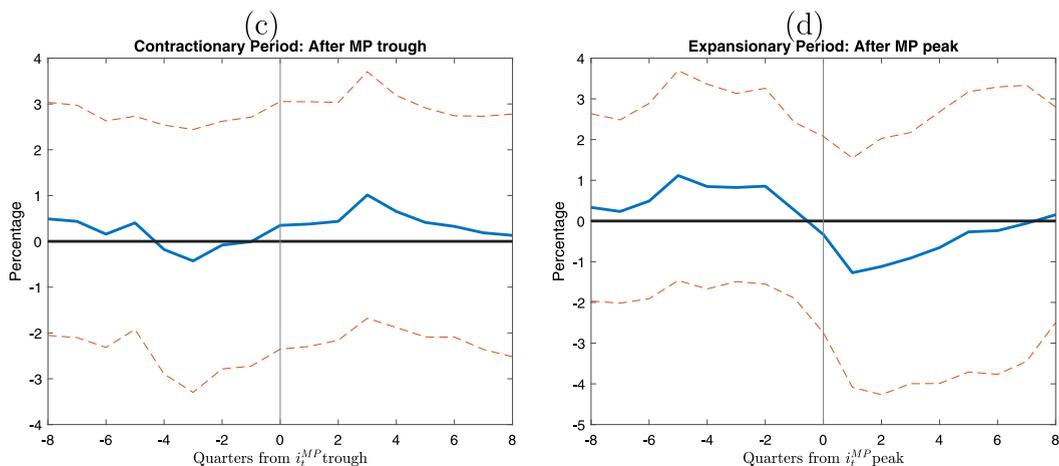
Appendix C. More tables

See Tables 12–16.

Monetary policy rate



GDP Growth



Credit Growth

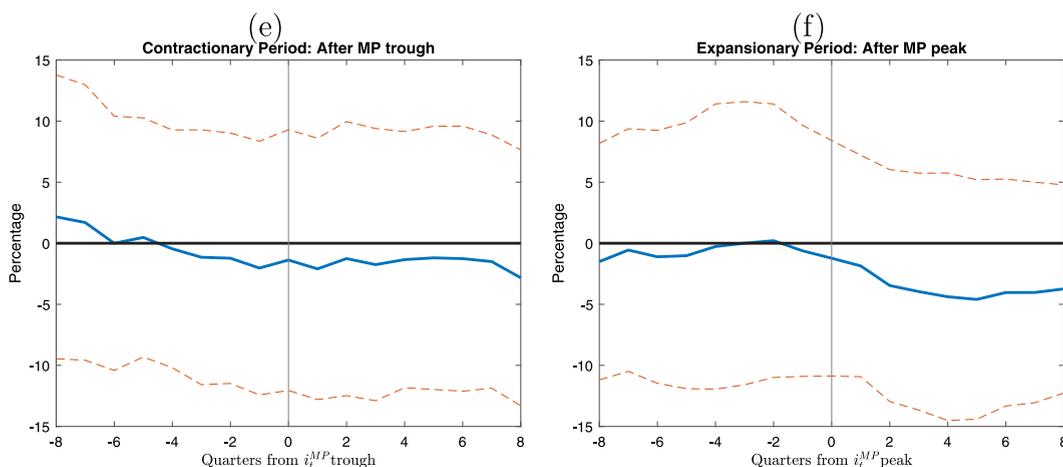


Fig. 6. Macroeconomic dynamics of monetary policy phases in Latin American countries: Expansionary vs. contractionary periods. Own elaboration. Note: It shows the median of the GDP growth and credit growth relative to their long-run average during the 8 quarters before and after the peak or trough in MP cycle. The bands comprise the median \pm the mean absolute deviation. We identify dates of Monetary policy cycle peaks and troughs by looking at turning points for the quarterly policy rates in a sample of 50 countries. We consider quarterly information from 2000:Q1–2019:Q4. See [Appendix A](#) for more details of the algorithm that we use.

Source: IFS, IMF.

Table 12
Regression results: By country income level.

	LMI		UMI		HI	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: $Y = \text{real GDP cycle}$						
ΔMP_{it-1}	0.237 (0.582)	-0.235 (0.545)	1.253*** (0.363)	1.245*** (0.354)	0.578** (0.263)	0.575** (0.240)
$D_{it-1} \Delta MP_{it-1}$	1.065 (2.206)	2.111 (1.977)	-1.719*** (0.519)	-1.755*** (0.507)	-0.00323 (0.932)	0.0156 (0.861)
$MP_{it-2} \Delta MP_{it-1}$	0.00172 (0.0419)	0.0331 (0.0515)	-0.0217*** (0.00701)	-0.0215*** (0.00682)	-0.0380** (0.0155)	-0.0394*** (0.0135)
$D_{it-1} MP_{it-2} \Delta MP_{it-1}$	-0.133 (0.203)	-0.221 (0.184)	0.0827*** (0.0242)	0.0864*** (0.0229)	0.0766 (0.102)	0.0804 (0.102)
Observations	216	216	1033	1033	1228	1228
N	7	7	20	20	22	22
Adj. R-squared	0.013	-0.125	0.097	0.094	0.028	0.024
F test (ρ -value)	0.00148	0.759	9.56e-11	7.76e-09	5.60e-05	0.000173
Country FE	No	Yes	No	Yes	No	Yes
Time FE	No	No	No	No	No	No
Panel B: $Y = \text{nominal credit cycle}$						
ΔMP_{it-1}	1.984* (1.100)	1.877* (1.080)	1.208*** (0.372)	1.226*** (0.368)	-0.862 (0.570)	-0.431 (0.536)
$D_{it-1} \Delta MP_{it-1}$	-4.240** (1.689)	-4.461*** (1.420)	-0.996 (0.814)	-0.900 (0.886)	1.008 (1.819)	0.537 (1.655)
$MP_{it-2} \Delta MP_{it-1}$	-0.0687 (0.0551)	-0.0703 (0.0539)	-0.0218*** (0.00752)	-0.0217*** (0.00767)	0.112* (0.0555)	0.0651 (0.0478)
$D_{it-1} MP_{it-2} \Delta MP_{it-1}$	0.390*** (0.132)	0.419*** (0.109)	0.0819** (0.0390)	0.0740 (0.0450)	0.0937 (0.148)	0.185 (0.149)
Observations	964	964	1608	1608	1086	1086
N	19	19	29	29	21	21
Adj. R-squared	0.034	0.008	0.025	0.013	0.017	0.000
F test (ρ -value)	1.15e-05	0.000387	3.95e-07	1.54e-09	9.53e-05	0.000620
Country FE	No	Yes	No	Yes	No	Yes
Time FE	No	No	No	No	No	No

Table reports regression results by country income level (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period. ΔMP_{it} : absolute deviation of the policy interest rate; D_{it} : dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero; and MP_{it} : the policy interest rate level. LI: Low Income (no shown since there are zero observations); LMI: Lower Middle Income; UMI: Upper Middle Income; HI: High Income. Standard errors (in parentheses) are clustered at the country level. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

Table 13
Regression results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: $Y = \text{nominal GDP cycle}$								
ΔMP_{it-1}	-0.00928 (0.135)	-0.0138 (0.135)	-0.126 (0.162)	-0.107 (0.164)	0.388*** (0.131)	0.395*** (0.132)	0.545** (0.225)	0.594*** (0.216)
$D_{it-1} \Delta MP_{it-1}$			0.339 (0.221)	0.276 (0.207)			-0.879** (0.391)	-0.902** (0.386)
$MP_{it-2} \Delta MP_{it-1}$					-0.0167*** (0.00477)	-0.0171*** (0.00486)	-0.0204*** (0.00699)	-0.0217*** (0.00705)
$D_{it-1} MP_{it-2} \Delta MP_{it-1}$							0.0766* (0.0418)	0.0716* (0.0399)
Observations	3001	3001	3001	3001	3001	3001	3001	3001
N	58	58	58	58	58	58	58	58
Adj. R-squared	0.000	-0.020	0.003	-0.018	0.013	-0.006	0.017	-0.002
F test (ρ -value)	0.946	0.919	0.169	0.243	0.00398	0.00372	0.00401	0.00438

(continued on next page)

Table 13 (continued).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel B: $Y =$ nominal credit cycle at monthly frequency.								
ΔMP_{it-1}	0.518** (0.231)	0.546** (0.240)	0.0641 (0.219)	0.147 (0.253)	1.173*** (0.254)	1.209*** (0.263)	0.607 (0.524)	0.664 (0.589)
$D_{it} \Delta MP_{it-1}$			1.127*** (0.375)	1.002** (0.395)			0.644 (0.695)	0.744 (0.826)
$MP_{it-2} \Delta MP_{it-1}$					-0.0237*** (0.00669)	-0.0240*** (0.00704)	-0.0154 (0.0109)	-0.0149 (0.0130)
$D_{it} MP_{it-2} \Delta MP_{it-1}$							0.0114 (0.0177)	-0.000562 (0.0236)
Observations	12,656	12,656	12,656	12,656	12,656	12,656	12,656	12,656
N	80	80	80	80	80	80	80	80
Adj. R-squared	0.003	-0.019	0.006	-0.017	0.005	-0.017	0.006	-0.016
F test (p -value)	0.0279	0.0256	2.72e-05	3.24e-05	5.87e-05	5.84e-05	2.14e-05	5.00e-06
Country FE	No	Yes	No	Yes	No	Yes	No	Yes
Time FE	No	No	No	No	No	No	No	No

Table reports regression results with the full sample (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period (Panel A) and at monthly frequency for the 2004:M1–2019:M12 period (Panel B). ΔMP_{it} : absolute deviation of the policy interest rate; D_{it} : dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero; and MP_{it} : the policy interest rate level. Standard errors (in parentheses) are clustered at the country level. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

Table 14

Regression results: By geographical regions.

	EAP (1)	ECA (2)	LAC (3)	MENA (4)	NA (5)	SA (6)	SSA (7)
$Y =$ real GDP cycle							
ΔMP_{it-1}	0.202 (0.374)	0.666** (0.329)	1.015*** (0.132)	-0.410 (0.844)	1.476 (0.940)	-9.282 (11.22)	0.931 (0.614)
$D_{it-1} \Delta MP_{it-1}$	0.431 (0.657)	-0.456 (0.528)	-1.307*** (0.271)	-1.238 (1.540)	-1.635 (1.634)	-28.90 (120.9)	-1.906 (1.508)
$MP_{it-2} \Delta MP_{it-1}$	-0.0234 (0.0524)	0.00982 (0.0237)	-0.0174*** (0.00290)	0.180 (0.198)	-0.701** (0.270)	1.248 (1.426)	-0.0710 (0.0508)
$D_{it-1} MP_{it-2} \Delta MP_{it-1}$	-0.0425 (0.0808)	0.0216 (0.0420)	0.0521** (0.0240)	0.225 (0.442)	1.266** (0.506)	3.592 (16.20)	0.170 (0.137)
Observations	545	922	583	155	64	21	187
N	10	17	12	3	1	1	5
Adj. R-squared	-0.012	0.006	0.077	0.027	0.230	0.137	-0.028
F test (p -value)	0.715	6.25e-10	0	0.480	0.00348	0.646	0.568

Table reports regression results by geographical regions (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period. ΔMP_{it} : absolute deviation of the policy interest rate; D_{it} : dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero; and MP_{it} : the policy interest rate level. EAP: East Asia & Pacific; ECA: Europe & Central Asia; LAC: Latin America & Caribbean; MENA: Middle East & North Africa; NA: North America; SA: South Asia; SSA: Sub-Saharan Africa. All regression include country fixed effects. Standard errors in parentheses. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

Table 15

Regression results. Robustness — Time fixed effects.

	MC = MP		MC = MP^{dev}		MC = π	MC = π^{dev}		MC = π^{tar}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Y =$ real GDP cycle								
ΔMP_{it-1}	0.513*** (0.180)	0.582** (0.215)	0.776*** (0.262)	0.899** (0.343)	0.465** (0.222)	0.524** (0.250)	0.597* (0.311)	0.517** (0.237)
$D_{it-1} \Delta MP_{it-1}$	-0.739** (0.338)	-1.013** (0.407)	-0.548** (0.242)	-0.626* (0.320)	-0.467 (0.356)	-0.323 (0.226)	-0.385 (0.275)	-0.425 (0.293)
$MC_{it-2} \Delta MP_{it-1}$	-0.00761** (0.00335)	-0.00895** (0.00404)	-0.0895*** (0.0322)	-0.101** (0.0433)	-0.00457 (0.00772)	-0.0183 (0.0222)	-0.0208 (0.0243)	-0.00810 (0.0109)
$D_{it-1} MC_{it-2} \Delta MP_{it-1}$	0.0446* (0.0228)	0.0651** (0.0266)	0.113*** (0.0375)	0.132** (0.0499)	0.0306 (0.0272)	0.0431 (0.0352)	0.0563 (0.0372)	0.0389 (0.0316)

(continued on next page)

Table 15 (continued).

	MC = MP		MC = MP ^{dev}		MC = π	MC = π^{dev}		MC = π^{tar}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Observations	2587	2011	2502	1944	2498	2417	1897	2018
N	52	39	50	39	50	50	38	39
Adj. R-squared	0.432	0.413	0.439	0.425	0.421	0.420	0.405	0.405
F test (p -value)	7.46e-10	0	0.0161	0.0283	0.00519	0.00648	0.0583	0.0170

Table reports regression results with the full sample of countries (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period. MC_{it} : monetary conditions. We consider different measures of the current monetary conditions: policy rate level (column 1), as in column 1 with only IT countries (column 2), policy rate deviation from the average over time (column 3), as in column 3 with only IT countries (column 4), inflation level (column 5), inflation deviation from its average over time (column 6), as in column 6 with IT countries (column 7) and inflation deviation from its inflation target (column 8). ΔMP_{it} : absolute deviation of the policy interest rate; D_{it} : dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero. All regressions include time fixed effects. Standard errors (in parentheses) are clustered at the country level. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

Table 16

Regression results. Robustness — With controls.

	MC = MP		MC = MP ^{dev}		MC = π	MC = π^{dev}		MC = π^{tar}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y = real GDP cycle								
ΔMP_{it-1}	0.840*** (0.200)	0.845*** (0.255)	1.230*** (0.297)	1.295*** (0.449)	0.766*** (0.246)	0.786** (0.292)	0.883** (0.370)	0.845*** (0.268)
$D_{it-1} \Delta MP_{it-1}$	-1.048** (0.398)	-1.182** (0.490)	-0.757** (0.302)	-0.721 (0.474)	-0.771* (0.418)	-0.340 (0.328)	-0.464 (0.410)	-0.673* (0.343)
MC $_{it-2} \Delta MP_{it-1}$	-0.0136*** (0.00382)	-0.0138*** (0.00479)	-0.124*** (0.0353)	-0.131** (0.0548)	-0.0103 (0.00920)	-0.0241 (0.0243)	-0.0262 (0.0264)	-0.0161 (0.0116)
$D_{it-1} MC_{it-2} \Delta MP_{it-1}$	0.0575** (0.0266)	0.0677** (0.0304)	0.182*** (0.0429)	0.201*** (0.0594)	0.0662** (0.0319)	0.145*** (0.0452)	0.151*** (0.0405)	0.0857*** (0.0312)
CREGDP _{it}	-0.00145 (0.00113)	-0.00176** (0.000742)	-0.00189 (0.00127)	-0.00198** (0.000875)	-0.00226** (0.00112)	-0.00242** (0.00116)	-0.00200** (0.000751)	-0.00253*** (0.000747)
XMGDP _{it}	0.000801 (0.000557)	0.00172 (0.00109)	0.00108* (0.000615)	0.00132 (0.00118)	0.000916** (0.000440)	0.00120*** (0.000395)	0.000285 (0.00104)	0.00140* (0.000810)
Observations	1961	1608	1901	1556	1932	1873	1528	1634
N	40	32	40	32	39	39	31	32
Adj. R-squared	0.048	0.045	0.073	0.080	0.043	0.043	0.063	0.061
F test (p -value)	3.14e-10	1.27e-07	3.08e-06	9.93e-07	2.42e-06	1.62e-08	0	2.12e-07

Table reports regression results with the full sample of countries (excluding outliers) at quarterly frequency for the 2004:Q1–2019:Q4 period. MC_{it} : monetary conditions. We consider different measures of the current monetary conditions: policy rate level (column 1), as in column 1 with only IT countries (column 2), policy rate deviation from the average over time (column 3), as in column 3 with only IT countries (column 4), inflation level (column 5), inflation deviation from its average over time (column 6), as in column 6 with IT countries (column 7) and inflation deviation from its inflation target (column 8). ΔMP_{it} : absolute deviation of the policy interest rate; D_{it} : dummy variable that takes one if $\Delta MP_{it} > 0$; otherwise, it takes zero. CREGDP_{it}: credit to GDP ratio (%). XMGDP_{it}: Exports and imports to GDP ratio (%). All regressions include time fixed effects. N: number of countries. *** Statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%. Estimation method: OLS.

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