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Measuring the Effects of Monetary Policy Using Market Expectations

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Measuring the Effects of Monetary Policy Using Market Expectations[1]

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Abstract

In order to quantify the effects of monetary policy, this paper employs an alternative empirical measure of monetary policy shocks based on market expectations obtained from media and survey information in Peru. Using monthly data for the period 2003-2011, we use the proposed measure as a variable representing exogenous variation in monetary policy and evaluate its dynamic impact on output and prices. The results show a coherent picture of the effects of monetary policy compared to alternative approaches in terms of both the magnitude and the timing of the effects.

Key Words : *Monetary policy, media, survey.*
JEL Classification : E52, E58.

1 Introduction

Ideally, the real and nominal effects of monetary policy would be estimated using a controlled experiment in which an exogenous change in monetary policy occurs, holding everything else constant, and then analysing the reaction of key real and nominal variables, such as real output and prices. However, to perform such experiments in macroeconomics is seldom possible, as recently discussed by Sims (2010). Instead, the empirical literature on monetary policy has focused on alternative econometric approaches in order to quantify the effects of monetary policy, ranging from simple regressions (where some indicator of monetary policy is specified as a regressor and assumed to be exogenous) to more recent and sophisticated dynamic systems where monetary policy shocks represent the exogenous component of monetary policy. In this paper we investigate the possible effects of monetary policy actions using an alternative measure of monetary policy shocks based on media and survey information about market expectations.

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Monetary policy shocks are defined in many ways. Most of the recent literature about the effects of monetary policy defines a monetary shock as the residual of one dynamic equation from a vector autoregression (VAR) or as a linear combination of residuals from two or more equations. Other important definitions are provided by Friedman and Schwartz (1965) and Romer and Romer (1989). Friedman and Schwartz (1965) define a monetary shock as a movement that is unusual given economic developments, i.e. a movement that would not have occurred in other periods or other circumstances given the pattern of real activity (this definition does not imply that a monetary shock is a monetary movement entirely unrelated to underlying economic developments). Romer and Romer (1989) define a shock as an "episode in which the Federal Reserve attempted to exert a contractionary influence on the economy in order to reduce inflation", i.e. "times when the Federal Reserve attempted not to offset perceived or prospective increases in aggregate demand but to actively shift the aggregate demand curve back in response to what it perceived to be 'excessive' inflation".[2]

Alternatively, a monetary policy shock can be defined as an unexpected change in monetary policy. Let r denote the monetary policy instrument (e.g. an interest rate controlled by the central bank) and $E(r)$ the market expectation about the level of the monetary policy instrument. Theoretically, the difference between the observed interest rate and market expectations, $r - E(r)$, is defined as a monetary policy shock and could be considered as a measure of exogenous monetary policy actions. Given this definition, a main empirical issue involved in measuring monetary policy shocks would be the quantification of "expectations", $E(r)$. As it will be explained in the following section, some financial prices have been used as proxies of market expectations about the official interest rate. In this paper, we use information gathered from the media and economic surveys to approximate empirically $E(r)$, and thus quantify monetary policy shocks, $r - E(r)$, which can be used to analyse the effects of monetary policy.

Using the proposed measure of monetary policy shocks, evidence from Peru shows a coherent picture of the effects of monetary policy in terms of both the magnitude and the timing of the effects compared to alternative approaches. In particular, the results show that the maximum effect of an exogenous 25-basis-points rise in the official interest rate is: (i) a decrease of 0.3 percentage points in inflation which occurs after 14 months, and (ii) a decrease of 1.2 percentage points in output growth which occurs after 9 months. Furthermore, we show that the time series for market expectations constructed using media and survey information is a good measure under the unbiased expectations hypothesis.

[2]In other words, a shock is defined as a time "when concern about the current level of inflation led the Federal Reserve to attempt to induce a recession (or at least a "growth recession")". However, as these authors state, this particular definition of a monetary shock is very limited.

The paper is structured as follows. In section 2 we present a brief survey of a very large literature on measuring the effects of monetary policy actions. The methodology and data used is described in section 3. Section 4 shows the econometric results and finally, some conclusions are presented in section 5.

2 A brief literature review

The Vector Autoregressive (VAR) framework is considered as the standard tool to identify and analyse the effects of monetary policy shocks on the economy[3] This approach, proposed by Sims (1980), has been applied by several authors to the empirical analysis of monetary policy, Bernanke and Blinder (1992) and Christiano and Eichenbaum (1992) being two of the most important early applications. In general, VAR models can be applied to either the identification of monetary policy shocks or the analysis of the dynamic effect of the shock once it has been identified and fed into the model, or both. For example, Gordon and Leeper (1994) identify monetary policy shocks outside the VAR model and then feed an unrestricted VAR with a shock (in the initial period) in order to analyse the dynamic response of the macro variables.

However, if we focus on the identification of monetary policy shocks only, the literature can be divided into three main lines of research. The first line of research is based on VAR measures of monetary policy shocks, which are closely related to the identification procedure of a VAR, VARX, FAVAR or any other extension of a VAR model. In particular, the identification of a VAR can be performed either recursively or using a structural (or semi-structural) model. Some examples of this approach are given by Sims (1980), Bernanke and Blinder (1992), Sims (1992), Christiano and Eichenbaum (1992), Strongin (1995), Lastrapes and Selgin (1995) and Gerlach and Smets (1995), Gordon and Leeper (1994), Leeper et al. (1996), Bernanke and Mihov (1998), Sims and Zha (1998), Christiano et al. (1999), Bernanke et al. (2005), among others.

The second line of research is based on non-VAR measures of monetary policy shocks. Some examples of this approach are given by Gordon and Leeper (1994), Krueger et al. (1996), Rudebusch (1998), Bagliano and Favero (1999), Kuttner (2001), Bomfim (2003), Bernanke and Kuttner (2005), Gurkayna et al. (2007), Piazzesi and Swanson (2008), and Hamilton (2009). Within this line of research, two general methodologies can be identified:(i) monetary policy shocks come as residuals from empirical models that describe a particular market (e.g. reserve market), and (ii) the use of a financial price as a proxy for

[3]As stated by Bernanke and Mihov (1998) and Christiano et al. (1999), the VAR approach focuses on policy shocks and not on the systematic component of monetary policy or "policy rule". The main reason is that tracing the dynamic response of the economy to a monetary policy innovation allows one to observe the effects of policy changes under minimal identifying assumptions.

expected interest rate.

Gordon and Leeper (1994) construct an empirical model that imposes identifying restrictions consistent with the standard treatment of private sector behaviour and monetary policy actions.[4] They estimate the supply and demand functions of the reserve market and the M2 market, and identify monetary policy shocks as the disturbances from the corresponding supply functions. Then, the effects of these disturbances on price (interest rate) and quantities (reserves or M2) are used as the initial impulse in an unrestricted VAR in order to analyse the effects of monetary policy shocks on macro variables.

Alternatively, authors like Krueger et al. (1996) and Rudebusch (1998) propose the use of some particular financial prices as proxies for market expectations about future monetary policy actions[5], $E(r)$. Recently, some studies have developed this idea of measuring monetary policy expectations using some asset prices. The most widely used indicators in this branch of the literature are the Fed funds futures prices (Krueger et al. (1996), Rudebusch (1998), Bagliano and Favero (1999), Kuttner (2001), Bomfim (2003), Bernanke and Kuttner (2005), Gurkayna et al. (2007), Piazzesi and Swanson (2008), and Hamilton (2009), among others), and the Eurodollar deposit rate (Cochrane and Piazzesi (2002); Rigobon and Sack (2006)). In the case of the Fed funds future prices, Krueger et al. (1996) found that funds rate forecasts based on the futures price are "efficient", in the sense that the forecast errors are not significantly correlated with other variables known when the contract was priced.

Finally, the third line of research is based on the so-called "narrative approach", developed by Friedman and Schwartz (1965), Romer and Romer (1989), Romer and Romer (2004), among the most important ones. Romer and Romer (1989) call it the narrative approach because its central element is the identification of "monetary shocks" through non-statistical procedures. In particular, the identification of monetary policy shocks is based mainly on the analysis of documentary evidence from central banks (minutes, internal reports and forecasts etc.). Romer and Romer (2004), for example, obtain a series of monetary policy shocks in two steps. First, based on internal documentary information, they extract a series of intended Federal funds rates (FFRs) around the FOCM meetings. Then, they extract the part of the series that is not influ-

[4]Gordon and Leeper (1994) state that "$(\cdots)$most time series studies avoid jointly modelling monetary policy and private behaviour by equating statistical innovations in variables with monetary policy shocks. This approach makes extreme assumptions about the interest elasticity of money supply or demand and produces dynamic responses of macro variables that are anomalous relative to generally accepted views about the effects of monetary policy shocks".

[5]Rudebusch (1998) also criticize the conventional VAR measure of monetary policy shocks. He states that VAR models derive policy shocks as innovations with respect to a time-invariant, linear reaction function of the monetary authority, which is assumed to react only to the limited set of variables included in the model. Thus, the final estimate of monetary policy disturbances has little or no relation with the true underlying policy shocks.

enced by future developments, regressing the intended FFR against the Federal Reserve's forecasts of the economy. Thus, the residuals from this regression are considered as the intended monetary policy actions not driven by the information about future economic developments.

Previous research on the effects of monetary policy in Peru has focused on VAR models, featuring León (1999), Quispe (2000), Rossini (2001), Winkelried (2004), Bigio and Salas (2006), Castillo et al. (2011), Lahura (2010), among others. Thus, this paper constitutes the first attempt in Peru in line with the so-called "narrative approach" based on media and survey information about market expectations.

3 Data and methodology

In this paper we use information for the Peruvian economy during the period October 2003-September 2011, thus covering most of the period under the inflation targeting regime that started in January 2002. In particular, the sample starts one month after the Central Bank of Peru announced the use of an official interest rate as the monetary policy instrument (September 2003), the key variable around which market expectations about monetary policy are formed and the main focus of this paper.

Under the assumption that market expectations about the official interest rate can be summarized into a single series representing expected interest rate, $E(r)$, the difference between the actual rate and the expectations, $r - E(r)$, can be treated as a measure of monetary policy shocks, and thus can be used as a variable representing exogenous variation in monetary policy.[6] Given this, we propose the use of media and economic surveys as sources of valuable information to measure market expectations and thus quantify the effects of monetary policy using monetary policy shocks. In particular, we use newspapers, magazines, and economics surveys performed by Bloomberg in order to construct a time series of expected interest rate. Monetary policy shocks are then calculated as the difference between the official interest rate series and the time series of expected interest rate. This approach could be especially useful for Peru and other developing economies where no financial indicator is available as a proxy for market expectations, as is the case in the United States and other developed economies.[7]

Prior to the announcement of potential changes to the official interest rate level r by the Central Bank of Peru, several analysts' forecasts of the new official interest rate are published. These forecasts represent either institutional or

[6]It should be noted that the use of a series of monetary policy shocks does not necessarily mean that monetary policy in Peru has been conducted by "surprises", but it is just an econometric device to quantify the exogenous effect of monetary policy on output and prices.

[7]See Hamilton (2009) and other authors mentioned in Section 2.

personal expectations (or both) about future monetary policy actions. Given this, a comprehensive search of the principal Peruvian newspapers and magazines (Gestión, El Comercio, El Peruano, La República, La Primera, Expreso and Caretas) was undertaken to extract all relevant information relating to expectations of the interest rate (in the days eading up to each Central Bank monetary policy announcement) for the period October 2003 until September 2011. Duplicative information such as interviews of the same analyst by several newspapers was discarded. Furthermore, only information about market expectations up to 15 days before each monetary policy announcement was taken into account.

A Bloomberg survey is performed each month and during the days prior to the announcement of the new official interest rate. This survey contains forecasts about the official interest rate from the most important local economic and financial institutions and individuals: commercial banks, key university economic professors, private consultancy firms, and stockbrokers, among others. The data obtained from Bloomberg's survey is particularly useful as it asks for a specific numerical forecast of every surveyed institution or individual. The number of surveyed institutions is not constant but usually the respondent institutions are the same. Obviously, the forecasts are not unanimous; thus in order to construct a single series of "expected official interest rate" we use the median response and not the average (thus avoiding the possibility of having a positive or negative shock because few people deviate from an almost unanimous forecast). The main disadvantage of the Bloomberg survey is that it has only been available since July 2006.

Based on the available information we construct a single time series of "expected official interest rate" or "market expectations" as follows. For the period October 2003-June 2006 the series contain the median of expected interest rate extracted only from newspapers and magazines. For this period, a numerical forecast of the future interest rate was generally not reported but only whether the analyst expected an increase or decrease in the official rate. Thus, based on the historical evolution of the official interest rate, we assume that an expected increase or decrease was of 25 basis points.[8] For the period July 2006-September 2011, we used the median of the expected interest rate reported by the Bloomberg survey. As a test of consistency of the data, we compared the survey's information with the qualitative data extracted from newspapers and magazines for the same period. The comparison (not reported here) shows that both sources provide the same expected interest rate (median response).

In order to evaluate the effects of monetary policy on real output and prices, we follow the same empirical procedure as Romer and Romer (2004). In particular, we estimate the parameters of the following regression equation:

[8]Since the announcement of the official interest rate (or reference interest rate) in September 2003, the median change in the official rate has been 25 basis points (up or down).

$$\Delta y_t = \beta_0 + \Sigma_{i=2}^{m} \delta_i D_{it} + \Sigma_{k=1}^{p} \theta_i S_{t-k} + \Sigma_{j=1}^{q} \beta_i \Delta y_{t-j} + \epsilon_t \quad (1)$$

where y_t represents the relevant macro variable (for example, real output or prices), S is the measure of monetary policy shocks, and D_{it}'s are monthly dummies. Then, we can use the estimated parameters to analyse the response of y_t to a one-time realization of S (e.g. a change of 25 basis points). In particular, the estimated response of y_t after one period can be calculated as θ_1, $\theta_1 + (\theta_2 + \beta_1\theta_1)$ after two months, and so forth. Alternatively, we can accumulate the S series and include it in a conventional VAR using a particular identification approach (e.g. Cholesky or a structural factorization of residuals).

In order to analyse the effects of monetary policy, we estimate equation (1) using year-on-year real output growth and inflation and construct the corresponding impulse-response functions. We use monthly data for the period October 2003- September 2011. Real output is measured using a real GDP index (base year 1994) published by the Central Bank of Peru and inflation is obtained from the CPI (base year 2009) index. Prices were measured using the consumer price index (base year 2009) published by the Central Bank of Peru.

Unlike what happens at the Federal Reserve, a main advantage of Peruvian data is that the Board of Governors' meetings are scheduled every month, and the specific day is known in advance at the start of every year. This practice is part of the transparency policy implemented by the Central Bank since the adoption of the inflation targeting regime in 2002. Thus, unlike Romer and Romer (2004) we do not need to adjust the data in order to get a coherent monthly series.

4 Quantifying the effects of monetary policy

The results of the effects of monetary policy measure by the constructed shocks are based on the estimation of the following equation:

$$\Delta y_t = \beta_0 + \Sigma_{k=1}^{p} \theta_i S_{t-k} + \Sigma_{j=1}^{q} \beta_i \Delta y_{t-j} + \epsilon_t \quad (2)$$

where y_t represents the log of the relevant macro variable (output and prices), and S is the new measure of monetary policy shocks. Because of the small size of the available available, we used seasonally adjusted data instead of dummy variables, thus avoiding a big loss in degrees of freedom. We chose $p = 12$ and $q = 12$ as the maximum possible values for lagged regressors.

The estimated impulse-response functions (IRFs) obtained from the estimation of equation (2) are based on a 25 basis points shock to the policy rate, which reflects the observed median change in the Peruvian official interest rate. Figure 1 shows the impulse-response function of output with a 95% confidence interval. As expected, the output decreases after a positive (contractive) monetary

policy shock, $r - E(r) > 0$, showing a hump-shaped response. The maximum effect of a 25-basis-points shock is a decrease of 1.2 percentage points in output growth (e.g. from 5% to 3.8%) and occurs after 9 periods (months).

Figure 1

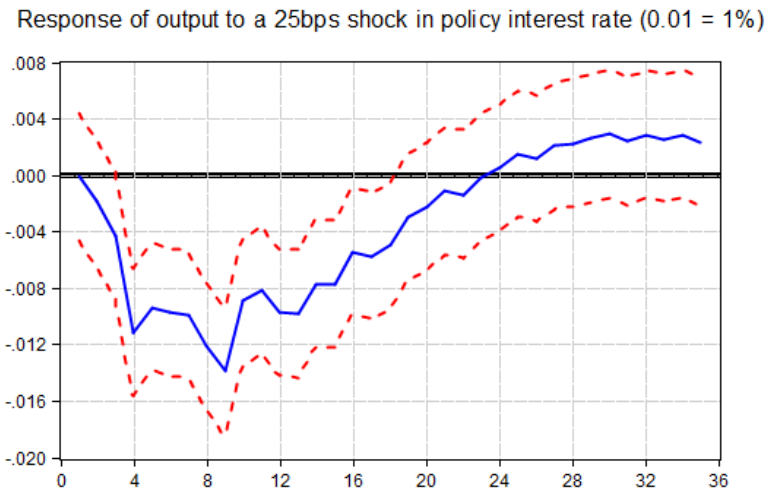
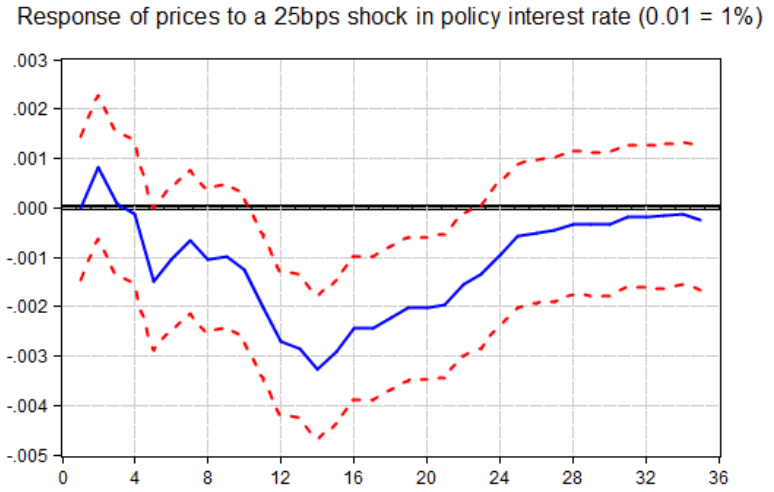


Figure 2 shows the impulse-response function of prices with a 95% confidence interval. As expected, the price level decreases after a positive (contractive) monetary policy shock, $r - E(r) > 0$, showing a hump-shaped response. The maximum effect of a 25-basis-points shock is a decrease of 0.3 percentage points on prices and occurs after 14 periods (months).

Figure 2



Previous studies on Peru have provided a variety of results due to the use of different samples, frequency of data and different measures of monetary policy instrument. The top part of Table 1 shows a summary of results based on monthly data and the bottom part results using quarterly data.[9] The effect of monetary policy on output and prices varies among studies, ranging from 0.08 to 1.0 percent. However, compared to Salas (2011)-whose period of analysis is the most similar to the one used in this paper- the timing of the effects are similar for both output and prices, even though the magnitude of the effects is different.

Table 1. *The Effects of Monetary Policy in Peru: A Brief Survey on Recent Studies*

		Maximum effect on prices		Maximum effect on output			
Year	Author(s)	Magnitude	Number of months	Magnitude	Number of months	Data frequency	Sample
2011	Lahura	0.30	14	1.2	9	m	2003-2010
2010	Lahura	0.23	6	0.16	7	m	1995-2005
2010	Castillo, Pérez and Tuesta	1.00	29	0.40	41	m	1995-2009
2006	Bigio and Salas						1994-2004
	* high growth	0.50	16	0.50	10	m	
	* low growth	0.25	16	1.00	10	m	
2004	Winkelried	0.20	12	0.50	12	m	1993-2003
2009	Salas	0.40	12	0.30	9	q	2001-2008
2009	Vega et al.	0.15	18	0.10	9	q	1999-2006
2009	Castillo, Montoro and Tuesta						1994-2007
	* without dollarization	0.08	12	0.41	6	q	
	* with dollarization	0.17	12	0.38	9	q	
2007	Rossini and Vega						1994-2007
	* without intervention	0.08	15	0.10	12	q	
	* with intervention	0.15	23	0.09	12	q	
	* net export effect	0.20	30	0.20	24	q	
	* balance sheet effect	0.10	15	0.10	12	q	

As is evident from the results in Table 1, it is difficult to make an accurate comparison mainly because of different sample periods and monetary regimes.[10] As an attempt to obtain a more reasonable comparison of our results with alternative approaches, Figures 3 and 4 show the IRFs of output and prices for the same period analysed in this paper, using the change in the official interest rate as the measure of monetary policy shock. In both cases, the magnitude of the effect is very small compared to the benchmark case. Furthermore, in the particular case of output, the IRFs are very erratic.

[9]For comparison purposes, the bottom part of Table 1 includes results from studies based on calibrated models

[10]From 1992 to 2001 monetary policy in Peru was implemented under a monetary target regime, and since 2002 under an inflation targeting regime

Figure 3

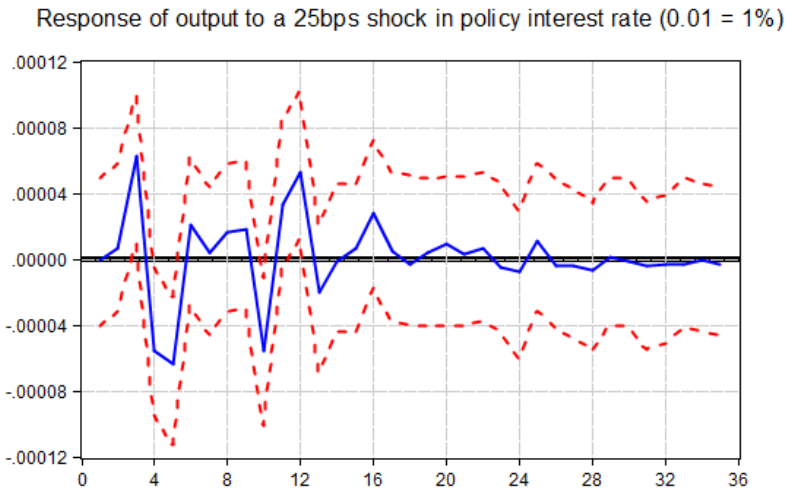
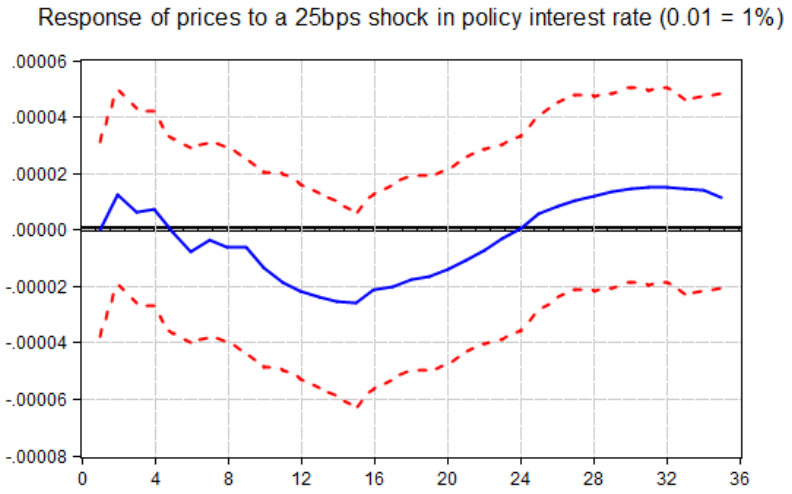


Figure 4



For comparison purposes, Appendix A shows the IRFs from the estimation of a standard VAR model that includes output, prices and the interest rate. The identification assumption of the VAR models is that the interest rate is set at the beginning of the month and is not affected by output and prices contemporaneously; thus the official interest rate goes first in the corresponding Cholesky ordering. Although the effects on output and prices seem to be more reasonable (between -0.5% and 0.5%), the sign of the effects and the evolution are not as expected. Overall, output and prices increase after the increase of interest rate. Thus, based on the IRFs' behaviour, our proposed measure of monetary policy shock seems to perform better than other traditional candidates.

Finally, as an additional robustness analysis, we assess the validity of the measure of monetary policy expectations. The criterion is based on unbiased expectations: if the agents' behaviour responds to unbiased expectations, then the expected interest rate R_t^E should not deviate from the actual rate R_t systematically and must coincide on average. Given that R_t and R_t^E are non-stationary for the analysed period, an appropriate statistical method to analyse their relationship is cointegration.[11] Therefore, if the variables are statistically cointegrated with a cointegrating vector $(1, -1)$, then the measure of monetary policy expectations is a good proxy of unbiased expectations.

Table 2. *Augmented Dickey-Fuller test for Monetary Policy Shocks*

	Median shock	Average shock
Akaike Information Criterion (AIC)	0.000	0.000
Schwarz Information Criterion (SIC)	0.000	0.000
Hannan-Quinn Information Criterion (HQ)	0.000	0.000
Modified AIC	0.001	0.000
Modified SIC	0.001	0.000
Modified HQ	0.001	0.000

* The null hypothesis is unit root. Entries of the table represent the corresponding p-values.
** Monetary policy shock is defined as the difference between the official interest rate and a measure of expected interest rate, using either the median or the average expectation

We evaluate the presence of cointegration by testing the stationarity of the linear combination given by $R_t - R_t^E$, using the ADF unit root test (with no intercept or trend). The results in Table 2 show that the null of no cointegration is rejected at 1%, thus supporting the unbiased expectations hypothesis. Furthermore, there is evidence that the actual interest rate is weakly exogenous which means that market expectations adjust in the short run when there is any discrepancy between the expected and actual interest rates, a fact that could be consistent with a learning-type model but we do not analyse here.

5 Comparison with alternative measures of monetary policy shocks

Conventional measures of monetary policy shocks have some important flaws. For the case of VAR-based measures, the most evident drawback is the correct specification of the VAR model. Although recent studies based on FAVAR models (e.g. Bernanke et al. (2005)) provide a reasonable solution to this problem, one can still argue in favour of Gordon and Leeper (1994) criticism: that most time series studies avoid jointly modelling monetary policy and private

[11] We do not attempt to provide an economic interpretation of the possibility of cointegration between the expected and actual interest rate, mainly because of the short period of time analysed. Instead, we make use of cointegration as the most appropriate statistical tool in order to analyse the relationship between these variables.

behaviour by equating statistical innovations in variables to monetary policy shocks.

Romer and Romer (2004) emphasize two other general important problems. The first one is the possibility that the measure of monetary policy shock could contain endogenous movements; for example, "the tendency of the funds rate to rise endogenously with economic activity may cause researchers to underestimate the negative impact of increases in interest rates on real economic variables". The second refers to the fact that conventional measures almost surely contain anticipatory movements, as long as the monetary policy decisions are made based on forecasts of the main economic variables.

We argue that our proposed empirical measure of monetary policy shock, based on information from the media, does not seem to be subject to any of these criticisms and constitutes an alternative in the literature for monetary policy analysis. First, the calculation of $r - E(r)$ does not depend on any estimated VAR model, or any other model, because it is obtained directly from media and survey information. Therefore, the shock is not related to any statistical innovation in the variables involved in the estimation.

Second, given the definition of monetary policy shock, it is not a problem that r is determined endogenously (as a response to increased economic activity) or that it reacts in order to be consistent with future movements in the economy (e.g. to avoid future inflation). The idea is that if the observed level of r is different to what people expected, no matter what the reasons are[12], then this difference matches with the definition of a policy shock, $r - E(r)$. It is possible that the decision over r may not reflect only pure exogenous components as stated by Romer and Romer (2004); however, extracting the "exogenous" part from the official interest rate would not be useful in calculating $r - E(r)$ because what matters for the definition of the shock is "the observed interest rate". Therefore, focusing only on one side of the story (in this case, on the behaviour of the Central Bank) can be a misleading approach when trying to obtain a good empirical measure of a monetary policy shock.

[12]The difference can arise for many reasons: because people's expectations do not incorporate future developments that the Central Bank does (or vice versa), erroneous forecasts of people due to incomplete information compared to the Central Bank's information, and so on.

6 Conclusions

In order to analyse the effects of monetary plicy, this paper proposes a new empirical measure of monetary policy shocks for the case of Peru, which is used as a variable representing exogenous variation in monetary policy. A monetary policy shock is defined as the difference between the actual value of the monetary policy instrument, r, and the value expected by economic agents, E(r). Following the so-called narrative approach, we propose an alternative empirical measure of market expectations $E(r)$ obtained from media (newspapers and magazines) and survey information. The results show a coherent picture of the effects of monetary policy compared to alternative approaches. This new measure could be especially useful for Peru and other developing economies where no financial indicator is available as a proxy for market expectations, as is the case in the United States and other developed economies.

Using recent Peruvian data for the period 2003-2011 (during which the official interest rate was used explicitly as the monetary policy instrument), we show that the proposed measure provides a more coherent picture of the effects of monetary policy shocks compared to other traditional approaches. The comparison was made on the basis of the corresponding impulse-response functions. Furthermore, we show evidence that the constructed series of expectations is consistent with the existence of unbiased expectations.

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APPENDIX

A Monetary Policy Shocks in Peru: Evidence from standard VARs

Figure A-1

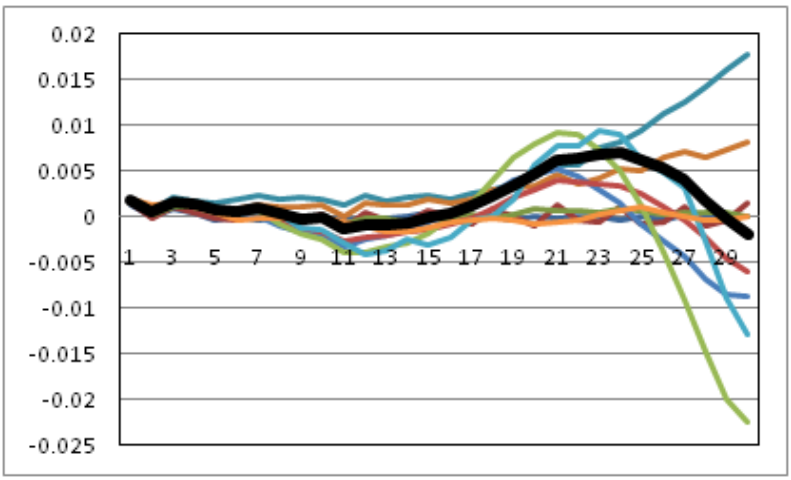

Figure A-2