sciendo
Scientific Annals of Economics and Business
66 (1), 2019, 101-115
DOI: 10.2478/saeb-2019-0006

Discretion of the Monetary Policy: An Exemplification with Bolivia

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Abstract

In this paper, we evaluate and quantify the role of the discretion of the monetary policy in an open small and open economy (the case of Bolivia). The results suggest that conventional instruments of the Central Bank respond in different ways: interest rates present a sensitive/elastic response to output gap (actual economic cycle) [1.8]; an inelastic mechanism to inflation [0.5]. On the other hand, open market operations in the Central Bank responds elastically to inflation [1.2] and insensible to the output gap. These results are robust to alternative specification utilizing the Generalized Method of moments (GMM), for the quarterly period from 2000(T1)-2015(T4).

Keywords: monetary policy; inflation; output gap; open market operations; elasticity; generalized moments.

JEL classification: C36; E31; E32; E43; E52; E58.

1. INTRODUCTION

This paper answers a research question: *how does the monetary policy react to the behavior of inflation and economic activity in Bolivia?*

To answer the question, the discretion of the monetary policy is assessed, which it employs the interest rates and open-market operations (Central Bank securities auctions), as the main instruments to control the inflation of the country (Crow, 1990; Mishkin, 1997; Hetzel, 2004), as well as its feedback of the level of the economic activity (Fischer, 1990; Dwyer, 1993; Gichuki *et al.*, 2012).

Empirically, the monetary policy in Bolivia is not guided by a rule of interest rates, which it generates the possibility of free discretion by the monetary authority. While some

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monetary instruments may be more effective than others, the measurement relevance will enable the assessment of the monetary authority's discretion dealing with economic shocks.

Similarly, there is no consensus in the Central Bank's interest rate response as an instrument of reaction to the inflation. In a sensitive way: for each 1% of inflation, the interest rate is increased by more than 1% (Valdivia and Montenegro, 2008; Mendieta, 2010) or even with a lower sensitivity response (inelastic or less to the unit) (Cerezo, 2010; Cernadas and Aldazosa, 2011).

Since the basic contribution of Taylor (1993), there are approaches to quantify the discretion of the central banks. These are addressed by increasing the interest rates of the monetary policy against the contemporary behavior in the inflation rates and positive gaps in the level of output or Gross Domestic Product – GDP (overheating stages), as well as a decrease in the interest rates (in the opposite direction).

The objective of this paper is to explain the generality of the monetary policy, with the main emphasis on the real economic activity and the price level. For this purpose, a Bolivian example is taken as a case study for the trimestral period: 2000 (T1) – 2015 (T4)[1], with alternative specifications in the estimations of models utilizing the Generalized Method of Moments (GMM).

As a result, the paper is structured into four sections. The first one approaches the theoretical foundation; the second one is the quantitative modelling of monetary policy; the third is about the findings and results based on different models specifications (robustness analysis); and the fourth section deals with the discussion of results, comparing them with previous studies, as well as the implications for public policies, limitations and agenda for future studies. At the end of the paper, the main conclusions of the paper are established.

1.1 Brief theoretical justification: the discretion of monetary policy

Since Taylor's (1993) transcendental contribution and the formalization of the interest rate instrument, there is a direct relationship with the level of inflation and the output gap. This mechanism was based on the quantification of the management of the Federal Reserve's monetary policy in the United States, during the period of 1987-1992, and it was determined by the following specification:

$$i_t = p_t + 0.5\, y_t + 0.5\, (p_t - p^*) + 2 \tag{1}$$

Where i_t is the interest rate of the monetary policy; p_t is the level of year on year inflation; y_t is the level of deviation from the real GDP in relation to its level of trend or potential output (GDP gap); finally, p^* is the target inflation level. Since the objective inflation of monetary policy was around 2% (p = 2), the expression (1) is reduced to Taylor's rule or principle:

$$i_t = 1 + 1.5\, p_t + 0.5\, y_t \tag{2}$$

Looking at the expression (2), if the inflation level is maintained at its target value ($p_t = 2$) and the actual GDP growth rate is equivalent to the potential growth rate of the economy ($y_t = 0$), then, the target policy interest rate will be 4%. For each unit increase in the price level, the interest rate is increased by 1.5 times: '*reacting more than one at a time* *at the level of inflation' (Taylor's principle*). On the other hand, for every 1% of positive deviation in the GDP gap (overheating of the economy); the interest rate is increased by 0.5%. In other words, at a higher level of inflation, a higher interest rate for the monetary entity; in addition, at a higher effective growth over its trendy level (output gap or overheating), a higher interest rate in the monetary policy.

1.2 Forward discretion

In the expression (2), it is assumed a contemporary role with a feedback effect (delay), where the interest rate, in *time t*, depends on the inflation and the GDP gap. Their variables perform a lag comparison (*backward looking*) between *time t* and its past values *t-4* (example: inflation); as a result, the critique is based on omitting future expectations (inflation and GDP gap).

Consequently, the contributions of Clarida *et al.* (1998) allow to consider a forward discretionary monetary policy:

$$i_t^* = i^* + \beta\left[E(\pi_{t,k}|\Omega_t - \pi^*\right] + \gamma E\left[y_{t,q}|\Omega_t\right] \quad (3)$$

i^* is the nominal interest rate of equilibrium; E implies expectations between time t and time forward; t+k; $y_{t,q}$ is the output gap between time t and time forward; t+q; Ω_t is the availability of information at time t. On the other hand, assuming that:

$$\alpha = i^* - \beta\pi^* \quad (4)$$

you get:

$$i_t^* = \alpha + \beta\left[E(\pi_{t,k}|\Omega_t\right] + \gamma E\left[y_{t,q}|\Omega_t\right] \quad (5)$$

In the expression (5), two additional explanatory factors are incorporated:

$$i_t^* = \alpha + \beta\left[E(\pi_{t,k}|\Omega_t\right] + \gamma E\left[y_{t,q}|\Omega_t\right] + \eta E\left[R_{t,q}|\Omega_t\right] + \rho i_{t-1} + \upsilon_t \quad (6)$$

where a feedback parameter is incorporated in the past interest rate (ρ) and an additional return on real exchange policy($R_{t,q}$).

2. QUANTITATIVE MODELING OF THE MONETARY POLICY

2.1 The data

According to Table no. 1, four relevant time-series are used: *the GDP gap*[1], as the difference between the effective and potential GDP (as a percentage of the potential GDP) (Banegas, 2016b, 2016a); 2) *the annual inflation rate* and 3) the variation of the interest rate of the securities in the Bolivian Central Bank (BCB).

Most of the variables are considered in different phases in order to avoid spurious relationships (stationary variables) according to the ADF and Ph-P tests. The variables were previously deseasonalized by the ARIMA-CENSUS-X12 method.

Table no. 1 – Descriptive Statistics

	GDP gap	Inflation	Variation in the interest rate
	100*(Yt-Y*)/Y*	π_t	Δi_t
Mean	0.1	5.9	(0.3)
Median	0.0	4.7	(0.1)
Maximum	2.2	15.2	3.0
Minimum	(1.7)	0.3	(4.8)
Std. Deviation	0.9	3.4	1.6
Std. Deviation/ Mean	15.2	0.6	(5.8)
Asymmetry	0.3	0.9	(0.8)
Kurtosis	2.9	3.3	4.5
Prob. J-B.	0.7	0.1	0.0

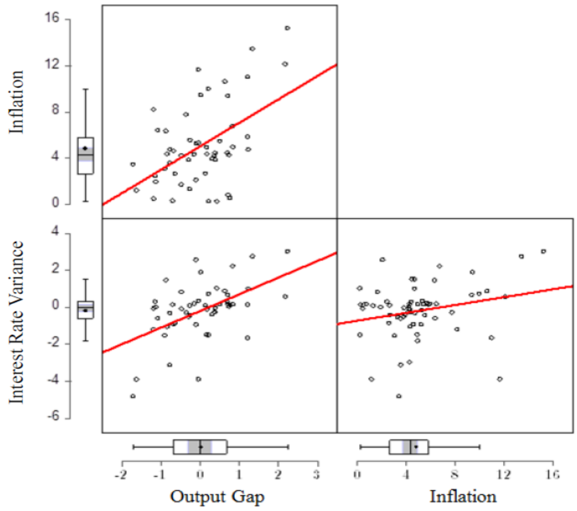
Source: own estimates

Descriptive statistics suggest that the inflation is the series with the highest value in its central trend during the period of 2000-2015. It is followed by the variation in the interest rate, which it records an average value of decrease (negative); the inflation and the output gap follow a normal behavior in terms of asymmetry, kurtosis and non-rejection of adjustment in the distribution. On the contrary, the interest rate variation does not follow a normal distribution, explained by high or low values in the ends (kurtosis with heaviness in the ends) – see Table no. 1.

Table no. 2 – Correlations

Correlation	GDP gap	Inflation	Variation in the interest rate
Probability	100*(Yt-Y*)/Y*	π_t	Δi_t
100*(Yt-Y*)/Y*	1.00		
π_t	0.60***	1.00	
Δi_t	0.60***	0.37**	1.00

Source: own estimates.



Source: own estimates

Figure no. 1 – Contemporary Scatter Diagram

In the contemporary correlations Table no. 2, the following statistically significant associations are explained: i) 1% of overheating in the economic activity, is positively related to 0.6% of positive variation in the inflation and the interest rate variation (0.01 level); ii) for each variation in the inflation of 1%, it is related to a positive variation in the interest rate of the Central Bank of Bolivia at 0.37% (at the level of 0.05). In the Figure no. 1, the associations (positive, negative or null) of the different interest variables are reflected.

2.2 Estimation models

2.2.1 The problem of utilizing OLS

The problem of utilizing linear estimation methods, such as Ordinary Least Squares (OLS) or Two-stage Least Squares (2LS), is based on the violation of the supposition of fixed explanatory variable in repeated sampling. There is a problem of endogeneity or simultaneity between the dependent variable (interest rate) and the explanatory variables (inflation and the output gap): simultaneous dependence (at the same time). Consequently, in order to solve the problem, it is important to use the default instruments or variables; therefore, the Generalized Method of Moments (GMM) is applied to solve the mentioned problem, and in function of the alternative specification instruments (Skumsnes, 2013).

2.2.2 Econometric Specifications: GMM

To demonstrate consistent responses related to the discretionary answers of the monetary policy, it is important to assess the robustness of the conclusions (reliability and consistency), especially when addressing different econometric specifications that are applied to the monetary policy (McCallum, 1999; Taylor, 1999). For this reason, the discussed methodologies are explained below.

2.2.3 Econometric Methods Employed

This method (GMM) contributes in eliminating the problem of endogeneity (between a dependent variable and explanatory factors), and the analysis of residual problems of heteroscedasticity and autocorrelation; not to mention, the assumption of relaxation in skewed residual distributions.

Accordingly, the following expression is mentioned:

$$\Delta i_t = \alpha + \beta\left[E(\pi_{t,k}|\Omega_t\right] + \gamma E\left[y_{t,q}|\Omega_t\right] + \eta E\left[R_{t,q}|\Omega_t\right] + \rho i_{t-1} + \upsilon_t \tag{7}$$

In (7), an auxiliary variable is introduced ϵ_{1t}

$$\epsilon_{1t} = -\left(\beta\left[\pi_{t,k} - E(\pi_{t,k}|\Omega_t\right] + \gamma\left(y_{t,q} - E\left[y_{t,q}|\Omega_t\right]\right) + \eta\left(R_{t,q} - E\left[R_{t,q}|\Omega_t\right]\right)\right) + \rho i_{t-1} + \upsilon_t \tag{8}$$

Therefore, it can be resolved:

$$\upsilon_t = \left(\beta\left[\pi_{t,k} - E(\pi_{t,k}|\Omega_t\right] + \gamma\left(y_{t,q} - E\left[y_{t,q}|\Omega_t\right]\right) + \eta\left(R_{t,q} - E\left[R_{t,q}|\Omega_t\right]\right)\right) + \epsilon_{1t} \tag{9}$$

In (9) i_t is introduced:

$$\begin{aligned}\Delta i_t = \alpha + \beta\left[E(\pi_{t,k}|\Omega_t\right] + \gamma E\left[y_{t,q}|\Omega_t\right] + \eta E\left[R_{t,q}|\Omega_t\right] + \rho i_{t-1} \\ + \left(\beta\left[\pi_{t,k} - E(\pi_{t,k}|\Omega_t\right] + \gamma\left(y_{t,q} - E\left[y_{t,q}|\Omega_t\right]\right) + \eta\left(R_{t,q} - E\left[R_{t,q}|\Omega_t\right]\right)\right) + \epsilon_{1t}\end{aligned} \tag{10}$$

Then, it will only remain:

$$\Delta i_t = \alpha + \beta \pi_{t,k} + \gamma y_{t,q} + \eta R_{t,q} + \rho i_{t-1} + \epsilon_{1t} \tag{61}$$

The expression (11) corresponds to the rule of monetary policy objective to estimate, eliminating the terms of expectations; using the instruments Z_t (lagged and contemporaneous variables and not correlated with ϵ_{1t}), in the information set Ω_t, which is orthogonal to ϵ_{1t}; therefore, you want to meet the condition.

$$E[\epsilon_{1t}|Z_t] = E\left[\Delta i_t - \alpha - \beta \pi_{t,k} - \gamma y_{t,q} - \eta R_{t,q} - \rho i_{t-1} \middle| Z_t\right] = 0 \tag{7}$$

The parameter vector to be estimated is:

$$\theta = f\{\alpha, \beta, \gamma, \eta, \rho\} \tag{8}$$

2.2.4 J-Test (Hansen)

In a general expression, (11) is equivalent to:

$$\Delta y_t = g_T(X_t, \theta) + \epsilon_{1t}, \quad t = 1,2,,,,,,T \tag{94}$$

Introducing in (14), zero covariance between the instruments and remains:

$$E[Z_t' \epsilon_t] = 0 \tag{10}$$

Replacing (14) in (15):

$$E\left[Z_t'\left(\Delta y_t - g_T(X_t, \theta)\right)\right] = 0 \tag{11}$$

In (16) a function is defined to estimate:

$$f\{\theta, \Delta y_t, Z_t, X_t\} = Z_t'\left(\Delta y_t - g_T(X_t, \theta)\right) \tag{12}$$

The orthogonality condition is written as:

$$E[f\{\theta, \Delta y_t, Z_t, X_t\}] = 0 \tag{13}$$

In (18), a theoretical expectation is expressed and the expression of the empirical average of the values is obtained$f\{\theta, \Delta y_t, Z_t, X_t\}$:

$$g_T(\theta, \Delta y_t, Z_t, X_t) = \frac{1}{T}\sum_{t=1}^{T} f(\theta, \Delta y_t, Z_t, X_t) = \frac{1}{T}\sum_{t=1}^{T} Z_t'\left(\Delta y_t - g_T(X_t, \theta)\right) \tag{14}$$

Therefore, in (19) the basic definition of GMM is to choose θ estimators to achieve that $g_T(\theta, \Delta y_t, Z_t, X_t)$be as close as possible to the theoretical expectations of$E[f\{\theta, \Delta y_t, Z_t, X_t\}]$. Likewise, the J-test is established in a test for over-identified restrictions (the number of instruments exceeds the number of parameters): $Z_{t_n} > \theta_n$.

The null hypothesis, of correct specification of the model in instruments and orthogonality (over-identified): where there is zero covariance between remains and instruments, is considered with:

$$H_0: g_T(\theta, \Delta y_t, Z_t, X_t) = 0$$
$$H_1: g_T(\theta, \Delta y_t, Z_t, X_t) \neq 0 \quad (20)$$

In (20), it is expected to not reject the null hypothesis and therefore, the model is adjusted to the data, as far as $g_T(\theta, \Delta y_t, Z_t, X_t)$ is around zero; otherwise, the model will be poorly specified (instruments and its relation to waste).

In particular, the General Method of Moments (GMM) is applied to address the relationship of the discretionary monetary policy according to the interest rate and the output gap (in a problem of endogeneity).

3. FINDINGS AND RESULTS

3.1 Robustness analysis in the discretion of the monetary policy

The evaluation of the discretion of the monetary policy through the variation of the interest rate, allows the conclusion of the following assessments:

- For every 1% of the contemporary inflation (in the current period), the interest rate of the Central Bank is increased between 11 and 14 points (at 0.05 of statistical significance); in other words, in order to increase the Bolivian Central Bank (BCB) interest rate by 1%, the contemporary inflation must be in the range of [7%-9%] (Table no. 3: models A, B, C and D).

Table no. 3 – Response in the variation of the interest rate – contemporary discretionary monetary policy

Dependent variable: Variation in the interest rates in the Central Bank					
Method: Generalized Method of Moments (GMM)					
Standard errors, covariances with estimations: HAC (Bartlett kernel, Newey-West fixed bandwidth = 4.0000).					
Variable	**Parameter**	**Model A**	**Model B**	**Model C**	**Model D**
Intercept	α	**-0.64*****	**-0.64*****	**-0.52†**	**-0.57****
		(0.22)	(0.20)	(0.27)	(0.22)
		-2.88	-3.28	-1.94	-2.57
Δi_{t-1}	ρ	**-0.12**	**-0.04**	**-0.18**	**-0.15**
		(0.09)	(0.11)	(0.14)	(0.12)
		-1.39	-0.41	-1.31	-1.22
π_t	β	**0.14*****	**0.13*****	**0.11****	**0.12*****
		(0.04)	(0.03)	(0.05)	(0.03)
		3.22	3.71	2.40	3.36
$100*(Y_t-Y^*)/Y^*$	γ	**0.46****	**0.50*****	**0.50*****	**0.50*****
		(0.20)	(0.15)	(0.20)	(0.17)
		2.34	3.22	2.54	2.98
$100*(R_t-R^*)/R^*$	η			**-0.04**	**-0.03**
				(0.05)	(0.04)
				-0.80	-0.72
Adjusted R^2		0.45	0.53	0.49	0.49

Variable	Parameter	Model A	Model B	Model C	Model D
# of Instruments		9.00	12.00	9.00	12.00
Stat - J (Prob. J)		1.51(0.68)	3.75(0.71)	2.40 (0.49)	4.09(0.66)
Norm. J-B. (Prob. J-B)		3.81(0.15)	3.37(0.18)	0.71(0.70)	1.10(0.58)
Durbín-Watson (D-W)		1.63	1.70	1.58	1.63
Number of impulse variables		2.00	2.00	1.00	1.00
Standard regression error		1.13	1.06 $^{\xi}$	1.09	1.10

Note: Statistical significance level: *** 1%; ** 5%; † 10%. $^{\xi}$ It implies minimization of standard errors of models.

Source: own estimates

In the adjusted sample, observations are lost back and forth by the use of the Baxter-King filter (band-step filter). These results are practically identical to the estimates with the Christiano-Fitzgerald filter).

- For every 1% of the future inflation to one year (forward), the Central Bank's interest rate is increased between 0.19 and 0.21 points (at 0.05 of statistical significance); in other words, in order to increase the interest rate of the Central Bank by 1%, the future inflation (one year ahead) must be around 5% (Table no. 4: models E and F).

Table no. 4 - Response in the variation of the interest rate – discretionary monetary policy with a forward perspective

Dependent variable: Variation in the interest rates in the Central Bank			
Method: Generalized Method of Moments (GMM)			
Standard errors, covariances with estimations: HAC (Bartlett kernel, Newey-West fixed bandwidth = 4.0000).			
Variable	**Parameter**	**Model E**	**Model F**
Intercept	α	**-1.21****	**-1.16****
		(0.55)	(0.52)
		-2.21	-2.24
Δi_{t-1}	ρ	**-0.13†**	**-0.16**
		(0.07)	(0.11)
		-1.87	-1.39
$\pi_{(t,k)}$	β	**0.21****	**0.19****
		(0.10)	(0.09)
		2.23	2.18
$100*(Y_{t,q}-Y^*)/Y^*$	γ	**0.48*****	**0.49*****
		(0.10)	(0.15)
		4.97	3.33
$100*(R_t-R^*)/R^*$	η		**-0.10†**
			(0.06)
			-1.85
Adjusted R^2		0.45	0.47
# of instruments		9.00	12.00
Stat. - J (Prob. J)		1.13(0.57)	1.90(0.93)
Norm. J-B. (Prob. J-B)		2.43(0.30)	0.94(0.92)
Durbin-Watson (D-W)		1.57	1.68
Number of impulse variables		2.00	2.00
Standard regression error		1.13	1.12 $^{\xi}$

Note: Statistical significance level: *** 1%; ** 5%; † 10%. $^{\xi}$ It implies minimization of standard errors of models. In the adjusted sample, observations are lost back and forth by the use of the Baxter-King filter (band-step filter). These results are practically identical to the estimates with the Christiano-Fitzgerald filter).

Source: own estimates

- For every 1% of the future inflation between 2 and 3 trimesters forward, the open market operations (purchase of bonds in auctions) are increased at 1.2% (at 0.05 of statistical significance) on average (Table no. 5: models H, I, J and K).
- For every 1% of overheating in the economic activity (effective output above the potential GDP), the interest rate is increased between 46 and 50 points (at 0.05 of statistical significance) (Table no. 4 and no. 5: models A, B, C, D, E and F).
- The GDP gap does not statistically affect the variations in in the open market operations (securities auctions) (Table no. 5: models H, I, J and K).

Table no 5 – Response in the variation of open market operations – discretionary monetary policy with a forward respective

Dependent variable: Variation of open market operations					
Method: Generalized Method of Moments (GMM)					
Standard errors, covariances with estimations: HAC (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)					
		k' =2		***k' =3***	
Variable	**Parameter**	**Model H**	**Model I**	**Model J**	**Model K**
Intercept	α	**0.11**	**-5.35†**	**-6.57****	**-2.76**
		(1.74)	(2.88)	(2.49)	(1.88)
		0.06	-1.86	-2.64	-1.47
Δ ***Log (OMA)***$_{t-1}$	ρ	**0.20**	**0.16**	**0.17**	**0.25****
		(0.13)	(0.16)	(0.13)	(0.10)
		1.63	1.00	1.29	2.59
$\pi_{(t, k)}$	β	**0.71****	**1.51*****	**1.55*****	**0.95*****
		(0.34)	(0.53)	(0.45)	(0.30)
		2.06	2.83	3.45	3.11
$100*(Y_{t,q}-Y*)/Y*$	γ	**1.53**	**0.77**	**1.78†**	**2.70*****
		(1.04)	(1.15)	(0.96)	(0.75)
		1.48	0.67	1.86	3.58
$100*(R_t-R*)/R*$	η		**-0.40****	**-0.68*****	**-0.64*****
			(0.18)	(0.22)	(0.19)
			-2.22	-3.09	-3.40
Adjusted R^2		0.45	0.51	0.41	0.41
# of instruments		9.00	9.00	9.00	12.00
Stat. - J (Prob. J)		2.48(0.78)	4.24(0.37)	2.72(0.61)	4.92(0.67)
Norm. J-B. (Prob. J-B)		0.50(0.78)	0.45(0.80)	0.18(0.91)	0.49(0.78)
Durbin-Watson (D-W)		1.73	1.81	1.77	1.86
Number of impulse variables		0.00	0.00	0.00	0.00
Standard regression error		6.34	5.96$^{\xi}$	6.52	6.57

Note: Statistical significance level: *** = 1%; ** = 5%; † = 10%. $^{\xi}$ It implies minimization of standard errors of models. k' = 2 y k' = 3 It implies that the dependent variable is based on the expected inflation in two and three trimesters forward respectively. In the adjusted sample, observations are lost back and forth by the use of the Baxter-King filter (band-step filter). These results are practically identical to the estimates with the Christiano-Fitzgerald filter).

Source: own estimates

The initial approach was related in evaluating the interest rate response and open-market operations to the inflation and the GDP gap, in line with Taylor's (1993) traditional perspective. Likewise, the discretionary monetary policy in Bolivia is explained between 47% and 53% due to the inflation behavior and the GDP gap (Tables no. 3, no. 4 and no. 5: models A, B, C, D, E, F, H and K).

In the Table no. 6, the null hypothesis is rejected, which it consists that 1% of the inflation (contemporaneous or forward) increases the interest rate in the same magnitude (at the level of the 0.01 of statistical significance) [models A, B, C, D, E and F]; however, the null hypothesis of unitary response is not rejected in the variation of open market operations or public auctions (Table no. 7, models H, I, J and K).

Table no 6 – Taylor's hypothesis test: response of interest rate (Monetary Policy)

Ho: $\gamma = 0.50$		
Model	**Prob. t**	**Prob. $\chi 2$**
A	0.827	0.826
B	0.991	0.991
C	0.998	0.998
D	0.990	0.990
E	0.847	0.223
F	0.962	0.863

Source: own estimates

Table no. 7 - Taylor's hypothesis test: response of open market operation (Central Bank)

Ho: $\beta = 1.00$		
Model	**Prob. t**	**Prob. $\chi 2$**
A	0.000	0.000
B	0.001	0.000
C	0.000	0.000
D	0.000	0.000
E	0.000	0.000
F	0.000	0.000

Source: own estimates

According to Taylor's approach (1993), 1% of overheating increases the interest rate by 0.5%, therefore, the null hypothesis is not rejected (Table no. 8: models A, B, C, D, E and F).

Table no. 8 – Taylor's hypothesis test: response of interest rate to GDP gap

Ho: $\beta = 1.00$		
Model	**Prob. t**	**Prob. $\chi 2$**
H	0.396	0.391
I	0.346	0.340
J	0.231	0.223
K	0.864	0.863

Source: own estimate

Table no. 9 – Elasticities in the variation of the interest rate (response to inflation and GDP gap) GMM Estimations

Model	**Equation**		
Lin-Log	$\Delta it = \alpha + \beta \pi t + \gamma (Yt-Y^*)/Y^* + \varepsilon t$		
	Variation of the interest rate - Inflation (πt)		
	Slope	Semi-elasticity	Elasticity (ξ)
Model	β $(1/\pi t)$	β	$\|\beta/\Delta i\|$
A	0.02	0.14***	0.52

	Slope	Semi-elasticity	Elasticity (ξ)
B	0.02	0.13***	0.48
C	0.02	0.11**	0.41
D	0.02	0.12***	0.44
Mean Distribution	0.02	0.13	0.5
Model	**Equation**		
Lin-Log	**$\Delta it = \alpha + \beta\ \pi\ t{+}k + \gamma\ (Yt-Y^*)/Y^* + \varepsilon t$**		
	Variation in the interest rate - Inflation expected to 1 year (πt+4)		
	Slope	Semi-elasticity	Elasticity (ξ)
Modelo	*β (1/π t)*	*β*	|*β*/Δ*i*|
E	0.04	0.21**	0.78
F	0.03	0.19**	0.70
Mean Distribution	0.03	0.2	0.7
	Variation in the interest rate - Output gap		
	Slope	Semi-elasticity	Elasticity (ξ)
Model	*γ (1/(Yt-Y*)/Y*)*	γ	|γ/Δ*i*|
A	7.72	0.46**	1.70
B	8.39	0.50***	1.85
C	8.39	0.50***	1.85
D	8.39	0.50***	1.85
E	8.06	0.48***	1.77
F	8.22	0.49***	1.81
Mean Distribution	8.2	0.5	1.8

Note: Statistical significance level: *** 1%; ** 5%; N.S. Not significant.

Source: own estimates

Table no. 10 – Elasticities in the auction public securities (Response to inflation and GDP gap)

Model	**Equation**	
Log-Log	**$\Delta Log\ (OMAs\ t) = \alpha + \beta\ \pi\ t{+}k + \gamma\ (Yt-Y^*)/Y^* + \varepsilon t$**	
	Variation in the open market operations - Inflation	
	Slope	Elasticity (ξ)
Model	*β (Δ Log (OMAs)/π t)*	|*β*|
H (πt+2)	0.5	0.7**
I (πt+2)	1.0	1.5***
J (πt+3)	1.0	1.6***
K (πt+3)	0.6	1.0***
Mean Distribution	**0.8**	**1.2**
	Variation in the open market operations - Product gap	
	Slope	Elasticity (ξ)
Model	γ (Δ (Log (OMAS t)/(Yt-Y*)/Y*)	|γ|
H	N.S.	N.S.
I	N.S.	N.S.
J	N.S.	N.S.
K	N.S.	N.S.

Note: Statistical significance level: ***1%; **5%; N.S. Not significant.

Source: own estimates

When calculating the sensitivity (in terms of elasticities) of the instruments of the discretionary monetary policy (interest rate and public auctions) to the heading of inflation and fluctuations in the real production (Tables no. 9 and no. 10), it is evident that:

- Discretion of lower sensitivity in variations of the interest rate to inflation (inelastic sensitivity) with an average value of 0.5. For every 1% in the price change, the Central Bank's interest rate is increased by 0.5% (Table no. 9).
- Elastic response in the variation of the interest rates to the changes in cyclical fluctuations. For every 1% change in the GDP gap, the interest rates vary 1.8% (Table no. 9).
- Sensitive response (elastic) in the public auctions placement of the Central Bank securities (open market operations) against the behavior of inflation (Table no. 10).
- The percentage changes in the public auctions placements of the Central Bank securities do not significantly respond to the changes in the cyclical fluctuations of the economy (Table no. 10).

4. DISCUSSION OF RESULTS

According to the results of the document, (applied it to a small and open economy: the case of Bolivia) there is a theoretical and empirical consistency that the interest rate of the Central Bank responds positively and directly to the inflation rate (contemporary and expected), as well as to the overheating phases in the GDP gap.

However, the response magnitude is different to the reference parameters from the Taylor's seminal paper (1993). On the one hand, there is evidence in the literature where the Central Bank (the case of Bolivia), through its instrument of discretionary interest, responds in a sensible way above the ratio of 1 to 1 with inflation (Valdivia and Montenegro, 2008; Mendieta, 2010) or even with a lower sensitivity (less than one) response (Cerezo, 2010; Cernadas and Aldazosa, 2011). There is also no consensus on the orientation of the interest rate response to the GDP gap.

In the case of Bolivia, the Central Bank reacts in a positive/direct way on the interest rates (on a discretionary basis), against the behavior of the inflation and the GDP gap. However, the response preference is different: sensitivity is presented in the interest rate reaction to the GDP gap ($\xi > 1$); while the balances of public auctions or open market operations respond in an elastic and unitary way to the inflation behavior ($\xi \geq 1$). In Table no. 12, a comparison is made with previous studies (the case of Bolivia)

The quantification of the discretion of the monetary policy (the case of Bolivia), allows to quantify the orientation of responses, in terms of instruments and against scenarios of specific disturbances. Also, the estimated parameters will serve for the evaluation and simulation of monetary rules compared to alternative and dynamic economic structures (DSGE models). Table no. 11 presents a systematization of responses and discretionary instruments of the monetary policy.

Table no. 11 – Systematization of the monetary policy in Bolivia Instruments

Answer to:	Instrument
Inflation	Open market operations instrument (elastic sensitivity)
GDP gap (real economic cycle)	Interest rate (elastic sensitivity)

Source: own elaboration

Table no. 12 – Discretion of the monetary policy – comparison of parameters with previous studies in Bolivia

Authors	Specification	Description	Methodology	Parameters
Valdivia and Montenegro (2008)	$r_t = \psi_i r_{t-1} + (1-\psi_i)(\psi_\pi \pi_t + \psi_y y_t + \psi_{\Delta s}\Delta s_t) + v_t$	r_t Is the real interest rate; ψ_π y ψ_y y are the long term responses of inflation deviations; (π_t) is the product growth(y_t) of their steady state levels; $\psi_{\Delta s}$ is the reaction of a nominal devaluationΔs_t.	DSGE, based on Taylor´s rule of type Schmith – Hebbel & Tapia (2002) and Caputo et. al. (2006).	$r_t = 0.96 r_{t-1} + (1-0.96)(1.25\,\pi_t + 6.9070\,y_t - 14.95\,\Delta s_t) + v_t$
Cernadas and Aldazosa (2011)	(1) $i_t = (1-\rho)\bar{\imath} + \alpha(1-\rho)\pi_{t+n} + \gamma(1-\rho)(Y_t - Y^*) + \rho i_{t-1} + \varepsilon_t$ (2) $SCN_t = (1-\rho)\overline{SCN} + \alpha(1-\rho)\pi_{t+n} + \gamma(1-\rho)(Y_t - Y^*) + \rho i_{t-1} + \varepsilon_t$	i_t is the nominal interest rate. π_{t+n} Is the inflation of n months forward; $Y_t - Y^*$ represents the GDP gap; SCN_t symbolizes the balances placed in the open market operations.	Generalized Method of Moments (GMM), 1995-2009	ρ ; $\bar{\imath}/\overline{SCN}$; α ; γ n=3 (1) 0.897 ; 4.762 ; 0.273 ; 0.416 (2) 0.829 ; 2.869 ; 1.211 ; 0.773 n=6 (1) 0.881 ; 4.653 ; 0.236 ; 0.313 (2) 0.929 ; 2.171 ; 1.106 ; 0.455 n=9 (1) 0.933 ; 4.200 ; 0.329 ; -0.31 (2) 0.889 ; 1.735 ; 0.954 ; 0.546 n=12 (1) 0.858 ; 4.826 ; 0.133 ; 0.656 (2) 0.895 ; 2.353 ; 0.754 ; 0.946
Cerezo (2010)	(1) $(\widehat{1+\iota_t}) = \rho_\iota(\widehat{1+\iota_{t-1}}) + \rho_\pi\widehat{\pi_{c,t}} + \rho_y\widehat{y_{c,t}} + \rho_e\widehat{e_{c,t}} + sm_t$ (2) $(\widehat{1+\iota_t}) = \rho_\iota(\widehat{1+\iota_{t-1}}) + \rho_\pi\widehat{\pi_{c,t}} + +\rho_e\widehat{e_{c,t}} + sm_t$	i_t is the nominal interest rate; $\pi_{c,t}$ is the inflation of n months forward; y_t represents the GDP gap; e_t represents the exchange rate.	DSGE Model, log-linearized (the value of each variable with respect to its long term value).	(1) $(\widehat{1+\iota_t}) = 0.95(\widehat{1+\iota_{t-1}}) + 0.62\widehat{\pi_{c,t}} + 0.61\widehat{y_{c,t}} - 0.84\widehat{e_{c,t}} + sm_t$ (2) $(\widehat{1+\iota_t}) = 0.98(\widehat{1+\iota_{t-1}}) + 0.30\widehat{\pi_{c,t}} - 0.34\widehat{e_{c,t}} + sm_t$
$^{\xi}$This paper	(1) $\Delta i_t = \alpha + \beta\pi_t + \gamma y_{t,k} + \eta R_{t,q} + \rho i_{t-1} + \epsilon_{1t}$ (2) $\Delta i_t = \alpha + \beta\pi_{t,k} + \gamma y_t + \eta R_{t,q} + \rho i_{t-1} + \epsilon_{2t}$ (3) $\Delta\log(OMA)_t = \alpha + \beta\pi_{t,k} + \gamma y_t + \eta R_{t,q} + \rho\log(OMA)_{t-1} + \epsilon_{3t}$	i_t is the nominal interest rate; $\pi_{t,k}$ is the inflation of k months forward; y_t represents the GDP gap; R_t represents the real exchange rate; OMA represents the open market operations (securities auction).	Generalized Method of Moments (GMM), 2000-2015	Better specifications according to RMSEA criteria of information and minimization. (1) $\Delta i_t = -0.64^{***} + 0.13^{***}\pi_t + 0.50^{***}y_t - 0.04 i_{t-1} + \epsilon_{1t}$ (2) $\Delta i_t = -1.16^{**} + 0.19^{***}\pi_{t+4} + 0.49^{***}y_t - 0.16 i_{t-1} + 0.10^{\dagger}y_t + \epsilon_{2t}$ (3)$\Delta\log(OMA)_t = -5.35^{\dagger} + 1.51^{***}\pi_{t+2} + 0.77 y_t + 0.40^{**}R_t + 0.16\log(OMA)_{t-1} + \epsilon_{2t}$ Response of interest rate (elasticities) (ξ) $\xi_{conteporary\ inflation.} = 0.5$ $\xi_{future\ inflation} = 0.7$ $\xi_{product\ gap} = 1.8$ Elasticities in the auction public securities (open market operations) (ξ) $\xi_{future\ inflation} = 1.2$ $\xi_{product\ gap} = N.S.$ Statistical significance level: ***1%; ** 5%; † al 10%; N.S: not significant.

Source: own elaboration

Within the limitations of the paper, it is intended as an agenda for future research, the combined role between interest rates, open market operations, expectations and uncertainty models, with alternative model specifications to avoid the wrong conclusions, and therefore their robust evidences.

5. CONCLUSIONS

This paper provided an answer to a research question about the reaction and discretion of the discretionary monetary policy against the behavior of the inflation and the GDP gap in a small and open economy (the case of Bolivia).

Previous studies found statistical significance explained by inflation rate (contemporaneous, back or forward approach), as GDP gap and nominal exchange rate devaluation, even though elastic or inelastic effect is the debate in order to assess what variables are the key macroeconomic attention that reflect the greatest sensibility to conduct the monetary policy.

To this end, we used a discretionary quantification (standard) from the Taylor´s measurement (1993), where the interest rate of the Bolivian Central Bank responds positively and inelastic against the change in the level of inflation (elasticity = 0.5) and sensitive to the GDP gap/actual economic cycle (elasticity = 1.8). However, the instrument in the public auction of securities (open market operations) responded in a sensible way (elasticity = 1.2) at the price level, therefore, the null hypothesis of unitary sensitivity (1 to 1) is not rejected. We found no difference between the responses of monetary policy to contemporaneous or forward inflation rate (with the same implication to conduct the interest rate policy).

The significant incidence of the inflation and the GDP gap help to explain about 50% of the variance in the interest rate and the Central Bank's securities auction balances (open market operations). The conclusions provided were robust to different alternative models of econometric specification (General Method of Moments – GMM), for the case of Bolivia.

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Notes

[1] Period characterized by a downward course in the interest rates and the presence of two slowdowns, influencing the Bolivian economy: the low rates of growth in the real economic activity after 1999 and the international financial crisis (2009).

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