E C O N O M I C S B U L L E T I N

DYNAMICS OF THE SELIC INTEREST RATES-TARGET IN BRAZIL

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Abstract

The present work analyzes the discrete dynamic of the SELIC interest rates-target defined in the meetings of the Brazilian Monetary Policy Council (COPOM). The probit model methodology was applied in order to study the probability of Central Bank increase or decrease SELIC-target interest rate. We found that the inclusion of a fiscal (primary fiscal surplus/GDP) and the lagged output gap variables must be considered important ones to COPOM's decision making processes.

We thank Marcelo Portugal, Ronald Hillbrecht and Roberto Meurer for helpful comments that greatly improved this paper
Citation: Caetano, Sidney and Geraldo Silva Jr., (2007) "DYNAMICS OF THE SELIC INTEREST RATES-TARGET IN BRAZIL." *Economics Bulletin*, Vol. 5, No. 19 pp. 1-12
Submitted: June 7, 2007. **Accepted:** October 6, 2007.
URL: http://economicsbulletin.vanderbilt.edu/2007/volume5/EB-07E00004A.pdf

1. INTRODUCTION

Since the ends of years 40, the monetarism of Milton Friedman already advocated a rule for the behavior of the monetary policy, establishing a target to the monetary aggregates growth rates. Such rate always would be constant and equal to rate of growth of GDP. His criticism and proposals had been oriented toward avoid discretionary behavior of monetary authorities in a time rules would impose discipline to the government, raising credibility and efficiency to monetary instruments.

Historically, the advocation of rules based on monetary aggregates, caused by financial innovations, and institutional changes, and unexpected of money circulation velocity, become an unsuccessful event. Although, the tribute to Friedman's seminal contributions on monetary policy has centered on inflation control to be the role monetary authority, according to Barro (2007).

Consequently, the simplicity of Friedman's rule were changed by important methodological and empirical innovations that enhanced the debate rules versus discretion on monetary policies as a filed of research the last century quarter.

In line to a theoretical discussion another one sourced by empirical results and the unsuccessful monetary aggregate rules presented inflation target as guide to monetary policy since early of 1990. That regime was adopted by New Zealand Central Bank in 1989/1990 and currently has been followed for many countries, including not officially Federal Reserve Board (FED) in the United States, see Mankiw (2006).

In 1999, the Brazilian Central Banking also adopted that regime in order to search deflationary policies in substitution of nominal exchange rate anchor established since 1994.

A generalized characteristic of inflation target regime has been the use of Taylor's rule, suggested by Taylor (1993), arranged as a guide for monetary policy and providing credibility, flexibility and cleared up the position of monetary authority what must be necessary on inflationary and developing economies, as well as developed and non inflationary ones (see Taylor, 2000)

COPOM's decisions on SELIC interest rate-target has been predicted by financial institutions, economists, academics, and other ones, intending to know its motion.

SELIC's trend alternated directions, through the period from July 1999 to August 2006, proving the role of Central Bank in control aggregate demand and surpass inflationary inertia assuring inflation convergence for targets stipulated by National Monetary Council (CMN).

The apprehensive market behavior appears in the eves of COPOM's meetings to decide the SELIC interest rate-target. So, the unknown parameters and determinant variables to COPOM's choices explain market uncertainty.

Therefore, this paper analyzed the dynamics of the SELIC interest rate-target from discrete approach. The specific objective was to investigate if the lagged output gap and inflation deviations from the inflation target would be determinant factors to explain COPOM's decisions for direction of SELIC interest rate-target motion.

The reminder of this paper is organized as follow: in section 2 was presented a discussion on rules of monetary policies; in section 3 was presented the data set and probit model methodology; in section 4 the results and a discussion were considerate; finally, in section 5 a conclusion were established.

2. RULE OF MONETARY POLICY

According to Barro (2007), a proposal to fix a rule for monetary authorities constitutes the Friedman's legacy, mainly Friedman's rule and seminal contributions on monetary policies in the ends of the Forties.

Amongst fixed rules and feedbacked ones the practical and accepted for its flexibility has beend Taylor'r rules, proposed by Taylor (1993), ans specified as:

$$r = p + 0.5y + 0.5(p - 2) + 2 \quad (1)$$

where:
r = is the federal funds rate;
p = is the rate of inflation over the previous four quarters; and
y = is the percent deviation of real GDP from a target.

As Central Bank uses the nominal interest rates to minimize inflation and output variations the equation (1) demonstrate that federal fund rate rises if inflation surpass a target of 2 percent or if real GDP is on target, and then the federal funds rate would be equal to 4 percent.

Questions about criticism to this kind of rules would be that monetary aythorities would use rules mechanically. But, economic literature has no evidence from mechanic aspects of Central Banks using rules. However, if rules are specified as equations like motion equation it still would be a mechanic formula. The suggestions for use monetary rules are that rules works out as guides, even to emergent countries. Taylor's rule woul be an excellent example (see Taylor, 1993, p. 198-199): […] the term "policy rule" need not necessarily mean either a fixed setting for the policy instruments or a mechanical formula.

Another question would be that the pragmatism of rules requires limited discretion except on situations which changes on monetary instruments, on targets, and controlled variables requests.

Original Taylor's rules presented signicant empirical results as well as modified Taylor's rule adapted to emergent countries. Thus, reactions's function has been proposed and estimated including variables alternatives to original ones, Dueker (1999); Clarida *et al.* (2000); McCallum (2000); Hamilton and Jorda (2002); Salgado *et al.* (2005); Carneiro and Wu (2004); Hu and Phillips (2004).

In that collection of published papers, some authors used a discrete approach for the dynamics of the interest rates as an alternative to continuum, see Dueker (1999), Hamilton and Jorda (2002) and Hu and Phillips (2004). The present paper adopted that perspective in order to study the SELIC interest rate-target using probit model methodology.

3. PROBIT MODEL METHODOLOGY AND DATA

The complexity of COPOM's decision, once its members forecasts risks of inflation convergence to target, two basic variables are considered: lagged output gap and inflation deviations from a target. Therefore, would be necessary to verify if those variables determines the direction of SELIC's motion: increase or decrease. Moreover, changing inflation deviation for inflation expectations (12 leads), as well as including a fiscal variable (primary fiscal surplus/GDP) were analyzed.

Probit models methodologies are important to achievement of marked aims of this paper. They use cumulative distribution functions of standard normal distributions. Let be an occurrence of COPOM increase SELIC equal to one and other possibility, to decrease receive the attribute zero. So, generically the problem is presented as:

$$\Pr(y_i = 1 | x_i, \beta) = 1 - F(-x_i'\beta) \quad (2)$$

where:
F = a continuous and strictly increasing function;
y_i = SELIC increased;
x_i = independent variables; and

β = parameters.

The choice of the function F determines the type of binary model. The opposite option is determinated as:

$$\Pr(y_i = 0 | x_i, \beta) = F(-x_i'\beta). \quad (3)$$

The estimation of model parameters is provided using maximum likelihood procedure given by equation (4):

$$l(\beta) = \sum_{i=0}^{n} y_i \log(1 - F(-x_i'\beta)) + (1 - y_i)\log(F(-x_i'\beta)). \quad (4)$$

The first order conditions for this likelihood are nonlinear so that obtaining parameter estimates requires an iterative solution. We use a second derivative method for iteration and computation of the covariance matrix of the parameter estimates.

Statistics dataset encloses monthly frequencies from August of 1999 to August of 2006 sourced from Brazilian Central Bank (www.bcb.gov.br) e National Bureau of Geography and Statistics (www.ibge.gov.br). We used variations of official inflationary index – Broad Consumer Price Index (IPCA), expectations of inflation measured to IPCA twelve leads, the lagged output gap considered monthly industrial production as appropriated proxy and its trends computed by Hodrick-Prescott filter, and primary fiscal surplus/GDP as a fiscal variable to be tested.

A gradualist procedure for SELIC interest rate-target has been announced by monetary authorities therefore would be corroborated by the evidence of short length and some trend inversions (see Martins, 2003, p.64).

Figure 1 shows evidence for a gradualist procedure for the period from March 1999 to August 2006. In Table 1 we synthesize 19 decisions to increase SELIC-target and 39 to decrease from 89 meetings. Despite that the length of motions concentrates from 50 to 100 point base in absolute terms. Amongst the length of motions we concluded decreases occurrences surpass in number increase ones.

Also we appointed 32 days as average number for each motion, 147 to maximum number of days without motion, and 2 days to minimum. It determines that Brazilian Central Bank behavior excluding weekends and holidays.

Another fact would be that uncommon inversions in trend occurred, characterized as inversions proceeded by opposite motion. So, from 58 determined changes on SELIC-target, 19 increases and 39 decreases, only 7 represented trend inversion.

4. ANALYSIS

We specified four models applied to data set in order to predict the COPOM's decision to direction of SELIC-target, as known:

(i) First model: inflation deviation and lagged output gap as independent variables;
(ii) Second model: inflation expectations (12 leads) deviations and lagged output gap;
(iii) Third model: inflation deviation, lagged output gap, and primary surplus/GDP; and
(iv) Fourth model: inflation expectations (12 leads) deviations, lagged output gap, and primary fiscal surplus/GDP.

Table 2 summarizes basic results to our four models. To first model both independent variables (inflation deviation and lagged output gap) are significant in explain predicted probability of the COPOM to increase/decrease SELIC interest rate-target, caused by relation among variables.

To second model showed higher impact for inflation deviation on COPOM's decisions, and as in the first model the significance were the same one.

Based on the structures of both models we concluded inflation deviation and lagged output gap consisted in important parameters for market predictions on COPOM's decisions.

Inserting primary fiscal surplus/GDP in the analysis, see Table 2, we noted direct and significant relation to that fiscal variable. Maybe the mechanism accorded to IMF about primary surplus imposed a new target to monetary authorities and searching that aim caused statistical significant results.

Coefficient values on binary models are troublesome and cannot be considered as marginal effects on dependent variable. Marginal effects of x_j independent variables vector on the conditional probability are given by:

$$\frac{\partial E(y_i|x_i,\beta)}{\partial x_{ij}} = f(-x_i'\beta)\beta_j \text{, where } f(x) = dF(x)/dx \text{ is F's density function.} \quad (5)$$

Note that β_j is weighted by a factor f that depends on the values of all of the regressors in x. So, a form to present the marginal effect would be through the average of the derivatives, showed in Tables 3 to 5.

Inflation deviation proportional differences were distinguishable. Noted in Table 3 inflation deviation caused higher effect in COPOM's decision to increase SELIC-target. So, Brazilian Central Bank is always declared the aims on convergence process of inflation to the target inflation and some concern on inflation level.

The differences between Third and Fourth models are described by importance of primary fiscal surplus/GDP variable. Pursuing inflation deviation marginal effect behavior primary fiscal surplus/GDP constitutes an important variable and signal to market decisions on COPOM's decision processes. Since output lagged gap maintained its robustness inclunding fiscal variable.

The estimation coefficients process for binary models to investigate how probabilities predictions changes with independent variables includes plotting 'Probability Response Curves' to Fourth models.

Suppose we are interested in the output lagged gap marginal effect on SELIC-target. To trace fitted SELIC-target probabilities as output lagged gap applying on SELIC-target fix primary fiscal surplus/GDP average ($\bar{s}$). So, included/excluded output lagged gap and replace primary fiscal surplus/GDP to inflation deviation, see Greene (1997, chapter 19th).

Figure 2 presented estimation results for models that explain the increase on Selic-target. The LR statistics and p-values showed the rejection of the joint null hypothesis, implying in the overall significance of the models. McFadden R-squared revealed to it better in Fourth Model.

We noted lagged output gap effect on probabilities, showed in Figure 3, to inflation deviations and primary fiscal surplus/GDP cases with and without lagged output gap.

Another measure of adjustment for models with binary dependent variable is the "fraction correctly forecast" that would use the following rule: if Y_i=1 and the predicted probability exceeds 50 percent, or if Y_i=0 and the predicted probability covering other cases, established Y_i is correctly classified.

To Fourth Model observations 41 covering Y_i=Dep=0 case and 12 for Y_i=Dep=1 alternative one. Overall, the model predicts correctly 92.98% of the observations (95.35% of the Dep=0 and 85.71% of the Dep=1 observations). For heteroskedasticity LM tests applied to the models they had indicated little evidence against the null hypothesis of homoskedasticity, to see Table 2.

After remark the SELIC–target increasing behavior we searched to analyze complementary form to decreasing one. According to Table 4, perceived the asymmetry in relation evidenced in Table 2, that is, although some signals are theoretical supported by the impacts of the independent variable would be bigger in the direction of high of the interest rates. Persistence in reductions and some rigidity degree were remarked corroborating Table 1 results.

Table 4 reveals inflation expectations are important to COPOM's decisions implied to aim of convergence to inflation target established by CMN. In addition to results inflation expectations caused higher impact on expected COPOM's decisions in decrease SELIC-target, see Table 5.

Marginal effects for primary fiscal surplus/GDP attatched to inflation deviations behavior illustrated differences for Third Model compared to Fourth one, mainly in opposite signals for variables coefficients.

Lagged output gap presented robstness independent on model considered includind inflation deviations or not and includind primary fiscal surplus/GDP or not. As noted the estimated coefficients analyzed from "probability response curves", Figure 3 and Figure 5, in both cases the lagged output gap effects were significant, besides the marginal difference in two fuctions displayed.

LR statistics and p-values implied significant signals to models parameters. McFadden's R-squared revealed advantage to Fourth Model in our collection. The measure of "fraction correctly forecast adjustment" showed 30 of the Y_i=Dep=0 observations and 15 of the Y_i=Dep=1 observations are correctly classified. Overall, the model correctly predicts 78.95% of the observations (85.71% of the Dep=0 and 68.18% of the Dep=1 observations). LM tests for heteroskedasticity applied to the models also had indicated little evidence against the null hypothesis of homoskedasticity, except to Third Model, to see Table 4.

When the inversion direction probability is analyzed, inputting past days without changes, daily data to fixed SELIC-target the estimated probit model for the Brazilian economy from March/1999 to August/ 2006, with 58 movements in the SELIC-target were determined by COPOM, which them 7 represented direction inversion displayed in the following equation to SELIC interest rate-target inversion probability:

$$P(I=1) = \Phi(-3{,}203 + 0{,}035D) \quad (6)$$
$$(0.2475)\ (0.0053)$$

It's verified parameters standard error significance at 1% significance level; moreover, $pseudo - R^2 = 0{,}59$ showed reasonable model's adjustment degree. This equation dissociate the fact of sequences of increases in SELIC-target changes the probability of direction invertion of SELIC-target motion. This result corroborated results obtained for Federal Reserve Bank monetary policy from January of 1990 and December of 2001 (see Martins, 2003, p.65).

5. CONCLUSIONS

This paper analyzed the dynamic of SELIC interest rates-target fixed by COPOM with a discrete approach using a probit model. For that the fundamental variables were inflation deviations and lagged output gap which presented direct relation with increase probability, and statistical significance to explain COPOM's behavior for both covariates. We proved the aim of convergence of inflation expectation toward its target as an important objetctive of monetary authorities. Likewise, including a primary fiscal surplus/GDP, as a guideline accorded with IMF, we obtained statistical results rating decisions to increase of SELIC-target caused by negative effects of higher interest rates on aggregate demand and public debt stokes.

The probit model also permited to analyze the predicted probability of decrease in the SELIC-target. The results had shown an asymmetry COPOM's behavior because independent variables presented higher coefficients in increases decisions compared with coefficients to decreases.

Finally, the evidence of a persistent behavior in decreases decisions performing rigidity in reducing SELIC interest rate-target. The conduct of monetary policy aims inflation

convergence toward a target and it explain the changes in mechanism decision processes adopted by COPOM.

New facts and results that lead to robust conclusion on Brazilian monetary policy should consider rigidity, persistence on monetary policy target, and asymmetry in decision processes. The future research would conduce to explain the SELIC interest rate-target maintained in high level.

Table 1 – Motion and persistence in SELIC interest rates-target

SELIC interest rates-target					
Motion \interval		>=100 p.b.	75 p.b.	50 p.b.	25 p.b.
Number of motion	58	22	5	23	8
Increases Motion	19	5	1	10	3
Decreases Motion	39	17	4	13	5
Direction Invertion	07				
Average days for motions	32				
Maximum days without changes	147				
Minimum days without changes	02				
Average days for inversion and the previous changes	234				

Notes: excludes weekends and holidays.

Table 2 – Probit model estimated – increases in the SELIC-target

	1st model[a]	2nd model[b]	3rd model[a]	4th model[b]
Constant	-2.1351*** (0.4885)	-2.0968*** (0.6171)	-5.6251*** (1.6945)	-18.816*** (7.1557)
$(\pi_t - \pi^*)$	0.3741*** (0.1187)		0.4248*** (0.1319)	
h_{t-1}	0.4818*** (0.1245)	0.4828*** (0.1810)	0.5420*** (0.1392)	0.5892** (0.2696)
$(E\pi_t - \pi^*)$		1.2268*** (0.6171)		3.6245*** (1.4719)
s_{t-1}			0.7867** (0.3467)	3.1696*** (1.2674)
$pseudo - R^2$	0.33	0.49	0.39	0.72
LM test [p-value]	3.3827 [0.1843]	0.2139 [0.8986]	5.4827 [0.1397]	4.2253 [0.2381]

Notes: a e b => 07:1999-08:2006 and 11:2001-08:2006; *** level of significance of 1%, ** level of significance of 5%, * level of significance of 10%; ( ) standard errors.

Table 3 - Marginal effects

	1st model	2nd model	3rd model	4th model
$(\pi_t - \pi^*)$	0,0739		0,0764	
h_{t-1}	0,0952	0,0759	0,0975	0,0500
$(E\pi_t - \pi^*)$		0,1929		0,3078
s_{t-1}			0,1415	0,2692

Table 4 - Probit model estimated – fall in the SELIC-target

	1st model[a]	2nd model[b]	3rd model[a]	4th model[b]
Constante	-0.1356 (0.2076)	0.1552 (0.2774)	-1.7066* (0.9252)	2.5428 (2.1292)
$(\pi_t - \pi^*)$	-0.1194* (0.0640)		-0.1457** (0.0679)	
h_{t-1}	-0.1685** (0.0714)	-0.1751 (0.1288)	-0.1840** (0.0735)	-0.1357 (0.1374)
$(E\pi_t - \pi^*)$		-1.0987*** (0.3466)		-1.3520*** (0.4509)
s_{t-1}			0.4049* (0.2313)	-0.5183 (0.4561)
$pseudo - R^2$	0.08	0.40	0.10	0.42
LM test [p-value]	3.2396 [0.1979]	0.8197 [0.6637]	11.9146 [0.0077]	4.0526 [0.2558]

Notes: a e b => 07:1999-08:2006 and 11:2001-08:2006; *** level of significance of 1%, ** level of significance of 5%, * level of significance of 10%; ( ) standard errors.

Table 5 - Marginal effects

	1st model	2nd model	3rd model	4th model
$(\pi_t - \pi^*)$	-0,0407		-0,0485	
h_{t-1}	-0,0575	-0,0398	-0,0612	-0,0294
$(E\pi_t - \pi^*)$		-0,2499		-0,2932
s_{t-1}			0,1347	-0,1124

Figure 1 – SELIC interest rates-target (%) - 03/05/1999 - 08/31/2006

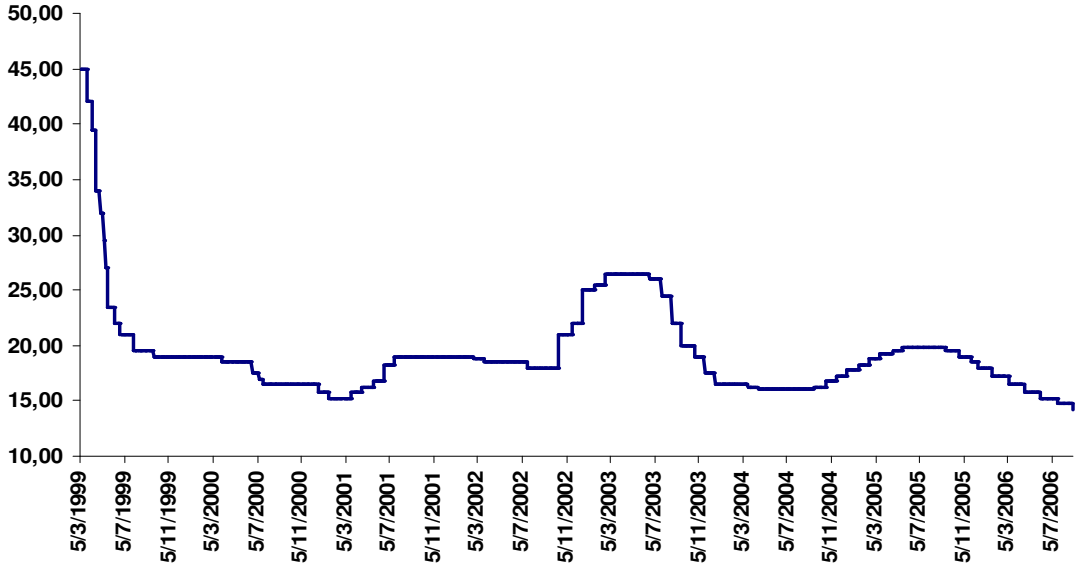
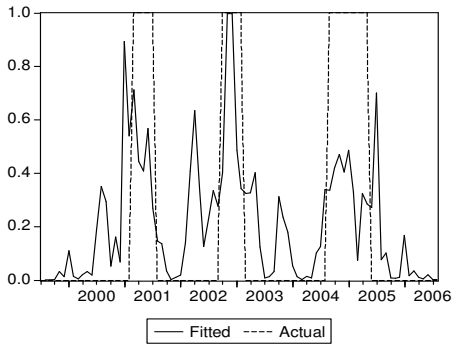
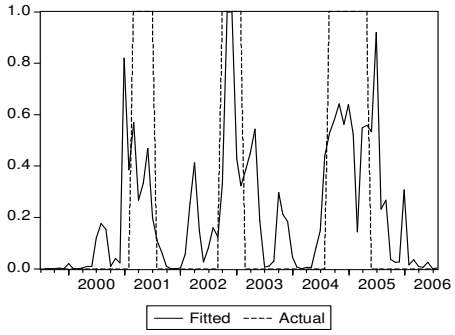


Figure 2 – Probit model estimated – increase in the SELIC-target

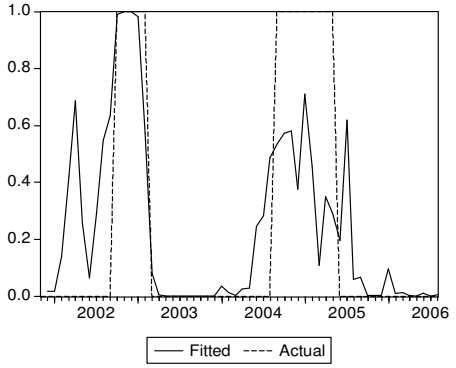
1st model



3rd model



2nd model



4th model

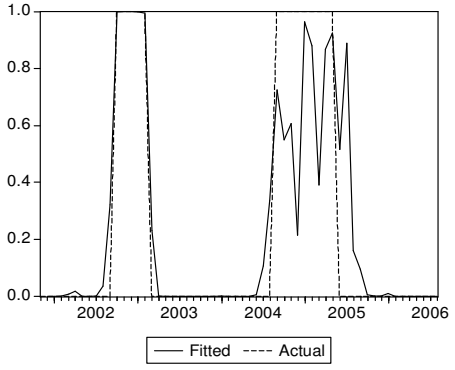
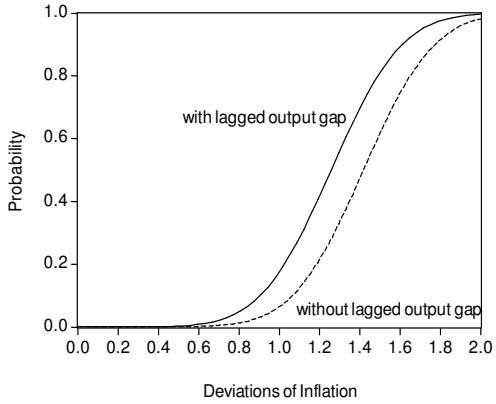


Figure 3 – Plotting Probability Response Curves



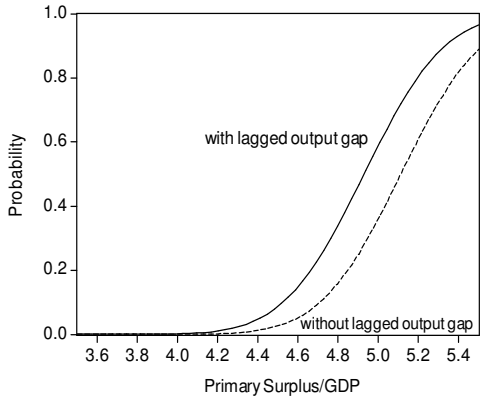
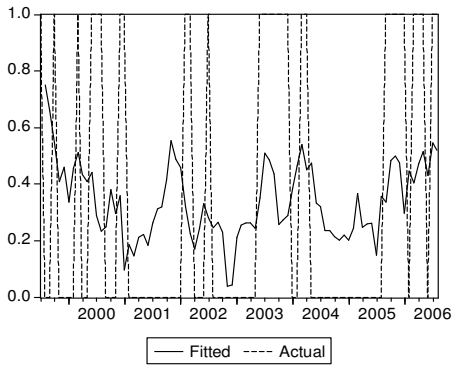
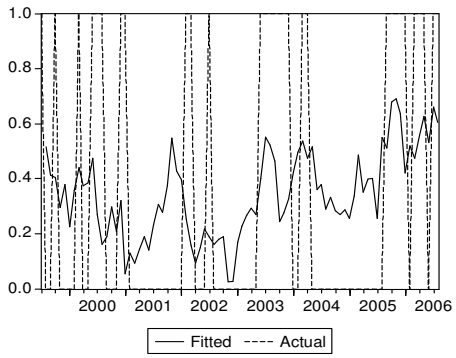


Figure 4 – Probit model estimated – decreases in the SELIC-target

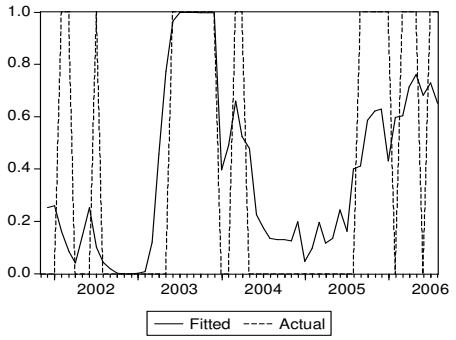
1st model



3rd model



2nd model



4th model

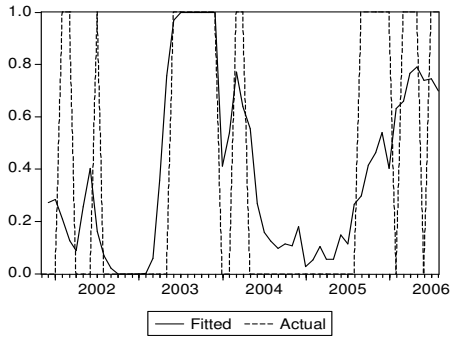
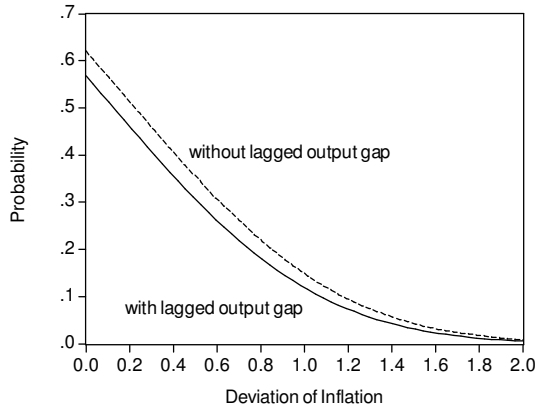
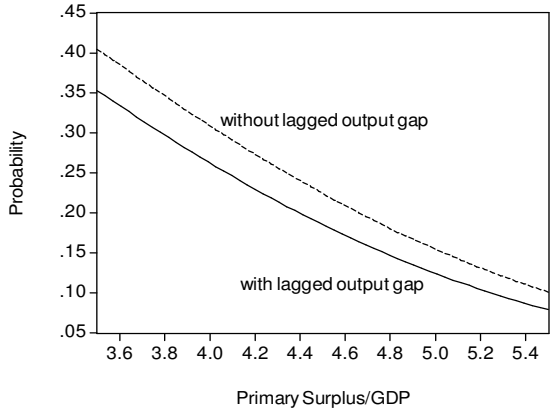


Figure 5 – Plotting Probability Response Curves





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