ISSN 1518-3548

BANCO CENTRAL DO BRASIL

Working Paper Series

20

Credit Channel without the LM Curve

Victorio Y. T. Chu and Márcio I. Nakane

May, 2001

ISSN 1518-3548
CGC 00.038.166/0001-05

Working Papers Series	Brasília	n. 20	May	2001	P. 1 – 21

Working Paper Series

Edited by:

Research Department (Depep)
(e-mail: conep.depep@bcb.gov.br , workingpaper@bcb.gov.br)

Reproduction permitted only if source is stated as follows: Working Paper Series n. 20.

Authorized by Ilan Goldfajn (Director of Economic Policy)

General Control of Subscription:

Banco Central do Brasil
Demap/Disud/Subip
SBS – Quadra 3 – Bloco B – Edifício-Sede – 2º subsolo
70074-900 - Brasília (DF)
Telefone (61) 414-1392
Fax (61) 414-3165

Number printed: 450 copies

Banco Central do Brasil Information Bureau

Address:	Secre/Surel/Dinfo Edifício-Sede, 2º subsolo SBS - Quadra 3, Zona Central 70074-900 - Brasília (DF)
Phones:	(61) 414 (....) 2401, 2402, 2403, 2404, 2405, 2406
DDG:	0800 992345
FAX:	(61) 321 9453
Internet:	http://www.bcb.gov.br
E-mail:	cap.secre@bcb.gov.br dinfo.secre@bcb.gov.br

Credit Channel without the LM Curve[∇]

Victorio Y. T. Chu[*]

Márcio I. Nakane[#]

Abstract

This paper extends Bernanke and Blinder (1988)'s macroeconomic model of credit channel to an environment where the monetary authority has control over a short-term interest rate. The comparative statics regarding changes in the market interest rate, in the required reserve ratio over bank deposits, and in the risk of public bonds are highlighted.

Keywords: credit channel, IS-LM model, interest rate instrument, required reserves, bank spread.

JEL classification: E44, E50.

[∇] Published in Economia Aplicada, vol. 5 no. 1, Janeiro-Março de 2001, 213-227.

[*] Banco Central do Brasil.

[#] Banco Central do Brasil and Universidade de São Paulo.

Credit Channel without the LM Curve

1 Introduction

The purpose of these notes is to develop a simple macroeconomic model to better understand the transmission mechanisms of monetary policy for a country like Brazil. We adapt Bernanke and Blinder (1988)'s model of credit channel to an environment characterized by the following features:[1]

- the monetary authority follows an inflation targeting regime.
- the monetary authority has control over two policy instruments, namely a short-term interest rate and the required reserve ratio on demand deposits.
- private companies do not issue bonds.
- households do not purchase bonds directly.

These features are in general accordance with what one observes for the Brazilian economy. This paper gives emphasis to the credit channel of monetary policy. It deals with a closed economy with no uncertainty and, therefore, other important transmission mechanisms working through e.g. the exchange rate and agent's expectations are ignored.

The main difference between our model and that of Bernanke and Blinder is that the monetary authority is not supposed to target a monetary aggregate. Instead, following the practice of many modern central banks, it is assumed that the monetary authority conducts monetary policy by manipulating a short-term interest rate. Romer (2000) explores the implications of such an assumption for the traditional IS-LM model. We extend Romer's

---

The authors thank, without implicating, Sérgio Werlang, Eduardo Lundberg, Paulo Springer de Freitas and Priscilla Lhacer for valuable comments. The views expressed here are solely the responsibility of the authors and do not reflect those of the Banco Central do Brasil or its members.

[1] In this paper we do not make any distinction between the credit channel and the bank lending channel, which we take as synonymous. See Kashyap and Stein (1994) for an overall survey on the bank lending channel.

model by introducing a banking sector, which allows us to discuss the bank lending channel of monetary policy.

This paper is a first step in a research effort whose aim is to empirically evaluate the relevance of the credit channel for Brazil.

The paper is organized as follows: section 2 develops the model. Section 3 performs some comparative static exercises. Section 4 concludes.

2 The Model

There are four agents in the economy: households, firms, banks and government.

Households can either consume or save their earnings. Let $S(y, r_B)$ denote real savings by the households with y being their real income and r_B the real interest rate on public bonds. The partial derivatives are $S_y > 0$ and $S_{r_B} > 0$.

The empirical literature has not achieved a consensus about the likely effects of the interest rate on savings. Perhaps, a more reasonable specification would be one in which the impact of real interest rate on aggregate savings would be close to zero. This is the likely impact for both the US according to Campbell and Mankiw (1989) as well as for Brazil according to Gleizer (1991). None of our conclusions change if we take $S_{r_B} = 0$.

Firms are responsible for the investment decisions. Let $I(r_B , r_L)$ be the economy's investment schedule where r_L is the real interest rate on bank loans. Assume that $I_{r_B} < 0$ and $I_{r_L} < 0$. The existence of a bank lending channel crucially relies on a non-zero value for I_{r_L}.

Firms rely on bank loans to finance part of their investment due to the special role that banks play in credit markets. Sharpe (1990) argues that banks establish "customer relationships" with their borrowers because, in the process of lending, a bank gathers valuable information about its own customers. As a result, lock-in effects that make costly for borrowers to switch lenders are created.

Banks hold three assets: reserves (R), public bonds (B^b) and loans (L^b). Banks' balance sheet is expressed as:

$$(1) \qquad R + B^b + L^b = D^b$$

where D^b is banks' total deposits. We assume that banks passively accept all deposits the non-bank public willingly offers. Suppose that the non-bank public's supply of deposits is $D^d(y, r_B)$ with the partial derivatives $D^d_y > 0$ and $D^d_{r_B} < 0$.

Deposits pay no interest and are subject to legal reserve requirements. We assume that banks hold no excess reserves. Total bank reserves are then given by:

$$(2) \qquad R = \alpha D^b$$

where the required reserve ratio α is exogenously determined by the monetary authority.

Banks' demand for public bonds is assumed to be $B^b(\sigma, r_L)$ where σ is a measure of economywide risk. The partial derivatives are assumed to be $B^b_\sigma > 0$ and $B^b_{r_L} < 0$. Notice that we are assuming that the demand for public bonds is totally inelastic with respect to its own interest rate. This specification captures, in a simple way, the idea that the demand for public bonds is primarily for liquidity purposes.

Replacing (2) and $B^b(\sigma, r_L)$ in (1) allows one to express the banks' supply of loans as:

(3) $L^b = (1-\alpha)\, D^b - B^b(\sigma, r_L)$

The non-bank public's demand for bank loans is given by $L^d(r_L, y)$ with the partial derivatives $L^d_{r_L} < 0$ and $L^d_y > 0$.

The government issues public bonds (B^g) and borrows reserves from banks (R). There are two policy instruments that the monetary authority seeks to control, the reserve ratio on deposits α and the interest rate on public bonds r_B.. We do not model the optimal choice of the policy instruments by the monetary authority; instead, both α and r_B are taken as exogenous in the model.

In most of the industrialized countries the management of reserve ratios as a tool of monetary policy has fallen out of favour.[2] This is not the case of Brazil, though. The Brazilian monetary authority still makes active use of required reserves as a monetary policy instrument.

We assume that the monetary authority pursues an inflation target and that it has control over the (nominal) interest rate on public bonds. In the absence of uncertainty, the inflation target regime implies that the monetary authority can control effective inflation[3] and, therefore, it can also control r_B. Consistent with this view, we take $r_B = \bar{r}_B$ where $\bar{r}_B$ is the real interest rate on public bonds, exogenously determined by the monetary authority. The supply of public bonds B^g is infinitely elastic at $\bar{r}_B$.

Let us now turn to the market-clearing conditions. There are four markets to consider: the markets for goods, deposits, public bonds, and bank loans. The respective market-clearing conditions are:[4]

[2] See Borio (1997).
[3] This assumption also explains why r_B and not the nominal interest rate on public bonds is the argument of the money demand.
[4] The signs below each variable indicate the assumed signs for the partial derivatives.

(4a) $$I(\underset{-}{\bar{r}_B}, \underset{-}{r_L}) = S(\underset{+}{y}, \underset{+}{\bar{r}_B})$$

(4b) $$D^b = D^d(\underset{+}{y}, \underset{-}{\bar{r}_B})$$

(4c) $$B^g = B^b(\underset{+}{\sigma}, \underset{-}{r_L})$$

(4d) $$L^b = L^d(\underset{-}{r_L}, \underset{+}{y})$$

Following Walras law, one of the market-clearing conditions can be ignored. In what follows, the market for public bonds is not considered.

The market clearing condition for the goods market corresponds to the *IS* schedule. Like an usual *IS*, its slope is negative in the (r_L, y) plan:

(5) $$\left.\frac{dr_L}{dy}\right|_{IS} = \frac{S_y}{I_{r_L}} < 0$$

We combine the market clearing conditions for both the deposits and bank loans in a single schedule. In order to accomplish that, replace equation (3) with $D^b = D^d$ in the market clearing condition for loans (4d), yielding:

(6) $$(1-\alpha)D^d(y, r_B) - B^b(\sigma, r_L) = L^d(r_L, y)$$

Equation (6) gives the combinations of r_L and y that guarantees the simultaneous equilibrium in the deposit and loan markets. Call this schedule *DL*. The *DL* locus can have either a positive or a negative slope in the (r_L, y) plan:

(7) $$\left.\frac{dr_L}{dy}\right|_{DL} = \frac{(1-\alpha)D_y^d - L_y^d}{B_{r_L}^b + L_{r_L}^d} \gtrless 0$$

The ambiguity arises because of the uncertain sign for the numerator. In what follows, we assume that the slope for *DL* can be either positive or negative but, in any event, that it is always greater than the slope for *IS*. A sufficient condition for such inequality to hold is that $S_y \approx D_y^d$ and $I_{r_L} \approx L_{r_L}^d$. In words, when the transactions demand for money closely follows the behaviour of aggregate savings and when a change in the loan interest rate shifts overall investment and the demand for bank loans in similar ways.[5]

The economy's general equilibrium is represented in Figure 1. Given the values for the exogenous variables, the equilibrium values for r_L and y are, respectively, represented by r_L^* and y^*.

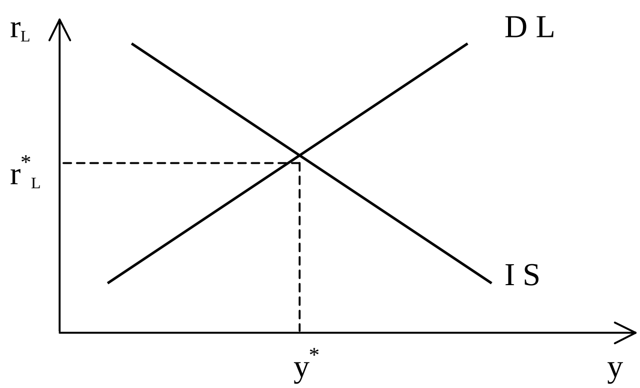


Figure 1: The Economy's General Equilibrium

[5] The illustrative figures show the case when the *DL* slope is positive. Except for one of our comparative static results, all the other results do not depend on this feature.

3 Comparative Static

The exogenous variables in the model are α, $\bar{r}_B$, and σ. Table 1 summarizes the comparative static results for the model. The appendix shows the formal results.

Variable λ	$dr^*_L/d\lambda$	$dy^*/d\lambda$
α	+	-
$\bar{r}_B$	?	-
σ	+	-

Table 1: Comparative Static

Consider, first, a decrease in the required reserve ratio α. The decrease in α causes an initial excess supply in the asset market, which shifts the *DL* locus to the right. The *IS* locus is not altered. With the decrease in α, banks have a higher volume of funds available for lending. To clear the market, the loan interest rate starts to reduce and the output starts to increase. The final result depicts an increase in the equilibrium value of the output and a decrease in the bank loan rate. Bank spread, as measured by (r_L - r_B), also reduces with the decrease in α. Figure 2 shows graphically these effects.

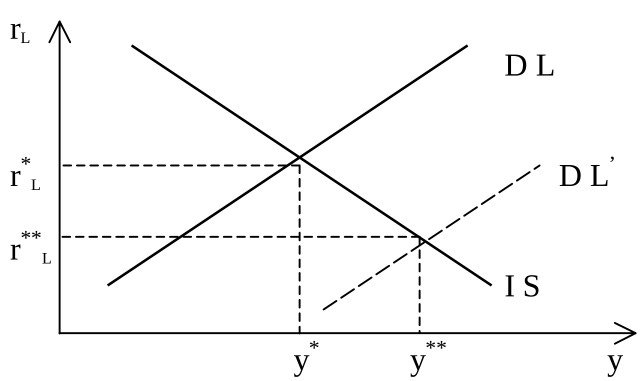


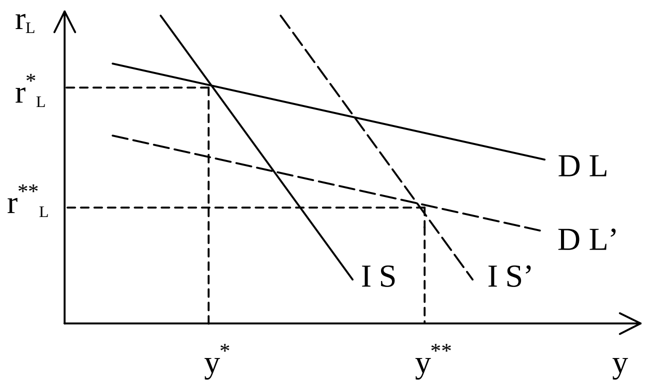
Figure 2: Effects of Reducing the Required Reserve Ratio.

If firms do not rely on bank loans to finance their investments, changes in the reserve ratio would have no effect on output.[6] Thus, the presence of the bank lending channel is responsible for the real impacts of modifications in α.

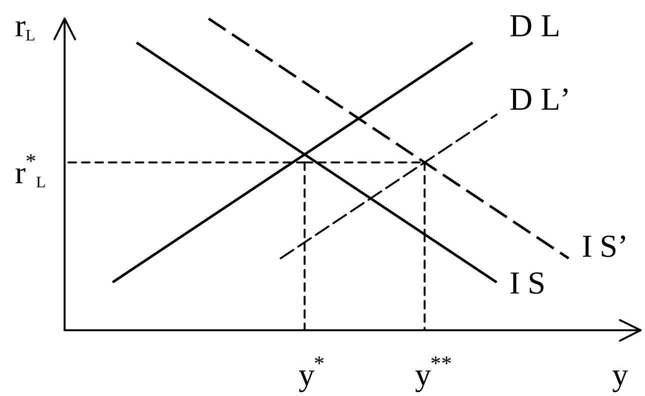
The model predictions seem to describe well the effects on the Brazilian economy. Puga (1998) estimates a Bayesian VAR model for Brazil with the result that shocks in the required reserves account for 9.6% of the variability in bank spread and for 14.8% of the variability in real GDP after 12 months.

The real interest rate on public bonds $\bar{r}_B$ is our measure of the stance of the monetary policy. A monetary policy loosening (a reduction in $\bar{r}_B$) increases aggregate demand shifting the *IS* curve to the right. In the asset market, a reduction in $\bar{r}_B$ has initially the effect of increasing the volume of funds available to banks because it causes an increase in the amount of the public's deposits. For each level of y, the loan interest rate starts to decrease, causing a downward shift to the *DL* curve. The new equilibrium depicts greater values for the output and an uncertain outcome for r_L. Figure 3 illustrates the possible outcomes.

[6] See equation (12b) in the appendix.



(a) Negative *DL* Slope



(b) Positive *DL* Slope

Figure 3: Effects of Reducing $\bar{r}_B$

As suggested by Figure 3, the impact on lending interest rates is dependent upon the slope of the *DL* curve. In panel (a), *DL* has a negative slope. In this situation, it is always true that the loan interest rate reduces with decreasing $\bar{r}_B$. If, however, the *DL* slope turns out to be positive one cannot rule out the possibility that the loan interest rate may actually increase when $\bar{r}_B$ is reduced. In order to investigate this possibility, rearrange terms in (13a) to obtain:

(8) $$\frac{dr_L^*}{d\bar{r}_B} = \frac{[\text{shift in IS}][\text{slope of DL}] - [\text{shift in DL}][\text{slope of IS}]}{[\text{slope of DL}] - [\text{slope of IS}]}$$

where:

$$[\text{shift in IS}] = -\frac{I_{r_B} - s_{r_B}}{I_{r_L}} < 0$$

$$[\text{shift in DL}] = \frac{(1-\alpha)D_{r_B}^d}{B_{r_L}^b + L_{r_L}^d} > 0$$

Expression (8) makes clear that a necessary condition for the sign of $\frac{dr_L^*}{d\bar{r}_B}$ to be negative is to have a positive slope for *DL*. Moreover, this outcome is more likely to arise when the shift in *IS* is large. The intuition is clear: a large *IS* shift to the right requires a large upward adjustment in the lending interest rate to clear the asset market.

As for the effects of changes in $\bar{r}_B$ on output, there is no ambiguity in our results. Regardless of the assumption on the *DL* slope reductions in $\bar{r}_B$ lead to an expansion in output. Moreover, the bank lending channel exacerbates the effects of monetary policy. In the absence of the bank lending channel, the expansionary effects of a loosening in monetary policy would be more modest.[7]

Our results are in line with those obtained by Bernanke and Blinder (1988). Miron et al. (1994) and Hallsten (1999), on the other hand, found that the effects of monetary policy on output as well as on bank interest rates are uncertain. Hallsten (1999) formally derives the

[7] See equation (13b) in the appendix. The bank lending channel is absent when $I_{r_L} = L_{r_L}^d = 0$.

conditions under which the monetary policy has a larger impact on output in the presence of a bank lending channel. Like Bernanke and Blinder, however, both Miron et al. (1994) and Hallsten (1999) deal only with the case of a monetary authority following a money supply rule.

The effects of changes in our measure of risk σ are predictable. A reduction in uncertainty leads banks to reduce their demand for public bonds, shifting the *DL* locus to the right. The result is a reduction in the loan interest rate and an increase in output. The graphical representation is exactly like the one depicted in Figure 2.

4 Concluding Remarks

This paper combined the bank lending model of Bernanke and Blinder (1988) and the interest rate rule IS-LM model of Romer (2000) to examine the channels of transmission of monetary policy for a country like Brazil. The monetary authority is supposed to control two policy instruments, namely the required reserve ratio on demand deposits and a short-term interest rate.

The credit channel is introduced via bank loans. Possible asymmetric information problems make firms dependent upon credit extended by banks to finance their investments. In addition, from the standpoint of bank liabilities, loans and public bonds are assumed to be imperfect substitutes.

We showed that changes in the required reserve ratio can produce real effects, changing both the loan interest rate (and, therefore, the volume of credit) as well as real output. Changes in the government-controlled interest rate have positive effects on output but the effects on bank spread are found to be ambiguous.

Romer (2000) remarks that:

> "One area in which both the IS-LM and IS-MP[8] approaches may have simplified too far is in their treatment of financial markets. In both models, the only feature of financial markets that matters for the demand for goods is 'the' real interest rate; and in both, monetary policy has a powerful and direct influence on that interest rate. In practice, however, the demand for goods depends on many different interest rates, and on how much credit is available at those rates. The impact of monetary policy on many of those rates, and on credit availability given those rates, is tenuous and uncertain. Thus it might be desirable to split the analysis of financial markets. One part would analyse how various aspects of financial markets affect the demand for goods; the other would analyse how various forces, including monetary policy, affect interest rates and credit availability.
>
> This two-pronged approach would emphasize that many aspects of financial markets other than the particular interest rate controlled by the central bank affect aggregate demand, and it would highlight from the beginning many of the difficulties and uncertainties of actual policymaking. The obvious disadvantage of this approach is that it would not produce a framework as simple or powerful as IS-LM or IS-MP." (p. 168)

We see our attempt in this paper as one step towards filling the gap spotted by Romer and yet keeping the model at a manageable tractability.

It remains to be investigated the empirical relevance of the credit channel for the Brazilian economy. This aspect is left to future research.

---

[8] Authors' note: The MP curve is a horizontal line in output-real rate space showing the central bank's choice of the real interest rate.

1 Appendix

This appendix derives the expressions for the comparative static results displayed in Table 1.

The two-equation system is represented by the *IS* and *DL* functions. They are shown below:

(9a) $$I(\bar{r}_B, r_L) = S(y, \bar{r}_B)$$

(9b) $$(1-\alpha)D^d(y, r_B) - B^b(\sigma, r_L) = L^d(r_L, y)$$

This system is solved for the loan interest rate r_L and output y taking as given the values for the exogenous variables. Let r^*_L and y^* be the respective values of r_L and y that solves the system (9). Differentiating this system totally and evaluating the result around the equilibrium values, one has:

(10) $$\begin{bmatrix} I_{r_L} & -S_y \\ -B^b_{r_L} - L^d_{r_L} & (1-\alpha)D^d_y - L^d_y \end{bmatrix} \begin{bmatrix} dr^*_L \\ dy^* \end{bmatrix} = \begin{bmatrix} 0 \\ D^d \end{bmatrix} d\alpha - \begin{bmatrix} I_{r_B} - S_{r_B} \\ (1-\alpha)D^d_{r_B} \end{bmatrix} d\,\bar{r}_B + \begin{bmatrix} 0 \\ B^b_\sigma \end{bmatrix} d\sigma$$

Let Δ be the system's Jacobian determinant evaluated at the equilibrium solution, which is equal to:

(11) $$\Delta = I_{r_L}\,(B^b_{r_L} + L^d_{r_L})\left[\left.\frac{dr_L}{dy}\right|_{DL} - \left.\frac{dr_L}{dy}\right|_{IS} \right] > 0$$

where all the expressions are evaluated at the equilibrium and the *IS* and *DL* slopes are given, respectively, by (5) and (7). The positive sign for Δ is due to our assumption that the slope for *DL* exceeds the one for *IS*.

It follows from (10) that the model's comparative statics are given by:

1.1 Variations in α

(12a) $$\frac{dr_L^*}{d\alpha} = \frac{D^d S_y}{\Delta} > 0$$

(12b) $$\frac{dy^*}{d\alpha} = \frac{D^d I_{r_L}}{\Delta} < 0$$

1.2 Variations in $\bar{r}_B$

(13a) $$\frac{dr_L^*}{d\bar{r}_B} = \frac{(S_{r_B} - I_{r_B})[(1-\alpha)D_y^d - L_y^d] - (1-\alpha)S_y D_{r_B}^d}{\Delta} \gtrless 0$$

(13b) $$\frac{dy^*}{d\bar{r}_B} = \frac{(S_{r_B} - I_{r_B})[(B_{r_L}^b + L_{r_L}^d] - (1-\alpha)D_{r_B}^d I_{r_L}}{\Delta} < 0$$

1.3 Variations in σ

(14a) $$\frac{dr_L^*}{d\sigma} = \frac{S_y B_\sigma^b}{\Delta} > 0$$

(14b) $$\frac{dy^*}{d\sigma} = \frac{B_\sigma^b I_{r_L}}{\Delta} < 0$$

References

Bernanke, B. S. and Blinder, A. S. (1988). ‘Credit, money, and aggregate demand’. *American Economic Review, Papers and Proceedings*, 78, 435–439.

Borio, C. E. V. (1997). ‘The implementation of monetary policy in industrial countries: A survey’. BIS Economic Papers No. 47, Bank for International Settlements, Basle, Switzerland.

Campbell, J. Y. and Mankiw, N. G. (1989). ‘Consumption, income, and interest rates: reinterpreting the time series evidence’. In Blanchard, O. J. and Fischer, S., editors, *NBER Macroeconomics Annual 1989*. MIT Press, Cambridge, MA.

Gleizer, D. L. (1991). ‘Saving and real interest rates in Brazil’. *Revista de Econometria*, 11, 63–92.

Hallsten, K. (1999). ‘Bank loans and the transmission mechanism of monetary policy’. Sveriges Riksbank Working Paper No. 73. Sveriges Riksbank. Stockholm.

Kashyap, A. K. and Stein, J. C. (1994). ‘Monetary policy and bank lending’. In Mankiw, N. G., editor, *Monetary Policy*. University of Chicago Press, Chicago.

Miron, J. A., Romer, C. D., and Weil, D. N. (1994). ‘Historical perspectives on the monetary transmission mechanism’. In Mankiw, N. G., editor, *Monetary Policy*. University of Chicago Press, Chicago.

Puga, F. P. (1998). ‘Uma estimação dos efeitos dos compulsórios sobre o spread bancário, o PIB e a inflação’. *Boletim Conjuntural do IPEA* No. 42, pages 39–42.

Romer, D. (2000). ‘Keynesian macroeconomics without the LM curve’. *Journal of Economic Perspectives*, 14, 149–169.

Sharpe, S. A. (1990). ‘Asymmetric information, bank lending, and implicit contracts: a stylized model of customer relationships’. *Journal of Finance*, 45, 1069–1087.

Working Paper Series
Banco Central do Brasil

1	Implementing Inflation Targeting in Brazil	Joel Bogdanski, Alexandre Antonio Tombini, and Sérgio Ribeiro da Costa Werlang	07/2000
2	Política Monetária e Supervisão do SFN no Banco Central	Eduardo Lundberg	07/2000
	Monetary Policy and Banking Supervision Functions on the Central Bank	Eduardo Lundberg	07/2000
3	Private Sector Participation: A Theoretical Justification of the Brazilian Position	Sérgio Ribeiro da Costa Werlang	07/2000
4	An Information Theory Approach to the Aggregation of Log-Linear Models	Pedro H. Albuquerque	07/2000
5	The Pass-through from Depreciation to Inflation: A Panel Study	Ilan Goldfajn and Sérgio Ribeiro da Costa Werlang	07/2000
6	Optimal Interest Rate Rules in Inflation Targeting Frameworks	José Alvaro Rodrigues Neto, Fabio Araújo, and Marta Baltar J. Moreira	09/2000
7	Leading Indicators of Inflation for Brazil	Marcelle Chauvet	09/2000
8	Standard Model for Interest Rate Market Risk	José Alvaro Rodrigues Neto	09/2000
9	Estimating Exchange Market Pressure and Intervention Activity	Emanuel-Werner Kohlscheen	11/2000
10	Análise do Financiamento Externo a Uma Pequena Economia	Carlos Hamilton Vasconcelos Araújo e Renato Galvão Flôres Júnior	03/2001
11	A Note on the Efficient Estimation of Inflation in Brazil	Michael F. Bryan and Stephen G. Cecchetti	03/2001
12	A Test of Competition in Brazilian Banking	Márcio I. Nakane	03/2001
13	Modelos de Previsão de Insolvência Bancária no Brasil	Marcio Magalhães Janot	03/2001
14	Evaluating Core Inflation Measures for Brazil	Francisco Marcos Rodrigues Figueiredo	03/2001
15	Is It Worth Tracking Dollar/Real Implied Volatility ?	Sandro Canesso de Andrade and Benjamin Miranda Tabak	03/2001
16	Avaliação das Projeções do Modelo Estrutural do Banco Central do Brasil Para a Taxa de Variação do IPCA	Sergio Afonso Lago Alves	03/2001
17	Estimando o Produto Potencial Brasileiro: Uma Abordagem de Função de Produção	Tito Nícias Teixeira da Silva Filho	04/2001
18	A Simple Model for Inflation Targeting in Brazil	Paulo Springer de Freitas and Marcelo Kfoury Muinhos	04/2001
19	Uncovered Interest Parity with Fundamentals: A Brazilian Exchange Rate Forecast Model	Paulo Springer de Freitas, Marcelo Kfoury Muinhos and Fabio Araújo	05/2001