ISSN 1518-3548

BANCO CENTRAL DO BRASIL

Working Paper Series 133

A New Proposal for Collection and Generation of Information on Financial Institutions' Risk: the case of derivatives

Gilneu F. A. Vivan and Benjamin M. Tabak

March, 2007

ISSN 1518-3548
CGC 00.038.166/0001-05

Working Paper Series	Brasília	N. 133	Mar	2007	P. 1-37

Working Paper Series

Edited by Research Department (Depep) – E-mail: workingpaper@bcb.gov.br

Editor: Benjamin Miranda Tabak – E-mail: benjamin.tabak@bcb.gov.br
Editorial Assistent: Jane Sofia Moita – E-mail: jane.sofia@bcb.gov.br
Head of Research Department: Carlos Hamilton Vasconcelos Araújo – E-mail: carlos.araujo@bcb.gov.br

The Banco Central do Brasil Working Papers are all evaluated in double blind referee process.

Authorized by Mário Mesquita, Deputy Governor for Economic Policy.

General Control of Publications

Banco Central do Brasil

Secre/Surel/Dimep

SBS – Quadra 3 – Bloco B – Edifício-Sede – M1

Caixa Postal 8.670

70074-900 Brasília – DF – Brazil

Phones: (5561) 3414-3710 and 3414-3567

Fax: (5561) 3414-3626

E-mail: editor@bcb.gov.br

Consumer Complaints and Public Enquiries Center

Address:	Secre/Surel/Diate
	Edifício-Sede – 2º subsolo
	SBS – Quadra 3 – Zona Central
	70074-900 Brasília – DF – Brazil
Fax:	(5561) 3414-2553
Internet:	http://www.bcb.gov.br/?english

A New Proposal for Collection and Generation of Information on Financial Institutions' Risk: the case of derivatives

Gilneu F. A. Vivan*

Benjamin M. Tabak

"The end result is that a major component of bank profitability over the last decade does not appear in any consistent way in the financial reports of banks. Shareholders and financial analysts find it difficult to assess bank performance, while regulators and rating agencies face problems when they try to determine the riskiness of bank activities. Likewise the true risk profile of some nonblank corporation may also be unclear from their financial reports." Crouhy et al. (2001, p. 30)

Abstract

This article aims at providing a new alternative for the collection of information on risks taken by financial institutions, which enables the calculation of risk tools usually used in risk management, such as VaR and stress tests. This approach should help risk managers, off-site supervision and academics in assessing the potential risks in financial institutions principally due to derivatives positions. The basic idea, for linear financial instruments, like the traditionally used by the management risk systems, is to reduce positions in risk factors and then mapping by vertices. For the nonlinear financial instruments all of the positions in different types of options – European, Americans, exotic, etc.– are represented as plain vanilla European options or replicated by portfolios of plain vanilla European options. The methodology was applied to Brazil, within the worst scenarios during the period from 1994 to 2004, and the paper demonstrates that the proposed approach captured the risks satisfactorily in the analyzed portfolios, including the risk existent in the strategies involving options, given an accepted error margin. This approach could be useful for regulators, risk managers; financial institutions and risk management modeling as it can be used as an input in general risk management models.

Keywords: derivatives; information; risk management; off-site supervision; systemic risk.
JEL Classification: G21; G28

* Banco Central do Brasil. Corresponding author: Benjamin.tabak@bcb.gov.br. Benjamin M. Tabak gratefully acknowledges financial support from CNPQ Foundation

1. Introduction

The analysis of accounting and non-accounting information provided by financial institutions to the supervisory bodies is one of the main tools to evaluate financial institution's risk. Furthermore, another tool is the comparison of this information with the information regarding other financial institutions with the same profile. These tools are often used by supervision throughout the world for the monitoring and identification of institutions, which could present problems or become a source of concern, requiring the adoption of preventive actions.

This information is generally summarized through indicators by the supervisory body. Indicators are relations amongst groups of information of each institution, which make information comparable. One of the most known examples of group of indicators is the Uniform Bank Performance Report – UBPR, created by the Federal Deposit Insurance Corporation – FDIC of the Federal Financial Institutions Examination Council's – FFIEC from the United States of America.

When the reality is summarized in a document or report, some information is always lost. Nevertheless, the classical structure of accounting and disclosure positions held by financial institutions and indicators present satisfactory outcomes insofar the main income source is the financial intermediation. If not this assertion is not true.

The increasing demand for derivatives and the evolution of risk management techniques changed dramatically the profile of some institutions to the point that revenues from the intermediation of "risks" have become the major source of revenue. Moreover, the effects of derivatives on the equity structure are not properly reflected in the financial statements.

The difficulty in understanding the information and risks involved in derivatives' positions is concerning regulators because (i) the adequate treatment of information on derivatives is essential to the supervisors' information collection regarding the financial health of institutions and (ii) financial analysts have difficulties in assessing institutions without comprehensive information regarding the risks inherent to the derivatives operations held by those institutions[1].

With the purpose of addressing this problem, important international efforts towards the assessment of the risk involved in positions held by financial institutions and its disclosure to the interested public have been made by the Financial Accounting Standard Board (FASB)[2], by the Bank of International Settlements (BIS)[3] and by the International Organization of Securities Commissions (IOSCO)[4].

Nonetheless, it is up to the supervisory authority to monitor the economic and financial situation of banks[5]. In order to perform this duty, the information collection, which makes viable the understanding of each bank's risk exposure, is essential.

---

[1] Lopes and Lima (1998)

[2] The Statement 133 (1998) with the changes of the Statement 137 (1999), 138 (2000) and 149 (2003).

[3] In the Basel Capital Accord and in the text jointly written with the IOSCO. See bibliography: BIS (1996) Amendment to the Capital Accord to Incorporate Market Risks and BIS (2003) The New Basel Capital Accord.

[4] 1999 publication, entitled "Public Disclosure of Trading and Derivatives Activities".

[5] (...) assess if the bank is viable, meets its regulatory requirements, and is sound and capable of fulfilling financial commitments to its creditors (including depositors). Supervisory authorities also verify whether or not

Reviewing the information collected by some supervisory entities[6], it is noticed that the data aims, essentially, at monitoring the capital requirements for the regulated risks. In their majority, they are accounting data that enable the identification of the share of each financial instrument, but not the risk associated to them.

Even when the risk associated to an instrument is calculated on a more elaborated manner – options, for example – the presentation form aims, exclusively, at calculating the Basle capital requirements and, therefore, does not enable a more profound study. Nevertheless, there is other complimentary information required by supervisory authorities that can help in risk estimation. Luxembourg, for example, requires a document in which assets and liabilities are presented according to maturity bands, but the risk factors are not identified.

Yet regarding this issue, it is important to remember one BIS statement, in the "Recommendations for public disclosure of trading and derivatives activities": the information should be comparable, because the comparability enables users to assess the financial position and performance of institutions comparing to other institutions. Moreover, comparability over time is necessary for the identification of trends[7].

The simple collection of numbers generated by financial institutions in their management risk systems, for example, would not fulfill this requirement, because these numbers are not comparable, since each institution calculates its risk using standards of measure considered to be more appropriate, defined, according to its own criteria, may it be through the calculation method (parametric, historical simulation, etc.), the parameters of holding period and level of confidence, the criteria for risk aggregation, the yield curve, amongst others.

Another way to collect data would be the prior definition, by the supervisory authority, of the VaR calculation methodology or of the stress scenarios to be applied. This, by one side, would bring as a consequence the discouragement of evolution of more powerful risk calculation methodologies, and could induce the supervisor to commit mistakes, because, according to the combination of an institution's positions, the stress scenario shall not be an extreme fluctuation in the market prices, but, instead, a small oscillation[8].

The need for obtaining the same risk measure for all institutions, using the same methodology, at the same date, and the possibility of using different scenarios, defined by supervisors, for all institutions at the same time, in a comparable basis, which integrate, even on a primitive way, the market risk and the credit risk, is a challenge to supervisors, because of the potential that those information could aggregate to the supervisory activity. Moreover, this would enable the development of new comparable indicators, to be disclosed or not, as, for example, VaR by equity or loss in the worst scenario for the institution by its equity.

It must be clear that it is not up to the supervisory authority to manage supervised banks' risks, but only understand the risk profile of each institution and monitor the risk volume of each one according to its equity, for example. Therefore, the proposed system should present

---

the bank's operations are likely to jeopardize the safety of the banking system as a whole". (Greuning and Bratanovic, 1999, p. 16).

[6] The Federal Reserve System (FED), from the United States of America, the Financial Services Authority (FSA), from the United Kingdom, the Deutsche Bundesbank, from German, the Commission de Surveillance du Secteur Financier (CSSF), from Luxembourg and the Central Bank of Brazil (Bacen), from Brazil.

[7] BIS, 1999, p.8

[8] See, as example, Hull (2000, p. 363), Jorion (1999, p. 182).

an error margin in the results that enables knowing the institution, detecting eventual problems, even though not being precise.

This article aims at assessing some alternatives of collection of information on risks taken by financial institutions which enable the supervisor to calculate the risk averages usually used in risk management, like VaR and stress tests, for example, using for all institutions the same methodology and comparing the results among institutions over time, not having to face those limitations.

The objective is to define a set of information sufficient for the proposed calculation, based on information used in most popular risk systems (as RiskMetrics TM, for example), not giving rise to more expenses for institutions, which could discourage the development of safer practices of risk management, or interfering in the management process of each institution.

In this article, this set of information are approached only under a stress test view, because, if they are adequate for this kind of analysis, they are also adequate for other risk measures calculations, as VaR, for example, using the same Monte Carlo simulation techniques or historical simulation, that basically consist in the distribution analysis resulting of the application of various scenarios on the existing positions.

As noticed before, when positions held by an institution are summarized on a report, some information is lost. Therefore, when applied to a stress scenario, for instance, the result obtained by institutions using all the available information (full valuation) would be more precise than the one obtained using only the reports where those positions are summarized.

Therefore, the first question is to establish the acceptable error on those methodologies. The parameter to be used in this article is the same obtained on a survey responded by 47 risk management professionals, where the conclusion was that they would accept the use of risk measures obtained based on reports, provided the difference between this result and the results obtained through *full valuation* is less than ± 10%.

According to the objective of using the financial instrument as the basis for the definition of the set of information to be collected by the management risk system, the financial instruments were classified as linear or non-linear instruments. This classification describes the relation between a financial instrument face value and its risk factors. Generally speaking, it is classified as linear the financial instrument in which a fluctuation on its risk factors causes the same effect over the value of the financial instrument[9].

In practice, generally speaking, there is a linear relation and a non-linear relation among risk factors and the price of a financial instrument. The latter relation can or cannot be ignored, according to its relevance to the formation of the financial instrument's value and the relevance of this instrument to the portfolio.

The following financial instruments are considered linear: securities, shares, foreign currencies, commodities and some derivatives as swaps and futures which does not present options or characteristics which pose limits or nullify their payoffs as, for instance, *cap, floor*, etc. Options and contract characteristics in financial instruments, which work as options, generally denominated embedded options, are considered non-linear. Throughout all bibliography used, financial instruments classified as linear and non-linear are the same.

---

[9] J.P. Morgan (1996, p. 123)

In comparisons performed throughout this article among values obtained by *full valuation* and those obtained using the proposed set of information, in different scenarios, the error generated according to the following equation defines if a comparison is acceptable or not:

$$error = \frac{V_{FV} - V_{CI}}{V_{FV}}$$

Where:

$V_{FV} =$ value obtained by full valuation

$V_{CI} =$ value obtained using the set of information

To create these scenarios, the variations were, in all the cases, more severe than those that happened in the last 10 years in Brazil, when the crisis of Russia, Asia, Brazil and Argentina occurred.

In this article, the focus was bank supervision, but this approach could be useful for other like risk managers, financial institutions or academicians. Risk managers could use this data as an input in general risk management models.

The paper is divided as follows. In section 2 we show how to evaluate risk for linear financial instruments, while section 3 focuses on nonlinear financial instruments. Section 3 presents the proposed information set that can be helpful in assessing financial institution's risk due to exposure to derivatives, while section 5 concludes the paper.

2. Linear Financial Instruments

The risk management systems, RiskMetrics™, for instance, total all positions in linear instruments marked-to-market, according to the risk factor, instead of financial instrument. On a second stage, after totaling up by risk factor, the maturities are mapped into standardized position vertices, and then the risk calculations are performed. These procedures reduce significantly the volume of data to be processed through the system.

The first test to be performed aims at verifying if the positions in financial instruments classified by risk factors and vertices enable the use of stress tests considered to be adequate by the supervisor. The results are within the range of ±10% of difference among the number that would have been obtained by full valuation and is obtained based on the information set.

The test was performed in a foreign currency security with credit risk BBB[10], and maturing in one year. Theoretically, the future value of this security is given by the following equation:

$$VF = M \times S \times (1 + d) \quad (1)$$

Where:

VF= Future Value of the security

[10] rating used by Standard & Poor's, like table 1.

A=Amount of foreign currency to be paid at maturity date (including the interest)

S=spot rate of the foreign currency

d= foreign exchange change estimated for the period

The present value is:

$$VP = \frac{VF}{(1 + i_c)} \tag{2}$$

Where:

VP = Present Value of the security;

i_c = discount rate, considering the credit risk of the issuer. In this article, i_c is defined[11] as $i_c = (1 + r)(1 + rc)$, where r is the rate free of risk and rc is the credit risk of the issuer.

Replacing the equation (1) in equation (2) and considering the definition of i_c:

$$VP = \frac{A \times S \times (1 + d)}{(1 + r)(1 + rc)} \tag{3}$$

Where:

r = risk free interest rate;

rc = credit risk of the issuer.

In Brazil, there is no significant market of foreign exchange fluctuation. Therefore, the foreign exchange coupon market is used, which relates the domestic interest rates with the foreign exchange fluctuation, i.e., it represents the domestic interest rate in American dollars, in order to establish the present value of the security.

Replacing the equation (4) in equation (3):

$$(1 + cc) = \frac{(1 + r)}{(1 + d)} \tag{4}$$

$$VP = \frac{A \times S}{(1 + cc)(1 + rc)} \tag{5}$$

---

[11] It is possible to find in books $i_c = r + rc$. If $(1 + i_c^*) = (1 + r)(1 + rc) \therefore i_c^* = r + rc + r \times rc$ and supposing $r < 1$, $rc < 1$ and both being small enough, then $r \times rc$ can be considered next to zero, then $i_c^* \cong i_c$.

The equation (5) defines the present value of the security. The risk factors of a financial instrument, generally speaking, are the parameters that influence in the calculation of a present value of a financial instrument. In this case, the risk factors are $f(S, cc, rc)$. The next step is to identify the relation between these risk factors and the security value. The fluctuation of the present value of the security (VP) in relation to the present value when the parameters are changed according to the scenario $\alpha(S^{\alpha}, cc^{\alpha}, rc^{\alpha})$, is given by:

$$\frac{VP^{\alpha}}{VP} - 1 = \ln\left(\frac{VP^{\alpha}}{VP}\right) \tag{6}$$

Replacing VP and VP^{α} in the second part of the equation (6) by the equation (5) and simplify:

$$\ln\left(\frac{VP^{\alpha}}{VP}\right) = \ln\left(\frac{S^{\alpha}}{S}\right) - \ln\left(\frac{1+cc^{\alpha}}{1+cc}\right) - \ln\left(\frac{1+rc^{\alpha}{}_{BBB}}{1+rc_{BBB}}\right) \tag{7}$$

Therefore, one long position on a foreign exchange security with credit risk BBB is separated into the following risk factors[12]: one long position on foreign currency; one short position in foreign exchange coupon; and one short position on credit risk BBB. In order to calculate the value of the security using linear estimation, the following equation is used:

$$VP^{\alpha}_{FR} = \frac{\left(S^{\alpha} - S^{0}\right)}{S^{0}} VP^{0} - \frac{\left(cc^{\alpha} - cc^{0}\right)}{\left(1 + cc^{0}\right)} VP^{0} - \frac{\left(rc^{\alpha}_{BBB} - rc^{0}_{BBB}\right)}{\left(1 + rc^{0}_{BBB}\right)} VP^{0} + VP^{0} \tag{8}$$

Where:

VP^{α}_{FR} = Present value of the security estimated using the risk factors of the α scenario;

^{o} = Value of parameters and of securities at the initial scenario.

Using equation (5) and assuming as initial parameters: S^{o} =3, r^{o} =15% and cc^{o} =5%, and rc^{o}_{BBB} =0,1796%, the present value of this security in the initial scenario is 2,8520.

The value of rc^{o}_{BBB} is calculated based on the table presented by Crouhy *et al.* (2001) which present the following default rates calculated by Standard & Poors, based on the following relation between credit risk and default probability[13]:

---

[12] Other examples of risk factors separations can be find at J.O. Morgan (1999) and Jorion (1999)

[13] This relation is obtained as follows: calculating the expected value at loan's maturity ($E(VF)$), using the default probability, the security will have two likely results: it will not be paid (probability of default p) or it will be paid (probability of default $(1-p)$). In practice, it will be assumed zero return of the loan in case of default. Therefore,

$$\left(1+rc\right)=\frac{1}{\left(1-p\right)} \quad (9)$$

Where:

p = default probability;

Table 1. Aggregated Default Rate

Aggregated Average Default Rate (% in years)								
Rating	**1**	**2**	**3**	**4**	**5**	**7**	**10**	**15**
AAA	-	-	0,07	0,15	0,24	0,66	1,40	1,40
AA	-	0,02	0,12	0,25	0,43	0,89	1,29	1,48
A	0,06	0,16	0,27	0,44	0,67	1,12	2,17	3,00
BBB	0,18	0,44	0,72	1,25	1,78	2,99	4,34	4,70
BB	1,06	3,48	6,12	8,68	10,97	14,46	17,73	19,91
B	5,20	11,00	15,95	19,40	21,88	25,14	29,02	30,65
CCC	19,79	26,92	31,63	35,97	40,15	42,64	45,10	45,10
Source: Standard & Poor's (April 15th, 1996)								

Crouhy at al. (2001, p.324)

Two scenarios were applied to this security: spot value of foreign currency unit ranging between 1 and 5 Reais, with 25 cents intervals; foreign exchange coupon ranging from 2% to 20%, in intervals of 0,5 %. For the credit risk it was considered the increase and the decrease of credit quality in 1 or 2 levels, using the probabilities given by the Standard & Poor's Table. Considering all possible combinations of these scenarios, 1,530 scenarios were tested.

It is important to notice that in the process of building this scenario there was no concern with the economical reasonability. Simply, it aims at evaluating if, when using different stress scenarios, disregarding the consistency of the used scenario, the results obtained by full valuation (equation 5) are equivalent to those obtained using the risk factors (equation 8).

Even using these scenarios with fluctuations much higher than the stress scenarios normally used, the outcomes obtained show that in 87,8% of the generated scenarios, the

---

$$E\left(VF\right)=p\times 0+\left(1-p\right)\times VF=\left(1-p\right)\times VF$$

According to the non-arbitrary hypothesis, a financial instrument with credit risk must have return equivalent to a financial instrument without credit risk of future value equal to $E\left(VF\right)$, i.e., the present value of both instruments should be equal. Therefore,

$$\frac{VF}{\left(1+i_c\right)}=VP=\frac{E\left(VF\right)}{1+r}$$

replacing equations and using the definition of $\left(1+i_c\right)=\left(1+r\right)\left(1+rc\right)$, after simplifying the equation:

$$\frac{VF}{\left(1+r\right)\left(1+rc\right)}=\frac{\left(1-p\right)\times VF}{\left(1+r\right)}$$ and, finally,

$$\left(1+rc\right)=\frac{1}{\left(1-p\right)}$$

fluctuation remained within the proposed error margin. Even considering only the combinations of extreme fluctuations of each risk factor, 74.1% remained within the acceptable margin.

Table 2. Error in a Linear Asset with Credit Risk

Gap Bands	Extreme Scenarios	% vertical	Other scenarios	% vertical	All scenarios	% vertical
between -30% e -10%	4	14.8%	159	10.6%	163	10.7%
between -10% e -5%	5	18.5%	144	9.6%	149	9.7%
between -5% e -2,5%	3	11.1%	76	5.1%	79	5.2%
between -2,5% e 0%	2	7.4%	526	35.0%	528	34.5%
between 0% e 2,5%	10	37.0%	474	31.5%	484	31.6%
between 2,5% e 5%		0.0%	63	4.2%	63	4.1%
between 5% e 10%		0.0%	41	2.7%	41	2.7%
between 10% e 20%	1	3.7%	14	0.9%	15	1.0%
between 20% e 50%	2	7.4%	6	0.4%	8	0.5%
Total	**27**	100.0%	**1,503**	100.0%	**1,530**	100.0%

In another test performed with a foreign currency future, applying the same methodology and the same scenarios, with the exception of the credit risk, and including the scenarios for the risk free interest rate, beginning at 15% and ranging between 5% and 29%, in intervals of 2 points, totaling 3,978 scenarios, the error using linear estimation by risk factors instead of the theoretical value equation, in 96.5% of the generated scenarios, the error ranged between + or -10%.

Therefore, according to the results obtained, the separation of linear financial instruments into their risk factors simplifies significantly the number of information and calculations necessary. The error caused by this simplification is within the proposed error margin, meaning that it should be an acceptable alternative for the definition of a set of information on linear instruments to be collected by the supervisor.

3. Non-Linear Financial Instruments

Generally, for the non-linear instruments, the management risk systems, RiskMetrics^{TM}, for example, uses *greeks*. The *greeks* are derivatives of the price of an option in relation to its risk factors, representing how the price of an option would react due to infinitesimal fluctuations on its risk factors. The estimate fluctuation of the price of a european buy option using *greeks* is given by the following equation:

$$dc \cong \Delta dS + \frac{1}{2}\Gamma(dS)^2 + \nu d\sigma + \rho_i di + \rho_q dq + \Theta dt \quad (10)$$

Where:

Δ = delta

Γ = gamma

v = *vega*

ρ_i = rho of interest rate

ρ_q = rho of dividend

θ = theta

The following study aims at determining if the representation of the positions in options using *greeks* is strong enough for the supervisor. Collecting information on non-linear instruments in this way enables the application of the stress test, which is considered to be adequate and one can also obtain results within the limits indicated by the research.

In order to evaluate the significance of the error caused by the use of *greeks* and if it is acceptable, a European buy option of foreign currency is used, with the following parameters: S=3; cc=5%, r=15%, $(T-t)$=1year, σ=10%, X=3. The price of this option in the beginning is 0,2942. The theoretical value of the option in each scenario α (c^{α}) was calculated using the Black-Scholes equation, and the estimated value of the option through the use of *greeks* (c_G^{α}) is calculated by the following equation:

$$c_G^{\alpha} \cong \Delta\left(S^{\alpha}-S^{0}\right)+\frac{1}{2}\Gamma\left(S^{\alpha}-S^{0}\right)^{2}+\Lambda\left(\sigma^{\alpha}-\sigma^{0}\right)+\rho_i\left(i^{\alpha}-i^{0}\right)+\rho_{cc}\left(cc^{\alpha}-cc^{0}\right)+c^{0} \quad (11)$$

Where:

^{0} = initial value of a parameter or price;

$^{\alpha}$ = value of the parameter or price in the scenario α.

The scenarios were the same scenarios applied to the linear instruments: spot value of foreign currency unit ranging between 1 and 5 Reais; interest rate free of risk, beginning at 15% and ranging between 5% and 29%, in intervals of 2%; foreign exchange coupon ranging from 2% to 20%, in intervals of 0,5 %. Scenarios for the volatility were also included (ranging from 5% to 50%, in intervals of 5%). Considering all the combinations among them, 39,780 scenarios were created.

The results of the simulation demonstrated that the error due to the comparison between the calculation performed using *greeks* instead of the Black-Scholes equation, were within the + or -10% margin, which would be considered acceptable according to the study, in only 14,1% of the scenarios.

It is important to notice that the results of this simulation can be extended to other options with other values of S and X, since the proportion between the S and X of the simulated scenarios is kept.

Table 3. Error generated by the use of *greeks*

Gap Bands	Extreme Scenarios	% vertical	Other Scenarios	% vertical	All Scenarios	% vertical
less than -50%	34	42.0%	12,418	31.3%	12,452	31.3%
between -50% e -20%	4	4.9%	7,231	18.2%	7,235	18.2%
between -20% e -10%	-	0.0%	2,386	6.0%	2,386	6.0%
between -10% e -5%	1	1.2%	1,305	3.3%	1,306	3.3%
between -5% e -2,5%	-	0.0%	665	1.7%	665	1.7%
between -2,5% e 0%	-	0.0%	757	1.9%	757	1.9%
between 0% e 2,5%	2	2.5%	793	2.0%	795	2.0%
between 2,5% e 5%	2	2.5%	841	2.1%	843	2.1%
between 5% e 10%	5	6.2%	1,234	3.1%	1,239	3.1%
between 10% e 20%	5	6.2%	1,406	3.5%	1,411	3.5%
between 20% e 50%	4	4.9%	1,989	5.0%	1,993	5.0%
more than 50%	24	29.6%	8,674	21.8%	8,698	21.9%
Total	81	100.0%	39,699	100.0%	39,780	100.0%

The collection of information on non-linear financial instruments using *greeks* produces highly unsatisfactory results, as the collected data does not enable the supervisor to have confidence that the obtained result really represents the effect that would occur in a financial institution.

One alternative to be explored for the collection of data on non-linear financial instruments is transforming all the positions in options in European plain vanilla options[14]. In order to adopt this alternative it is necessary to verify theoretically, in which situations this alternative is applicable and which limitations should be considered.

The options that are not European plain vanilla options can be divided into two groups: the American options (plain vanilla) and the exotic options. The American options generally are priced using binomial trees. Nonetheless, literature on this subject shows[15] that the American call options on shares, which do not pay dividends, should never be exercised before their expiry date, and, therefore, can be priced as European call options. One extension of this theory says that when dividends are paid before the expiry date on an American call option, the ideal choice is only exercise it just before the last dividends payment. This led some theorists[16] to suggest a pricing procedure that make use of this characteristic. Basically, it is necessary to calculate the price for two European call options: one expiring along with the American option and the other expiring just before the payment of the last dividend. The price of an American option will be the greater of these 2 values. Yet according to the literature, the error generated using this method is 1,48%[17].

The American options that do not pay dividends nor pay discreet dividends at expected dates can be priced as they were European options, having observed the rule contained in the last paragraph.

[14] The authors thank Professor Theodore Barnhill, from the George Washington University, for suggesting this approach.

[15] Hull (2001)

[16] Black (1975), according to Hull (2001)

[17] Hull (2001) presents a study made by Whaley (1982), using three pricing models of American call options: the equation proposed by Rol-Geske-Whaley, that starts from the same hypothesis of Black; the Black model; and the Black-Scholes equation. "The models produce errors with averages 1.08%, 1.48% and 2.15%, respectively" (Hull, 2001, p.277-8).

Remain a pending solution the American options that pay dividends continuously. It would be the case of an option on foreign currency, for example. In this case the foreign exchange coupon is considered as a dividend of the underlying asset. If demonstrated that the fluctuation of the price of an American option that pays dividends continuously in different scenarios is near to the fluctuation of a European option with the same scenarios, then they could be reported as European options.

In order to evaluate this possibility, a study was conducted with eight American options with different expiring dates and with the same parameters: S=3, cc=10%, r=20%, σ=30%, X=3. The theoretical prices of these options at the initial moment, using binomial trees and Black-Scholes were:

Table 4. Theoretical prices of options at the initial moment

Maturity	American	European
1 month	0.1151	0.1151
2 months	0.1685	0.1686
3 months	0.2112	0.2113
6 months	0.3111	0.3112
1 year	0.4543	0.4543
1.5 year	0.5595	0.5584
2 years	0.6415	0.6380
2.5 years	0.7077	0.6995

The extreme values of the applied scenarios are detailed in the table bellow. However, each one of them was divided in smaller intervals as described in the other scenarios applied. All combinations among scenarios resulted in 2,160 scenarios for each option.

Table 5. Extreme values of the applied scenarios

	Scenarios		
	Minimum	**Initial**	**Maximum**
Dollar Spot	1.50	3.00	6.00
Volatility	5%	30%	100%
Foreign Exchange Coupon	5%	10%	20%
Interest Rates	5%	20%	50%

According to the results of the simulations performed, the error caused by treating American options as European options is within the error margin accepted by the study (±10%) only for options with expiring date up to 1 year.

Table 6 . Percentage Distribution according to error bands

Percentage Distribution according to error bands				
Expiring date	**equal**	**between 100% and 110%**	**more than 110%**	**Total**
1 month	93.4%	6.3%	0.4%	100.0%
2 months	91.0%	8.2%	0.8%	100.0%
3 months	88.7%	9.3%	2.0%	100.0%
6 months	83.4%	12.5%	4.2%	100.0%
1 year	72.9%	18.4%	8.7%	100.0%
1.5 year	64.5%	21.8%	13.7%	100.0%
2 years	58.4%	23.2%	18.4%	100.0%
2.5 years	54.4%	23.2%	22.4%	100.0%
Total	75.8%	15.3%	8.8%	100.0%

Nevertheless, despite the results have shown to be acceptable only for the options up to 1 year, they are sufficient for accepting the presentation of American options as European, because the maturity structure of options traded in Brazil is extremely short, up to 1 year.

A short maturity structure is not an exclusive characteristic of the Brazilian market. According to Carvalho (2003), for example, the longest American option traded in England has an expiration period of less than 1 year.

Yet remain the exotic options. An exotic option is one of the denominations given to options that are not plain vanilla or standardized. In this category are included the over-the-counter options, developed for addressing specific necessities of each client, and the flexible options, traded in stock exchanges, with some standardized characteristics and other characteristics open to negotiation, as, for example, the exercise price, the maturity period or the kinds of barriers.

There is an enormous diversity of exotic options and frequently new kinds of exotic options are created. The most known are: barrier options, dual strike options, lookback options, Asian options and compound options[18].

In most of the cases, there is no analytical solution for the evaluation of exotic options. For these options, the numerical procedures presented by Hull (2001) are used, mainly binomial trees and Monte Carlo simulation.

Despite the difficulties in pricing, in some cases it is possible to find analytical solutions. It is the case, for example, of the exotic options with simple barrier - in this kind of option the barrier is touched in the expiring date, the payoff is limited to the difference between the exercise price and the barrier price. It is possible to build a portfolio of European options that reproduce the cash flow of this exotic option. For example, a long position in a call option with a single barrier is equivalent to the buying of a plain vanilla call, with the same exercise price of the exotic option and the selling of a call option plain vanilla, when the exercise price is equal to the barrier.

[18] See Hull (2001, p. 536-538)

An evolution of this idea, known as static reproduction of options, presented by Derman *et al.* (1994), consists, basically, in finding a portfolio of plain vanilla options whose value across a frontier is equivalent to the value of the exotic option in the same frontier, due to the fact that if two portfolios have the same value in the same frontier, they will have the same value in all points inside this frontier[19], enabling, therefore, the pricing or hedging of an exotic option.

One critic to this kind of methodology is that the options necessary to the replication are not always available in the market. This critic is relevant if the methodology is being used in order to hedge one position, but, as the objective of this study is to calculate the "theoretical value" of the option, this critic loses relevance.

Derman *et al.* (1994) demonstrate an application of this methodology for a *knock up-and-out* option, but affirm that it can be extended to other kinds of options, as, for example, dual-strike-options, interest rate options, foreign currency options or to options with more than one underlying asset.

Other authors, more than only looking for means of replicating statically other types of options, searched for alternatives in order to solve some static replication problems: Carr *et al.* (1998) and Carr and Chou (1997) present an alternative approach for the static replication and how to proceed with different types of exotic options. Liljefors (2001) proposes an alternative for the static replication under dynamical market conditions using optimization techniques. Sbuelz (2000) presents static replication for two barrier options. Ilhan and Sircar (2003) aimed at optimizing the hedge of exotic options using a combination of static replication and dynamic replication. All those works, nevertheless, aimed at the same objective: finding a portfolio basically composed by plain vanilla options or "simple" instruments that represent the same payoff of an exotic option.

Theoretically, this technique, when reducing an exotic option to a portfolio of plain vanilla European options enables these options to be included in the proposed report. Nonetheless, it is necessary to assess the quality of the obtained results with this technique.

Testing a *knock up-and-out* option - in this type of option if the underlying asset price raises above a pre-established value (barrier), the option expires - this methodology presents satisfactory results for fluctuations in the underlying asset, nevertheless, when all the parameters fluctuate at the same time, as, for example, interest rate and volatility, the results do not meet the proposed quality standard.

The methodology proposed by Derma *et al.* (1994) is acceptable only for stress scenarios for the underlying asset. Although changes proposed by other authors have not been tested, considering that in Brazilian market, exotic options which require the use of this kind of methodology represents only 0.5% of total derivatives listed on clearing houses, the use of this methodology does not bring big distortions to the results.

Positions in exotic options and in American options can be represented by plain vanilla European options, according to the methodologies described in this study and their limitations. Therefore, the report used for the collection of information on non-linear financial instruments was designed using the methodology explained in the next section[20].

---

[19] (Hull, 2001, p. 536-538)

[20] We thank Professor Theodore Barnhill for suggesting this approach.

4. Proposed Information Set

The following sections contain reports that reproduce the proposed information sets for linear and non-linear instruments. The comments on the use of each one and the results of some tests are also presented.

4.1 Report For Linear Instruments

As previously established, this document is designed based on data generated on an intermediary stage of the management risk systems where the market value of the linear financial instruments is totaled by risk factor and mapped on to a vertices structure.

The market value of each financial instrument and the identification of risk factors are made according to the same methodology used for foreign currency securities with credit risk.

The number of data to be processed decreases significantly if positions are totaled up according to their risk factors. For example, if an institution has only two positions of the same value and maturity: one long in a foreign currency security with credit risk BBB and other short in dollar future. The final situation would be the following:

Table 7. Calculation of the net position by risk factor

Risk Factors		Net Position
foreign currency Security with credit risk	Dollar future	
+ Dollar spot	- Dollar spot	0
- Foreign exchange coupon	+ Foreign exchange coupon	0
- Credit premium (BBB)		- $
	- Interest rate free of risk	- $

The risk factors "spot dollar" and "foreign exchange coupon" of the foreign currency security were offset by the risk factors of the dollar future, remaining only a short position in credit risk and a short position in risk free interest rate.

The mapping in vertices can be made according to different methodologies. Nevertheless, an option was made for the linear mapping, because it is more intuitive, easily implemented and because it reacts better to the other methodologies when there are extreme fluctuations in volatilities and correlations[21].

The report for the collection of information on linear financial instruments will have the following feature:

[21] Mina, 1999, p.12: "We propose a linear cash flow map that performs well even under extreme volatility and correlation scenarios. Moreover, under normal circumstances, the results produced by the proposed map and the RiskMetrics maps are virtually indistinguishable. In addition, the linear map is very intuitive and easy to implement".

Table 8. Example of report on positions in linear instruments

	VERTICES (weekdays)						
RISK FACTORS	**1**	**22**	**67**	**132**	**252**	**504**	**...**
Interest rate free of risk							
Foreign exchange rate							
Spot dollar							
Ibovespa							
Credit Risk AAA							
Credit Risk AA							
Credit Risk A							
Credit Risk BBB							
....							

OBS: the gray lines are due to the fact that for spot prices there are information only for the vertex 1 day.

Finally, positions held in shares can be reported individually or be transformed into number equivalent to stock exchange indexes through the beta of the CAPM. The risk credit ratings must be standardized according to a scale defined by the supervisor in order to make all of them comparable[22], and the risk factors to be informed must also be chosen by the supervisor amongst the most relevant to the financial system.

4.1.1 How to use this information

The use of this information follows basically the same structure used by a security described by equation (8). The position of each vertex must be reevaluated according to the fluctuation of each risk factor in the α scenario. Therefore, the impact on the portfolio value due to the fluctuation in the various risk factors is given by:

$$\Delta V_C = \sum_{FR=1}^{j} \sum_{v=1}^{n} \left(V_{FR,v}^{\alpha} - V_{FR,v}^{0} \right) \qquad (12)$$

Where:

ΔV_C = fluctuation in the portfolio value;

$_{FR}$ = each one of the existing risk factors, ranging from 1 to j;

v = vertices in number of days, ranging from 1 to n;

$V_{FR,v}^{\alpha}$ = value of the risk factor FR in the vertex v when applied the α scenario;

$V_{FR,v}^{0}$ = Value of the risk factor FR in the vertex v at the initial moment.

If the risk factor is a spot price, therefore:

[22] See example at Crouhy et al. (2001, p.272)

$$V_{FR,1}^{\alpha} = \frac{\left(FR_1^{\alpha} - FR_1^0\right)}{FR_1^0} \times V_{FR,1}^0 \qquad (13)$$

Where:

FR_1^{α} = Value of the risk factor in the α scenario;

FR_1^0 = Value of the risk factor in the initial scenario.

$$V_{FR,v}^{\alpha} = \frac{\left(FR_v^{\alpha} - FR_v^0\right)}{\left(1 - FR_v^0\right)} \times V_{FR,v}^0 \qquad (14)$$

Where:

FR_v^{α} = Aggregated rate for the vertex v in the α scenario;

FR_v^0 = Aggregated rate for the vertex v in the initial scenario.

4.1.2 Evaluation of the Results obtained with this information.

In order to evaluate if the results obtained using only information of the proposed document meets the defined criteria, i.e., error not bigger than ±10%, two portfolios were tested. The first portfolio represents all the linear financial instruments, assets or liabilities existing in the Brazilian financial system - BFS[23] in September, 2003 and the second portfolio represent all the futures listed on the Stock and Futures Exchange - BM&F in January 23rd, 2004.

The portfolio held by the BFS in September, 2003 was the following:

Table 9. Balance Sheet - All the BFS (as of September, 2003)

million Reais

ASSETS		LIABILITIES		
Cash	22.790	Deposits	Interbank	277.109
Interbank deposits	154.692		time	240.903
Federal Government securities	293.999		demand	60.993
Shares	4.899		savings	139.973
Loans	433.822	Loans	In Brazil	79.594
non-classified accounts	60.762		Abroad	95.872
Fixed Assets	49.416	Net Equity		125.937
Total Assets	1.020.380	Total Liabilities		1.020.380

Source: Central Bank of Brazil's website - Quarterly Financial Information

In the process of building the report that presents the risk factors mapped on to vertices, the values classified as cash, fixed assets and demand deposits are not directly influenced by

[23] There is no detailed information available comprehending all the BFS, therefore, some simplifications were necessary. However, the original characteristics were preserved to the possible extent.

market risk fluctuations or credit risk, and therefore, they are not included. The net equity is indirectly influenced by the reevaluation of the various positions; therefore, it won't be included in the map either. The final report on risk factors mapped on to vertices of the BFS is the following:

Table 10. Report on positions in linear instruments for BFS (September, 2003)

million Reais

RISK FACTORS	VERTICES (weekdays)								
	1	22	67	132	252	504	1008	2520	5040
SPOT DOLLAR	55,792	-	-	-	-	-	-	-	-
DOLLAR COUPON	-	(1,011)	(253)	(7,762)	(2,147)	(32,274)	(11,167)	(620)	(559)
SELIC INTEREST RATE	(122,417)	(72,425)	(18,106)	56,191	15,542	83,821	28,252	9,877	1,146
FIXED INTEREST RATE	-	41,855	10,464	(10,084)	(2,789)	6,545	(7,916)	(2,307)	(136)
SHARES	4,899	-	-	-	-	-	-	-	-
CREDIT RISK AAA	-	(31,554)	(7,888)	(23,921)	(6,616)	(21,142)	(7,095)	(5,636)	(1,817)
CREDIT RISK AA	-	(36,549)	(9,137)	(27,707)	(7,664)	(24,484)	(8,210)	(6,535)	(2,103)
CREDIT RISK A	-	(19,115)	(4,779)	(14,490)	(4,008)	(12,794)	(4,288)	(3,389)	(1,084)
CREDIT RISK BBB	-	(10,265)	(2,566)	(7,782)	(2,152)	(6,860)	(2,287)	(1,782)	(572)
CREDIT RISK BB	-	(4,823)	(1,206)	(3,657)	(1,011)	(3,153)	(1,003)	(726)	(228)
CREDIT RISK B	-	(2,838)	(710)	(2,152)	(595)	(1,785)	(543)	(385)	(121)
CREDIT RISK CCC	-	(4,822)	(1,205)	(3,655)	(1,011)	(2,943)	(867)	(598)	(193)

The scenarios to be applied are based in the major fluctuations of the following risk factors: spot dollar, Selic interest rate, Bovespa Index and the yield curve in the last 10 years in the Brazilian market. For the dollar coupon, the major fluctuations in the last 5 years are considered and, for credit risk, the downgrade of two levels is considered[24]. 486 scenarios were built, representing all the possible combinations amongst the following values for each risk factor:

Table 11. Scenarios used in the assessment of the BFS's portfolio

	Spot dolar	Selic Rate	Ibovespa Index	Fixed Interest Rate			dolar coupon			Credit Risk
				6 months	12 months	24 months	6 months	12 months	24 months	
High	4,80	48,6%	28.411	38,0%	35,0%	31,2%	7,1%	8,5%	10,7%	N/A
Low	2,33	6,6%	8.659	10,7%	10,3%	11,0%	0,7%	1,4%	2,4%	2
Initial	2,92	19,8%	16.010	18,2%	18,1%	18,6%	2,0%	3,1%	5,1%	0

The results obtained show that, for the adopted portfolio, only in 9 scenarios the error would raise above the limit accepted by the study. And, even in those cases, the error would not reach -15%, demonstrating that the map for the linear instruments, considering the example, would present satisfactory results.

[24] The two levels downgrade is the methodology used by the Central Bank of Brazil on its Financial Stability Report, available at the website <http:www.bcb.gov.br> and is also used by Crouhy at al. (2000) as a methodology for the credit risk sensitivity analysis.

Table 12. Error in the estimation of the fluctuation of the BFS's portfolio

ERROR BAND	QUANTITY	%
between -15% e -10%	9	1.9%
between -10% e -5%	69	14.2%
between -5% e 0%	336	69.1%
between 0% e 5%	72	14.8%
TOTAL	**486**	**100.0%**

The portfolio of all the future contracts listed on BM&F including dollar futures, dollar coupon futures, and interbank deposits (DI) futures in January 23rd, 2004, presented the following structure:

Table 13. Summary of the futures contracts by type and expiring date

R$ mil

Expiring dates	Types of future contracts			Total	%
	Dollar coupon	Interbank deposits	Dollar		
up to 3 months	49,091,898	82,719,477	21,785,149	153,596,524	45.8%
3 to 6 months	19,604,679	49,484,570	935,672	70,024,920	20.9%
6 to 12 months	19,796,048	44,890,745	1,579,926	66,266,718	19.8%
1 to 1,5 year	8,600,603	7,038,126	0	15,638,729	4.7%
1,5 to 2 years	5,279,583	4,950,392	0	10,229,975	3.1%
above 2 years	15,960,610	3,655,955	0	19,616,565	5.8%
Total	118,333,420	192,739,265	24,300,747	335,373,432	100.0%

This portfolio can be divided into 3 risk factors: dollar spot, dollar coupon, and fixed interest rates. Applying the same scenarios described in the previous example, 27 scenarios were built using the major positive and negative fluctuations verified in the last few years. Two errors were calculated: in relation to the adjustment and in relation to the future value of the portfolio.

In 4 of the 27 scenarios the adjustment error would be higher than the error margin considered acceptable by the study. However, the future value error would never be significant. The major adjustment error (74.9%) is due to the fact that the fluctuation of the future value, used as basis for the adjustment calculation, is very small. In these cases, a small difference between the theoretical fluctuation and the projected fluctuation can result in a significant percentage difference amongst the adjustments, despite the fact that the future values are very close. In the other cases, in spite of the fact that the adjustment error is higher than the accepted by the study, it was never higher than 20%.

In other words, the proposed report on linear instruments grouped by risk factors and vertices presented a satisfactory performance even in extreme scenarios, as the scenarios verified in Brazil in the last few years, both for the portfolio that represents the BFS and for the portfolio that represents all the futures listed on BM&F.

4.2 Report For Non-Linear Instruments

According to the discussion presented initially, the document to be evaluated for non-linear financial instruments will be based in the hypothesis that all options can be summarized in European options' portfolio. In case of financial instruments with embedded options, the instruments were separated into two positions: one in a linear instrument and other in a non-linear instrument. Each one reported in the respective report.

After the exotic options have been transformed into plain vanilla options' portfolios and the American options have been converted into European options, according to the presented methodologies, all the plain vanilla European options can be grouped according to their underlying assets.

For each plain vanilla European option, call or put, with a different underlying asset, a report will be filled out. For this purpose, it is necessary to know the quantity - in underlying assets units, which generally is represented by the notional, multiplied by the number of options -, the exercising price and the expiring date. Moreover, the percentage distance (D%) between the asset price and the exercise price must be calculated for each one of them:

$$D\%_i = \frac{(X_i - S)}{S} \tag{15}$$

Having all these information, the quantities are linearly mapped on to the report, firstly according to the expiring date and then according to the percentage distance between the exercise price and the spot price. Therefore, each option will be distributed into 4 cells of the report. Then, in each cell the quantities are included. Therefore, they are informed in the report.

Table 14. Example of the positions map on non-linear instruments - Call European Options

Maturity Vertices	-15%	-10%	-5%	0%	5%	10%	15%
1							
10							
21							
35							
50							
70							
...							

4.2.1 How to use this information

In order to use the non-linear instruments' report, the first stage is to price the report. For this purpose, the Black-Scholes equation is used. Each cell presents the price of an option, calculated for one underlying asset unit, considering the period until the maturity and the percentage distance (D%) between the price of the underlying asset and the exercise price converted again into exercise price. Other required parameters - spot price, volatility and dividends - are collected by the supervisor in the market.

Therefore, the report price is:

$$VC_{NL} = \sum_{p;d=1}^{n} c_{(pxd)} Q_{(pxd)} \qquad (16)$$

Where:

VC_{NL} = Value of the non-linear portfolio;

$c_{(pxd)}$ = price of an option for each cell (pxd), resulting of the intersection of the period until maturity (p) with the percentage distance between the underlying asset price and the exercise price (d).

$Q_{(pxd)}$ = quantity allocated in the report for the cell (pxd).

In order to assess the impact of an α scenario on a portfolio, new parameters $f(S^{\alpha};\sigma^{\alpha};r^{\alpha};q^{\alpha})$ must be established and it is necessary to recalculate the Black-Scholes equation in order to obtain the price of an option on the new scenario. This value must be multiplied by the respective quantity in order to obtain the value of the report on the new scenario (VC_{NL}^{α}):

$$VC_{NL}^{\alpha} = \sum_{p;d=1}^{n} c_{(pxd)}^{\alpha} Q_{(pxd)} \qquad (17)$$

Therefore, the impact of the use of the new scenario is given by the following equation:

$$\Delta VC_{NL} = VC_{NL}^{\alpha} - VC_{NL}^{0} \qquad (18)$$

Where:

VC_{NL}^{α} = Value of the portfolio considering the α scenario

VC_{NL}^{0} = Value of the portfolio at the initial time.

4.2.2 Evaluation of the Results obtained with this information.

In order to assess if the results obtained using only the information contained in the proposed report meet the requirement of error less or equal to ± 10% in relation to the results obtained by the full valuation method, two tests were performed: one using some options strategies, in order to verify if the risk inherent to each option is properly captured by the proposed document and other assessing the foreign exchange options portfolio listed on the BM&F in 01/23/2004.

The tests were performed using three kinds of strategies: box, butterfly and spread. For each one the biggest fluctuations verified in the last few years in the Brazilian markets were used. In all performed tests the comparison between the value of the options portfolio in each strategy priced using the Black-Scholes equation and the value of the portfolio obtained using the proposed report was not higher than + or - 2%.

The BM&F portfolio on 01/23/2004[25] comprehended 100 call options and 15 put options, all European plain vanilla. The target was to verify if the fluctuation, in different stress scenarios, estimated based on the report will be close enough of the fluctuation of the portfolio value when the value of each option is recalculated individually using the Black-Scholes equation.

Table 15. Summary of the dollar options portfolio listed on BM&F

as of : 01/23/2004 — Quantity

Exercise Prices bands		Maturity Bands		
		Up to 3 months	6 to 12 months	Total
from 2,7 to 3,05	Call	15	5	20
	Put	13	2	15
from 3,05 to 3,4	Call	15	15	30
from 3,40 to 3,75	Call	12	14	26
from 3,75 to 4,05	Call	7	7	14
from 4,05 to 4,40	Call	1	9	10
Total		**63**	**52**	**115**

Source: BM&F website

The scenarios representing the major fluctuations verified in the last few years in the Brazilian market for each risk factor were applied to the portfolio and to the information contained in the proposed report. 81 scenarios results were evaluated. In none of them the error was higher than the accepted by the study. Therefore, for this portfolio, the results are considered satisfactory.

Table 16. Error comparing the estimated value and the theoretical value

Error Bands	**Quantity**
from -5% to 0%	16
from 0% to 5%	64
from 5% to 10%	1
Total	**81**

Therefore, the proposed document for the collection of information on non-linear financial instruments captured adequately the risks inherent to the options strategies and the risks of the options portfolio listed on the BM&F, even in extremes scenarios, as those occurred in Brazil in the last few years.

5. Conclusions

Considering the increasing use of derivatives by financial institutions, to the point that they became one of the major revenue sources, the difficulties that this fact has brought to the assessment of the risk in the financial institutions, once the effects of the derivatives on the

[25] Excludes those maturing on February 2004, because information on expired options is not available at the BM&F website

institution are not transparent to supervisors and to market analysts. Taking into consideration the need of the banking supervisor, in the monitoring financial system activity, to have comparable risk measures in order to distinguish institutions or assess which institutions, given a scenario, could present problems. Hence, an instrument for the collection of information on risks incurred by financial institutions that enable supervisors to perform this task was evaluated.

Analyzing the information and reports to be collected, the study aimed at choosing, within the risk management systems, which data would be necessary and how they are usually treated, with the purpose of not imposing new costs to the financial institutions.

For the linear financial instruments, the separation into risk factors and the aggregation in maturity vertices showed to be a consistent alternative, capable of presenting satisfactory results even in major price and other market fluctuations parameters scenarios.

For the non-linear financial instruments, the use of *greeks* hasn't shown to be adequate when extreme fluctuations scenarios were applied. This is due to the fact that they represent only the effect of infinitesimal fluctuations of each risk factor in the price of a financial instrument and not fluctuations in stress situations.

As an alternative, the possibility of representing all kinds of existing options by European options or European options portfolios, without producing a significant error was assessed. For most options, alternatives were found in literature meeting this hypothesis. But, in both cases, this proposal presented some limitations.

American options can be represented by a European option when it does not pay dividends or pay discreet dividends at expected dates. Nevertheless, when representing American options with continuous dividends by a European option, the results were satisfactory only for those with maturity date of less than one year. But, according to stock exchange and clearing houses' data, the derivatives market in Brazil, mainly the options market, presents maturity dates of less than one year, enabling, therefore, the use of this simplification. This statement is also valid for other countries, as England, for example.

It is also important to have in mind that, in these tests, we used scenarios more severe than those that happened in the last 10 years in Brazil, when of the Russian, Asian, Brazilian and Argentina crises. If the country where this model will be applied has a smaller historical variation when compared to Brazil, it will be possible to use the above simplification for longer maturity options.

In the case of exotic options, the exotic option with simple barrier can be represented by an European plain vanilla options portfolio. In the other case, the results were satisfactory when only the underlying asset price fluctuates. This is due to the characteristics of the methodology chosen for transforming exotic options in European plain vanilla options portfolios. This problem is minimized by the fact that this methodology would be applied to only 0.5% of the financial volume of derivatives in Brazil. Moreover, this article mentions methodological alternatives that could be tested.

In all tests performed, both reports for linear and non-linear financial instruments presented results within the error margin established as acceptable comparing to the calculations performed according to the full valuation method. Furthermore, the report for non-linear financial instruments showed to be capable of capturing the risk of various strategy options.

In this work, the collection of information on market risk and credit risk was assessed. Nevertheless, there are other risks that should be considered, such as liquidity risk. An alternative would be to include in each risk factor the information of the underlying asset liquidity (high, medium and low, for example).

The proposed documents do not involve the adoption of sophisticated systems by the supervisory authorities and at the same time enables the measurement of the same risk for all financial institutions, using the same methodology, or the application of the same stress scenario, making results comparable with an acceptable accuracy level.

It must be clear that it is not up to the supervisor to manage the risks of the supervised banks, but simply to know the risk profile of each institution and monitoring the risk volume each one is incurring in relation to its capital, for example. Therefore, the proposed system should accept an error margin where the results enable knowing the institution, despite the fact that they are not precise.

Finally, in this article, the focus was bank supervision, but this approach could be useful for others, such as risk managers, financial institutions or academicians. This approach can be helpful in building risk management models as it can be used as an input in such models.

References

BIS. **Amendment to the Capital Accord to Incorporate Market Risks**. Basel Committee on Banking Supervision, Jan. 1996.

BIS. **Recommendations for public disclosure of trading and derivatives activities.** Basel Committee on Banking Supervision, May 1999a.

BIS. **Trading and Derivatives Disclosures of Banks and Securities Firms — Results of the survey of public disclosures in 1998 annual reports.** Basel Committee on Banking Supervision, Dec. 1999b.

BIS — BANK FOR INTERNATIONAL SETTLEMENTS. **Public Disclosures by Banks**: Results of the 2001-Disclosure Survey**.** Basel Committee on Banking Supervision, May 2003.

BIS. **The New Basel Capital Accord — Consultive Document**. Basel Committee on Banking Supervision, July 2003.

Black, F. and Scholes, M. The Valuation of Option Contracts and a Test of Market Efficiency. **The Journal of Finance,** v. 27, n. 2, May 1972.

Carr, P. and Chou, A. **Hedging Complex Barrier Options**. Apr. 1997.

Carr, P., Ellis, K. and Gupta, V. Static Hedging of Exotic Options. **Journal of Finance,** v. 53, p. 1165-1190, June 1998.

Carvalho, A. P. **Pricing American Options.** Dissertation, Lancaster University, 2003.

Crouhy, M., Mark, R., and Galai, D. **Risk Management**. New York: McGraw-Hill, 2001.

Dembo, R. S., Asis, A., Rosen, D., and Zerbo, M. **Mark to Future: A framework for measuring risk and reward**. Algorithmics Publications, 2000.

Derman, E., Ergener, D., and Kani, I. Static Options Replication. **Quantitative Strategies Research Notes**, Goldman Sachs, May 1994.

Derman, E. The boy's guide to pricing and hedging. **Risk Magazine**, Jan. 2003.

FASB — FINANCIAL ACCOUNTING STANDARDS BOARD. **Statement No. 107**: Disclosures about Fair Value of Financial Instruments. Dec. 1991.

FASB. **Statement No. 133**: Accounting for Derivative Instruments and Hedging Activities. June 1998.

FASB. **Statement No. 137**: Accounting for Derivative Instruments and Hedging Activities—Deferral of the Effective Date of FASB Statement No. 133—an amendment of FASB Statement No. 133. June 1999.

FASB. **Statement No. 138**: Accounting for Certain Derivative Instruments and Certain Hedging Activities-an amendment of FASB Statement No. 133. June 2000.

FASB. **Statement No. 149**: Amendment of Statement 133 on Derivative Instruments and Hedging Activities. Apr. 2003.

Gardner, M. J., Mills, D., and Cooperman, E. **Managing Financial Institutions**: An Asset/Liability Approach. 4. ed. Orlando, FL: Dryden Press, 2000.

Greuning, H. V and Bratanovic, S. B. **Analyzing Banking Risk**. Washington, D. C.: The World Bank, 1999.

Hull, J. **Introdução aos Mercados Futuros e de Opções**. 2. ed. São Paulo: Cultura, 1996.

Hull, J. **Opções, Futuros e Outros Derivativos**. 3. ed. São Paulo: BM&F, 2001.

Ilhan, A.; Sircar, R. **Optimal Static-Dynamic Hedges for Barrier Options**. Nov. 2003.

Jorion, P. **Value at Risk**: A nova Fonte de Referência para o Controle do Risco de Mercado. São Paulo: Cultura, 1999.

RiskMetrics: Technical Document. 4. ed. Dec. 1996.

Koch, T. W.; Macdonald, S. S. **Bank Management**. 4. ed. Orlando, FL: Dryden Press, 2000.

Krugman, P.; Obstfeld, M. **Economia Internacional**: Teoria e Política. 5. ed. São Paulo: Makron Books, 2001.

Laubsch, A. **Risk Management**: A Practical Guide. RiskMetrics Group. Aug. 1999.

Liljefors, J. **Static Hedging of Barrier Options under Dynamic Market Conditions**. Sept. 2001.

Lopes, A. B.; Lima, I. S. Disclosure de Operações com Derivativos: panorama internacional. **Caderno de Estudos**, São Paulo, FIPECAFI, v.10, n. 18, mai./ago. 1998.

Mina, J. **Improved Cashflow Map**. RiskMetrics Group. 1999.

Sbuelz, A. **Hedging Double Barriers With Singles**. Nov. 2000.

Vieira Neto, C. A. and Urban, F. Um modelo de teste de stress menos subjetivo e mais abrangente. **Resenha da BM&F**, n. 139, 2000.

Weichert, M. A. **Avaliação de opções com barreira considerando os efeitos da volatilidade da volatilidade**. Dissertation, Universidade Federal do Rio de Janeiro, 2002.

Banco Central do Brasil

Trabalhos para Discussão

Os Trabalhos para Discussão podem ser acessados na internet, no formato PDF, no endereço: http://www.bc.gov.br

Working Paper Series

Working Papers in PDF format can be downloaded from: http://www.bc.gov.br

1	**Implementing Inflation Targeting in Brazil** *Joel Bogdanski, Alexandre Antonio Tombini and Sérgio Ribeiro da Costa Werlang*	Jul/2000
2	**Política Monetária e Supervisão do Sistema Financeiro Nacional no Banco Central do Brasil** *Eduardo Lundberg*	Jul/2000
	Monetary Policy and Banking Supervision Functions on the Central Bank *Eduardo Lundberg*	Jul/2000
3	**Private Sector Participation: a Theoretical Justification of the Brazilian Position** *Sérgio Ribeiro da Costa Werlang*	Jul/2000
4	**An Information Theory Approach to the Aggregation of Log-Linear Models** *Pedro H. Albuquerque*	Jul/2000
5	**The Pass-Through from Depreciation to Inflation: a Panel Study** *Ilan Goldfajn and Sérgio Ribeiro da Costa Werlang*	Jul/2000
6	**Optimal Interest Rate Rules in Inflation Targeting Frameworks** *José Alvaro Rodrigues Neto, Fabio Araújo and Marta Baltar J. Moreira*	Jul/2000
7	**Leading Indicators of Inflation for Brazil** *Marcelle Chauvet*	Sep/2000
8	**The Correlation Matrix of the Brazilian Central Bank's Standard Model for Interest Rate Market Risk** *José Alvaro Rodrigues Neto*	Sep/2000
9	**Estimating Exchange Market Pressure and Intervention Activity** *Emanuel-Werner Kohlscheen*	Nov/2000
10	**Análise do Financiamento Externo a uma Pequena Economia Aplicação da Teoria do Prêmio Monetário ao Caso Brasileiro: 1991–1998** *Carlos Hamilton Vasconcelos Araújo e Renato Galvão Flôres Júnior*	Mar/2001
11	**A Note on the Efficient Estimation of Inflation in Brazil** *Michael F. Bryan and Stephen G. Cecchetti*	Mar/2001
12	**A Test of Competition in Brazilian Banking** *Márcio I. Nakane*	Mar/2001

13	**Modelos de Previsão de Insolvência Bancária no Brasil** *Marcio Magalhães Janot*	Mar/2001
14	**Evaluating Core Inflation Measures for Brazil** *Francisco Marcos Rodrigues Figueiredo*	Mar/2001
15	**Is It Worth Tracking Dollar/Real Implied Volatility?** *Sandro Canesso de Andrade and Benjamin Miranda Tabak*	Mar/2001
16	**Avaliação das Projeções do Modelo Estrutural do Banco Central do Brasil para a Taxa de Variação do IPCA** *Sergio Afonso Lago Alves*	Mar/2001
	Evaluation of the Central Bank of Brazil Structural Model's Inflation Forecasts in an Inflation Targeting Framework *Sergio Afonso Lago Alves*	Jul/2001
17	**Estimando o Produto Potencial Brasileiro: uma Abordagem de Função de Produção** *Tito Nícias Teixeira da Silva Filho*	Abr/2001
	Estimating Brazilian Potential Output: a Production Function Approach *Tito Nícias Teixeira da Silva Filho*	Aug/2002
18	**A Simple Model for Inflation Targeting in Brazil** *Paulo Springer de Freitas and Marcelo Kfoury Muinhos*	Apr/2001
19	**Uncovered Interest Parity with Fundamentals: a Brazilian Exchange Rate Forecast Model** *Marcelo Kfoury Muinhos, Paulo Springer de Freitas and Fabio Araújo*	May/2001
20	**Credit Channel without the LM Curve** *Victorio Y. T. Chu and Márcio I. Nakane*	May/2001
21	**Os Impactos Econômicos da CPMF: Teoria e Evidência** *Pedro H. Albuquerque*	Jun/2001
22	**Decentralized Portfolio Management** *Paulo Coutinho and Benjamin Miranda Tabak*	Jun/2001
23	**Os Efeitos da CPMF sobre a Intermediação Financeira** *Sérgio Mikio Koyama e Márcio I. Nakane*	Jul/2001
24	**Inflation Targeting in Brazil: Shocks, Backward-Looking Prices, and IMF Conditionality** *Joel Bogdanski, Paulo Springer de Freitas, Ilan Goldfajn and Alexandre Antonio Tombini*	Aug/2001
25	**Inflation Targeting in Brazil: Reviewing Two Years of Monetary Policy 1999/00** *Pedro Fachada*	Aug/2001
26	**Inflation Targeting in an Open Financially Integrated Emerging Economy: the Case of Brazil** *Marcelo Kfoury Muinhos*	Aug/2001
27	**Complementaridade e Fungibilidade dos Fluxos de Capitais Internacionais** *Carlos Hamilton Vasconcelos Araújo e Renato Galvão Flôres Júnior*	Set/2001

28	**Regras Monetárias e Dinâmica Macroeconômica no Brasil: uma Abordagem de Expectativas Racionais** *Marco Antonio Bonomo e Ricardo D. Brito*	Nov/2001
29	**Using a Money Demand Model to Evaluate Monetary Policies in Brazil** *Pedro H. Albuquerque and Solange Gouvêa*	Nov/2001
30	**Testing the Expectations Hypothesis in the Brazilian Term Structure of Interest Rates** *Benjamin Miranda Tabak and Sandro Canesso de Andrade*	Nov/2001
31	**Algumas Considerações sobre a Sazonalidade no IPCA** *Francisco Marcos R. Figueiredo e Roberta Blass Staub*	Nov/2001
32	**Crises Cambiais e Ataques Especulativos no Brasil** *Mauro Costa Miranda*	Nov/2001
33	**Monetary Policy and Inflation in Brazil (1975-2000): a VAR Estimation** *André Minella*	Nov/2001
34	**Constrained Discretion and Collective Action Problems: Reflections on the Resolution of International Financial Crises** *Arminio Fraga and Daniel Luiz Gleizer*	Nov/2001
35	**Uma Definição Operacional de Estabilidade de Preços** *Tito Nícias Teixeira da Silva Filho*	Dez/2001
36	**Can Emerging Markets Float? Should They Inflation Target?** *Barry Eichengreen*	Feb/2002
37	**Monetary Policy in Brazil: Remarks on the Inflation Targeting Regime, Public Debt Management and Open Market Operations** *Luiz Fernando Figueiredo, Pedro Fachada and Sérgio Goldenstein*	Mar/2002
38	**Volatilidade Implícita e Antecipação de Eventos de *Stress*: um Teste para o Mercado Brasileiro** *Frederico Pechir Gomes*	Mar/2002
39	**Opções sobre Dólar Comercial e Expectativas a Respeito do Comportamento da Taxa de Câmbio** *Paulo Castor de Castro*	Mar/2002
40	**Speculative Attacks on Debts, Dollarization and Optimum Currency Areas** *Aloisio Araujo and Márcia Leon*	Apr/2002
41	**Mudanças de Regime no Câmbio Brasileiro** *Carlos Hamilton V. Araújo e Getúlio B. da Silveira Filho*	Jun/2002
42	**Modelo Estrutural com Setor Externo: Endogenização do Prêmio de Risco e do Câmbio** *Marcelo Kfoury Muinhos, Sérgio Afonso Lago Alves e Gil Riella*	Jun/2002
43	**The Effects of the Brazilian ADRs Program on Domestic Market Efficiency** *Benjamin Miranda Tabak and Eduardo José Araújo Lima*	Jun/2002

44	**Estrutura Competitiva, Produtividade Industrial e Liberação Comercial no Brasil** *Pedro Cavalcanti Ferreira e Osmani Teixeira de Carvalho Guillén*	Jun/2002
45	**Optimal Monetary Policy, Gains from Commitment, and Inflation Persistence** *André Minella*	Aug/2002
46	**The Determinants of Bank Interest Spread in Brazil** *Tarsila Segalla Afanasieff, Priscilla Maria Villa Lhacer and Márcio I. Nakane*	Aug/2002
47	**Indicadores Derivados de Agregados Monetários** *Fernando de Aquino Fonseca Neto e José Albuquerque Júnior*	Set/2002
48	**Should Government Smooth Exchange Rate Risk?** *Ilan Goldfajn and Marcos Antonio Silveira*	Sep/2002
49	**Desenvolvimento do Sistema Financeiro e Crescimento Econômico no Brasil: Evidências de Causalidade** *Orlando Carneiro de Matos*	Set/2002
50	**Macroeconomic Coordination and Inflation Targeting in a Two-Country Model** *Eui Jung Chang, Marcelo Kfoury Muinhos and Joanílio Rodolpho Teixeira*	Sep/2002
51	**Credit Channel with Sovereign Credit Risk: an Empirical Test** *Victorio Yi Tson Chu*	Sep/2002
52	**Generalized Hyperbolic Distributions and Brazilian Data** *José Fajardo and Aquiles Farias*	Sep/2002
53	**Inflation Targeting in Brazil: Lessons and Challenges** *André Minella, Paulo Springer de Freitas, Ilan Goldfajn and Marcelo Kfoury Muinhos*	Nov/2002
54	**Stock Returns and Volatility** *Benjamin Miranda Tabak and Solange Maria Guerra*	Nov/2002
55	**Componentes de Curto e Longo Prazo das Taxas de Juros no Brasil** *Carlos Hamilton Vasconcelos Araújo e Osmani Teixeira de Carvalho de Guillén*	Nov/2002
56	**Causality and Cointegration in Stock Markets: the Case of Latin America** *Benjamin Miranda Tabak and Eduardo José Araújo Lima*	Dec/2002
57	**As Leis de Falência: uma Abordagem Econômica** *Aloisio Araujo*	Dez/2002
58	**The Random Walk Hypothesis and the Behavior of Foreign Capital Portfolio Flows: the Brazilian Stock Market Case** *Benjamin Miranda Tabak*	Dec/2002
59	**Os Preços Administrados e a Inflação no Brasil** *Francisco Marcos R. Figueiredo e Thaís Porto Ferreira*	Dez/2002
60	**Delegated Portfolio Management** *Paulo Coutinho and Benjamin Miranda Tabak*	Dec/2002

61 **O Uso de Dados de Alta Freqüência na Estimação da Volatilidade e do Valor em Risco para o Ibovespa** Dez/2002
João Maurício de Souza Moreira e Eduardo Facó Lemgruber

62 **Taxa de Juros e Concentração Bancária no Brasil** Fev/2003
Eduardo Kiyoshi Tonooka e Sérgio Mikio Koyama

63 **Optimal Monetary Rules: the Case of Brazil** Feb/2003
Charles Lima de Almeida, Marco Aurélio Peres, Geraldo da Silva e Souza and Benjamin Miranda Tabak

64 **Medium-Size Macroeconomic Model for the Brazilian Economy** Feb/2003
Marcelo Kfoury Muinhos and Sergio Afonso Lago Alves

65 **On the Information Content of Oil Future Prices** Feb/2003
Benjamin Miranda Tabak

66 **A Taxa de Juros de Equilíbrio: uma Abordagem Múltipla** Fev/2003
Pedro Calhman de Miranda e Marcelo Kfoury Muinhos

67 **Avaliação de Métodos de Cálculo de Exigência de Capital para Risco de Mercado de Carteiras de Ações no Brasil** Fev/2003
Gustavo S. Araújo, João Maurício S. Moreira e Ricardo S. Maia Clemente

68 **Real Balances in the Utility Function: Evidence for Brazil** Feb/2003
Leonardo Soriano de Alencar and Márcio I. Nakane

69 **r-filters: a Hodrick-Prescott Filter Generalization** Feb/2003
Fabio Araújo, Marta Baltar Moreira Areosa and José Alvaro Rodrigues Neto

70 **Monetary Policy Surprises and the Brazilian Term Structure of Interest Rates** Feb/2003
Benjamin Miranda Tabak

71 **On Shadow-Prices of Banks in Real-Time Gross Settlement Systems** Apr/2003
Rodrigo Penaloza

72 **O Prêmio pela Maturidade na Estrutura a Termo das Taxas de Juros Brasileiras** Maio/2003
Ricardo Dias de Oliveira Brito, Angelo J. Mont'Alverne Duarte e Osmani Teixeira de C. Guillen

73 **Análise de Componentes Principais de Dados Funcionais – Uma Aplicação às Estruturas a Termo de Taxas de Juros** Maio/2003
Getúlio Borges da Silveira e Octavio Bessada

74 **Aplicação do Modelo de Black, Derman & Toy à Precificação de Opções Sobre Títulos de Renda Fixa** Maio/2003
Octavio Manuel Bessada Lion, Carlos Alberto Nunes Cosenza e César das Neves

75 **Brazil's Financial System: Resilience to Shocks, no Currency Substitution, but Struggling to Promote Growth** Jun/2003
Ilan Goldfajn, Katherine Hennings and Helio Mori

90	**Bank Privatization and Productivity: Evidence for Brazil** *Márcio I. Nakane and Daniela B. Weintraub*	Dec/2004
91	**Credit Risk Measurement and the Regulation of Bank Capital and Provision Requirements in Brazil – A Corporate Analysis** *Ricardo Schechtman, Valéria Salomão Garcia, Sergio Mikio Koyama and Guilherme Cronemberger Parente*	Dec/2004
92	**Steady-State Analysis of an Open Economy General Equilibrium Model for Brazil** *Mirta Noemi Sataka Bugarin, Roberto de Goes Ellery Jr., Victor Gomes Silva, Marcelo Kfoury Muinhos*	Apr/2005
93	**Avaliação de Modelos de Cálculo de Exigência de Capital para Risco Cambial** *Claudio H. da S. Barbedo, Gustavo S. Araújo, João Maurício S. Moreira e Ricardo S. Maia Clemente*	Abr/2005
94	**Simulação Histórica Filtrada: Incorporação da Volatilidade ao Modelo Histórico de Cálculo de Risco para Ativos Não-Lineares** *Claudio Henrique da Silveira Barbedo, Gustavo Silva Araújo e Eduardo Facó Lemgruber*	Abr/2005
95	**Comment on Market Discipline and Monetary Policy by Carl Walsh** *Maurício S. Bugarin and Fábia A. de Carvalho*	Apr/2005
96	**O que É Estratégia: uma Abordagem Multiparadigmática para a Disciplina** *Anthero de Moraes Meirelles*	Ago/2005
97	**Finance and the Business Cycle: a Kalman Filter Approach with Markov Switching** *Ryan A. Compton and Jose Ricardo da Costa e Silva*	Aug/2005
98	**Capital Flows Cycle: Stylized Facts and Empirical Evidences for Emerging Market Economies** *Helio Mori e Marcelo Kfoury Muinhos*	Aug/2005
99	**Adequação das Medidas de Valor em Risco na Formulação da Exigência de Capital para Estratégias de Opções no Mercado Brasileiro** *Gustavo Silva Araújo, Claudio Henrique da Silveira Barbedo,e Eduardo Facó Lemgruber*	Set/2005
100	**Targets and Inflation Dynamics** *Sergio A. L. Alves and Waldyr D. Areosa*	Oct/2005
101	**Comparing Equilibrium Real Interest Rates: Different Approaches to Measure Brazilian Rates** *Marcelo Kfoury Muinhos and Márcio I. Nakane*	Mar/2006
102	**Judicial Risk and Credit Market Performance: Micro Evidence from Brazilian Payroll Loans** *Ana Carla A. Costa and João M. P. de Mello*	Apr/2006
103	**The Effect of Adverse Supply Shocks on Monetary Policy and Output** *Maria da Glória D. S. Araújo, Mirta Bugarin, Marcelo Kfoury Muinhos and Jose Ricardo C. Silva*	Apr/2006

104	**Extração de Informação de Opções Cambiais no Brasil** *Eui Jung Chang e Benjamin Miranda Tabak*	Abr/2006
105	**Representing Roomate's Preferences with Symmetric Utilities** *José Alvaro Rodrigues-Neto*	Apr/2006
106	**Testing Nonlinearities Between Brazilian Exchange Rates and Inflation Volatilities** *Cristiane R. Albuquerque and Marcelo Portugal*	May/2006
107	**Demand for Bank Services and Market Power in Brazilian Banking** *Márcio I. Nakane, Leonardo S. Alencar and Fabio Kanczuk*	Jun/2006
108	**O Efeito da Consignação em Folha nas Taxas de Juros dos Empréstimos Pessoais** *Eduardo A. S. Rodrigues, Victorio Chu, Leonardo S. Alencar e Tony Takeda*	Jun/2006
109	**The Recent Brazilian Disinflation Process and Costs** *Alexandre A. Tombini and Sergio A. Lago Alves*	Jun/2006
110	**Fatores de Risco e o *Spread* Bancário no Brasil** *Fernando G. Bignotto e Eduardo Augusto de Souza Rodrigues*	Jul/2006
111	**Avaliação de Modelos de Exigência de Capital para Risco de Mercado do Cupom Cambial** *Alan Cosme Rodrigues da Silva, João Maurício de Souza Moreira e Myrian Beatriz Eiras das Neves*	Jul/2006
112	**Interdependence and Contagion: an Analysis of Information Transmission in Latin America's Stock Markets** *Angelo Marsiglia Fasolo*	Jul/2006
113	**Investigação da Memória de Longo Prazo da Taxa de Câmbio no Brasil** *Sergio Rubens Stancato de Souza, Benjamin Miranda Tabak e Daniel O. Cajueiro*	Ago/2006
114	**The Inequality Channel of Monetary Transmission** *Marta Areosa and Waldyr Areosa*	Aug/2006
115	**Myopic Loss Aversion and House-Money Effect Overseas: an experimental approach** *José L. B. Fernandes, Juan Ignacio Peña and Benjamin M. Tabak*	Sep/2006
116	**Out-Of-The-Money Monte Carlo Simulation Option Pricing: the join use of Importance Sampling and Descriptive Sampling** *Jaqueline Terra Moura Marins, Eduardo Saliby and Joséte Florencio do Santos*	Sep/2006
117	**An Analysis of Off-Site Supervision of Banks' Profitability, Risk and Capital Adequacy: a portfolio simulation approach applied to brazilian banks** *Theodore M. Barnhill, Marcos R. Souto and Benjamin M. Tabak*	Sep/2006
118	**Contagion, Bankruptcy and Social Welfare Analysis in a Financial Economy with Risk Regulation Constraint** *Aloísio P. Araújo and José Valentim M. Vicente*	Oct/2006

119	**A Central de Risco de Crédito no Brasil: uma análise de utilidade de informação** *Ricardo Schechtman*	Out/2006
120	**Forecasting Interest Rates: an application for Brazil** *Eduardo J. A. Lima, Felipe Luduvice and Benjamin M. Tabak*	Oct/2006
121	**The Role of Consumer's Risk Aversion on Price Rigidity** *Sergio A. Lago Alves and Mirta N. S. Bugarin*	Nov/2006
122	**Nonlinear Mechanisms of the Exchange Rate Pass-Through: A Phillips curve model with threshold for Brazil** *Arnildo da Silva Correa and André Minella*	Nov/2006
123	**A Neoclassical Analysis of the Brazilian "Lost-Decades"** *Flávia Mourão Graminho*	Nov/2006
124	**The Dynamic Relations between Stock Prices and Exchange Rates: evidence for Brazil** *Benjamin M. Tabak*	Nov/2006
125	**Herding Behavior by Equity Foreign Investors on Emerging Markets** *Barbara Alemanni and José Renato Haas Ornelas*	Dec/2006
126	**Risk Premium: insights over the threshold** *José L. B. Fernandes, Augusto Hasman and Juan Ignacio Peña*	Dec/2006
127	**Uma Investigação Baseada em Reamostragem sobre Requerimentos de Capital para Risco de Crédito no Brasil** *Ricardo Schechtman*	Dec/2006
128	**Term Structure Movements Implicit in Option Prices** *Caio Ibsen R. Almeida and José Valentim M. Vicente*	Dec/2006
129	**Brazil: taming inflation expectations** *Afonso S. Bevilaqua, Mário Mesquita and André Minella*	Jan/2007
130	**The role of banks in the Brazilian Interbank Market: Does bank type matter?** *Daniel O. Cajueiro and Benjamin M. Tabak*	Jan/2007
131	**Long-Range Dependence in Exchange Rates: the case of the European Monetary System** *Sergio Rubens Stancato de Souza, Benjamin M. Tabak and Daniel O. Cajueiro*	Mar/2007
132	**Credit Risk Monte Carlo Simulation Using Simplified Creditmetrics' Model: the joint use of importance sampling and descriptive sampling** *Jaqueline Terra Moura Marins and Eduardo Saliby*	Mar/2007