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Using Swaps to Manage the Interest Rate Risk in the Brazilian External Debt

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1. Introduction

This paper will study the factors that influence sovereign external debt interest rate risk management, and the use of interest-rate swaps to mitigate this risk. We do not intend to exhaust the ideas and concepts behind this important issue, but rather want to develop a model for evaluating the use of interest-rate swaps in order to mitigate the interest rate risk on Brazil's external debt. Moreover, the idea of this paper is to make some comments and suggestions on the important aspects of this theme.

If this paper serves as a framework for internal discussions at the pertinent governmental offices in Brazil, it will achieve its goal.

Brazilian sovereign external debt must be understood here as the federal, or central government, debt. We exclude local government and state owned company debt from this analysis. This formula may be merely asimplification; however both types of debt have been frequently transferred to the central government. We will probably not see these debt transfers in the future foremost because of two aspects: first, financial administration in state owned companies, according to the new regulations and institutions in Brazil, is much more professional nowadays, and, second, restrictions were created by the central government on the absorption of local government debts.

Moreover, in this study we will be concentrating on the bond market debt, in other words, the sovereign debt, which is tradable in the international capital secondary market. In this way, all the debt with multilateral organisms will not be part of this study. Likewise, the Brazilian debt with the Paris Club will also be out of the scope.

Recently, some economic crises happened in the so-called emerging market economies. Crises in Argentina, Russia and Ecuador, showed the importance of a program to manage the external debt risk of such countries.

In the context of a globalization process, debt management has become more complex and more relevant due to the liberalization of capital markets and to the large-scale capital flows. Therefore, there are increasing risks associated with greater market volatility caused by the instability of capital flows for emerging markets. In a globalized environment, even macroeconomic stability is dependent on sound external debt management.

As can be seen, an efficient strategy to manage assets, and especially liabilities, is a key element for the whole market. Indeed, the wise administration of public external debt has been growing in significance.

Risk management has been getting tremendous attention lately. There is a generalized perception that, because of the market integration, economic units are exposed to greater financial risk today than in the past. The growing derivatives market can be seen as a consequence of the search for a hedge against these financial risks. Admittedly, however, such instruments as derivatives might be the cause of the growing potential risks to which those institutions are exposed.

Some countries, such as Ireland, Sweden, New Zealand, Mexico and Colombia, have started giving special attention to risk management. Some of them even created dedicated debt management offices.

In Brazil, the sovereign debt management is spread throughout a great number of offices. The Central Bank has an important role in the internal debt and, especially, the external debt management. Historically the Central Bank conducted all the external debt renegotiations, including the last one in 1994

under the Brady Plan structure. Presently, the Central Bank, as an agent of the Treasury, is responsible for all the Republic debt issues in the external capital markets, as well as the risk management of the debt's structure[1].

In this sense, to manage the exposure to interest rate risk is one of the greatest concerns for sovereigns and other participants in the market. One of the most powerful tools for handling that risk is the interest-rate swap.

Until the late 1970s, the propensity for interest rates to change was relatively low. Since that time, though, many factors, including market deregulation, and global financial market integration, along with volatile oil prices and inflation, has contributed to a sharp rise in financial market volatility. The result has been a dramatic increase in the interest rate risk faced by corporations, by financial institutions and, mainly, by countries.

The study is separated into an introduction, two chapters, a conclusion and references. The second chapter describes the general conceptions of swaps. The third one, the most complex, gives an idea of the Brazilian external debt portfolio in terms of its interest rate exposure and the variety of floating rate instruments linked to 6-month Libor[2]. In addition, it shows how six-month Libor has been behaving over the years and its impacts on the Brazilian floating rate bonds. Moreover, this chapter introduces the ways that interest-rate swaps mitigate interest rate risk, and evaluates the possible results of an interest-rate swap. Finally, it also discusses risks associated with using these derivatives. Chapter four and five are the conclusion and references, respectively.

[1] The responsibilities regarding the external debt management will be transferred, ultimately, for the Treasury in 12/31/2004.

[2] Libor (London Interbank Offered Rate) is the rate for Eurodollar funds, usually three or six months, although it can range from overnight to five years. Different banks may quote differing (lending) Libor rates simply because they use different sources of banks. The rate which a bank is willing to pay for such funds is the London Interbank Bid Rate (Libid). The average of the Libor and Libid rates is known as Limean.

2 – Describing Swaps

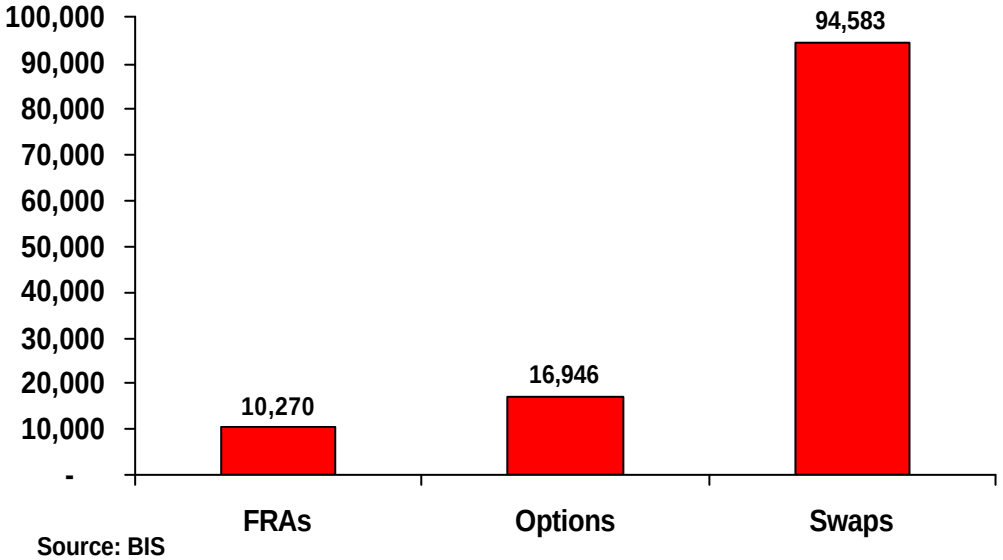
2.1 – The Principles of a Swap

A swap represents an exchange of obligations or payments. The current three principal types are currency swaps, interest-rate swaps and currency-interest rate swaps.

In dealing with interest rate and currency risks, investors and debtors frequently rely on swaps. Swaps are used, for instance, extensively by banks, by companies, and by some governments to manage risk exposure on their assets and liabilities.

From the graph that follows, we can get a better sense of how important the interest-rate swap market is in the total of the interest rate derivatives contracts traded over the counter (OTC derivatives markets).

OTC Interest Rate Contracts - Jun/2003 (US Billions)



Source: BIS

A swap is a contract whereby two parties (called counterparties) agree to a periodic exchange of cash flows. On each payment date, only a net payment is made, which means that the two cash flows are netted and a payment is made by the counterparty owing money. As a matter of fact, some currency swaps may involve an exchange of principal amounts (called notional principals) at the initiation of the swap when one of the parties has an actual need for the principal amount in a particular currency.

According to swap terminology, each side of the swap is called a leg. In order to illustrate, an interest-rate swap in dollars could have a 5% fixed interest-rate as one leg, and a six-month Libor, the floating rate, as the other leg.

A swap, as mentioned above, is simply a contract stating the formula to be used to compute the net amount paid or received on each payment date. A swap can also be regarded as a long-term package of periodic forward contracts, as we will see in great details in the next chapter.

2.2 – The Different Instruments

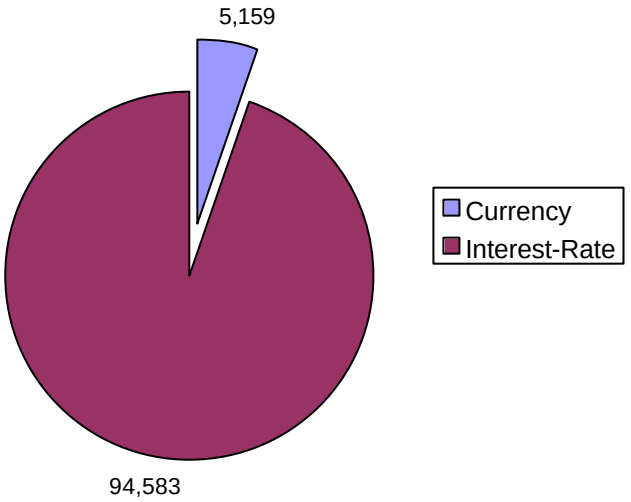
Historically, three major types of swaps were offered in the marketplace: currency swaps, interest-rate swaps and currency-interest rate swaps. Recently, many other types of swaps have been successfully offered, such as credit swaps, and total return swaps[3]. Indeed, the swap market has been increasing in significant proportions, not only in terms of negotiated contracts but also in terms of the amount of money transacted as we saw in the last section.

[3] According to EMTA (Emerging Market Trade Association), USD 49 billions was traded in credit derivatives on the second quarter of 2003. They consider by credit derivatives credit default swaps, total return swaps and, collateralized debt obligations and credit link notes.

2.2.1 – Interest-Rate Swaps

For now we will describe the swap instrument which will be the main focus of this paper, not only for its strategic importance to diminish Brazil's debt risk portfolio, but because it is the most tradable one in the swap market, as depicted in the graph below, which take into account the two most important swap instruments.

OTC Swap Contracts - Jun/2003 (US Billions)



Source: BIS

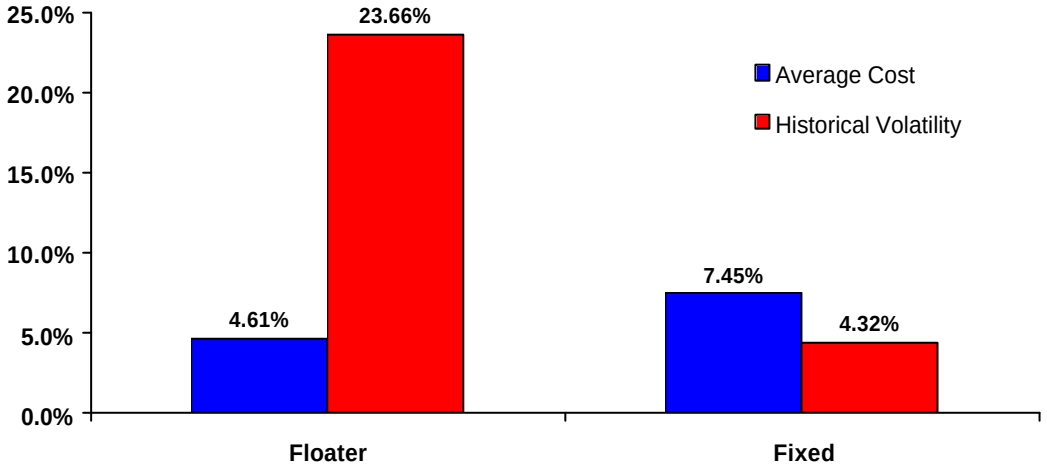
The significance of this instrument for our debt portfolio is the fact that it can transform Brazilian floater external bonds into fixed ones. In this sense, the Brazilian government could achieve a less volatile debt portfolio, but this does not mean, in most cases, a cheaper one[4]. Actually, the trade-off between cost and risk is clear: a floater bond in the majority of the circumstances represents a cheaper debt instrument, but at the same time, a more volatile one. A fixed bond

[4] As long as the Treasury is a public entity, most people advocate in favor of a less risk debt portfolio, even if it means a more expensive one. The reason for that is explained by the fact that the government is supposed to be conservative. Consequently, it can not bear greater risks.

is usually more expensive but less risky due to expectations and a liquidity premium being built into fixed rate.

The following graph gives us an idea about the trade-off between cost and risk for floaters and fixed bonds. It shows two debt portfolios: one with 100% in floater instruments, and other with 100% in fixed ones. The floater portfolio presents an average cost of 4.61% and a volatility of that cost of 23.66%, which reveals to be a very volatile one in terms of cost. In other words, the debtor can pay less in some periods but could pay huge interest expenses in others. Alternatively, the fixed portfolio is a more expensive than the floater, 7.45% for average interest rate, but is less volatile, 4.32% in terms of historical volatility of that interest rate[5].

Fix x Floating Debt Composition - Nov/88 to Nov/03



Source: Banco Central do Brasil

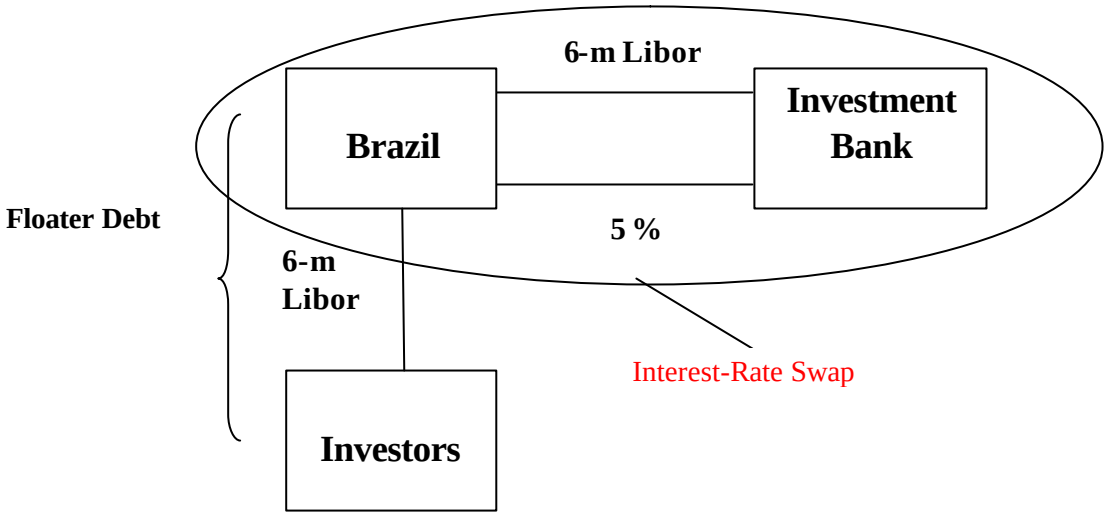
An interest-rate swap is a contract whereby two counterparties agree to exchange streams of cash flow in the same currency but based on two different interest rates. The dollar amount of the interest payments exchanged is based on some predetermined dollar principal, which is called, as we saw, the notional

[5] It is assumed 20% of refinancing each year for the fixed portfolio in order to find the average cost.

principal amount. The dollar amount each counterparty pays to the other is the agreed-upon periodic interest rate multiplied by the notional principal amount. Therefore, unlike some currency swaps, the only dollars that are exchanged by the parties are the interest payments, which are calculated based on the notional amount.

In the most common type of interest-rate swap, a floating/fixed type, one party agrees to pay the other party fixed interest payments at designated dates for the life of the contract. This party is referred to as the fixed-rate payer, or the fixed-rate leg of the swap. The other party agrees to make interest rate payments that float with some index, and is referred to as the floating-rate leg payer. In the case of Brazilian floating debt, this index, as in the majority of swap floating/fixed contracts, is the six-month Libor. Swaps may be structured so that the floating rate resets on a daily, weekly, monthly, quarterly, or semiannual basis for either monthly, quarterly, semiannual, or annual settlement.

For example, suppose that Brazil wants to change its exposure in a float debt into a fixed one. In order to achieve this Brazil has to enter into an interest-rate swap. For instance, Brazil participates with an investment bank in a swap for US$ 1 billion, receiving a six-month Libor and paying a fixed rate at 5%. The example below illustrates this sort of swap agreement.



Payments on the swaps are semiannual, and interest rates are computed linearly, which means that semiannual rate is obtained by dividing the annualized rate by two. At some later reset date, the six-month Libor is at 4%. What is the value of swap for Brazil on the following payment date?

Value of swap = ((4% – 5%) / 2) x US$ 1,000,000,000 = - US$ 5,000,000

Therefore, Brazil will have to pay US$ 5,000,000.00 to its counterparty, an investment bank, on the following payment date. As we can see, the cash flow and the value of a swap agreement can represent, depending on the notional, a lot of money for a given counterparty. For this reason it is very important to analyze the risks embedded in swap contracts, as seen later in the next chapter.

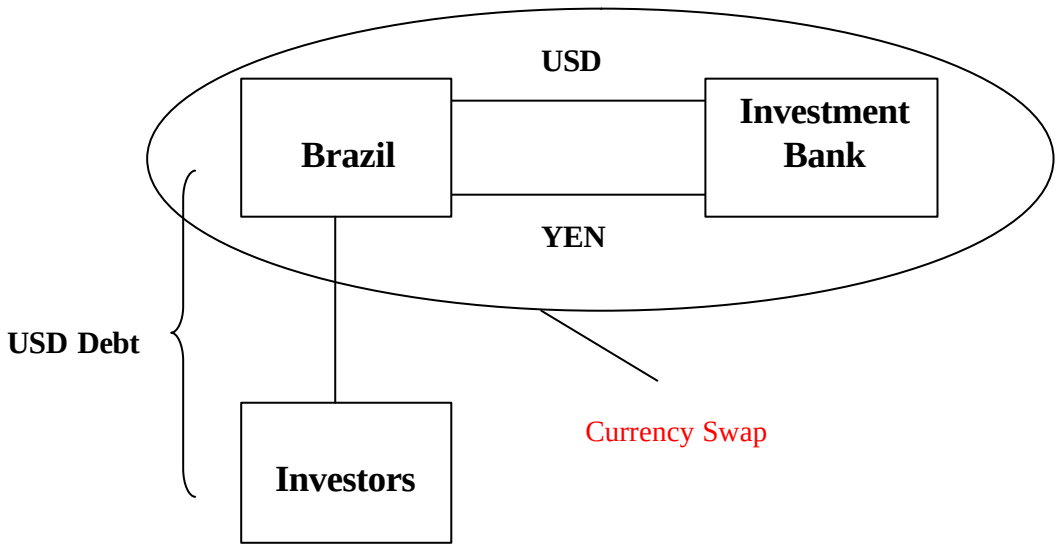
2.2.2 – Currency Swaps

Despite the fact that this paper is focused on interest-rate swaps, we will also briefly describe two more types of swaps, currency swaps and currency

interest-rate swaps, since Brazil can use them in order to manage its external debt.

A currency swap is an agreement to exchange streams of fixed cash flows in different currency denominations. It can be used to transform a debt or an asset in one currency into in another currency. A typical currency swap can be illustrated by the following example. Brazil enters in a five year swap with an investment bank to receive dollars and to pay yens.

The reason for Brazil to enter into this transaction could be the lack of a market to issue bonds in yens, and the willingness to make debt in that currency. The only way to solve this dilemma is by using currency swaps. The following example gives a better sense of the transaction.

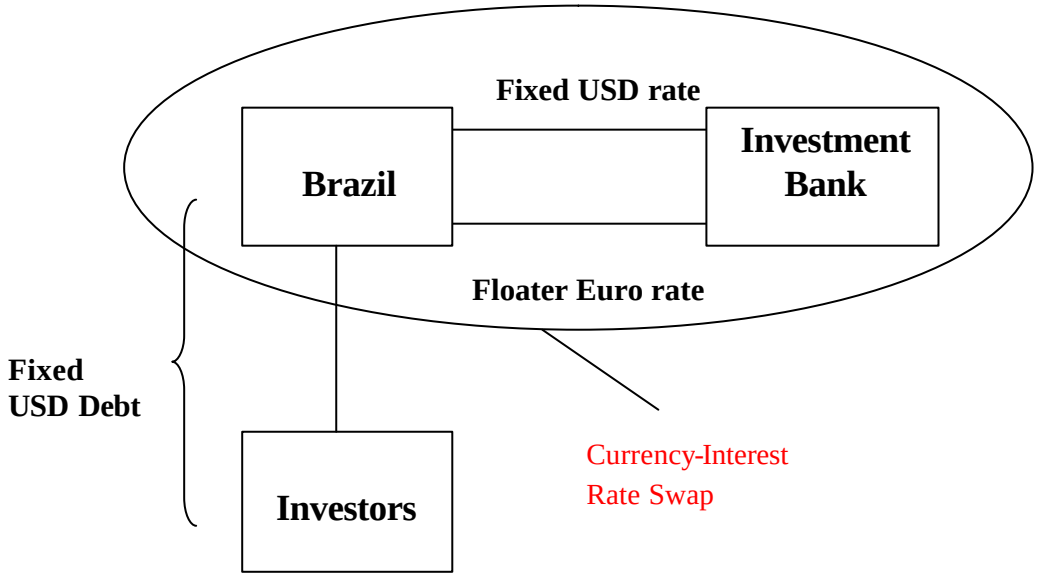


2.2.3 – Currency-Interest Rate Swaps

This type of swap is a combination of interest-rate swaps with currency swaps. In this combined swap, there is an exchange of fixed-rate for floating rate payments when the two payments are in different currencies.

If Brazil is able to issue a dollar fixed bond in the global market, but at the same time it can not access the market via a floater euro bond, it might enter into a currency-interest rate swap. In this way it would swap a fixed-rate dollar-currency denominated liability for a Euro liability with the floating rate tied, for instance, to the Euro Libor. From the standpoint of Brazil, this transaction would create a combined USD/Euro currency swap, together with a fixed/floating interest-rate swap.

The illustration below describes the situation.



2.3 Credit Risk in Swaps

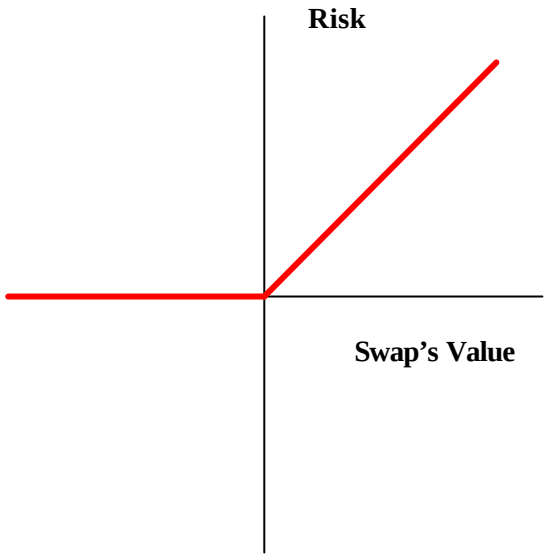
Contracts that represent agreements between two parties, such as swaps, always involve credit risks.

As interest rates go down below the fixed rate agreed in the swap, the counterparty that pays fixed interest rates must make payments, on periodical basis, to the party that pays floating interest rates. These payments are known as marking-to-market for swap instruments. The opposite happens when the interest rates go up above that fixed rate. In other words, the counterparty that is in the float leg of swap has to make those daily payments. Hence, one of the counterparties may suffer financial difficulties, and as a result can default in its payment obligations.[6]

Suppose that, some months after the beginning of the swap's contract, the value of that contract is positive for counterparty A and, as expected, negative for a counterparty B. As a result, if B defaults, A would lose the positive value embedded in the contract. To hedge its position, A would have to find another party, let's call it C, which would want to take over the position of B. To make C accept this position, A would have to pay an amount equals to the value of the contract with B before the default.

An institution takes the credit risk in a swap only when its value is positive. What if its value is negative and the counterparty is in financial difficulty? In theory, the institution could get an unexpected profit, since it would escape of its payment obligations to the counterparty. In practice, the counterparty will sell its payment rights to another institution or rearrange its business in order not to lose the positive value in the contract's swap. The more realistic situation is the one in which the institution will lose money if it has payment rights in a swap and its counterparty defaults. In addition, this will not have any impact on its financial position if it owes money to the counterparty once again in default. This situation is depicted in the graph below.

[6] It is worth to mention that some credit risks can be mitigated by dealing with high grade counterparties, such as AAA/AA or by using collateral on the transaction.



It is important to distinguish between credit risk and market risk on swap contracts. As was said, credit risk comes from the possibility of default of one of the parties involved on the swap agreement. While market risk arises from the possible movements on the variables associated with the swap instrument, such as interest rate and exchange rates, that makes the value of the swap negative for one of the parties involved in it. Both risks can be hedged; market risk easier than credit risk. Credit risk could be hedged with the growing credit default swaps market.

3 – Using Swaps to manage Brazilian External Debt Portfolio

3.1 – Some Historical Aspects of Brazilian External Debt and its Current Composition

In the 1970s, many developing countries (LDC), which are now emerging economies, increased their international borrowing in order to accelerate their economic growth. This foreign capital supply allowed them to run large current account deficits, which came mainly from importing capital goods and exporting commodities. As Abel and Bernanke describe:

> "Over the 1972-1981 period, a group of fifteen developing countries that were later to be designated as 'heavily indebted' by the International Monetary Fund (IMF) ran current account deficits averaging more than 18% of their exports of goods and services. These current account deficits were financed by borrowing abroad, primarily form commercial banks in the United States, Japan and Europe. By 1986 the outstanding debt of these countries exceeded 60% of their combined annual GDPs"

Following the 70s, the world witnessed a huge liquidity contraction in the financial markets. From what we can surmise, the decrease in the global liquidity was caused by the adverse supply oil shocks of 1973 and 1979, which brought uncertainty to the global economy along with high inflation and high nominal interest rates.

The consequences of those shocks in the developed countries were dreadful. Some of them were: reduction in global output, employment, consumption, investment and increase in the inflation rate and interest rate.

Although the costs of the two oil shocks were terrible in such rich countries, they were much more severe in the less developed ones. One example was Brazil, which was heavily indebted in the beginning of 80s.

Two main factors strangled developing countries regarding their external obligations: the rise in interest rate, since most of the loans were in floating rate, and the drop in commodities prices in the international market, which are until now important products exported by developing countries.

With the increase in the burden of foreign debt by the causes mentioned above, those private banks that had lent to developing countries began to lose confidence that their loans would be repaid as promised. Consequently, they refuse to make new loans. Hence, the combination of the decrease in the international liquidity, the deficits in the current account, the high external debts and the lack of refinancing led some developing countries to default in their foreign debt during the 80s.

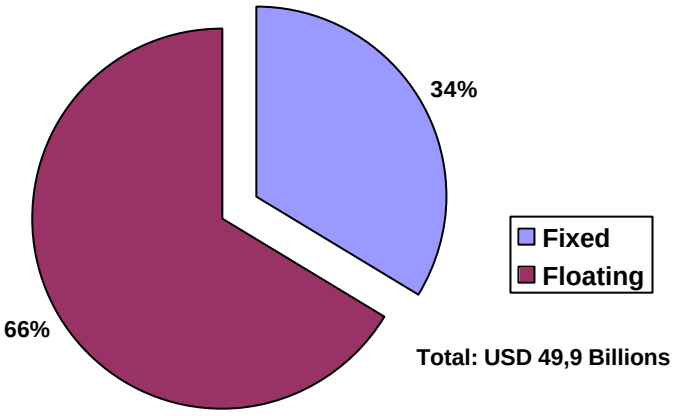
In 1989, after several defaults mainly in Latin America countries, such as Mexico in 1982, Brazil in 1987, and Venezuela in 1989, the U.S. Treasury Secretary Nicholas Brady launched an initiative to provide a satisfactory solution to this debt crisis.

The Brady Plan was basically a debt-reduction program whereby defaulted commercial loans were repackaged into tradable Brady bonds, with the goal of reducing the heavy debt burdens faced by the countries in debt crisis. One of the main advantages for the creditors was the tradable feature of this new debt. To make the deals more attractive to investors, the bonds were tailor-made, carrying different characteristics such as collateral, warrants and recovery values among others. Many Brady bonds have principal backed by US Treasury Strips.

Brazil concluded its debt restructure under the Brady Plan agreement in 1994. What came out from this debt renegotiation was a debt portfolio still burdened with floating rate debt since the foreign creditors, at that time, had a big concern about the behavior of the interest rates in the economy. Therefore, by having floating rate bonds they would be hedged against the interest rate risk.

In the graph that follows, we can get a better sense of the Brazilian debt portfolio right after the Brady Plan.

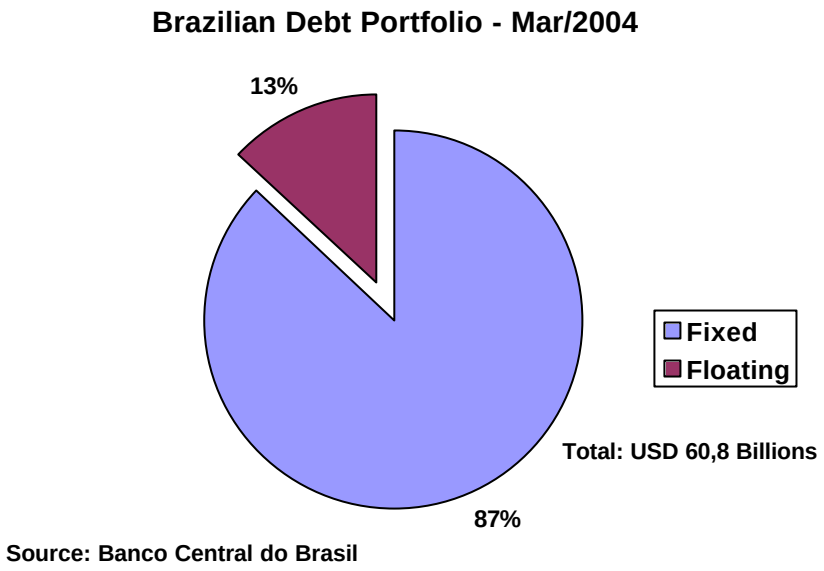
Brazilian Debt Portfolio - Jun/1994



Source: Banco Central do Brasil

Nevertheless, this floating rate debt has been decreasing through the last years due to three factors: Brazil never issued a floating rate bond since the Brady Plan's conclusion; cheaper global fixed bonds are being issued to retire Brady bonds, including, obviously, the floating ones; preexisting floating rate Brady bonds have been maturing since their inception.

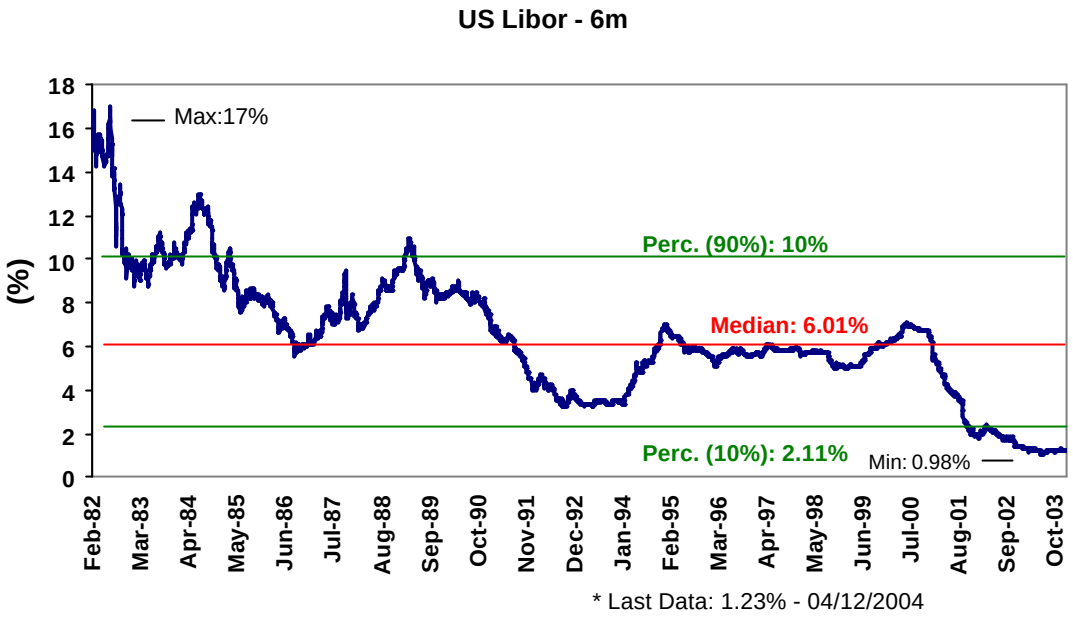
The current debt composition, as the result of reduction in floating rate instruments, is seen as much less risky in terms of interest rates. The graph below shows the most recent breakdown between floating and fixed instruments on the Brazilian debt portfolio.



3.2 – The Interest Rate Risk in Brazilian Debt Portfolio and the 6-Month Libor Behavior over the last years

As we previously saw in the last section, Brazil, along with other emerging market countries, faced a terrible debt crisis triggered, among other factors, by the sharp increase in the interest rates in the beginning of 1980s. Although the debt crisis was caused by an ample spectrum of factors and not only by the interest rate shocks, the fact is that with the high interest rates many countries became unable or unwilling to service their loans from international banks.

The graph that follows depicts the high levels of the 6-month Libor in the beginning of 80s and gives us an idea of its behavior since 1982.

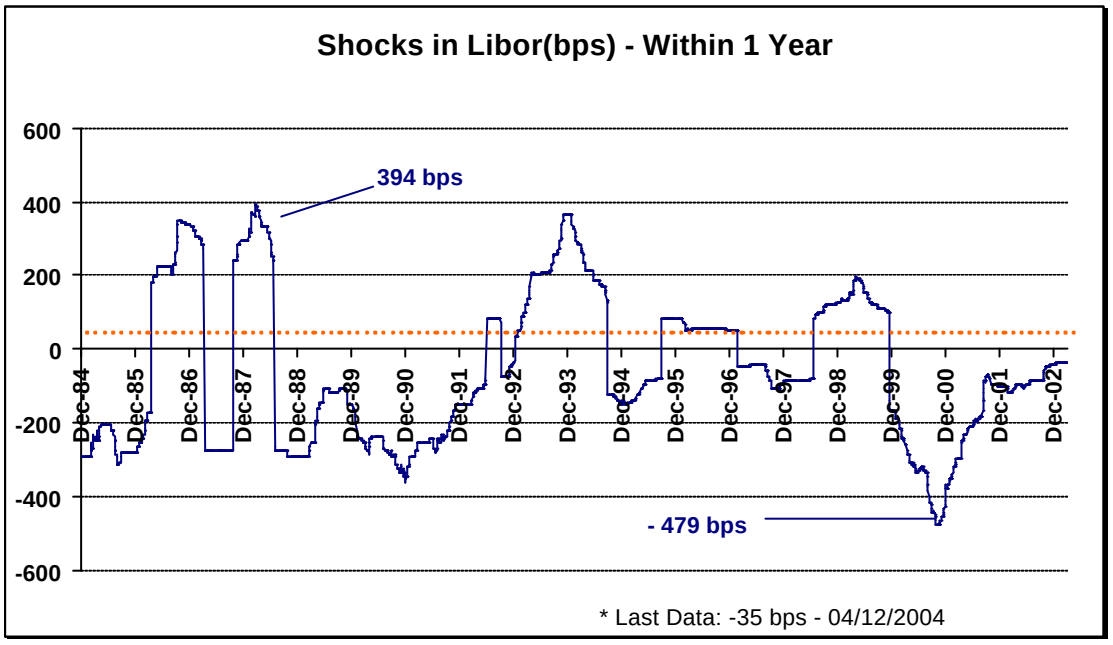


This graph shows that the current levels of interest rates are extremely low when compared with historical ones. For instance, the 6-month Libor reached a maximum of 17% in 06/28/1982 and has been decreasing since then. The Libor today is even below its historical 10% percentile. This implies that if we assume interest rates follow a mean reversion process, they are likely to increase in the coming years.

At this stage, an important question comes up: if there is an abrupt increase in the interest rates, will Brazil face a serious problem in its external debt? There are two motives to believe that the answer is no: the present external debt is less concentrated in floating instruments than it was in the recent past, and even if an adverse economic shock occurs, it is very unlikely that the interest rates will come back to the levels of the 80s.

Nonetheless, even if the interest rate does not overshoot in the coming years, there are potential losses that Brazil can incur in its floating debt in case of a sharp increase in the 6-month Libor.

Just in terms of illustration, according to historical data, 6-month Libor already increased 394 bps within only one year. This means that the Brazilian interest payments debt service in floater bonds, for example, could be more expensive by 3.94% in the next year, assuming the worst case historical scenario. The following graph shows the one-year shock in Libor since December of 1984.



The next section will analyze what the Brazilian Treasury could do to diminish interest rate risk in its debt portfolio by using interest-rate derivatives. However, the use of derivatives could turn out to be more expensive since it has its embedded risks and pricing that reflects expectations and those risks. The question that we will be raised in the following section is: whether it is it better for Brazil to enter into an interest-swap to lock-in a fixed rate for its floating rate bonds instead or leave them floating?

3.3 – Pricing an Interest-Rate Swap

The typical quotes in the swap market are calculated in terms of basis points over a Treasury security of comparable maturity, as well as the Brazilian sovereign external debt bonds. In addition, they are usually quoted reflecting the fixed rate paid. For instance, the swap spread quote for a 2-year swap could be "50 basis points over 2-year Treasuries". If the 2-year Treasuries are quoted at 2.50% this mean that the 2-year swap rate would be 3.00%. The floating-rate quote usually is "flat". That is, the floating rate is set equal to an index such as 6-month Libor with no premium, in most of the cases.

Interest-rate swaps can be viewed as a package of more basic interest-rate control tools, such as forwards. If the forward market is based on, or corresponds to, the same index as the swap, say Libor, and if the reset dates on the swap correspond to the settlement dates for the forward contracts, the forward rates can be used to determine the present values of a swap cash flows. This procedure assumes that the forward rates are realized and are equal to the Libor rates that predominate in the future periods.

Although an interest-rate swap is merely a combination of forward contracts, it is not a redundant contract for several reasons. First, for forward or future contracts, the longest maturity does not extend as far as that of an interest-rate swap. In contrast, an interest-rate swap with a term of even 20 years or longer can be obtained in the swap market in selected currencies. Second, an interest-rate swap is a more efficient instrument, since it can effectively establish a payoff equivalent to a package of forward contracts. On the other hand, forward contracts have to be transacted separately. Third, the swap market is much more liquid than forward rate contracts as shown in the graph of page 6 on the section 2.1.

The most important thing when pricing a swap is that in the beginning its present value is zero, which means that neither counterparty has a gain or loss in its inception. This is simply to say that there is an equilibrium between what the two counterparties agree to pay. Assuming Libor flat (no premium), the swap rate for the fixed-rate payer is that interest rate which will equate the present value of the fixed-rate payment with the present value of the floating-rate payments.

3.4 – Illustrating present-value calculations for Brazilian external debt

As seen earlier, at the present time Brazil has 16% of this debt portfolio in floating bonds. They do not represent a big proportion in the whole portfolio, but they might increase Brazilian debt service expenses in a case of an increase in the international interest rates, particularly, in the Libor rates, as mentioned in the earlier sections.

The total floating debt of Brazil today is USD 7,989 billions. The chart below shows the floating debt composition and its main characteristics.

Bonds	Issue Date	Maturity	Coupon	Outstandings (US$)	Average Life
EI	4/15/1994	4/15/2006	Libor + 13/16%	1,233,460,800	2.03
FLIRB	4/15/1994	4/15/2009	Libor + 13/16%	513,677,154	5.03
NMB 94	4/15/1994	4/15/2009	Libor + 7/8%	1,145,848,000	5.03
DCB	4/15/1994	4/15/2012	Libor + 7/8%	3,754,619,000	8.04
Discount	4/15/1994	4/15/2024	Libor + 13/16%	1,341,798,000	20.04
Source: Banco Central do Brasil			Portfolio	7,989,402,954	

* The Average Life of the Discount Bond is not taking into account the fact that its principal is guaranteed by US Treasuries. In other Words, it is already pay, which means that its average life does not make much sense, it is better to use duration as a proxy for the remaining time until the maturity.

The following chart illustrates how the next coupon payment for the Brazilian floating bonds varies according to negative shifts in the 6-month Libor in the magnitude of 1%, 2% and 5% respectively. The result is that Brazil would be paying more, compared to current Libor of 1.20%, USD 40 millions if Libor

increases 1%, USD 80 millions if it increases 2%, and USD 200 millions in the case of a negative shift of 5%.

Current 6-month Libor (%)	1.2		? Libor 1%	? Libor 2%	? Libor 5%
Bonds	Outstandings (US$)	Next Coupon Payment (US$)	6-month Libor 2.2%	6-month Libor 3.2%	6-month Libor 1%
EI	1,233,460,800	12,411,699	18,579,003	24,746,307	43,248,219
FLIRB	513,677,154	5,168,876	7,737,262	10,305,648	18,010,805
NMB 94	1,145,848,000	11,888,173	17,617,413	23,346,653	40,534,373
DCB	3,754,619,000	38,954,172	57,727,267	76,500,362	132,819,647
Discount	1,341,798,000	13,501,842	20,210,832	26,919,822	47,046,792
Portfolio	7,989,402,954	81,924,763	121,871,778	161,818,793	281,659,837
Increase in the next interest rate expenses			39,947,015	79,894,030	199,735,074

The table below shows how to price an interest-rate swap. The 6-month Libor forward (column 2) is crucial in the analysis because it will determine the floating cash flows (column 4) and the discount factors (column 3), which will be used to find the present values. As seen before, in the beginning of the swap its present value is zero, meaning that nobody has gains or losses. Therefore, the fixed rate is easily found by seeking a discount rate that will make equal the present value of floating and fixed cash flows (columns 5 and 7). In the example below this fixed rate, called swap rate, for five years would be 3.21%[7].

[7] We are assuming a theoretical 6-month Libor forward.

Notional	1,000,000.00
Fixed Rate (%aa)	3.21

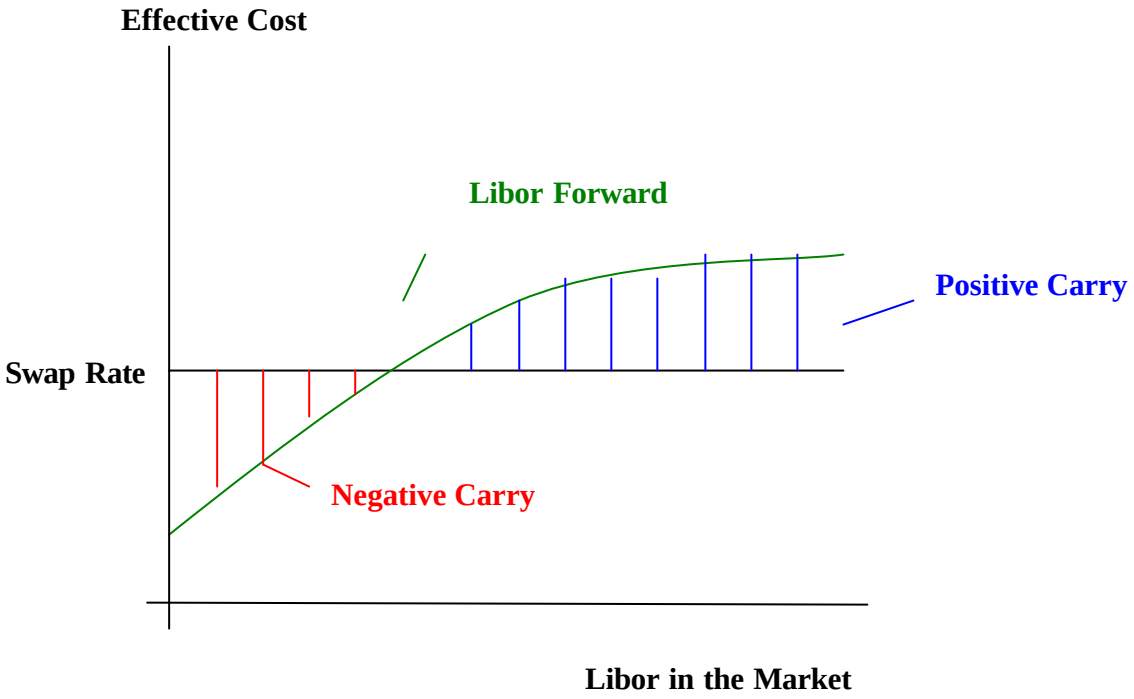
Semester	Libor Forward (%aa)	Discount Factor	Floating Cash Flows	PV Floating Cash Flows	Fixed Cash Flows	PV Fixed Cash Flows
1	1.80	0.99	9,000.00	8,919.72	16,043.46	15,900.35
2	2.1	0.98	10,500.00	10,298.21	16,043.46	15,735.13
3	2.2	0.97	11,000.00	10,671.22	16,043.46	15,563.93
4	2.6	0.96	13,000.00	12,449.60	16,043.46	15,364.20
5	3.2	0.94	16,000.00	15,081.28	16,043.46	15,122.24
6	3.3	0.93	16,500.00	15,300.12	16,043.46	14,876.77
7	3.4	0.91	17,000.00	15,500.25	16,043.46	14,628.10
8	4.2	0.89	21,000.00	18,753.55	16,043.46	14,327.22
9	4.6	0.87	23,000.00	20,077.81	16,043.46	14,005.11
10	5.2	0.85	26,000.00	22,121.50	16,043.46	13,650.20
Total				**149,173.25**		**149,173.25**

The floating cash flows (column 4) are: Libor Forward/2 * Notional[8]. The fixed ones, column 6, are: Fixed Rate/2 * Notional. The present values (columns 5 and 7) will be merely the cash flows multiplied by the discount factors. The discount factors are: $\prod_{t=1}^{T} 1 / (1 + F_t / 4)$

Where $\prod$ is the multiplicative sign and F_t is the forward rate for semester t. For the first semester we have a discount factor of 1 / (1 + (0.018/2)) = 0.99; for the second semester, 1 / [(1 + 0.018/2)*(1 + 0.021/2)] = 0.98; and so forth.

The swap rate can be interpreted as an average rate using the present value of the Libor forwards. In this sense, when Libor forward is below the swap rate (red area in the graph below), the 3.21% swap rate is greater than the 1.80% floating rate, in the first semester of our example. This difference is called negative carry. On the other hand, when forward Libor is above the swap rate (blue area) the fixed rate is lower than floating rate, what we call positive carry. As a matter of fact, in the beginning of the swap transaction the two areas must be equal. This is the equilibrium condition mentioned earlier.

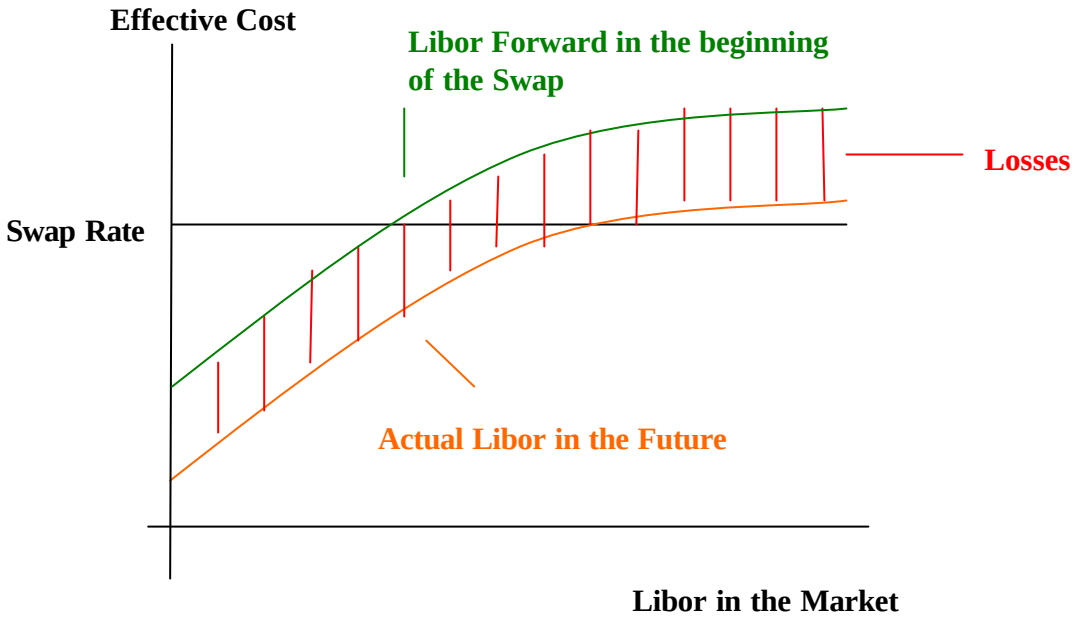
[8] For simplicity, we assume that each semester has the same number of days.



As we can infer, when we enter into a swap to a pay fixed rate we believe that the future 6-month Libor will follow the 6-month Libor forwards of today[9] or will be even above what the Libor forwards are projecting for the actual Libor in the future. At this moment one question arises: what if the future 6-month Libor does not follow its forward rates? What if the 6-month Libor in the future is lower than the forwards today?

Those questions will be answered in the next section. However, we can anticipate that once a 6-month Libor in the future was lower than the Libor forward the fixed rate payer in the swap would be losing money in the swap transaction, as shown by the red area in the graph below.

[9] Remember that an interest-rate swap is priced based on what Libor forwards are projecting for the actual Libors in the future.



3.5 – Value at Risk of an Interest-Rate Swap

As observed in the previous section, although an interest-rate swap is supposed to be used to reduce risks in a debt portfolio, it has some embedded risks that can end up making the swap more expensive, in terms of debt service, than letting the debt portfolio in floating instruments.

As a matter of fact, the value of an interest–rate swap will vary according to what the actual 6-month Libor will be on the future. In this way, it is very important in terms of liability management to have a model to generate scenarios for the potential values of 6-month Libor for the next semi annual payments.

In order to analyze the outcomes of a swap transaction we will generate some future values for 6-month Libor.

The model that we use to generate future values for 6-month Libor assumes that it, as well as other interest rates, follows a mean reversion process. This kind of process better describes the behavior for interest rates, due to the nature of rates and their mean reverting tendency in the long-term.

This type of process would be described as follows:

Libor (t+1) = Libor (t) + K * (U - Libor (t)) + E(t)

Where,

K = Speed of adjustment of the mean reversion (between 0% and 100%)
U = Long Term mean
E(t) = Random Shock (volatility impact)

The problem is that mean reversion makes calculations of volatility significantly more difficult. At the same time, if we ignore mean reversion, we will overestimate volatility.

In order to make things simpler, to replicate the mean reversion behavior of rates we use market forward rates. By using the forward rates as the mean of our simulation it is assumed that this variable is a good predictor of the actual 6-month Libor, which is not true in most of the cases. An alternative mean for our process could be economic forecasts for 6-month Libor or simply to project it according to past behavior.

In this work we use two slightly simpler models to generate future interest rates: the lognormal model, which is applied to generate values below the forward rates and the normal model, which is applied to generate values above the forward rates. The normal model is used because it takes into account the skewed nature of interest rate distributions.

The lognormal model is as follows:

Libor (t) = Fwd (t) * Exp (Vol * Sqrt(t) * N (0,1))

Where,

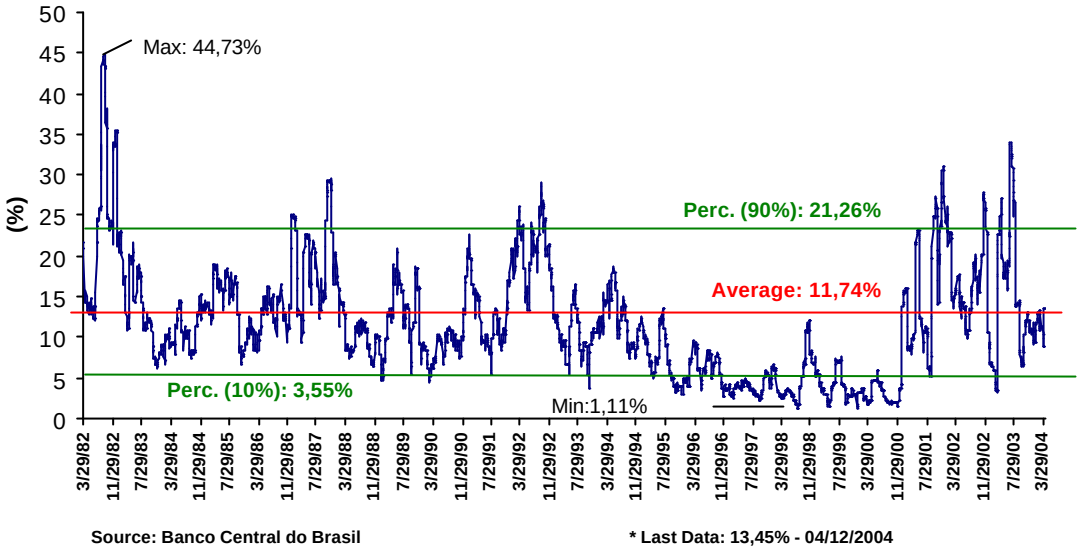
Fwd (t) =Libor forward rates
Vol = is the historical volatility in semi annual terms
t = is expressed in semesters
N (0,1) = random variable distributed normally with mean zero and variance 1

The normal model is described as follows:

Libor (t) = Fwd (t) + Fwd (t) * (Vol * Sqrt(t) * N (0,1))

The historical volatility assumed in the process was 11.75%, which is the mean for the semi annual volatility in the last 22 years. This assumption seems to be extremely reasonable when compared with historical standards. The following graph shows the semi annual volatility in a 30-day window. It can be concluded that 6-month Libor volatility has definitely not remained constant over the years. On the contrary, it fluctuates considerably. Nonetheless, its fluctuations seem to converge for its long term average.

6-month Libor Semi Annual Volatility - 30 days

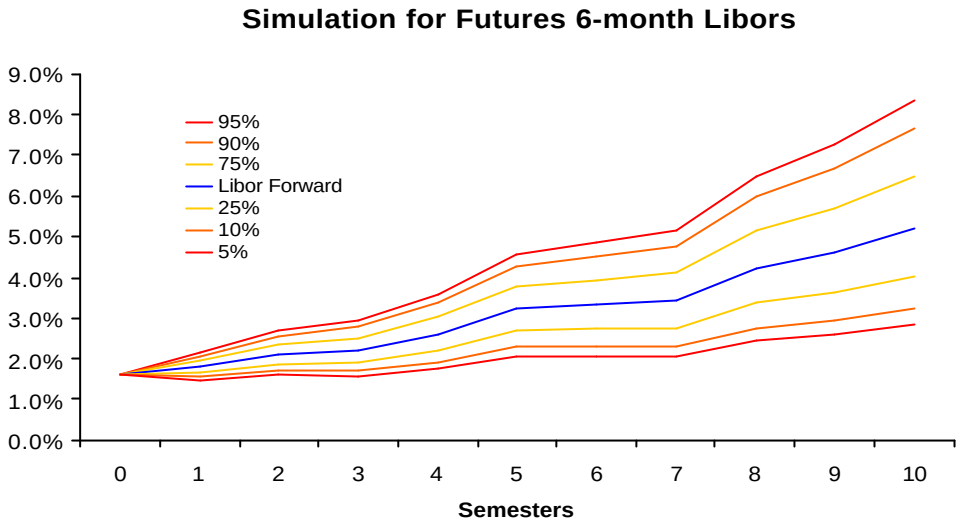


Source: Banco Central do Brasil *** Last Data: 13,45% - 04/12/2004**

Finally to calculate the VaR model, the N (0,1) input is adapted to the amount of standard deviations needed according to the confidence interval that is desired in the simulation process.

For example, in the 95% confidence interval we would use 1.644853 for the upward rate bound and –1.644853 for the lower rate bound.

The graph below shows the result of the simulation process according to the models that we adopted.



Once the actual 6-month Libor is lower than Libor forward, the swap causes losses for the fixed rate payer, because they could be enjoying the lower 6-month Libors but instead are paying the higher fixed rate. However, if they do the swap and the 6-month Libors in the future are systematically higher than the forwards, the present value of the swap would be positive for the fixed rate payer. In practical terms we will focus our model in the negative results of the swaps, since this will represent higher costs for the Brazilian Treasury.

The table below shows how much Brazil would loose, in terms of present value, by entering into a swap to lock-in a fixed rate for its floating debt in case the 6-month Libor remains low in the future or is at least lower than current forward rates. As is seen, there is 25% chance that Brazil will lose USD 24,3 millions in a swap of USD 1 billion notional, which is not a negligible amount.

PV Libor Forward	149,173.25

	PV	Losses
V@R 25%	**124,839.52**	24,333.74
V@R 10%	**106,320.76**	42,852.49
V@R 5%	**96,586.18**	52,587.07

The losses are calculated when subtracting the present value of the swap (Swap's PV) when using the 6-month Libor Forward from the Swap's PV when using the 6-month Libor simulated for different percentiles, 25%, 10% and 5% respectively. Therefore, with a chance of 5% Brazil would loose USD 52,5 million or more in the interest-rate swap when paying a fixed rate.

4 – Conclusion

Undoubtedly the debt sovereign management is one of the topics most discussed nowadays. Therefore, the need to implement of modern and sophisticated techniques in examining the risk factors embedded in the debt portfolio of countries is well recognized. An accurate debt management strategy is not a necessary condition of a sustainable macroeconomic policy environment, however, it helps considerably to achieve and maintain it.

As was seen in chapter 3, the high interest rates in the beginning of 80s, driven by the two oil shocks of 70s, strangled LDC or emerging market countries in their external debts. This happened because their debt portfolios were extremely concentrated in floating instruments. To make matters worse, some of them ended up defaulting in their external obligations. Therefore, the debt portfolio of a LDC country, such as Brazil, should be arranged in such a way to decrease the costs associated with external shocks, crisis or decrease in the global liquidity.

In this work, we demonstrated that a way to achieve a better debt portfolio composition for a LDC country is by having a debt portfolio more concentrated in fixed instruments or by using interest rate swaps to reach that enhanced debt portfolio.

Certainly an exposure in floating instruments is also desired since it could reduce the costs of the whole debt portfolio, as shown in the Chapter 2. However, since the Treasury is supposed to be a conservative entity, it is in theory more concerned with volatility than costs. Consequently, it is not recommended to exceed in the floating instruments.

Finally, it is important to point out that despite interest-rate swaps to be an efficient instrument to change the exposure of a debtor from floating rate to fixed

one; it can also represent risks in terms of the future payments. For this reason it is very important to analyze and consider all possible scenarios for interest rates before entering in such instrument.

5 – References

ABEL, Andrew B. & BERNANKE, Ben S. ***Macroeconomics***, 5th Ed., Chapter 5: Saving and Investment in a Small Open Economy, Chapter 9: Price Adjustment and the Attainment of General Equilibrium, Pearson Addison Wesley, 2005.

BANK FOR INTERNATIONAL SETTLEMENTS (BIS), ***OTC Derivatives Market Activity in the first half of 2003***, November 2003.

BHATTACHARYA, Anand K. & FABOZZI, Frank J. "Interest-Rate Swaps" in FABOZZI, Frank J. (ed) – ***The Handbook of Fixed Income Securities***. McGraw-Hill, 1997.

CLIFFORD JR., W. Smith, SMITHSON, Charles W., WAKEMAN, Lee Mcdonald. "The market for interest-rate swaps". ***Journal of the Financial Management Association*** (winter 1988), pp. 34-44.

DUNN, Robert M. & MUTTI, John H. ***International Economics***, 6th Ed., Chapter 20: The international monetary system: history and current controversies, Routledge, London, 2004.

HULL, John. ***Introduction to Futures Markets and Options***. 3th Ed, Chapter 5: Swaps, Prentice Hall, Upper Saddle River, NJ, 1999.

IMF, ***Global Financial Stability Report (GFSR)***, September 2003, Chapter IV: Volatility of Private Capital Flows to Emerging Markets.

JORION, Philippe. ***Value at Risk***. McGraw-Hill, 1997.

PETTIS, Michael. ***The Volatility Machine***. Oxford University Press, 2001.

REUTERS GLOSSARY: ***International Economic & Financial Terms***, Longman, Essex, 1989.

SOLNIK, Bruno & MCLEAVEY, Dennis. ***International Investments***, 5th Ed., Chapter 10: Derivatives, Pearson Addison Wesley, 2004.

VAN HORNE, James C. ***Financial Market Rates and Flows***, 6th Ed., Chapter 11: Derivative Securities: Interest-Rate and Credit Swaps, Prentice Hall, Upper Saddle River, NJ, 2001.

YOUNG, Andrew R. ***A Morgan Stanley Guide to Fixed Income Analysis***. Chapter 9: Swaps, Morgan Stanley & Co. Incorporated, 1997