Banco Central de Chile
Documentos de Trabajo

Central Bank of Chile
Working Papers

N° 259

Mayo 2004

EVALUATING THE CHILEAN GOVERNMENT'S DEBT DENOMINATION

Elías Albagli

BANCO CENTRAL DE CHILE

CENTRAL BANK OF CHILE

La serie Documentos de Trabajo es una publicación del Banco Central de Chile que divulga los trabajos de investigación económica realizados por profesionales de esta institución o encargados por ella a terceros. El objetivo de la serie es aportar al debate de tópicos relevantes y presentar nuevos enfoques en el análisis de los mismos. La difusión de los Documentos de Trabajo sólo intenta facilitar el intercambio de ideas y dar a conocer investigaciones, con carácter preliminar, para su discusión y comentarios.

La publicación de los Documentos de Trabajo no está sujeta a la aprobación previa de los miembros del Consejo del Banco Central de Chile. Tanto el contenido de los Documentos de Trabajo, como también los análisis y conclusiones que de ellos se deriven, son de exclusiva responsabilidad de su o sus autores y no reflejan necesariamente la opinión del Banco Central de Chile o de sus Consejeros.

The Working Papers series of the Central Bank of Chile disseminates economic research conducted by Central Bank staff or third parties under the sponsorship of the Bank. The purpose of the series is to contribute to the discussion of relevant issues and develop new analytical or empirical approaches in their analyses. The only aim of the Working Papers is to disseminate preliminary research for its discussion and comments.

Publication of Working Papers is not subject to previous approval by the members of the Board of the Central Bank. The views and conclusions presented in the papers are exclusively those of the author(s) and do not necessarily reflect the position of the Central Bank of Chile or of the Board members.

Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
Huérfanos 1175, primer piso.
Teléfono: (56-2) 6702475; Fax: (56-2) 6702231

Documento de Trabajo
N° 259

Working Paper
N° 259

EVALUATING THE CHILEAN GOVERNMENT'S DEBT DENOMINATION

Elías Albagli
Economista
Gerencia de Investigación Económica
Banco Central de Chile

Resumen

Este trabajo propone un marco de análisis para evaluar la conveniencia de la denominación actual de la deuda del Gobierno Central de Chile, a través del efecto en el riesgo asociado al resultado fiscal. Se propone una metodología tipo VaR (*Value at Risk*) para comparar denominaciones alternativas de moneda y tasa. Si las correlaciones encontradas entre los principales factores que afectan el resultado fiscal se consideran a su valor puntual de estimación, el ejercicio sugiere que realizar un *swap* de las actuales tasas fijas que paga el Estado por su deuda a tasas Libor o de bonos de gobierno, contribuiría a reducir considerablemente su volatilidad. El ejercicio recomienda adicionalmente reducir la actual posición en dólares hacia euros y/o libras. Un análisis estadístico más riguroso que considera la volatilidad de las correlaciones, sin embargo, recomienda tomar los resultados con mayor cautela.

Abstract

This paper proposes a framework to assess the convenience of the current public debt denomination of the Chilean Government, through its implications on fiscal budget risk management. A "Value at Risk" methodology is proposed to compare alternative denominations regarding currency and interest rate. If the correlations found between the main factors affecting the fiscal result are valued at their point estimates, the exercise suggests that swapping the current debt denomination in fixed interest payments to variable payments indexed to Libor or government bond rates would significantly reduce fiscal results' volatility. The results also point to reduce current currency denomination in US dollars towards a stronger position in Euros or British Pounds. A more statistically rigorous analysis that considers the volatility of estimated correlations, however, recommends taking previous conclusions with caution.

I wish to thank the valuable comments of Ricardo Caballero, José de Gregorio, Esteban Jadresic, Klaus Schmidt-Hebbel, Matías Tapia and Rodrigo Valdés. The contents of this work are the author's exclusive responsibility, and do not necessarily reflect the opinion of the Central Bank of Chile.
E-mail: eliasa@bcentral.cl.

I. Introduction

As governments of developing countries manage to control public expenses by establishing criteria for long-term fiscal sustainability, the natural step forward is to include in the administration of the aggregate fiscal stance more advanced financial theory tools. In this context, the role of risk management of public assets and liabilities becomes essential to minimizing the exposure of the economy in general, and public finances in particular, in the face of the volatility of relevant factors. This approach is especially important in countries that depend substantially on the commerce of commodities, where the terms of trade explain a large part of their economic fluctuations.

Although this paper focuses on the Chilean government, its purpose is to provide an analytical framework that can be easily extended to emerging countries that

a) carry a big burden in interests accrued to the foreign public debt, and

b) their fiscal income is largely correlated to the price of some exportable or importable commodity, be it directly through the impact on state owned companies, or indirectly through its correlation with domestic activity.

Global trends in public debt management criteria

Recognizing the importance of public debt management in the risk exposure of countries at the face of real and financial shocks, the International Monetary and Financial Committee requested a joint investigation by the IMF and the World Bank with the objective of proposing a set of debt management guidelines as an assistance to countries concerned with such issue. The final document released in November 2002 includes in addition several case studies with examples of measures taken in this direction by several countries.

Among the observed trends, the study underlines the development in the last 15 years of risk management criteria in two main areas. The first has an institutional nature, and relates to the growing decentralization of public debt management away from monetary and fiscal policy, recognizing at the same time both the importance of attaining a necessary level of coordination and transparency in objectives, instruments and strategies as conditions for success. In most cases, this has materialized in the proliferation of self-contained units of debt management inside Finance Ministries and in more extreme cases the establishment of separate external agencies[1].

The second aspects relates with the replacement of the former criteria of choosing the particular debt structure which reduced the immediate debt burden with a long term approach, where debt

designs that protect fiscal balances at the face of external shocks are becoming the norm. Though for most countries this still means focusing on debt payment itself assessing interest rates risk imbedded in yield curve movements, in some cases the criteria extends to the joint consideration of other fiscal accounts that affect public results, and the main macro factors that govern their movements.[2]

It is worth mentioning that this focus, the closest in spirit to the present work, has recently been considered in the Chilean public debt strategy, as the recent bond issue of January 2004 shows. For the first time, the issue was placed in floating rate, and as the official Finance Ministry's statement points out, one of the main reasons is fiscal immunization in a context of correlated internal business cycles fluctuations and external interest rates [3].

The Chilean case

The stochastic component of the revenue of the Chilean Government depends, in a simplified framework, on the evolution of four main factors: Gross Domestic Product, the international price of copper, the main exchange rates and the different Libor rates to which its internal debt is linked. The exercise developed in this paper seeks to assess the convenience of the actual debt denomination, domestic and international, with the possibility of arranging swap agreements that modify the current interests payment profile, considering the historical joint evolution of interest rates and the correlation with the afored-mentioned factors. The evaluation criterion is to minimize the volatility of the fiscal result, not the volatility of interest's burden *per se*, a reasonable objective function supposition of a government concerned of protecting its potential deficits as a result of unexpected movements in relevant macro factors[4].

There are two aspects not considered in the paper worth to mention to avoid confusion. One is that, even though interest rates swaps also affect the expected profile (steepness) of interest payments, this aspect will be neglected as it depends on current economic conditions and not on long-term

[1] New Zealand, Colombia and Poland are illustrate the first type of rearrangements, while Ireland, Portugal, Sweden and South Africa represent more extreme cases of external agencies.

[2] This focus is called "Asset and Liabilities Management (ALM)". As an example, Portugal considers the evolution of other macro variables jointly with interests rates burden to assess potential public cash flow volatility. England goes one step ahead, including the evolution of the consolidated government assets, i. e, the international reserves of the Bank of England.

[3] The official statement can be found in the Finance Ministry's web page, www.minhda.cl. The structure and levels of debt included in this paper, though, considers outstanding liabilities as of November 2003.

[4] The usual immunization criterion in financial management relates to covering equity valuation in response to risk factor's movement, achieved through proper matching of duration and currency between assets and liabilities. For a Central Government, though, it seems more relevant to avoid "cash flow" mismatches that force new debt issuance in order to meet planned expenditures.

structural relations on the variables involved[5]. In the same line, risk/return aspects imbedded in debt contract maturity will be ignored (held constant)[6], as they respond to risk preferences subject to a different type of analysis.

The work is organized as follows: Section II introduces the main elements needed to perform a risk assessment analysis of the fiscal position; The methodology used, the main variables of interest in the Government's financial results and how they are affected by the risk factors considered. Section III analyzes the historical volatility and correlations between relevant factors. From these calculations, current fiscal exposure is computed and compared with the optimal attainable exposure using alternative debt denominations. Section IV assesses the costs/benefits aspects involved in the eventual swap arrangement, in an expected utility framework that seeks to quantify the welfare aspects of the proposal. Section V discuses the main risk scenarios of the recommended denomination in face of sudden changes of the main correlations. Section VI concludes.

II. Immunizing Fiscal Results

1. Risk assessment methodology; "Value at Risk" (VaR)

The VaR methodology can be defined as the answer to the following question: What is the maximum value that can be lost over a given period, under a certain level of confidence?

This methodology is useful for gauging, with a concrete number, the exposure of a portfolio made up by several accounts, each of which can be exposed to more than one risk factor. In this specific case, the VaR will be helpful to measure the impact on fiscal results of the relevant factors' stochastic behavior. This quantitative criterion will allow for an objective comparison of various alternative denominations for the public debt.

The methodology consists of the following steps: First, the identification of the main risk factors affecting the portfolio intended to be immunized. In this case, it is necessary to define the group of $J = 1,...n$ income statements that depend on a set of $i = 1,.....k$ factors. Second, the measurement of the response or elasticity of each account to the variations in each factor, and third, the measure of

[5] External debt burden can be swapped from current fixed to Libor rates. In "average", such rearrangement consider equivalent payments (constant net present value), but with a different time distribution. Given the actual expectations of higher future interests rates, reflected in FRA´s, this decision implies lower payments in the short run, compensated with higher debt service in the future.

[6] Historical issues of Chilean bonds (starting early 1999) have been placed with maturities between 5-10 years.

historical volatilities and correlations between the various factors involved. Then, each factor's VaR can be calculated using the following expression:

$$VaR_i = (\sum_{j=1}^{n} \frac{\partial \mathrm{j}}{\partial \mathrm{i}} di) * \sigma_i * Z_{(1-\alpha)} \quad (1)$$

which corresponds to the aggregate effect of one factor through the different j accounts, where σ_i stands for the standard deviation of factor i, and $Z_{(1-\alpha)}$ is the associated statistic for the desired confidence level.

Once each factor's VaR has been estimated, the total VaR for the portfolio (considering the VaRs of all factors) can be calculated as

$$VaR_{TOT} = (\mathrm{V\ x\ P\ x\ V^T})^{1/2} \quad (2)$$

where matrix V(1 x k) is the vector of the VaRs of all factors considered, and P (k x k) is the correlation matrix between them. From this expression it becomes clear that a successful immunization strategy is one that achieves negative correlations between equal-sign VaRs—and positive for opposite-sign VaRs—, such that the total VaR is smaller than the sum of individual VaRs.

2. Income statements and risk factors

The Central Government of Chile holds to date[7] liabilities that amount to 15.4% del PIB[8]. This can be divided into US$ 5.030 MM and US$6.826 MM of external and internal debt, respectively. These liabilities imply annual interests burdens of about US$ 450 MM, slightly over 2.3% of total public expenditures, or 0.6% of GDP.

Table 1 shows the central government's debt breakdown according to different criteria such as creditor's nationality, currency of denomination and reference rate, all at par value (the nominal value of outstanding payments).

[7] As of November 2003.

[8] All currency transformations used exchange rates as of Noviember 2003 average (US 1= $625.47 pesos).

Table 1. Central Government Debt by Category

(in millions of US dollars)

	Domestic debt	Foreign debt	Total
In pesos	742	0	742
In dollars	6,075	3,559	9,634
Yen	0	153	153
Euro	0	457	457
Other currencies	9	863	872
Total	6,827	5,031	11,858
Type of rate	US Lib 6M +0.5%	Fixed	
Nominal cost	1.87%	6.33%	
Debt/GDP	8.84%	6.52%	15.36%
Interests/GDP	0.17%	0.41%	0.58%

Source: Dirección de Presupuesto (Dipres), the Finance Ministry's Budget Division

The table shows the US dollar's dominant position, with 81.2% of the total. This exposure to foreign currencies means, directly, that the near 15% appreciation of the domestic currency with respect to the dollar over the year 2003 will result in an 11% reduction in interests paid.

The profile of interest payments, on the other hand, is mainly pre-established fixed amounts for foreign debt, but variable for the larger part of the domestic debt. As much as 89% of the latter is anchored to the six-month Libor rate in dollars plus 50 basis points. The 13-point drop of this anchor since last January has resulted in reduced interest payments of US$8 million, close to 2% of the debt service.

It is therefore clear that the exchange rate and the interest rate are important risk factors behind this account in the fiscal income statement. It is also necessary, however, to include the other accounts and their respective risk factors in order to perform an integral risk assessment (see table 2).

Table 2: Central Government; Selected Income Accounts, Fiscal Year 2002

(in millions of US dollars)

Total income	**16,199**
Current income	**15,861**
-Operating income	1,066
-Social Security Collection	1,085
-Net tax income	12,325
-Copper, net of CCF	555
-Transfers	137
-Other income	628

Source: Dipres

The entries that interest us for the analysis are the ones that can be affected by factors that may be correlated with variables such as the exchange rate and interest rates. With such criteria, it is possible to identify net tax income and copper proceedings.

Tax income is explained mainly by the evolution of GDP. Dipres calculations of the elasticity of tax collection on output estimate it at 1.05. Copper proceeds, on the other hand, are related with its price and with the effective exchange rate used to translate international sales into pesos[9]. The elasticities of copper income with the two factors are 2 with respect to the exchange rate and 2 with respect to the copper price.[10]

Once the relevant accounts in the analysis are identified, the problem is easily understood intuitively. If the government's purpose is to reduce the volatility of the income statement in aggregate terms rather than the volatility of interest payments *per se*, the debt's denomination becomes paramount. Picture, for example, the foreign debt. In this framework, the ideal would be to have it denominated in a currency that were positively related with GDP, and anchored to a variable rate with equal sign correlation. Then, in periods of low output levels, the average debt service would also be smaller, thus *immunizing* fiscal results. This is not possible in the present context of the foreign debt, subject to a fixed rate. As for domestic debt, currently 89% is dollar denominated at a variable rate (the US 6-month Libor rate). From the rate standpoint, this would be desirable if it were positively correlated with GDP.

III. Borrowing Possibilities

1. Description of available choices:

There are a large number of choices for alternative denominations. Regarding currency, the main options for the foreign debt, sticking to hard currencies, are the US dollar (Dl), the euro (EU), the yen (Yn) and the British pound (BP), and the Chilean peso and the UF[11] for domestic borrowing. The interest rate can be fixed (plus a spread) or anchored to a variable reference rate. In this case, the rate can be of short, medium or long term. Thus, it is possible to choose, for example, to borrow in yens at the three-month Japanese Libor rate. To restrict the analysis, Libor rates are considered for each of the aforesaid currencies for terms of 90 days to 12 months, plus the monetary policy rate

[9] However, the treatment of this account is complicated by the copper compensation fund (CCF). Because flows to and from the fiscal budget and the CCF are not exactly "current income" but only temporary financing, the analysis omits this consideration.

[10] Own estimates based on CODELCO simulations.

[11] UF: "Unidad de Fomento". Index that evolves according to CPI inflation.

(MPR) and the average deposit 90-day rate in UF for Chile (TP90UF). For larger maturities, ten-year rates of each country's treasury bonds are selected, and the PRC-8 for Chile.
To check for robustness in the calculations, three periods are considered: 1986-2002, 1994-2002 and 1998-2002. For each sub-period, quarterly, semiannual and annual series are used. The main correlations found are commented below[12]. Appendix 1 shows the respective calculations for alternative period/frequency results.

a) Exchange rates: generally, the negative correlation is confirmed between GDP and and parities. For annual series in the full period, the US dollar had the most negative correlation, around -0.74, followed by the British pound and the euro, with the Japanese yen on the other extreme, the least correlated currency with domestic output factors. For the price of copper, and consistently with economic intuition, all parities except the yen show negative and significant correlation.

b) Interest rates: in general, positive and significant correlations are observed with respect to GDP. Moreover, two regularities occur throughout the various periods and frequencies analyzed: first, long-term rates have a higher correlation than medium-term ones, and these have a higher correlation than short-term ones, for all currency examined. Second, the currencies' ranking remains almost unchanged, with the 10-year bond in pounds at the top of the list, closely followed by the same rate in Euros, with coefficients between 0.56 and 0.62. Domestic rates correlations with GDP are non-significant in most of the cases.

2. Results

a) Present status

The value at risk of the fiscal result with the present debt structure is shown in table 3, and corresponds to the longer period, annual frequency specification of correlations and volatilities.

[12] To calculate volatility (st. Dev.) and correlations, the first step was to convert all series in returns rates. Therefore, "price" variables (exchange rates, copper price, GDP, etc.) were computed as the % variation between periods. Interest rates were held constant.

Table 3: Value at Risk of the Present Financial Structure
(in millions of US dollars)[13]

		Effect of a 1% increase in...					
Exposure		GDP	PC	US	Yen	Euro	US libor 6M*
Net tax income	13,328	139.9					
Copper proceeds	715		14.3	14.3			
Foreign debt	5,031						
in dollars	3,559			-2.3			
In yen	153				-0.1		
In euros	457					-0.3	
Domestic debt	6,827						
In dollars	6,075			-2.2			-60.8
Total		139.9	14.3	9.8	-0.1	-0.3	-60.8
Factor volatility (%)		3.2	23.1	7.4	14.5	13.4	1.9
Value at risk at 95%		743	543	120	-2	-6	-185
Total VaR	**762**						

* 100 basis point increase.

The first column on the left shows the total value of the main fiscal accounts at stake. The right-hand side shows the effect of changes in value caused by 1% variations in each risk factor. Each factor can affect more than one account. An increase in the dollar parity, for example, affects copper proceeds positively, but it also increases domestic and external debt payments expressed in pesos.

Total VaR indicates that, if the historical behavior of the relevant factors is considered, fiscal results can decrease by a maximum of 762 million dollars, with a 95% confidence. To give an idea of the magnitude, this value accounts for around 4% of budgeted fiscal income, or 1% of current GDP in 2002.

b) Alternative denomination

To find the optimal finance structure, a VaR minimization problem was posed, which solve for optimal portfolio weights in each currency for the denomination of domestic and foreign debt, as well as for the relevant indexation rates. These weights depend on the specification of series used to calculate correlations and volatilities. The main results are shown in table 4.

[13] In conformity with the 2003 Budget Law.

Table 4: Optimal Debt Structure; Weights

Frequency	Year			Semester			Quarter		
Period	86-02	94-02	98-02	86-02	94-02	98-02	86-02	94-02	98-02
Foreign debt									
In dollars	0.35			0.66			0.58		
In yen									
In euros			1.00	0.33	1.00	1.00	0.42	1.00	1.00
In pounds	0.65	1.00							
Domestic debt									
In dollars				1.00			1.00		
In yen									
In euros		0.55	1.00		1.00	1.00		1.00	1.00
In pounds	1.00	0.45							
en UF									
In pesos									
Min VaR	650	589	548	327	277	292	101	76	71
Present VaR	764	746	646	353	349	342	108	99	95
Saving %	15%	21%	15%	8%	21%	15%	6%	23%	26%
Present VaR (floating)	691	660	619	330	311	314	102	84	79
Saving % float. rate	9%	11%	4%	7%	11%	8%	5%	15%	17%

The table shows the ideal weights with respect to the denomination currency. Although it does not indicate what rate it must be indexed to, for all series specifications, the positive and significant correlations between output variables and Libor rates indicate that the entire debt must be indexed to the government rate (or, by default, to the Libor of longest term available) in the currency indicated by the table. The exercise shows that the fiscal result's volatility might be reduced by swapping the current debt's denomination through some investment bank. Appendix 2 shows a simulation of the flows exchanged by the central government and the bank in question. The expected present value of this exercise equals zero. There is, however, an associated transaction cost. This cost and the convenience to pay it are estimated in section VI. Besides this caveat, one might say that the central government's debt is currently in an inefficient position in the risk-return spectrum offered by the market, and the volatility of interests paid can be reduced without increasing their present value.

IV. Costs and benefits of swap operations

It should be stressed that the purpose of this analysis is to recommend a debt denomination that allows the government to place its fiscal results as close to the efficient frontier as possible. In a friction-free world, with efficient markets and perfect competition, this adjustment would be a triviality, with no costs associated. In the real world, however, a commission must be paid for all proposed swaps, which is typically charged as a percentage of the amount swapped under the

contract. For this reason, it is necessary to quantify the benefits associated to the reduced volatility, and then compare them with the costs.

One standard framework for the analysis of this kind of problem involves quantifying the benefit by proposing a utility function with a decreasing marginal utility with implicit risk aversion. Assume the following government utility function:

$$U_0 = \sum_{t=0}^{\infty} \beta^t U(C_t) \tag{3}$$

where

$$U(C) = \ln(C) \tag{4}$$

C denotes in this case the fiscal expenditure. Let C be a random variable with some probability distribution that fluctuates around an expected value denoted by $E(C) = C_0$. Taking a Taylor approximation near said value, the expected utility can be expressed as

$$E\{U(C)\} \approx \ln(C_0) - \frac{\sigma_c^2}{2C_0^2} \tag{5}$$

where terms larger than order two are neglected. This expression can be used to measure the increase in utility that comes from the reduction in volatility that does not affect the expected value of the fiscal expenditure. From (5) and (3), the present value of the utility gain could be expressed as

$$\Delta U_0 = \frac{\sigma_c^2 - \sigma^{*2}_c}{2(1-\beta)C_0^2} \tag{6}$$

where σ_c^2 y σ^{*2}_c stand for the present variance and the variance proposed through the alternative debt denomination, while β represents the authorities' discount factor.

The swap cost, in turn, is simply a portion of the principal considered in the contract. Informal estimates on a swapped amount of US$20 million suggest a charge of 20 basis points, which can be reduced considerably if an amount such as today's government debt is swapped. To be on the conservative side, the exercise assumes the mentioned charge. Table 8 below shows the basic amounts involved in the analysis.

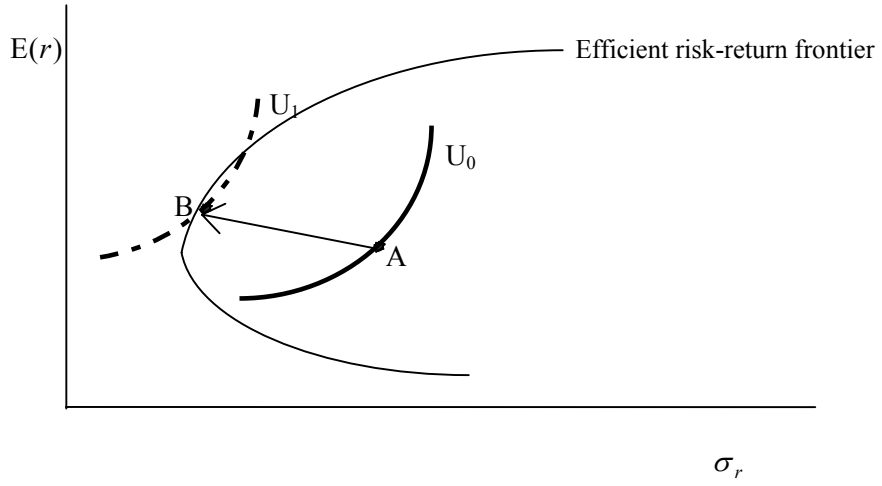
Table 8: Costs and Benefits of Swap, Central Government
(in millions of US dollars)

Swapped Ammount	11,858		
Comission (Basis Points)	20		
Cost (annuity)	0.89		
Discount Rate	0.95		
Fiscal Expenditure (20% GDP)	14,839		
	(annual series)		
Benefit	86-02	94-02	98-02
Uo (current σ)	14,832	14,832	14,834
U1 (minimum σ)	14,833	14,834	14,834
U2 (σ rate swap)	14,832	14,833	14,833
PV (U1-Uo)	24	36	12
PV (U2-Uo)	9	13	-10
PV (U1-Uo) /GDP	0.03%	0.05%	0.02%
PV (U2-Uo) /GDP	0.01%	0.02%	-0.01%

To estimate the swap cost, the 20 basis points were applied to the entire debt of the government, on an annualized basis that considered the present average cost of debt of 3.76%. To calculate utility, the base amount was assumed to be the fiscal expenditure, around 20% of GDP, or C_0 in the notation of the previous section. Utility differentials (expressed in pesos) in this conservative analysis indicate that benefits can be valued by using a discount rate in the central government's utility function of 0.95, that is, in the range from 0.02% to 0.03% of GDP. If only swapping fixed rates for variable rates is considered, this increase goes to the -0.01% to 0.02% range, depending on what correlations are considered more relevant to forecast the future behavior of risk factors.

Although these figures may seem small, there are at least two elements to consider that might make the proposal more appealing. The first is that the cost of the swap doesn't apply to a longer-term analysis, where new debt can be issued from the beginning at a floating rate, so the measure would be strictly welfare increasing. The second is that, from the more general objective of this paper, the potential benefits seem rather small for Chile given its modest amount of foreign debt, but could be much larger for countries where debt payments play a mayor role on fiscal expenditures. Such welfare increase is sketched in figure 1, in the traditional risk/return space.

Figure 1: Position of Fiscal Result in the Risk-Return Space



V. Risk Scenarios

The first thing to keep in mind before a recommendation of this kind concerns the effect of a possible change in the correlations between the main risk factors. In some circumstances, if domestic output begins to be negatively correlated with external rates, then the above measures will amplify the fiscal result substantially. However, it should be reckoned that, although in the beginning of expansionary or contractionary phases domestic rates loose their correlation with output because of the effects of the stabilizing monetary policy, over the larger part of the cycle there is positive correlation between output and long-term rates of government bonds at the world level. The quid of the problem lies, therefore, in identifying scenarios of different correlations between domestic and external activity, and then weight them by their probability of occurrence. These main scenarios are:

a) Domestic boom/ External boom: In this situation, the governments tax revenues and copper proceeds would both increase, as would the rates charged on its debt. This is an ideal situation from the immunization perspective: to pay a high debt and receive low returns on assets when the most important government source of income, GDP, is booming.

b) Domestic boom / External stagnation: Here, the low rates charged on the debt would add to the high tax revenues from domestic activity, partially mitigated by reduced copper proceeds. Although this situation would amplify the income statement, it would go in the desired direction.

c) Domestic stagnation / External boom: This situation has, of course, the reversed implications of the one above, that is, the proposed indexation to variable rates would enlarge the fiscal deficit.

d) Domestic stagnation / External stagnation: This is precisely the situation for which this strategy is conceived; to repay low debt whenever domestic activity generates less fiscal resources.

This simple analysis shows that, in the context of our main recommendation of anchoring to variable rates, the only worrisome scenario is c). In order to have a back-of-the-envelope assessment of the relative probability associated to each scenario, appendix 3 shoes a relatively simple exercise. The Y-axis shows the difference between semiannual (at annualized rates) growth of the Chilean economy for the 1986-2002 period. The X- axis shows the 10 year average government bond yield of each associated currency (German data for the Euro) for the same period and frequency. As the figure shows, the fourth quadrant (scenario c)) has relatively low frequency, accumulating between 15 - 24% of possible cases, depending the country of comparison. In the same line of argumentation, appendix 4 computes the correlation, in rolling windows of 4 years, between annualized quarterly GDP growth between Chile and the respective countries. Such correlation borders 0,4 in the present for the United Kingdom and the Euro area.

Regarding the future distribution of the scenarios, b) and c) are less likely, for two reasons. First, domestic output is closely related with (and dependent on) the price of copper, which is high when world activity rises. Second, a hypothesis sustained by common sense and recent empirical evidence[14] is that stronger commercial links implied by the several bilateral free trade agreements entered into by Chile recently will result in a higher correlation between the country's and international output.

Finally, it is interesting to formally test the results presented by assessing the stability of the computed correlations. The VaR approach provides a confidence interval for risk exposure given a set of correlations, which are assumed as constant parameters. In practice, however, these correlations are themselves parameters estimated through linear regressions, whose statistical

[14] See Calderón (2003).

properties would be interesting to include in the previous analysis. In this respect, two exercises are presented. The first tests the significance of correlations, both individually and jointly. Appendix 1 shows a summary of the most important correlations, tabulating only those significant at the 5% level. Underneath the tables the joint correlation analysis is presented, where the null hypothesis is that the matrix of correlations is equal to the identity matrix. In all specifications, the test rejects the jointly absence of significant correlations, also at 5% critical value.

The second exercise intends to capture the statistical properties of the estimated correlations for building significance tests for the estimated VaR itself. Using the Delta method for computing critical values for specific functions of estimated parameters, it is possible to test whether the estimated VaRs under current and proposed debt denomination alternatives is statistically different. Let $\text{plim} f(b) = f(\beta)$, where $f(b)$ is some function (in this case, the VaR) of the vector of estimated correlations, b. According to the delta method, $f(b)$ has the following asymptotic distribution,

$$(7) \qquad f(b) \approx N\left[f(\beta); \Gamma\left(\frac{\sigma^2}{n} \left(\frac{X`X}{n} \right)^{-1} \right) \Gamma` \right]$$

where Γ is the 1xL vector derivatives of $f(b)$ for each of the L correlations considered, X is the LTxL matrix of the data used to estimate these correlations, and $n = L\text{x}T$. Therefore, the appropriate t-statistic can be computed with the following formula:

$$(8) \qquad t = \frac{(fc(b) - fp(b))}{S_{avg}\sqrt{(2/n)}}; \qquad S_{avg} = \sqrt{\frac{(SSR_c + SSR_P)}{2}}$$

where the numerator is the estimated difference of VaR under current and proposed denomination and the denominator contains the average standard deviation of the estimations of correlations under both alternatives.

Unfortunately for the pretensions of this paper, the results for this contrast accept the null hypothesis under all specifications. In the annual, whole sample specification of estimated correlations, for example, the t-stat for the difference between the actual VaR and the proposed optimal denomination VaR is just 0.32. This result just reinforces the previous caution argument about the risk scenarios involved in the presence of unstable correlations. The decision to engage a

currency or interest rate swap as the one proposed should therefore consider the risks imbedded in the break of the correlation patterns. It is still under the author's opinion, however, that the increasing integration trend of the Chilean economy with the world's activity makes a strong case for the consideration of future debt denominations in the line of the last bond issuance at variable rates. Moreover, for countries with heavier public debt burdens the potential benefits of applying a similar evaluation approach might be substantially larger.

VI. Conclusions

This paper has evaluated the current denomination of the central government debt, focusing on the immunization of fiscal result. An analysis of the evolution of the main risk factors affecting the state's result and its relation with other financial instruments available, allows making certain assertions regarding the optimal currency denomination:

1. With today's debt, the fiscal result is exposed, with 95% confidence, to maximum fluctuations of 762 million dollars a year (1.1% GDP). The main reason for such exposure is the variation of the factors involved, mainly GDP, the copper price, the US six-month Libor rate and the exchange rate.

2. Although a large part of this exposure is due to factors exogenous to the debt structure, if the main correlations between activity, interest rates and currencies are taken at their point estimates, an optimal financial restructuring would allow reducing it by some 7%-22%, depending on the horizon and frequency considered calculating the key correlations. Such restructuring should include swaps of currencies and rates, of both the external debt and internal debt, so that the burden of the foreign debt would be positively related with the evolution of economic activity and the price of copper. A conservative cost/benefit analysis in the risk/return spectrum suggests that the net present value of the gain in utility from the proposal, while relatively modest for the Chilean case, is positive in most scenarios.

3. Although the optimal proposal varies depending on the data specification chosen to calculate the volatilities and correlations of all factors involved, most of the calculations yield a small number of candidates: external debt in euros and/or in pounds, anchored to their respective long-term rates. If the full estimation period is considered, the US dollar also appears as a feasible candidate. Regarding interest rate denomination, the answer is more clear-cut. Given the positive correlation

found among all external rates and the main output variables, regardless of the currency denomination chosen, the external debt should be anchored to the respective long-term government bond. In fact, it is possible to reduce the bulk of the present exposure by restricting it to the swap of interest rates only

4. Although the most important correlations were found to be statistically significant, both individually and jointly, a stricter test performed on the significance of the proposed VaR reduction casts some doubts about the effectiveness of the measure. The temporal instability problem of correlations, in the end, reflects in the statistical irrelevance found between the actual and proposed denomination alternatives. Further conclusions supporting the proposal should then rely on a subjective revision of the expectations about the future distribution of correlations. The growing trend in economic cycle integration caused by commercial agreements between trading partners could eventually make a case in this direction.

5. This framework of analysis might yield interesting results to countries with higher debt burdens, where volatility of fiscal result is dominated in a higher degree by the behavior of interest rates payments.

References

Calderón, C., (2003) “Do Free Trade Agreements enhance the Transmission of Shocks across Countries?” Central Bank of Chile, Working Paper No. 213.

Greene, W (1993) "Econometric Analysis", Prentice Hall, New Jersey. Second Edition.

Huang, C. and R. Litzenberger, (1988) “Foundations for Financial Economics”, Prentice Hall, New Jersey.

Hull, John (2000) “Options, Futures, and Other Derivatives”, Prentice Hall, New Jersey.

International Monetary Fund and World Bank (2001). “Guidelines for Public Debt Management”, Washington, D.C. *mimeo.*

New Zealand Debt Management Office (1993) “Institutional Arrangements of Government Debt Management in New Zealand”, *mimeo*

Pindyck, R. and J. Rotemberg, (1990) “The excess Co-movements of Commodity Prices”. The Economic Journal, Vol. 100 No. 403.

Appendix 1

a) Main Correlations

Quarterly; 86-02

	BP10Y	JY10Y	EU10Y	US10Y	PRC8	CHDL	CHBP	CHJY	CHEU	PIB	PC
BP10Y	1.00	0.95	0.81	0.86	0.35	-0.46	-0.23	-0.13	-0.40	0.37	
JY10Y	0.95	1.00	0.93	0.86	0.36	-0.44	-0.23		-0.37	0.37	
EU10Y	0.81	0.93	1.00	0.68	0.20	-0.43	-0.26	-0.17	-0.43	0.36	
US10Y	0.86	0.86	0.68	1.00	0.39	-0.46	-0.23	-0.14	-0.32	0.38	0.28
PRC8	0.35	0.36	0.20	0.39	1.00		-0.28				-0.20
CHDL	-0.46	-0.44	-0.43	-0.46		1.00	0.53	0.46	0.65	-0.19	-0.26
CHBP	-0.23	-0.23	-0.26	-0.23	-0.28	0.53	1.00	0.54		-0.29	0.15
CHJY	-0.13		-0.17	-0.14		0.46	0.54	1.00			
CHEU	-0.40	-0.37	-0.43	-0.32		0.65			1.00		-0.22
PIB	0.37	0.37	0.36	0.38		-0.19	-0.29			1.00	
PC				0.28	-0.20	-0.26	0.15		-0.22		1.00
					Stat.	203.66					
					X^2 Crit.	50.89					

Biannual; 86-02

	BP1Y	JY1Y	EU1Y	US1Y	PRC8	CHDL	CHBP	CHJY	CHEU	PIB	PC
BP10Y	1.00	0.95	0.84	0.85	0.38	-0.56	-0.32	-0.23	-0.47	0.46	
JY10Y	0.95	1.00	0.93	0.86	0.39	-0.52	-0.33		-0.42	0.43	0.18
EU10Y	0.84	0.93	1.00	0.70	0.24	-0.56	-0.36	-0.22	-0.54	0.45	
US10Y	0.85	0.86	0.70	1.00	0.40	-0.56	-0.28	-0.27	-0.32	0.44	0.40
PRC8	0.38	0.39	0.24	0.40	1.00		-0.39				
CHDL	-0.56	-0.52	-0.56	-0.56		1.00	0.60	0.52	0.68	-0.41	-0.25
CHBP	-0.32	-0.33	-0.36	-0.28	-0.39	0.60	1.00	0.56		-0.63	
CHJY	-0.23		-0.22	-0.27		0.52	0.56	1.00		-0.30	
CHEU	-0.47	-0.42	-0.54	-0.32		0.68			1.00		
PIB	0.46	0.43	0.45	0.44		-0.41	-0.63	-0.30		1.00	0.23
PC		0.18		0.40		-0.25				0.23	1.00
					Stat.	128.95					
					X^2 Crit.	50.89					

Annual 86-02

	BP1Y	JY1Y	EU1Y	US1Y	PRC8	CHDL	CHBP	CHJY	CHEU	PIB	PC
BP10Y	1.00	0.96	0.82	0.89	0.38	-0.74	-0.35		-0.76	0.63	0.30
JY10Y	0.96	1.00	0.90	0.89	0.42	-0.71	-0.44		-0.68	0.53	0.32
EU10Y	0.82	0.90	1.00	0.69		-0.73	-0.52	-0.28	-0.72	0.56	
US10Y	0.89	0.89	0.69	1.00	0.49	-0.68			-0.65	0.49	0.54
PRC8	0.38	0.42		0.49	1.00	-0.32	-0.53			0.32	
CHDL	-0.74	-0.71	-0.73	-0.68	-0.32	1.00	0.63	0.54	0.84	-0.75	-0.39
CHBP	-0.35	-0.44	-0.52		-0.53	0.63	1.00	0.49	0.36	-0.66	
CHJY			-0.28			0.54	0.49	1.00	0.53	-0.38	
CHEU	-0.76	-0.68	-0.72	-0.65		0.84	0.36	0.53	1.00	-0.50	-0.35
PIB	0.63	0.53	0.56	0.49	0.32	-0.75	-0.66	-0.38	-0.50	1.00	
PC	0.30	0.32		0.54		-0.39			-0.35		1.00
					Stat.	64.05					
					X^2 Crit.	50.89					

Appendix 1 (cont.)

Quarterly; 94-02

	BP10Y	JY10Y	EU10Y	US10Y	PRC8	CHDL	CHBP	CHJY	CHEU	PIB	PC
BP1Y	1.00	0.89	0.80	0.78	0.21	-0.50	-0.32	-0.35	-0.41	0.53	
JY1Y	0.89	1.00	0.88	0.86	0.20	-0.48	-0.36	-0.22	-0.39	0.56	0.35
EU1Y	0.80	0.88	1.00	0.81		-0.49	-0.36	-0.25	-0.48	0.62	0.33
US1Y	0.78	0.86	0.81	1.00	0.38	-0.52	-0.46	-0.27	-0.27	0.59	0.35
PRC8	0.21	0.20		0.38	1.00		-0.25				
CHDL	-0.50	-0.48	-0.49	-0.52		1.00	0.86	0.48	0.73	-0.35	-0.30
CHBP	-0.32	-0.36	-0.36	-0.46	-0.25	0.86	1.00	0.54	0.36	-0.35	-0.23
CHJY	-0.35	-0.22	-0.25	-0.27		0.48	0.54	1.00		-0.24	
CHEU	-0.41	-0.39	-0.48	-0.27		0.73	0.36		1.00		
PIB	0.53	0.56	0.62	0.59		-0.35	-0.35	-0.24		1.00	0.26
PC		0.35	0.33	0.35		-0.30	-0.23			0.26	1.00
					Stat.	173.57					
					X^2 Crit.	50.89					

Biannual; 94-02

	BP1Y	JY1Y	EU1Y	US1Y	PRC8	CHDL	CHBP	CHJY	CHEU	PIB	PC
BP1Y	1.00	0.95	0.82	0.78		-0.62	-0.41	-0.48	-0.52	0.58	0.24
JY1Y	0.95	1.00	0.95	0.90		-0.58	-0.42	-0.32	-0.47	0.55	0.51
EU1Y	0.82	0.95	1.00	0.82		-0.63	-0.46	-0.32	-0.58	0.69	0.54
US1Y	0.78	0.90	0.82	1.00	0.39	-0.61	-0.54	-0.32	-0.28	0.62	0.50
PRC8				0.39	1.00		-0.32				
CHDL	-0.62	-0.58	-0.63	-0.61		1.00	0.85	0.47	0.73	-0.44	-0.29
CHBP	-0.41	-0.42	-0.46	-0.54	-0.32	0.85	1.00	0.55	0.35	-0.45	
CHJY	-0.48	-0.32	-0.32	-0.32		0.47	0.55	1.00		-0.27	
CHEU	-0.52	-0.47	-0.58	-0.28		0.73	0.35		1.00		
PIB	0.58	0.55	0.69	0.62		-0.44	-0.45	-0.27		1.00	0.31
PC	0.24	0.51	0.54	0.50		-0.29				0.31	1.00
					Stat.	120.49					
					X^2 Crit.	50.89					

Annual; 94-02

	BP1Y	JY1Y	EU1Y	US1Y	PRC8	CHDL	CHBP	CHJY	CHEU	PIB	PC
BP1Y	1.00	0.92	0.83	0.82		-0.85	-0.74	-0.64	-0.77	0.87	
JY1Y	0.92	1.00	0.91	0.99		-0.78	-0.73		-0.68	0.68	0.49
EU1Y	0.83	0.91	1.00	0.83		-0.82	-0.80	-0.34	-0.75	0.78	0.67
US1Y	0.82	0.99	0.83	1.00	0.46	-0.80	-0.85		-0.48	0.68	0.50
PRC8				0.46	1.00		-0.39				
CHDL	-0.85	-0.78	-0.82	-0.80		1.00	0.87	0.48	0.82	-0.85	-0.56
CHBP	-0.74	-0.73	-0.80	-0.85	-0.39	0.87	1.00		0.57	-0.86	-0.58
CHJY	-0.64		-0.34			0.48		1.00	0.35	-0.77	
CHEU	-0.77	-0.68	-0.75	-0.48		0.82	0.57	0.35	1.00	-0.70	-0.45
PIB	0.87	0.68	0.78	0.68		-0.85	-0.86	-0.77	-0.70	1.00	
PC		0.49	0.67	0.50		-0.56	-0.58		-0.45		1.00
					Stat.	201.40					
					X^2 Crit.	50.89					

Appendix 1 (cont.)

Quarterly; 98-02

	BP10Y	JY10Y	EU10Y	US10Y	PRC8	CHDL	CHBP	CHJY	CHEU	PIB	PC
BP1Y	1.00				0.33						
JY1Y		1.00	0.26	0.78	0.50				0.55	0.62	
EU1Y		0.26	1.00	0.50						0.62	0.28
US1Y		0.78	0.50	1.00	0.56		-0.45		0.36	0.48	0.34
PRC8	0.33	0.50		0.56	1.00		-0.27				
CHDL						1.00	0.85	0.64	0.65		-0.35
CHBP				-0.45	-0.27	0.85	1.00	0.69			-0.34
CHJY						0.64	0.69	1.00			
CHEU		0.55		0.36		0.65			1.00	0.37	
PIB		0.62	0.62	0.48					0.37	1.00	0.37
PC			0.28	0.34		-0.35	-0.34			0.37	1.00
					Stat.	85.27					
					X^2 Crit.	50.89					

Biannual; 98-02

	BP1Y	JY1Y	EU1Y	US1Y	PRC8	CHDL	CHBP	CHJY	CHEU	PIB	PC
BP1Y	1.00							-0.52			
JY1Y		1.00	0.52	0.92	0.43		-0.35		0.68	0.76	0.50
EU1Y		0.52	1.00	0.47				-0.34		0.89	0.57
US1Y		0.92	0.47	1.00	0.54		-0.52		0.52	0.63	0.44
PRC8		0.43		0.54	1.00						
CHDL						1.00	0.87	0.63	0.58		
CHBP		-0.35		-0.52		0.87	1.00	0.69			
CHJY	-0.52		-0.34			0.63	0.69	1.00			
CHEU		0.68		0.52		0.58			1.00	0.42	
PIB		0.76	0.89	0.63					0.42	1.00	0.67
PC		0.50	0.57	0.44						0.67	1.00
					Stat.	283.97					
					X^2 Crit.	50.89					

Annual; 98-02

	BP1Y	JY1Y	EU1Y	US1Y	PRC8	CHDL	CHBP	CHJY	CHEU	PIB	PC
BP1Y	1.00				0.83	-0.56	-0.48			0.50	
JY1Y		1.00		0.95	0.68	-0.46	-0.78	0.66	0.54		
EU1Y			1.00			-0.47	-0.73			0.83	0.62
US1Y		0.95		1.00	0.69	-0.45	-0.89	0.45	0.67		
PRC8	0.83	0.68		0.69	1.00		-0.47				
CHDL	-0.56	-0.46	-0.47	-0.45		1.00	0.67				
CHBP	-0.48	-0.78	-0.73	-0.89	-0.47	0.67	1.00		-0.51	-0.45	-0.58
CHJY		0.66		0.45				1.00		-0.79	
CHEU		0.54		0.67			-0.51		1.00		
PIB	0.50		0.83				-0.45	-0.79		1.00	
PC			0.62				-0.58				1.00
					Stat.	215.38					
					X^2 Crit.	50.89					

Variable Definitions:

BP10Y: 10 year government bond, UK

JY10Y: 10 year government bond, Japan

EU10Y: 10 year government bond, Germany

US10Y: 10 year government bond, UK

PRC 8: Real 8 year Central Bank of Chile bond

CHDL: Exchange Rate; peso/dolar

CHJY: Exchange Rate; peso/yen

CHEU: Exchange Rate; peso/euro

CHBP: Exchange Rate; peso/pound

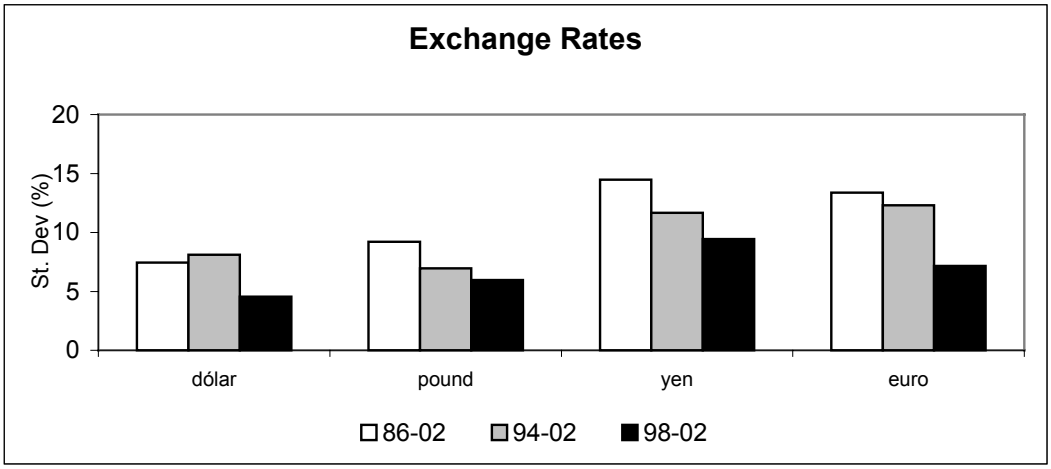
Cu: Copper price

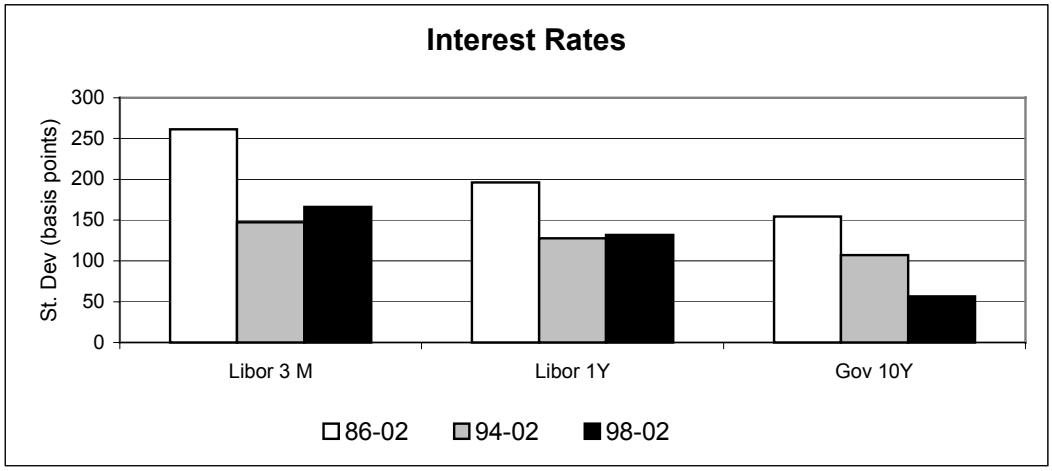
GDP: Gross domenstic product

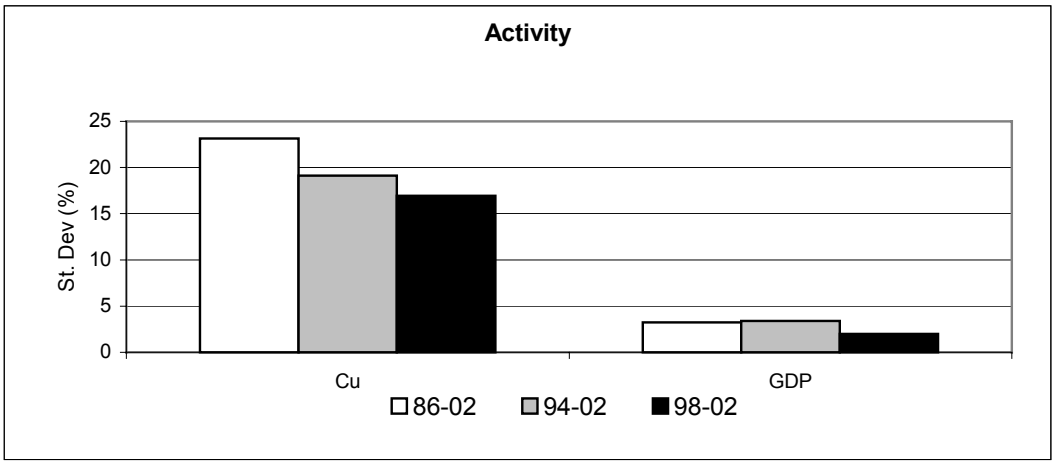
Note: Only significant coefficients reported.

Appendix 1 (cont)

b) Volatility







Appendix 2

Swap cash flow simulation

Notional amount: 1.000						
	I	II	III	IV	V	VI
Date	Recieve from bank	Pay t bank	Debtholders payment	Diff.	Diff. Payments	Net payment
5/23/03		62.1	0.0	62.1	0.0	0.0
7/15/03	27.5	11.8	27.5		0.7	12.5
1/15/04	27.5	11.4	27.5		0.7	12.1
7/15/04	27.5	11.9	27.5		0.7	12.7
1/15/05	27.5	14.0	27.5		0.9	14.9
7/15/05	27.5	15.7	27.5		1.0	16.7
1/15/06	27.5	19.2	27.5		1.2	20.4
7/15/06	27.5	20.9	27.5		1.3	22.2
1/15/07	27.5	23.2	27.5		1.4	24.6
7/15/07	27.5	24.5	27.5		1.5	26.1
1/15/08	27.5	26.4	27.5		1.6	28.1
7/15/08	27.5	27.5	27.5		1.7	29.2
1/15/09	27.5	28.8	27.5		1.8	30.6
7/15/09	27.5	29.3	27.5		1.8	31.1
1/15/10	27.5	30.0	27.5		1.9	31.9
7/15/10	27.5	30.3	27.5		1.9	32.2
1/15/11	27.5	31.4	27.5		1.9	33.3
7/15/11	27.5	31.4	27.5		2.0	33.4
1/15/12	27.5	32.1	27.5		2.0	34.1
7/15/12	27.5	32.4	27.5		2.0	34.4
1/15/13	1,027.5	1,033.3	1,027.5		64.1	1,097.4
Present Value	1,192.1					1,192.1

Source: Bloomberg (Asset swap calculator)

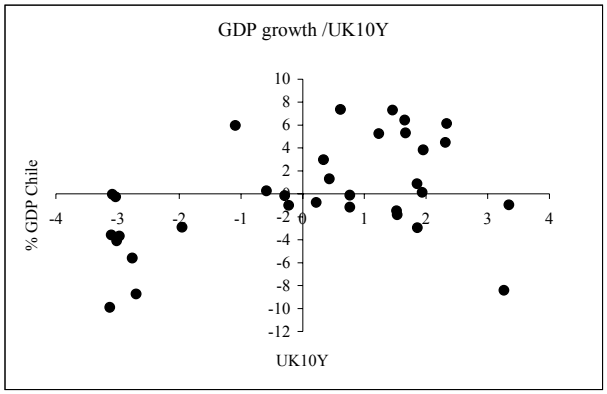
Column I shows the actual pre-determined payment schedule contracted by the government for a particular bond issue. The present value is computed for a 1000 notional amount, discounted to the 3 month US libor plus the Chilean spread, calculated at 104,2 basis points in april 23, 2003. The swap consists in exchanging with a third party (bank) fixed for variable rates, so the government receives fixed rate from bank and pays variable.

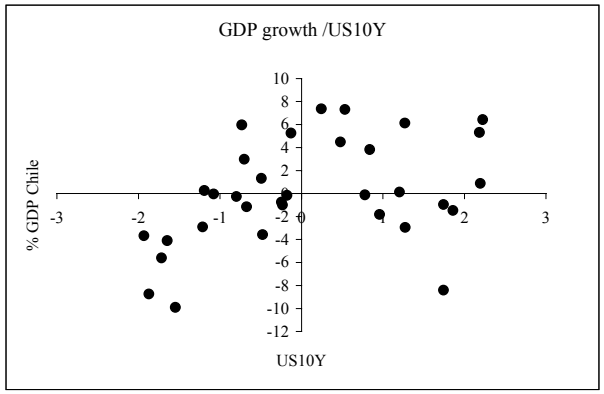
The payment demanded by the bank is equivalent to the Libor plus Chilean sovereign spread, values shown in column II. Given that such payments NPV is below the market value of the bond (issued at a time of higher Chilean spread), the government must pay the difference at the beginning. Such difference is simulated as a new debt issue (column IV) at variable rates. The strategies´ net

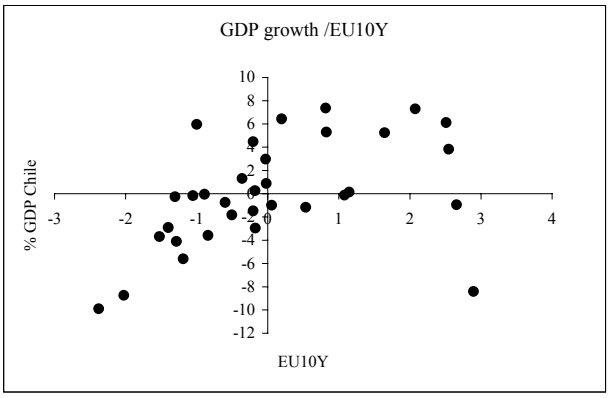
payments are shown in the last column, whose NPV is (and should be, by construction) equal to the current payments NPV, but with a different expected time profile.

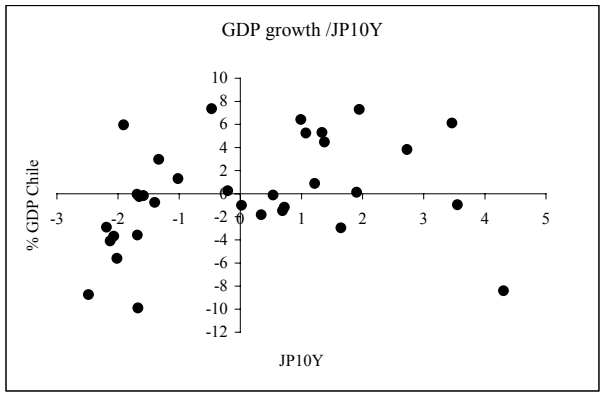
Appendix 3

Risk scenarios:









Frequency	UK10Y	US10Y	EU10Y	JP10Y
Boom/High Yield	0.36	0.27	0.24	0.27
Boom/Low Yield	0.06	0.15	0.18	0.15
Recession/High Yield	0.24	0.18	0.15	0.24
Recession/Low Yield	0.33	0.39	0.42	0.33

Documentos de Trabajo
Banco Central de Chile

Working Papers
Central Bank of Chile

NÚMEROS ANTERIORES

PAST ISSUES

La serie de Documentos de Trabajo en versión PDF puede obtenerse gratis en la dirección electrónica: www.bcentral.cl/esp/estpub/estudios/dtbc. Existe la posibilidad de solicitar una copia impresa con un costo de $500 si es dentro de Chile y US$12 si es para fuera de Chile. Las solicitudes se pueden hacer por fax: (56-2) 6702231 o a través de correo electrónico: bcch@bcentral.cl.

Working Papers in PDF format can be downloaded free of charge from: www.bcentral.cl/eng/stdpub/studies/workingpaper. Printed versions can be ordered individually for US$12 per copy (for orders inside Chile the charge is Ch$500.) Orders can be placed by fax: (56-2) 6702231 or e-mail: bcch@bcentral.cl.

DTBC-258 Mayo 2004
Desempleo y Consumo en Chile
Claudio Soto

DTBC-257 Mayo 2004
Función de Ingresos de los Hogares Chilenos: Ciclo de Vida y Persistencia de Shocks en el Tiempo
Paulina Granados Z.

DTBC-256 Abril 2004
Rapid Growth of Monetary Aggregates and Inflation: The International Evidence
José De Gregorio

DTBC-255 Enero 2004
Effects of Foreign Exchange Intervention under Public Information: The Chilean Case
Matías Tapia y Andrea Tokman

DTBC-254 Diciembre 2003
The Monetary Transmission Mechanism in Chile: A Medium-sized Macroeconometric Model
Carlos García, Pablo García, Igal Magendzo y Jorge Restrepo

DTBC-253 Diciembre 2003
Monetary Policy, Real Exchange Rate, and the Current Account in a Small Open Economy
Claudio Soto

DTBC-252 Diciembre 2003
Net Foreign Assets and Imperfect Financial Integration: An Empirical Approach
Jorge Selaive y Vicente Tuesta

DTBC-251 Diciembre 2003
Labor Market Distortions, Employment and Growth: The Recent Chilean Experience
Raphael Bergoeing, Felipe Morandé y Facundo Piguillem

DTBC-250 Diciembre 2003
The Harberger-Laursen-Metzler Effect Revisited: An Indirect-utility-function Approach
Roberto Duncan

DTBC-249 Diciembre 2003
Floating, Official Dollarization, and Macroeconomic Volatility: An Analysis for the Chilean Economy
Roberto Duncan

DTBC-248 Diciembre 2003
Quantifying the Costs of Investment Limits for Chilean Pension Funds
Solange M. Berstein y Rómulo A. Chumacero

DTBC-247 Diciembre 2003
The ECOGEM-Chile Model: A CGE Model for Environmental and Trade Policy Analysis
Raúl O'Ryan, Carlos J. de Miguel y Sebastián Miller

DTBC-246 Diciembre 2003
Productivity Growth and Disinflation in Chile
José De Gregorio

DTBC-245 Diciembre 2003
Growth and Adjustment in East Asia and Latin America
José De Gregorio y Jong-Wha Lee

DTBC-244 Diciembre 2003
On the Removal of Agricultural Price Bands in Chile: A General Equilibrium Analysis
David Holland, Eugenio Figueroa B., Roberto Alvarez y John Gilbert

DTBC-243 Diciembre 2003
Modeling a Small Open Economy: The Case of Chile
Vittorio Corbo y José Tessada