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Fiscal Policy for Good: Reducing Macroeconomic Volatility in Uruguay

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Abstract

This paper evaluates public debt sustainability in Uruguay in a context of uncertainty. I perform a Monte Carlo simulation to show that the historical expenditure behavior results in deficit bias and unsustainable government finances in expected terms. I argue that this is one of the sources of macroeconomic volatility in Uruguay. An implication is that structural reforms aiming at improving incentives affecting public expenditure decisions could have a positive effect in moderating this source of volatility. To this end, the paper explores various policy options. First, it evaluates the benefits of expenditure flexibility, and quantifies the expected decline of debt/GDP ratios if the government could commit to certain primary surplus targets every year. Second, the paper analyzes the case for a structural balance expenditure rule. Such rule would (1) be welfare superior in aggregate terms by contributing to smooth aggregate demand, (2) be of more realistic implementation in social and political terms, as it would avoid the need of large and recurrent expenditure adjustments, and (3) ensure long term financial sustainability. Other simulation experiments performed to evaluate the potential gains in terms of reducing volatility are the de-dollarization of public debt and the benefits in terms of reducing the required primary surplus of sustainability of a debt-equity swap.

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I. Introduction

Macroeconomic volatility has affected Uruguay over several decades. Average annual growth in Uruguay since the mid 1960s has been of 2.1% per year. However, growth volatility has been very high: the standard deviation of growth has been 4.5%. The central argument of this paper is that this costly pattern have to a large extent been caused or affected by the management of public sector finances. I show that historical long-term fiscal trends in Uruguay have systematically generated stress on public sector financing. Growth collapses in the last 50 years in Uruguay have been associated with large currency devaluations and/or public debt defaults (default in 1983 and market-based restructuring in 2003). High and persistent inflation prior to the 1990s is another indicator supporting such a proposition. Government average deficit since 1965 has been of 2.1% of GDP, and budget surpluses have only been observed in 5 years since then.

A combination of factors have contributed to macroeconomic volatility in the past. They can be categorized in two groups:

(1) Exogenous volatility, including terms of trade shocks, shocks from international financial markets, and, in particular, instability generated directly or indirectly by its two big and unstable neighbors: Argentina and Brazil.

(2) Endogenous volatility, as determined by Government's decisions that affect the overall assessment of risk of the economy. These are in general factors that affect the magnitude of cyclical fluctuations and that can increase the vulnerability to exogenous shocks. Among these, the most salient ones are (i) the government deficit bias, which historically resulted in a combination of high inflation and public debt accumulation, (ii) pro-cyclical fiscal policy, which implies that government increases domestic demand during booms and contributes to the slowdown during recessions, and (iii) the dollarization of public debt, which makes the perception of solvency of the economy vulnerable to real exchange rate fluctuations. (Section III shows data supportive of these stylized facts).

This paper focuses its attention on the issues listed in point (2) above, and considers alternatives in terms of fiscal policy and debt management with the objective of reducing macroeconomic volatility. The specific issues under consideration are as follows: (a) the probability of the public sector remaining financially sustainable if expenditures continue to show the behavior observed in the past, (b) an analysis of the appropriate primary surplus target, with particular attention on the effects of public sector level of indebtedness on macroeconomic volatility and growth, (c) the potential role of a structural balance public expenditure rule as a tool to minimize volatility through procyclical fiscal policy while ensuring at the same time long term financial consistency of the public sector, and (d) the potential role of de-dollarization of public debt, which could reduce the volatility of the debt service burden given that tax collection is largely based on non-tradable activities. As a result, debt de-dollarization could reduce risks of public debt default associated with real exchange rate fluctuations and its associated costs.

I argue that these factors affect the cost and the probability of Uruguay having access to financial markets at low interest rates. This issue could be important to reduce macroeconomic volatility for various reasons. First, because of the role of financial markets in terms of financing deficits and smoothing-out public expenditure fluctuations. Second, because the level and structure of public debt affect the probability and the cost of accessing financial markets. This last element can be important in avoiding liquidity crisis and expectations of public debt default/restructuring, including all the associated costs in terms of monetary and financial instability.

In order to analyze these issues, I estimate a dynamic econometric model for the Uruguayan economy, which includes endogenous variables that are relevant for debt sustainability analysis. The estimated model is then used to perform a Monte Carlo experiment, generating sequences of shocks to simulate a large number of artificial evolutions of the Uruguayan economy. In this way, the simulated values have statistical properties in terms of magnitude of fluctuations, persistence and mutual consistency, of the same characteristics than historical patterns. The result is a large number of simulated series that represent endogenous cyclical fluctuations of economic activity, captured by cyclical movements in fiscal revenues and the real exchange rate. The use of alternative public expenditures functions and the debt accumulation identity allows for the construction of a public debt paths associated to each simulated evolution of the economy. This exercise is repeated for various assumptions combinations including primary surplus targets, different primary expenditure rules (including a structural balance rule), international interest rates, interest spread on sovereign bonds, long term GDP growth rates, and the share of debt denominated in foreign currency. The analysis enables to obtain probabilistic outcomes of fiscal performance under various assumption combinations, which provide some conclusions in terms of fiscal surplus targets and debt management policies aiming at reducing volatility.

The economic crisis of 2002 shows that the issue is critical for Uruguay, and that it remains key in ensuring a smooth economic path in the years to come. After an economic recession in 1999 through 2001, with negative growth and fiscal deficits of about 4% of GDP, in 2002 Uruguay suffered a combined balance of payments and banking crisis. The factors triggering it had strong roots on its two big neighbors: Brazil, Uruguay's major trading partner in goods (30% of Uruguayan exports), which devalued its currency in January 1999, and the Argentina crisis of 2002, its second biggest trading partner in goods and its first trading partner in services, with a banking crisis that had direct effects on the Uruguayan financial system[2]. In that year, GDP declined –11%, spreads climbed to default levels of over 2500 basis points and debt ratios reached 108% of GDP as of end 2003, with Uruguay loosing its investment grade rating. In 2003 it had to restructure public debt to longer maturities to avoid a default. The social consequences of the crisis were terrible. Currency depreciation, inflation and unemployment contributed to an increase in poverty rates of 60%, which reached record high levels of 24% of total population.

Although economic recovering is underway, challenges remain substantial. Government access to financing has been recovered, although at higher interest rates. Debt restructuring enabled to postpone maturing debt compromises. However financing peaks

[2] The run on deposits on the Uruguayan financial system was triggered by the withdraw of Argentine depositors operating in Uruguay's offshore banking branches. The bankruptcy of some Argentine banks operating in Uruguay also contributed to the crisis.

appear as soon as 2006 and 2007. In addition, risks emanating from international financial markets remain high, as interest rates are at historically low levels and there are expectations of higher rates in the future. Finally, additional real and financial shocks from Argentina and Brazil in the future can not be discarded either. The stronger the financial position of Uruguay's government in an event consisting of any combination of those mentioned, the higher would be the degrees of freedom for an appropriate management of fiscal and monetary policies to cushion those shocks, and the lower would be the social and economic costs.

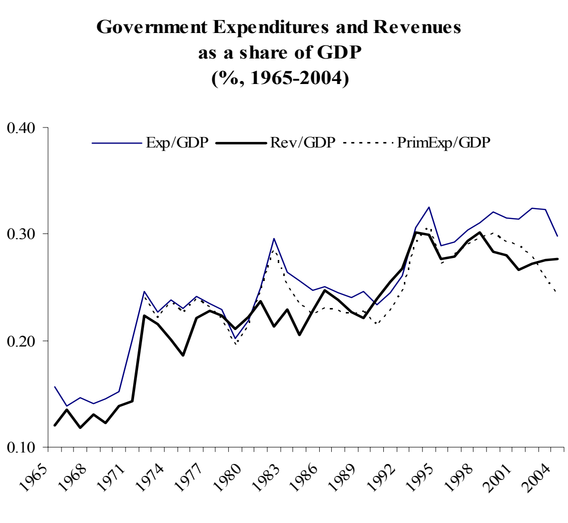
The paper is organized in seven additional sections. First, a review of long-term fiscal trends in Uruguay and a determination of some stylized facts. Second, a description of the methodology proposed to analyze fiscal sustainability under uncertainty. The section is only presented as a summary, and more technical details are developed in annexes I-IV. Third, an analysis of sustainability if public expenditure were to continue to behave as observed in the past. Fourth, an analysis of the implications for debt sustainability of structural balance rule for public sector spending. Fifth, an empirical evaluation of effects of de-dollarization of public debt. Sixth, the analysis of the potential gains of a debt-equity swap in terms of reducing the stock of debt and avoiding large expenditure adjustments. The final section summarizes the conclusions.

II. Long-Term Fiscal trends in Uruguay

Long term fiscal expenditure patterns in Uruguay show that the public sector was a contributor to macroeconomic instability rather than playing a stabilizing role. An analysis of long term fiscal trends in Uruguay reveals the following stylized facts:

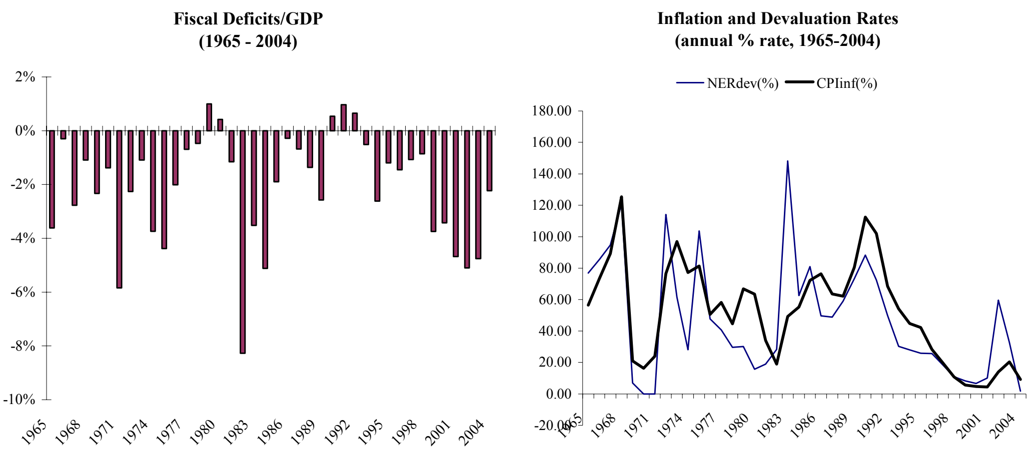
(a) *Sustained expansion of the size of the Public sector relative to that of the rest of the economy*. Average annual; growth of real government revenues in the period 1965-2003 is 3.2%, while real GDP grew at an average rate of 2.1% (average growth of the full sample period). The relative size of the public sector increased from under 20% of GDP in the 1960s to about 30% in the 2000s. Figure 1 shows government revenues and expenditures as a share of GDP.

Figure 1



(b) *Fiscal Deficit bias.* This resulted in chronic inflation and/or persistent accumulation of public debt. Periods in which stabilization was achieved through predetermined nominal exchange rate regimes were followed by large currency depreciations and/or debt default. Cycles of economic expansion and public debt accumulation followed by periods of stagnation and inflation. Uruguay had a debt default in 1983 and had to restructure debt in 2003. (Figure 2)

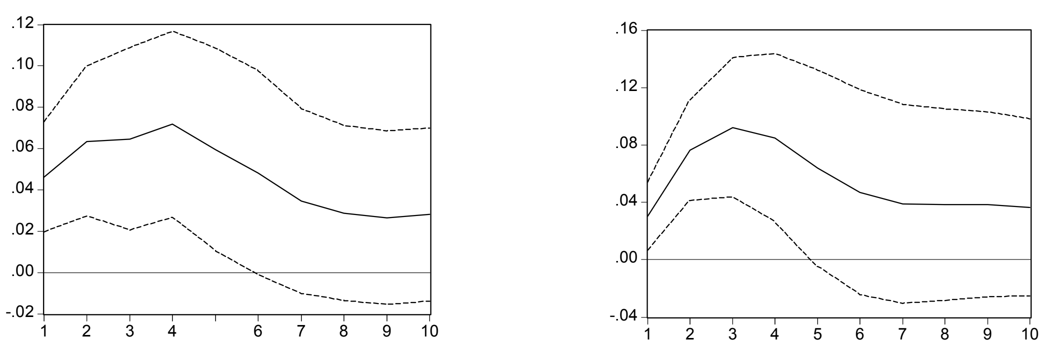
Figure 2



(c) *Pro-cyclical fiscal policy.* Real expenditures tend to increase during booms and to decline during recessions. Figure 3 illustrates the positive comovement of primary expenditures and two alternative measures of the state of economic activity: real GDP and real government revenues. This pattern could be contributing to macroeconomic volatility.

Figure 3: Generalized Impulse Responses of Primary Expenditures (Sample period: 1965 – 2004)

to a 1 std. dev. Innovation to the Log of Real Revenues | *to a 1 std. dev. Innovation to the Log of Real GDP*



Note: These impulse responses were obtained from two Vector Autoregression models including a measure of economic activity (real revenues and real GDP in logs) and real primary expenditures (in logs). In both cases 3 lags of each variable were included. The results are robust to various lag structures and model specification, including first differences and de-trended data (Hoddrick Prescott and Linear Trend)

(d) *Expenditure downward-inflexibility*. Recessions tend to be accompanied by deficits. Adjustment in real expenditures tend to take place through currency devaluation and inflation, with costs in terms of instability and growth. The correlation of fiscal balances and GDP growth is 0.68 (1965-2004), which implies that periods of low GDP growth also tend to be period of larger fiscal deficits. Also, the probability of a real adjustment of primary expenditures for the sample period is of 0.48. This means that in about ½ of the sample there were declines in real primary expenditures. However, conditional on an acceleration in inflation, such probability increases to 0.92. This means that in almost every year in which there were declines in primary expenditures there was also an increase in inflation. Finally, the probability of an increase in inflation conditional on a decline in real primary expenditures is of 0.73. This means that for approximately 3 out of 4 events of increases in the rate of inflation there was also a decline in real expenditures.

Candidate reasons that could explain these stylized facts in Uruguay are social/political pressures for spending, social resistance to change and reform due to risk aversion and ideological beliefs, and institutional rigidities affecting the speed of reform. External factors also affect these facts. Among these, the most important ones are shocks coming from Argentina and Brazil, which are Uruguay's most important trading partners, shocks from international financial markets and terms of trade shocks.

Some of the core reasons that could explain these stylized facts may not be easy to change, at least not in the short and medium term. As a result, a realistic assessment of public debt sustainability should incorporate these restrictions.

III. General description of the methodology

In order to assess probabilities of outcomes under various fiscal policy targets I perform a Monte Carlo experiment. I simulate a large number of artificial evolutions of the economy based on a dynamic econometric model containing key variables that are important for debt sustainability analysis. A detailed presentation of data and methodology are included in annexes I to IV. A summary of the steps is as follows:

(a) *Endogenous variables vector*. These are (i) the cyclical component of primary expenditures as a percentage of the long-term trend, and (ii) the logarithm of the real exchange rate (RER). Sample is annual data spanning the period 1965-2003. These variables incorporate the implicit assumption that the economy is in a balanced growth path and has a constant growth rate in the long term. (See annex I)

(b) *Data Calibration to a Vector Auto Regression (VAR) model*. Under this approach, the endogenous variables are treated as a two-tuple vector and are estimated jointly. As a result, it captures the equilibrium co-movement, persistence and cycle depth and length of endogenous variables as observed in historical data. (See annex II)

(c) *Specification of a Primary Government Expenditure Function*. I analyze three expenditure rules. First, a "historical rule", which is calibrated to historical behavior and incorporates parameters representative of inertia in government expenditure (as determined by past levels of expenditures), and pressures for spending (as determined by contemporary revenues). I show that this rule results in unsustainable fiscal outcomes. Second, I study an "actual balance" rule, that is, a situation in which a primary surplus target is achieved every year. This rule implies higher volatility of expenditures, but at the benefit of lower volatility of debt stock. Third, I analyze the case of a structural balance rule, which smoothes out cyclical revenues fluctuations at the cost of higher volatility of the debt stock. These policy rules are used to estimate deficits and the evolution of the stock of public debt based on simulated revenues and relative prices from the VAR model. (See annex III).

(d) *Monte Carlo experiment:* simulate a large number of sequences of variables in (a) using the model estimated in (b) (I perform 2000 simulations). The starting point is the state of the economy as of end 2004. The estimated model is then shocked every period under the assumption that deviations from expected values are normally distributed. The shocks are captured as deviations of real government revenues from the trend and cyclical RER fluctuations. (See annex IV).

(e) *Interest Payments:* Interest payments are computed on the basis of an exogenous assumption of international interest rates and sovereign spreads. The interest rate is applied to the end-of-previous-period stock of debt (See annex V).

(f) *Compute deficits and stock of debt.* Using the government expenditure rule, and the series for revenues and real exchange rates it is possible to compute the primary deficit in US dollars. Adding the interest payments as computed in (e) one obtains the total deficit. Assuming the share of government revenues to GDP remains constant, it is possible to obtain debt ratios as a share of GDP (Annex IV).

(g) Compute probability density functions of stochastic outcomes. The simulated evolutions of the Uruguayan economy in (d)-(f) are tabulated to obtain distributions of the stock of public debt as a share to GDP, for 1 to 20 year horizons (2005 to 2024).

These distributions enable to compute probabilities of the stock of public debt/GDP for various assumptions combinations. As mentioned, assumptions include long term international interest rates, sovereign spreads, currency denomination of public debt, and also long term GDP growth and primary surplus target.

IV. On the unsustainability of the "historical" public expenditure behavior

Calibrating an expenditure function to simulate historical behavior results in unsustainable public sector finances: public debt/GDP increases over time in expected terms. The rule proposed to capture historical behavior consists of an OLS estimate of primary expenditures at constant prices on a constant, the natural log of total revenues at constant prices and one lag of the natural log of primary expenditures[3].

The coefficient on revenues captures the degree to which expenditure is influenced by the availability of resources, and can be interpreted as representative of political economy factors influencing expenditures. The literature on pro-cyclical fiscal policy recognizes a series of arguments that give economic content to this proposition. Among them, one could mention special interests pressures for spending (Olson 1982, Talvi and Vegh 2000), finite

[3] The variables on the right-hand side are endogenous. Empirical tests can not reject the hypothesis of cointegration of real primary expenditure and real revenues series. However, the sample size is small to derive any strong statistical conclusion on this issue. Theoretical considerations would suggest that these two series are cointegrated. In that case, OLS estimates would provide super-consistent estimates.

decision horizon of political representatives (Alesina 1980, Roubini 1991), common pool problems in public sector spending (Chari and Cole 1995, Velazco 1998) and fragmented fiscal policies (Velazco 1998; Grilli, Masciandaro and Tabellini 1991; Gavin and Perotti 1997b).

The second coefficient of the historical primary expenditure equation, the lag of primary expenditures, captures the degree to which inertial forces (in particular social and political rigidities) affect expenditure decisions. For example, current expenditures are dominated by wages and pension payments, and are difficult to adjust downwards[4]. A second element is the preference of Uruguayans for the perceived security and protection brought about by public sector provision of basic services and of social insurance. This has been reflected in the past in strong reluctance of the population to accept privatization and other reforms aiming at promoting competitive behavior and efficiency. Capital expenditures can have an important inertial component as well, given the fact that public investment projects tend to be executed during various years.

Table 1: "Historical" Primary Expenditure Behavior in Uruguay

Dependent Variable: Natural logarithm of Government Primary Expenditures
Method: Ordinary Least Squares
Sample: 1973 to 2004

	Constant	Revenues (t)	Primary Exp. (t-1)
Coefficient	0.909896	0.500085	0.420347
t-statistic	1.369611	5.445281	4.162226

R-squared	0.900	Durbin-Watson stat.	2.145
Adj. R-squared	0.892	F-statistic	125.4
S.E. of regression	0.072	Prob (F-Statistic)	0.000

Notes:
Revenues(t) is the natural log of total government revenues at constant prices.
Primary Exp. (t-1) is the natutal log of primary expenditures at constant prices lagged one year

The coefficients of the historical rule are presented in table 1. Results in table 1 indicate that historically about 42% of the current expenditure level was historically determined by inertial forces, and about 50% by pressures for spending. Figure 4 displays actual and fitted estimate for the sample 1973-2003.

[4] Furthermore, according to Uruguayan law it is illegal to reduce them in nominal terms, and increases in pensions automatically translates to increases in public sector wages by law.

Figure 4: Predicted Primary Expenditures for the Historical Sample

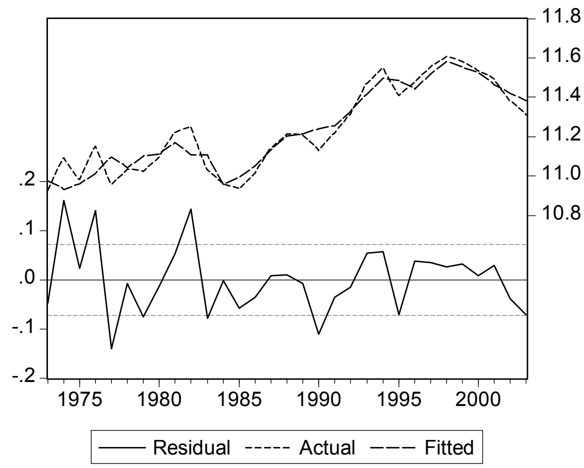


Table 2 presents the Monte-Carlo results if primary expenditures were to continue behaving as in the historical sample period, as predicted by the expenditure rule estimate of table 1. The table shows that debt ratios would grow in expected terms. The exercise predicts that the probability of debt ratios remaining below end-2004 levels after ten years is of about 50%. Moreover, it also predicts that the probability of debt declining to levels that could be expected to be consistent with fluent access to financial markets at reasonable interest rates is near zero. Notice also in Table 2 that the expected primary surplus would be of about 2.9% of GDP if expenditures continued to behave according to historical patterns, starting from the current position. In this case, the surplus is obtained as an endogenous result given other parameters used in the simulations and the expenditure rule, and is not set exogenously as a target.

Table 2: Debt Sustainability with "Historical" Primary Expenditure Pattern of Spending

Assumptions	
Fiscal Rule	Historical
Long-Term Growth, annual % rate	2.1
Spread, basis points	500
Share Public Debt in Dom. Currency	0.0
Target Primary, % of GDP	2.9

Public Debt Dynamics

	After 5 y.	After 10 y.	After 15 y.	After 20 y.
Expected Public Debt/GDP Ratio	84.7	100.7	123.1	142.5
Standard Deviation	20.9	29.6	44.9	50.9
Probability Debt Ratio < 40% of GDP	0.00	0.00	0.00	0.00
Probability Debt Ratio < 60% of GDP	0.10	0.03	0.06	0.01
Probability Debt Ratio < 80% of GDP	0.50	0.30	0.13	0.12
Probability Debt Ratio < 100% of GDP	0.76	0.52	0.39	0.19
Probability Debt Ratio < 120% of GDP	0.93	0.73	0.56	0.36
Probability Debt Ratio < 140% of GDP	1.00	0.86	0.68	0.54

The second and perhaps most important observation from table 2 is that the probabilities of debt remaining below each threshold level decline over time. The implication is that if primary expenditures follow the pattern observed historically, then the exercise predicts a trend towards systematic deterioration of the public sector financial position. Notice that this is true even for those cases in which "good luck", that is, positive shocks, prevails, as can be deducted from the debt/GDP paths that remain at relatively low levels.

This implies that a one-time expenditure adjustment would not guarantee long term sustainability if fundamental forces and incentives affecting the decision process of government expenditure do not improve, in the sense of eliminating the deficit bias and ensuring long-term sustainability. It is clear that such forces, captured here very generally as inertial and political pressures for spending, could be difficult to modify, at least in the short and medium term. However, as implied by the budget constraint identity, the costs of such behavior could be anticipated to be periodical one-time adjustments in expenditures that forces debt out of an unsustainable path, typically through devaluation/inflation. The resulting volatile and pro-cyclical expenditure path would clearly be welfare-inferior to fundamental and institutional alternatives that could yield an inter-temporally smoother expenditure pattern.

V. Fiscal prudence as a source of macroeconomic stability and growth

The previous section led to the conclusion that a continuation of the fiscal behavior observed in the past could be anticipated to bring debt sustainability problems. In this section I will assume that the expenditure rule changes so that a certain primary balance target is achieved every year. This implies a degree of flexibility in fiscal management that exceeds historical standards. I will refer to this primary expenditure assumption as the "Actual Balance" rule. Table 3 summarizes the Monte Carlo simulation results for such rule for a set of assumptions considered a benchmark case: long term growth at 2.1% per year (average annual growth for the sample period 1965-2004), primary surplus target at 4.0% of GDP and sovereign spread at 500 basis points.

Table 3: Debt Sustainability under Uncertainty
Benchmark Case

Assumptions	
Fiscal Rule	Actual Bal.
Long-Term Growth, annual % rate	2.1
Spread, basis points	500
Share Public Debt in Dom. Currency	0.0
Target Primary, % of GDP	4.0

Public Debt Dynamics

	After 5 y.	After 10 y.	After 15 y.	After 20 y.
Expected Public Debt/GDP Ratio	75.3	74.9	76.1	72.9
Standard Deviation	18.4	24.2	33.0	36.1
Probability Debt Ratio < 40% of GDP	0.00	0.03	0.09	0.17
Probability Debt Ratio < 60% of GDP	0.22	0.33	0.36	0.38
Probability Debt Ratio < 80% of GDP	0.67	0.59	0.59	0.63
Probability Debt Ratio < 100% of GDP	0.88	0.82	0.79	0.78
Probability Debt Ratio < 120% of GDP	0.99	0.97	0.88	0.90
Probability Debt Ratio < 140% of GDP	1.00	1.00	0.94	0.97

The table shows that under these assumptions the model predicts that the public debt/GDP ratio would gradually decline. Debt/GDP declines in expected terms from 92% as of end 2004 to 75% in 5 years, remaining roughly constant at that level thereafter in expectation. This means that the simulation predicts that public debt would be sustainable in expected terms. However, the exercise also shows that uncertainty and the possibility of negative shocks along the way could result in debt ratios that are larger than those observed today with roughly a 10% probability under these assumptions and fiscal targets.

An important factor to highlight is that a debt ratio at 92% of GDP can be considered "too high", in the sense that it may deteriorate prospects of access to financial markets at low interest rates, and also would make it unlikely recover the investment grade note. Furthermore, the possibility of loosing access to financial markets as in 2002 sometime in the future (especially during recessions, see Gavin and Perotti 1997b) should not be understated. High debt ratios can therefore be associated with lower investment levels, higher volatility and lower growth. Simulation results predict that the probability of debt ratio being below 60% of GDP after 10 years is only 33% in the benchmark case, and below 40% of GDP the probability is only 3%.

The results above leaves the reader wondering what would be the expected benefits in terms of reducing the debt ratio at a faster pace if a more aggressive fiscal policy target were pursued, that is, if the primary balance target is set at a higher level. Table 4 shows such results for the case in which the primary balance is set at 5% of GDP. At that surplus the debt ratio would be at 62% of GDP in expected terms after 10 years. Moreover, such fiscal target would bring debt ratios to under 60% of GDP with 77% probability after 10 years, and to under 40% of GDP with 20% probability. Predicted longer term declines in debt/GDP are larger. In 20 years debt ratios would be under 40% of GDP with a probability of 57%.

Table 4: Sensitivity to Alternative Primary Surplus Targets

GDP growth assumption	2.1						2.1					
Primary Surplus/GDP	3.0						5.0					
Sovereign Spread	500						500					
	Expected		Prob. Debt/GDP <				Expected		Prob. Debt/GDP <			
	Debt/GDP	Std. Dev.	100%	80%	60%	40%	Debt/GDP	Std. Dev.	100%	80%	60%	40%
After 5 years	80.6	19.0	0.81	0.56	0.12	0.00	69.9	17.9	0.93	0.73	0.31	0.02
After 10 years	87.5	25.7	0.69	0.45	0.13	0.01	62.3	22.9	0.95	0.77	0.49	0.19
After 15 years	98.9	36.9	0.59	0.37	0.10	0.02	53.3	29.9	0.91	0.80	0.65	0.36
After 20 years	108.0	40.7	0.48	0.24	0.10	0.01	37.7	33.3	0.96	0.89	0.77	0.57

On the other hand, if primary surpluses are set at 3% of GDP debt becomes unsustainable with high probability, with debt ratios increasing over time in expected terms. In particular, notice that this primary surplus target would be a risky strategy according to simulation results. The simulations show that debt ratios increase in expected terms. However, about 10% of the simulation results appear to remain below 60% in the long term. In other words, a 3% primary surplus would result in debt remaining in a sustainable path with a 10% probability.

If a faster decline in debt to GDP ratio brings about a reduction in instability from uncertainty about public sector financial sustainability and reduces spreads, investment and growth could be higher. Table 5 shows that if growth is 3% in the long term, then expected debt ratios decline to 66% after 10 years, and the probability of debt remaining below 40% of GDP in the long term roughly doubles.

Table 5: Sensitivity to Long-term GDP Growth

GDP growth assumption	1.0						3.0					
Primary Surplus/GDP	4.0						4.0					
Sovereign Spread	500						500					
	Expected		Prob. Debt/GDP <				Expected		Prob. Debt/GDP <			
	Debt/GDP	Std. Dev.	100%	80%	60%	40%	Debt/GDP	Std. Dev.	100%	80%	60%	40%
After 5 years	80.2	19.5	0.82	0.56	0.13	0.00	71.5	17.6	0.92	0.70	0.26	0.00
After 10 years	86.5	27.2	0.70	0.45	0.20	0.01	66.4	22.1	0.92	0.75	0.43	0.10
After 15 years	97.4	39.7	0.59	0.41	0.12	0.04	61.5	28.4	0.88	0.77	0.55	0.28
After 20 years	106.2	46.1	0.50	0.30	0.15	0.03	51.4	29.7	0.94	0.82	0.68	0.37

The results are very sensitive to changes in interest rates. Table 6 shows that a decline in sovereign spreads to 300 basis points, that is, to investment grade levels, reduces the debt ratio to 58% of GDP in expected terms after 10 years, and to 32% after 20 years. The probability of debt converging to levels below 40% of GDP in ten years increases from 3% to 22%.

On the other hand, if debt ratios remain high and as a result the economy has no choice but to access markets at higher interest rates, debt would become unsustainable in expected terms. The implicit interest rate on Uruguay's public debt is currently of about 5% in US$. According to the simulation results, if spreads are set to 700 basis points, ratios would grow in expected terms. Although only marginal debt would be affected by a higher interest spread (and not the entire stock of debt as in the simulation exercise), the result is still illustrative of the potential need for a more prudent fiscal stance if interest rates were to increase.

Table 6: Sensitivity to Changes in Interest Rates

GDP growth assumption	2.1						2.1					
Primary Surplus/GDP	4.0						4.0					
Sovereign Spread	300						700					
	Expected		Prob. Debt/GDP <				Expected		Prob. Debt/GDP <			
	Debt/GDP	Std. Dev.	100%	80%	60%	40%	Debt/GDP	Std. Dev.	100%	80%	60%	40%
After 5 years	67.4	16.7	0.95	0.76	0.38	0.03	109.7	26.6	0.76	0.51	0.10	0.00
After 10 years	57.7	19.8	0.97	0.83	0.56	0.22	111.9	34.7	0.57	0.36	0.10	0.01
After 15 years	47.2	23.9	0.95	0.89	0.74	0.41	131.8	52.7	0.44	0.23	0.08	0.00
After 20 years	31.7	23.9	0.99	0.98	0.89	0.67	154.5	64.2	0.25	0.15	0.06	0.01

VI. Costs and Benefits of a Structural Balance rule

Section II showed that fiscal policy in Uruguay has been pro-cyclical. This pattern is sub-optimal according to core economic theories of optimal fiscal policy management. Keynesian theories of business cycles based on nominal rigidities are generally favorable to a counter-cyclical fiscal policy stance, so as to smooth costly economic fluctuations. On the other hand, neoclassical theories of business cycles in general postulate that fiscal policy should be independent of cyclical considerations[5].

Various authors have recently argued that this pattern can be a reason exacerbating macroeconomic volatility[6]. The government increases demand during booms, when demand is already high, and reduces demand during recessions, contributing to the economic slowdown. At the same time, history reveals that Uruguay had difficulties to keep its public sector finances under control, as shown above.

Financial markets' behavior has also been argued to be a candidate explanation of pro-cyclical fiscal policies. Aizenman, Gavin and Haussman (1996) and Gavin, Haussman, Perotti and Talvi (1996) argue that lending tends to be pro-cyclical: investors are willing to lend during booms, but not during recessions. As these authors explain, this could result in pro-cyclical fiscal policy simply because there is no way of financing deficits during recessions. If one recognizes this constraint emanating from financial markets' behavior, then some mechanisms should be set in place to minimize the associated costs and risks. In particular, avoiding large degrees of indebtedness could minimize the risk of loosing access to financing during recessions. Recovering the investment grade status would provide access to a much liquid and broader supply of funds at lower costs. In addition, during a transition, the country could consider a self-insurance mechanism, saving during booms to finance transitory social spending during recessions.

A candidate solution to address these difficulties and reduce their associated welfare costs could be to adopt a structural balance rule for public sector spending. These rules ensure primary expenditures are smoothed-out along the cycle, avoiding disrupting social and political tensions. At the same time, they ensure public sector solvency as expenditures target a cyclically-adjusted primary surplus balance that is consistent with debt sustainability. Table 7 shows the results of the Monte Carlo experiment for the case of such a rule. In the results of the table it is assumed that the government estimates the position of the trend of its revenues and then sets a primary expenditure level to target a given primary surplus relative to the position of the revenue trend, instead of actual revenues (see annex III). This enables the government to run deficits during recessions, which are compensated with surpluses during booms, while primary balances remain at the long-term structural target level.

As table 7 shows, under a structural balance expenditure rule, expected debt ratios converge to debt ratios that are about 5 percentage points lower than those of the benchmark case in a 5 and 10 year period. In addition, the structural balance can be argued to be superior in terms of welfare, as the expenditure pattern is smoother by construction. However, this rule presents a downside. Debt ratios are more volatile: the standard deviation of the debt ratio after ten years is 35%, while that of the benchmark case was 24%. After 20 years, the standard deviation is 50%, while that of the benchmark case is of about 36%. A more volatile debt ratio implies that it is more likely that the government may face financial difficulties down the road, in terms of exhibiting "too large" debt ratios. For example, under

[5] See Barro (1979), Lucas and Stockey (1983).
[6] See for example Gavin, Haussman Perotti and Talvi (1996), Perri (2002).

a structural balance rule, the probability of debt ratios being larger than 80% of GDP after 10 years is 35%, while under the benchmark case it was 40%.

Volatility of debt ratios could be a source of endogenous volatility in the economy. High debt ratios have been shown to be associated with high spreads and, in extreme cases, with loss of access to financing[7]. Because expenditure smoothing requires access to markets, a structural balance rule may not be achievable given the way financial markets work. The possibility of Uruguay entering in recurrent financing crisis could be a source of volatility as much as (possibly more than) a pro-cyclical fiscal policy.

This argument is particularly relevant for the case of Uruguay because the debt ratio is at a high level, as mentioned above. A reasonable possibility in order to reduce volatility could be to target a decline in debt ratios at an initial stage, sacrificing expenditure smoothing if necessary, and gradually transition to a structural balance rule as debt ratios are lower and marginal increases in debt are unlikely to produce financing difficulties.

Table 7: Debt Sustainability under a Structural Balance Expenditure Rule

Assumptions	
Fiscal Rule	Structural Bal.
Long-Term Growth, annual % rate	2.1
Spread, basis points	500
Share Public Debt in Dom. Currency	0.0
Target Primary, % of GDP	4.0

Public Debt Dynamics

	After 5 y.	After 10 y.	After 15 y.	After 20 y.
Expected Public Debt/GDP Ratio	73.6	70.4	68.9	61.6
Standard Deviation	23.3	34.6	49.6	60.1
Probability Debt Ratio < 40% of GDP	0.05	0.22	0.34	0.38
Probability Debt Ratio < 60% of GDP	0.33	0.40	0.48	0.52
Probability Debt Ratio < 80% of GDP	0.67	0.65	0.62	0.67
Probability Debt Ratio < 100% of GDP	0.86	0.79	0.76	0.74
Probability Debt Ratio < 120% of GDP	0.96	0.91	0.86	0.85
Probability Debt Ratio < 140% of GDP	1.00	0.97	0.91	0.87

VII. Debt Management under Uncertainty: The Role of Indexed Pubic Debt in Domestic Currency

Given the fact that almost all Uruguayan public debt is denominated in foreign currency, the financial position of Uruguay appears to be highly vulnerable to real exchange rate fluctuations. If, as shown in the empirical literature referred above, debt ratios are key determinants of sovereign creditworthiness, then it is possible that a reduction of the share

[7] Debt ratios have been shown to be highly significant and robust in regressions on the determination of sovereign spreads. See Edwards (1983), Portes (1985), Cline and Barns (1997), Eichengreen and Mody (1998), Min (1998), Detragiache and Spilimbergo (2001), Catao and Sutton (2002).

of public debt that is denominated in foreign currency could bring about an improvement in debt sustainability prospects.

Table 8 presents simulation results for the case in which 50% of public debt is denominated in domestic currency. The share of domestic currency debt was set arbitrarily at that level for illustrative purposes. The table provides two key conclusions. First, debt ratios converge to higher levels in expected terms than those obtained under a "dollarized" public debt, all other assumptions constant. This is because the estimated dynamic model predicts a real exchange rate appreciation from the level of end 2004. This is not surprising, given the strong currency depreciation in 2002 and 2003. For example, if 50% of debt were swapped for domestic currency instruments, the decline in the debt /GDP ratio brought about by the predicted real exchange rate appreciation would be partially lost. Second, the volatility of the debt ratio declines significantly compared to that of the benchmark case. For example, the standard deviation of the debt ratio after 10 years declines from 24% to 16%, and after 20 years from 36% to 22%.

Table 8: Debt Sustainability and Currency Denomination of Debt

Assumptions	
Fiscal Rule	Actual Bal.
Long-Term Growth, annual % rate	2.1
Spread, basis points	500
Share Public Debt in Dom. Currency	0.5
Target Primary, % of GDP	4.0

Public Debt Dynamics

	After 5 y.	After 10 y.	After 15 y.	After 20 y.
Expected Public Debt/GDP Ratio	77.7	77.5	78.5	76.4
Standard Deviation	12.9	15.7	20.6	21.8
Probability Debt Ratio < 40% of GDP	0.00	0.01	0.02	0.03
Probability Debt Ratio < 60% of GDP	0.08	0.14	0.14	0.22
Probability Debt Ratio < 80% of GDP	0.61	0.54	0.58	0.60
Probability Debt Ratio < 100% of GDP	0.94	0.92	0.84	0.83
Probability Debt Ratio < 120% of GDP	1.00	1.00	0.97	0.98
Probability Debt Ratio < 140% of GDP	1.00	1.00	1.00	0.99

In the exercise above it is assumed that the interest spread is the same as in the benchmark case. However, it is possible that debt denominated in domestic currency would have a higher interest spread in equilibrium than foreign-currency denominated debt. Some candidate arguments supporting this proposition are (1) risk aversion of debt holders, who would now face exchange rate uncertainty, (2) a reduced market and less liquidity for instruments not denominated in a mainstream trading currency, (3) higher monitoring and valuation costs of such assets, (4) time inconsistency of monetary policy, given that non-anticipated money shocks would reduce the ex-post dollar-denominated return on domestic currency debt. On the other hand, these forces should be weighted against a possible reduction in spreads resulting from lower volatility in debt ratios, as argued above. Assuming the net effect of these forces is an increase in the spread, it could be interesting to analyze what is the effect of, say, a 100 basis points average increase in the spread (given that it is assumed 50% of debt is denominated in domestic currency, this would be equivalent to a 200 basis points excess spreads of peso-denominated bonds). The results are presented in Table 9.

The increase in spreads proposed in the table does not yield favorable results. Debt ratios grow over time in expected terms, implying that a larger fiscal effort would be required for sustainability, assuming other assumptions remain the same. In addition, it is unlikely that debt would gradually converge downwards. For example, the probability that debt stock would be higher than 80% of GDP after 10 years is 0.64.

Table 9: Domestic Currency Debt and Increase in Average Spread

Assumptions				
Fiscal Rule	Actual Bal.			
Long-Term Growth, annual % rate	2.1			
Spread, basis points	600			
Share Public Debt in Dom. Currency	0.5			
Target Primary, % of GDP	4.0			

Public Debt Dynamics	After 5 y.	After 10 y.	After 15 y.	After 20 y.
Expected Public Debt/GDP Ratio	82.0	87.6	96.7	104.7
Standard Deviation	13.5	17.4	24.2	26.9
Probability Debt Ratio < 40% of GDP	0.00	0.00	0.00	0.00
Probability Debt Ratio < 60% of GDP	0.05	0.03	0.06	0.03
Probability Debt Ratio < 80% of GDP	0.51	0.36	0.25	0.17
Probability Debt Ratio < 100% of GDP	0.88	0.74	0.58	0.46
Probability Debt Ratio < 120% of GDP	1.00	0.95	0.84	0.74
Probability Debt Ratio < 140% of GDP	1.00	1.00	0.94	0.90

On the other hand, if the net effect of the forces explained above of a conversion to pesos of a share of public debt were a reduction on the spread, then it would be in a win-win situation: volatility of debt ratios would be lower and interest costs (and as a result long term expected debt ratios) would be smaller as well. However, one should remain skeptical about this possibility, as currency spreads tend to be positive in financial markets.

VIII. Debt-Equity Swap and Structural Balance Rule

The exercises above show that the fiscal effort required to attain long term financial sustainability can be very large, in the sense that primary surpluses that were not observed in (at least) Uruguay's last 40 year of fiscal history would be required. In addition, success in terms of bringing debt ratios down to more manageable levels is not assured if negative shocks were to accumulate down the road. In addition, a degree of flexibility to adjust expenditures downward during recessions that has not been observed in the past seem to be required to improve sustainability prospects with fairly high probabilities. A politically and socially more friendly structural balance rule may not be attainable given the high current debt/GDP ratio and higher debt volatility of this rule, which could make it difficult to access financial markets in low states of nature, unless the rule were to include savings target for the purpose of debt reduction.

These considerations make it interesting to consider an alternative strategy to reduce debt in the short term, different from simply achieving large primary surpluses. The Uruguayan government could significantly reduce the amount of debt by swapping shares of ownership participation in public enterprises in exchange for public bonds. A lower starting point in debt would make required surpluses less spectacular, and also could make the adoption of a structural balance rule more realistic.

To illustrate and quantify this possibility, I performed a Monte-Carlo experiment for the case in which public debt is reduced 30% through a debt-equity swap. It is assumed that the Government adopts a structural balance rule starting in 2005. The primary surplus is calculated endogenously, so that debt ratios converge to 50% of GDP in expected terms in 10 years. Given that public enterprises contribute with about 10% of revenues through operating surpluses, revenues are also reduced proportionately in the exercise. The results are presented in Table 10.

Table 10: Debt-Equity Swap and Structural Balance Expenditure Rule

Assumptions	
Fiscal Rule	Structural Bal.
Long-Term Growth, annual % rate	2.1
Spread, basis points	500
Share Public Debt in Dom. Currency	0.0
Target Primary, % of GDP	2.8

Public Debt Dynamics

	After 5 y.	After 10 y.	After 15 y.	After 20 y.
Expected Public Debt/GDP Ratio	52.8	50.0	48.4	42.4
Standard Deviation	18.5	28.6	41.8	51.7
Probability Debt Ratio < 40% of GDP	0.26	0.39	0.49	0.51
Probability Debt Ratio < 60% of GDP	0.70	0.66	0.63	0.68
Probability Debt Ratio < 80% of GDP	0.91	0.83	0.78	0.76
Probability Debt Ratio < 100% of GDP	0.99	0.97	0.90	0.87
Probability Debt Ratio < 120% of GDP	1.00	0.99	0.92	0.92
Probability Debt Ratio < 140% of GDP	1.00	1.00	0.96	0.98

Simulation exercises show that in order to bring debt to about 50% in 10 years in expected terms, structural primary surplus of 2.8% would still be required, even after the debt swap mentioned (which would bring the debt/GDP ratio to 64% of GDP).

This alternative could be politically and socially viable, as it does not require a fiscal adjustment in expenditures from current levels. This is because of the strong currency depreciation accumulated since the beginning of 2002 was not accompanied by an increase in nominal expenditures to the same extent, and implied a strong adjustment in expenditures both measured in US$ dollars and in real terms. Notice that the same exercise without the debt swap would require a structural primary surplus of about 5.6% of GDP. Such target would imply a downward adjustment in real primary expenditures from current levels of about 9%.

IX. Conclusions

This paper shows that deep institutional reforms for the management of public sector finances could result in important welfare gains for Uruguay. The analysis shows that a continuation of Uruguay's historical expenditure behavior would be sub-optimal and unsustainable. Primary expenditures have been pro-cyclical, exacerbating economic fluctuations, and have also been dynamically unsustainable, expressed in a marked deficit bias, persistent high inflation, periodic and large currency devaluations and episodes of public debt default/restructuring.

The simulation exercises of this paper suggest that maintaining Government's primary surplus targets above 4% of GDP could be important to ensure debt sustainability and to minimize economic volatility. However, a more aggressive primary surplus target in the medium term could be a sound policy. It would enable to reduce the debt ratio to more manageable levels which would make it more likely to access to financial markets at reasonable interest rates. Simulation exercises show that the potential gains from recovering the investment grade note could be very important in terms of reducing the fiscal effort required to service debt in the long term.

The problem with the objective of achieving a certain primary surplus target every year, as suggested in the paragraph above, is that it may not be politically and socially feasible. This is because it may imply downward adjustments in government expenditures during recessions. Of course, such policy would not be optimal, as would also imply a high level of expenditure volatility. The adoption of a structural-balance primary expenditure rule would address this issue while at the same time would ensure long-term financial sustainability. The limitation of this proposal, however, is that, as simulation exercises show, it implies a larger volatility of debt, as debt is used to cushion transitory fluctuations in fiscal revenues. This was argued to be potentially costly given that high debt ratios could affect access to financial markets at reasonable interest rates, and may not be viable.

The main problem of a structural balance proposal is that the stock of debt is at a very high level as a share of GDP. A candidate policy analyzed in this paper shows that this issue could be overcome if the Government were to instrument a debt-equity swap, that is, if it were to exchange shares of public enterprises for public bonds. Simulation results show that if such operation were to reduce the stock of public debt by 30%, then the economy could adopt immediately a structural balance rule targeting a structural primary surplus of less than 3% of GDP, which would not require a downward adjustment in real primary expenditures from current levels and would bring debt ratios to about 50% of GDP in expected terms by 2014.

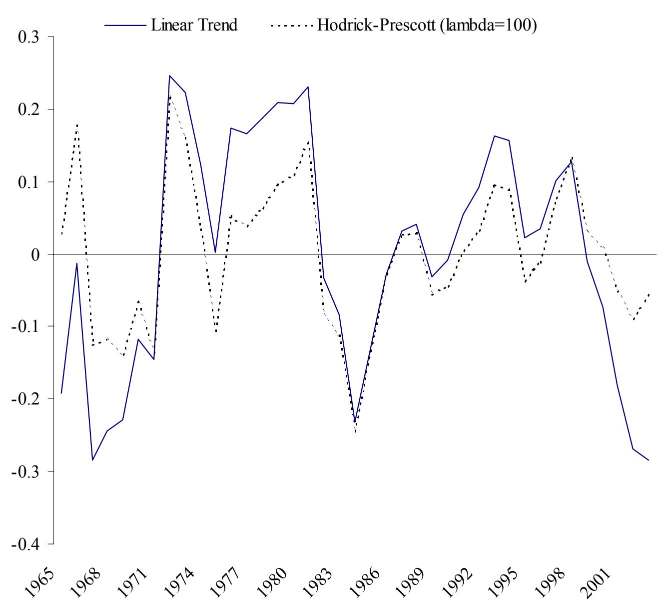
Annex I. *Endogenous Variables Vector in VAR*

Assume the government receives a stochastic sequence of real revenues $\{Y_t\}_{t=0}^{T}$, where sub-index t denotes years, $t \in [0;T]$. Real revenues are assumed to grow at a constant rate γ in the long run. Under this assumption, it is possible to estimate the long term trend of revenues by estimating the OLS relation between the logarithm of real revenues on a constant and a time trend. The exponential of the fitted value of this regression is the estimated trend. Denoting by $\bar{y}_t$ the estimated position of the trend at time *t* in logarithms, we can construct the series of real government revenues expressed as deviations from the revenue trend, y_t, by computing

$$y_t \equiv \log(Y_t) - \bar{y}_t \qquad \text{(A1.1)}$$

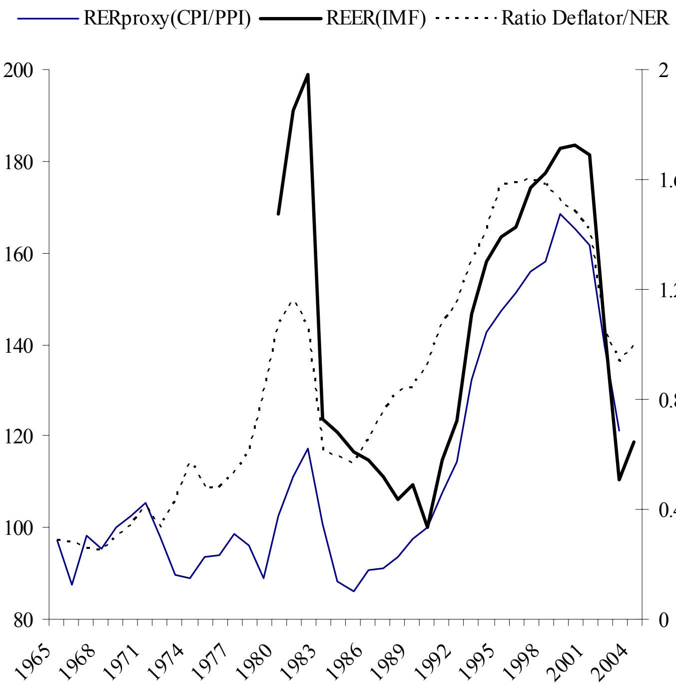
This is the first variable used in the VAR estimates. It takes values that are positive during periods of revenues' boom, and negative during lows. Notice also that calculated in this way the fluctuations around the trend are stationary, as they are expressed in units of the position of the trend. Figure A1.1 below depicts this series for the sample period 1965-2003. This measure is important in the results of the exercise as it determines the estimated magnitudes of the business cycles of revenues. For comparative purposes the figure also presents the Hodrick-Prescott (HP) filtered revenues expressed as deviations from the HP trend.

Figure A1.1. Revenues / Revenue Trend



The second variable included in the VAR estimate is a measure of the real exchange rate (RER). The proxy used was the ratio of the GDP deflator and the nominal exchange rate. Figure A1.2 shows the RER measure used in the exercise, along with other proxies usually presented for comparative purposes. The other two measures presented are the real effective exchange rate index that is produced by the IMF, which is a trade-weighted average of traded goods' prices, and the ratio of consumer to producer prices.

Figure A1.2. Real Exchange Rate Measures
(1990 = 100, 1965 – 2004)



Annex II. *Calibration to a VAR(2)*

Real revenues as deviations from the revenue trend and the real exchange rate proxy (GDP deflator / nominal exchange rate) were used to estimate a Vector Auto-regression model for the Uruguayan Economy. This model would capture the volatility of revenues around the trend, and also the historically-consistent cyclical fluctuations of the real exchange rate. This last measure is important in order to capture the effect of fluctuations in relative prices on the Debt/GDP ratio, given the fact that 99% of debt is denominated in foreign currency.

Table A1. Data Calibration to a VAR(2)

Sample(adjusted): 1967 2003

Included observations: 37 after adjusting endpoints

t-statistics in second row

	Log RER (t-1)	Log RER (t-2)	Rev/Trend (t-1)	Rev/Trend (t-2)	Constant	Outliers	R-sq.	Adj. R-sq	F-statistic
Log RER	1.045	-0.147	0.551	-0.288	0.023	-0.252	0.960	0.953	147.578
	[7.07211]	[-1.08439]	[2.84654]	[-1.32114]	[1.02649]	[-3.14346]			
Rev/Trend	0.288	-0.274	0.880	-0.283	-0.027	0.227	0.701	0.652	14.518
	[2.46039]	[-2.54623]	[5.73058]	[-1.63968]	[-1.49073]	[3.57433]			

Table A1 shows the VAR estimate. Notice that two lags for each of the two endogenous variables was included, following the Akaike information criterion. However, the small sample size does not allow us to consider the results below as a true estimation, but rather as a "calibration". Notice also the inclusion of a dummy to control for outliers in the series, with a value of 1 in years in which prediction errors were larger than two standard deviations of residuals, and 0 otherwise. This allowed to improve the predictive power of the estimation.

Annex III. *Primary Expenditure Rules*

The "historical" primary expenditure rule" was presented in the text. The "actual balance" rule is calculated according to the equation

$$G_t = \theta Y_t \qquad \text{(A3.1)}$$

where G_t denotes real primary expenditures as of year *t*. The parameter θ is calibrated through iteration to obtain a primary surplus balance of a given target size in expected terms. Notice that since real revenues are stochastic, primary expenditures are also stochastic under this specification, as they accommodate revenues to obtain the primary balance surplus targeted every period.

The "structural balance" expenditure rule is calculated according to the equation

$$G_t = \alpha \mathrm{T}_t \qquad \text{(A.3.2)}$$

where the parameter α is a scale parameter that captures the gap from the revenue trend. Given that the trend is assumed to be deterministic, with initial value as determined by the end-point of the estimated sample trend of real revenues, primary expenditures are also deterministic and smooth. This implies that the observed primary surplus may differ from the structural, and the surplus is therefore stochastic.

Annex IV. *Monte Carlo Experiment*

Consider the vector of endogenous variables $x_t' = [y_t; q_t]$, where y_t is real valued government revenues as deviations from the revenue trend and q_t denotes the real exchange rate index. The procedure followed to perform the simulations (for a VAR(1) for illustrative purposes) is as follows:

1. Calibrate the endogenous variables' vector to a VAR in standard form, by estimating the relation

$$x_t = A_0 + A_1 x_{t-1} + e_t \qquad \text{(A4.1)}$$

Notice that the estimation of (A4.1) required the imposition of some identification assumption. Following Sims (1980), it is assumed that the contemporaneous feedback on one of the endogenous variables on the other is equal to zero. This implies a triangular decomposition of the Variance-covariance matrix of the residuals (Cholesky decomposition).

2. Generate N sequences of T random realizations of N(0,1) errors. N is the number of repetitions of the experiment and T is the length of the simulation horizon.

3. Estimate the structural factorization matrix. The relation between the residuals of the estimated VAR in standard form (denominated e_t) and the residuals of the VAR in primitive form (denominated u_t, with $E[u_t u'_t] = I$) can be represented by

$$Ae_t = Bu_t .$$

where *B* is the matrix of coefficients of contemporaneous relations in the structural VAR. The estimated coefficient values of *A* and *B* shown in Table A4.1. Notice that the coefficient that captures the contemporaneous co-movement between the real exchange rate and revenues/trend (C(2)) is statistically significant.

Table A4.1. Structural Factorization Matrix

	Coefficient	Std. Error	z-Statistic	Prob.
C(2)	0.4982	0.1014	4.9112	0.0000
C(1)	0.1208	0.0140	8.6023	0.0000
C(3)	0.0745	0.0087	8.6023	0.0000
Log likelihood	67.89921			

Estimated A matrix:		Estimated B matrix:	
1.0000	0.0000	0.1208	0.0000
-0.4982	1.0000	0.0000	0.0745

This implies that the relation between the error terms of the estimated VAR and those of the VAR in structural form is given by

$$e_{qt} = C(1)u_{qt}$$
$$e_{yt} = C(2)e_{qt} + C(3)u_{yt}$$

where sub-index *q* represents the error term corresponding to the real exchange rate equation and *y* the error term of the revenue/trend equation.

4. Recover the error terms of the VAR in primitive or structural form u_t using the estimated structural factorization matrix, that is, calculate

$$\hat{e}_t = \hat{A}^{-1}\hat{B}\hat{u}_t$$

This operation gives the simulated disturbances of the VAR estimate.

5. Use the NxT simulated disturbances to generate N sequences of length T of each of the endogenous variables in x_t by computing

$$x_t = \hat{A}_0 + \hat{A}_1 x_{t-1} + \hat{e}_t$$

with initial values x_{-1} known, as given by end-of-sample values.

6. Tabulate the resulting simulated sequences of real exchange rate and revenues as deviations from the revenue trend. These values can be used to infer the evolution of stock

of debt at different time horizons for given behavior assumptions on government expenditures.

7. Compute simulated real-valued revenues

$$Y_t = (1 + y_t)T_t$$

where T_t is the revenue trend in year *t*.

8. Compute real-valued primary expenditures G_t using one of the expenditure rules proposed in annex III (or any other rule of interest).

9. Compute revenues and primary expenditures in current US$

$$\Upsilon_t = \frac{Y_t}{\varepsilon_0}\frac{q_t}{q_0}; \qquad \Gamma_t = \frac{G_t}{\varepsilon_0}\frac{q_t}{q_0}$$

The increase of the real exchange rate from its initial position indicates the excess of inflation in the GDP deflator over the rate of nominal depreciation. In this way, if for example domestic inflation is higher than the nominal exchange rate depreciation the dollar-valued government revenues would increase even if real revenues remain constant. With these values then compute the primary surplus in US$, $\Sigma_t = \Upsilon_t - \Gamma_t$.

10. Compute interest payments and the sequence of debt stock recursively. Start with the stock of debt as of end of sample (in our case, end of 2003), Δ_{-1}. Make an exogenous assumption on sequences of international interest rate and interest spreads on debt, $\{r_t; s_t\}_{t=0}^{T}$. Then compute the interest payments as of year *0* in the simulated sample, $(r_0 + s_0)\Delta_{-1}$. With this interest payments plus the primary surplus as of simulated year *0* compute the stock of debt as of end of simulated year *0* in US$,

$$\Delta_0 = (1 + r_0 + s_0)\Delta_{-1} - \Sigma_0$$

Proceeding in this way for subsequent periods it is possible to compute the entire sequence of debt in US$ for *t=0,1,…*T. Notice that the assumed interest rate on debt is the implicit interest rate and not the marginal interest rate.

11. To compute variables as a share of GDP, assume that real GDP is proportional to real revenues. This is equivalent to assuming that nominal revenues are proportional to nominal GDP, and that the price component of the two measures is the same. Let μ denote the scale parameter denoting revenues/GDP. Then, the public debt/GDP ratio, δ_t, and the primary surplus/GDP ratio, σ_t, would be given by

$$\delta_t = \mu\frac{\Delta_t}{\Upsilon_t} \quad ; \quad \sigma_t = \mu\frac{\Sigma_t}{\Upsilon_t}$$

12. The simulations performed as specified up to (11) assume that 100% of debt is denominated in US$ dollars or, more generally, that it is denominated in foreign currency and the exchange rates among international currencies remain stable. To analyze the evolution of the economy if a share of debt is denominated in domestic currency, the equations for dollar values revenues and expenditures in US$ are modified to

$$\Upsilon_t = \frac{Y_t}{\varepsilon_0}\left[\frac{q_t}{q_0}(1-\eta)+\eta\right]; \qquad \Gamma_t = \frac{G_t}{\varepsilon_0}\left[\frac{q_t}{q_0}(1-\eta)+\eta\right]$$

where ε_0 is the nominal exchange rate as of end of sample and η is the share of public debt denominated in foreign currency.

Annex V

- Government revenues and expenditures at current prices are from the International Financial Statistics (IFS) publication by the International Monetary Fund (IMF) up to 2001. Primary expenditures are from the Government Financial Statistics publication (GFS) also by the IMF. 2002-2004 figures were estimated using nominal growth rates of the Central Government fiscal statistics published by the Central Bank of Uruguay. The specific lines are: total revenues: 81…ZF; total expenditures: 82…ZF. Primary expenditures series were constructed as current revenues minus interests plus capital expenditures. These include budgetary and extra-budgetary operations and social security expenditures.

- Nominal exchange rates and the inflation series are also from IFS. All other data is from the Central Bank of Uruguay.

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