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Abstract

Recent empirical research on emerging markets debt, currency crises and fiscal sustainability has placed a significant focus on the role of currency mismatches with the emphasis placed on the currency composition of explicit government liabilities. The key insight of this paper is that these liabilities, while relevant, usually represent a small share of actual government liabilities: indeed, as an indicator of fiscal solvency, they are relatively uninformative – and possibly misleading – if not matched with the remaining liabilities (promises of wage and pension payments among others) and the asset side of the government's balance sheet: financial and real government assets as well as the present value of future tax collection. These non-debt liabilities and assets may be affected by changes in the real exchange rate in a way that dwarfs the effect on the explicit liabilities which are typically the focus of attention. With this in mind, this paper proposes a balance-sheet approach that, as illustrated by the practical applications included here, may radically alter the results from traditional sustainability evaluations – and, more generally, the perception of a country's fiscal vulnerability.

Keywords: assets, balance-sheet approach, currency, debt, emerging markets, fiscal sustainability, liabilities

JEL codes: P43, H20, H60, H61

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A Balance-Sheet Approach to Fiscal Sustainability[1]

Eduardo Levy Yeyati[2] Federico Sturzenegger[3]

I. Introduction

Recent empirical research on emerging markets debt, currency crises and fiscal sustainability has placed a significant focus on the role of currency mismatches. Calvo et al (2003) note that "sudden stops are typically accompanied by a substantial increase in the real exchange rate that breaks havoc in countries that are heavily dollarized in their liabilities, turning otherwise sustainable fiscal and corporate sector positions into unsustainable ones" while Hausmann and Panizza (2003) argue that "exchange rate mismatches associated with liability dollarization can expose balance sheets to serious risks associated with a positive feedback between large real exchange rate depreciations and perceptions of insolvency." However, the emphasis of this literature has been placed on the currency composition of *explicit* government *liabilities* –the idea being that the presence of foreign-currency denominated liabilities raises the cost of debt service in the event or a real depreciation as a result of an adverse real shock, increasing a priori the fiscal vulnerability of the country.

The key insight of this paper is that these liabilities, while relevant, usually represent a small share of actual government liabilities: indeed, as an indicator of fiscal solvency, they are relatively uninformative –and possibly misleading– if not matched with the asset side of the government's balance sheet. Much in the same way as in corporate finance, where no debt analysis is done

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without taking into consideration the asset side of the corporation's balance sheet and its revenue generating potential, a fiscal sustainability analysis should factor in the value of financial and real government assets as well as the present value of future tax collection. These non-debt liabilities and assets may be affected by changes in the real exchange rate in a way that dwarfs the effect on the explicit liabilities which are typically the focus of attention. With this in mind, this paper proposes a balance-sheet approach that, as illustrated by the practical applications included here, may radically alter the results from traditional sustainability evaluations –and, more generally, the perception of a country's fiscal vulnerability.

The ultimate goal of this research agenda is to produce a methodology that is both operational and replicable, and that could complement the standard sustainability assessments regularly conducted by analysts and market practitioners. To do so, the paper discusses in some detail the conceptual issues that distinguish the new approach from the traditional ones, and highlights the different implications it yields in terms of the country's currency imbalances and its vulnerability to swings in the real exchange rate.

Intuitively, while fiscal liabilities (most notably, pensions and wages that comprise the largest part of current expenditure in most developing economies) are largely denominated in the domestic currency, taxes collected on the tradable sector of the economy are in part "foreign-currency indexed" –particularly so in the case of commodity exporters where a significant share of the exported production is owned by the government. In that case, once the whole balance sheet effect is computed, by diluting the value of domestic currency liabilities while enlarging the resource base, a real depreciation may enhance the net worth of the government even in partially dollarized economies. Not surprisingly, governments more often than not *use* a devaluation to *solve* their fiscal problems, a practice that can be better understood from a balance-sheet perspective. More generally, the vulnerability and response to shocks associated with a given debt level and structure computes differently once the fiscal surplus is broken into its individual components, and the effect of the shocks is estimated on *all* asset and liability items.

Measuring debt sustainability by relating debts to assets (rather than the more traditional debt-to-GDP ratio) also allows to better understand the effects of changes that have an impact on the asset side of the balance sheet of the government with relatively little impact on debt ratios in the short run. A hike in oil prices –or an increase in proven oil reserves– may have a muted impact on traditional debt ratios despite the fact that they affect solvency in a critical way. Likewise, changes in future liabilities –as a result, for example, of a pension reform– have a direct impact on government's net worth but, again, no ostensible effect on debt ratios.

A related point refers to the unsettled discussion on whether emerging market crises are the result of solvency problems or the reflection of liquidity runs. A thorough computation of government's net worth is a first necessary step towards solving this puzzle. In fact, there is evidence that, for the case of *developed* countries, markets ultimately focus more on net worth than on debt ratios, as Guidotti and Kumar (1991) show by relating a simple calculation of the net worth of G-15 countries to contemporaneous market spreads. The opposite, however, appears to be the case for developing economies.

The paper is organized as follows. Section II provides a brief survey of the related literature. Section III presents our balance sheet approach, and describes the methodology. Section IV applies the methodology to the cases of Argentina and Chile. Section VI concludes.

II. Sustainability and solvency: what's in the menu?

Determining fiscal sustainability, namely, the government's ability to repay existing obligations over the indefinite future, presents a daunting task that cannot be addressed in the form of simple summary indicators. Governments will claim that they can make the payments, and generate the needed primary surpluses to do so even when history or common sense tends to suggest that the attainable surplus depends squarely on growth, interest rates, and real exchange rate, factors that are largely beyond the control of the government in the short run and on which forecasts by the parties involved often disagree.

Hence, assessing debt sustainability is as much an art as it is a science, and can be tackled through a wide range of alternative methodologies. Chalk and Hemming (2000) provide an excellent survey of the traditional approaches and its practical application to developing economies, while several recent papers—including Díaz Alvarado et al. (2004) and Mendoza and Oviedo (2004)— surveys alternative developments. The purpose of this section is not to provide a new survey of this growing literature, but rather to cover three key aspects on the subject: i) the basic intertemporal approach, which gives a rule of thumb to evaluate sustainability under the assumption that the economy is in its steady state; ii) the link between the exchange rate and sustainability in economies that have some of their public debts denominated in foreign currency, an issue that has played a prominent role in recent discussions; and iii) the link between sustainability and the volatility of key drivers such as growth and financial market conditions.

The Basic Intertemporal Approach[4]

We start from a basic debt accumulation equation ignoring, for the time being, the distinction between local currency and foreign currency debt (that is, we assume all debt is in local currency):

$$D_{t+1} - D_t = i_{t+1} D_t - P_{t+1} \tag{19}$$

where P_{t+1} is primary surplus of period t+1, D_{t+1} is the total end-of-period t+1 public debt stock, and i_{t+1} is period t+1 interest rate.

Dividing both sides by GDP and rearranging, we obtain

$$d_{t+1} = \frac{(1+i_{t+1})}{(1+g_{t+1})} d_t - p_{t+1} \tag{20}$$

[4] This section draws on Blanchard (1990) and Chalk and Hemming (2000).

where lower case letters denote ratios to GDP and g_{t+1} is the GDP growth rate from period t to period t+1.

Substituting forward and imposing the "no Ponzi game condition" that the present value of future debt as a percentage of GDP value must converge to zero, we obtain the present value budget constraint:

$$d_t = \sum_{v=0}^{\infty} R_{t+1,v}\, p_{t+1+v} \tag{1}$$

where $R_{t+1,v} \equiv \prod_{s=0}^{v} \frac{1+g_{t+1+s}}{1+i_{t+1+s}}$. This just says that the debt stock has to equal the present value of future primary surpluses.

In what sense is (1) a "debt sustainability condition"? Other than imposing the no-Ponzi-games condition —which follows from the very basic idea that individuals holding government debt will not allow the government to run a "Ponzi game" in which debt is rolled over forever—, we have derived equation (1) using only accounting identities. Here, the present value budget constraint simply tells us that there must be consistency between today's debt stock and the projected path of primary surpluses, interest rates, and growth, but not how this consistency is to be achieved. This could be done, for example, by adjusting the present debt stock through a restructuring, or diluting it through inflation (which raises nominal growth relative to interest rates and hence the discount factor R). Hence, the present value budget constraint is a condition on future required primary surpluses only if one assumes that the government wants to avoid these other ways of adjusting, that is, if the current debt stock as well as the path of g and i are taken to be exogenously fixed, rather than endogenously determined –at least partially– by government choices.

However, even when this assumption is made, the present value budget constraint imposes little "discipline" in the sense that there are infinitely many primary surplus paths that will make the equation hold. Whether debt is sustainable or not boils down to the question of whether at least some sustainable path is feasible. How do we know if this is the case? In essence, three approaches have been suggested and applied in practice.

First, one can impose "discipline" artificially, by way of a thought experiment, pretending that the economy is in steady state, and considering only flat primary surplus paths –in what is usually referred to as "static sustainability analysis". Thus, assuming that the interest rate and GDP growth rate are constant, equation (1) becomes:

$$d_t = \sum_{v=0}^{\infty} \left(\frac{1+g}{1+i} \right)^{v+1} p_{t+1+v} \tag{2}$$

If, in addition, we assume the primary surplus to be constant over time, we obtain:

$$p = d_t \left[\frac{1+i}{1+g} - 1 \right] = d_t \left[\frac{i-g}{1+g} \right], \text{ assuming } 0 < \frac{1+g}{1+i} < 1 \tag{3}$$

which gives the level of primary surplus that makes the current debt sustainable, a measure that can be computed very easily. While (3) is a useful rule of thumb, the underlying static sustainability approach is incomplete, as it does not deal with possible uncertainty regarding GDP and interest rate paths, and it abstracts from complications that arise if a portion of the debt is in foreign currency –two issues to which we return later in the paper.

In addition, one implication of static sustainability analysis is that it delivers something stronger that we actually need, namely, a primary surplus path that not only makes the debt sustainable, but also keeps it constant at its current level. However, there is no reason to assume that the current debt-to-GDP ratio is optimal.[5]

In practice, this problem can be dealt with in two ways. One approach is a more flexible version of the static one, in which equation (3) is used to calculate the required long-run primary surplus, while the short and medium run debt dynamics that might lead to that long run are modeled

[5] Additionally, this framework is silent about the practical feasibility of the "sustainable" primary surplus.

explicitly, assuming alternative short and medium term transition paths for interest rates, growth , and the primary surplus. This is the way in which debt sustainability analysis has traditionally been conducted by country authorities and international institutions such as the IMF (Chalk and Hemming, 2000)[6].

An alternative approach, based on Bohn (1998) has recently been applied to developing countries (IMF 2003a, Abiad and Ostry, 2005), modeling explicitly the primary surplus as a function of control variables such as the debt stock, the growth rate and the interest rate using historical data. In turn, fiscal sustainability is assessed by comparing the present value of fitted primary surpluses (predicted based on projected values of the controls) with the debt outstanding. The advantage of this approach is that it systematizes the historical evidence and models fiscal accounts more realistically; its disadvantage is that it assumes that the ability of the authorities or the country to generate primary surpluses will be the same in the future as it was in the past, ruling out the exceptional fiscal performance that is sometimes observed in the face of crises or after crises – most recently in countries such as Turkey, Brazil and Argentina– as a response to extreme conditions. Therefore, while this approach may be a reasonable starting point if the goal is to assess the sustainability of the *current* policies, it may be unduly pessimistic about the government's adjustment capacity in the event of a crisis.[7] More importantly, the projections at the core of this approach, to the extent that they are often based on long historical series, may miss most of the effect of *policy changes that have already taken place*, providing a biased depiction of the current scenario.[8]

[6] An application of this methodology that has led to interesting insights is Broda and Weinstein (2004), who look separately at future liabilities and income flows for the case of Japan, for which demographics play a critical role conclude that there is no serious solvency problem in spite of very high debt levels and an ageing population.

[7] See Abiad and Ostry (2005) for refinements of the endogenous primary surplus approach which attempt to address this objection.

[8] Another limitation of the approach is of course that it continues to rely to the projected fundamentals, which are uncertain. We return to this issue below.

How does a devaluation affect fiscal sustainability in the traditional approach?[9]

Because the currency composition of debt may differ from that of GDP or government resources, it is critical for our analysis to keep track of the denomination of debt in foreign and domestic currency. Ignoring the distinction between end of period and period average exchange rates, and focusing on the real exchange rate as the relative price of tradables and non-tradables, the debt to GDP ratio d can be expressed as:

$$d = \frac{D + eD*}{Y + eY*}, \quad (4)$$

where e is the real exchange rate (defined as the price of non-tradable goods relative to tradable goods), D is debt payable in domestic currency, $D*$ is debt payable in foreign currency, Y is output of non-tradables, and $Y*$ is output of tradables.

Mismatches between debt and output currency composition can result in a substantial impact of real exchange rate variations on the debt ratio. At one extreme, consider the case of a indebted closed economy in output is denominated in non-tradables, and all debt is foreign denominated, i.e. $d = eB*/Y$. At the other extreme, suppose $(B/eB*)/(Y/eY*) = 1$, so that the composition of debt and output is perfectly matched. In the latter case, a real depreciation has no effect on the debt ratio; in the former case, it raises it one to one. Calvo et al (2003) illustrate this point by estimating the effects of 50% real depreciation in a selected group of emerging economies. Using 1998 debt stocks and focusing on the relative price adjustment—i.e. assuming that interest rates on public debt and GDP growth remain unchanged—they argue that the debt ratio would have jumped from 36.5 percent of GDP to 50.8 in dollarized Argentina, whereas it would have barely moved in non-dollarized Chile (from 17.3 percent to 18.7 percent).

This analysis, however, is partially silent on the response of fiscal accounts as a result of a real devaluation. While it recognizes that a certain fraction of GDP –hence, of tax revenues– may be foreign currency linked, it abstracts from the fact that the main public liability (in turn, the main fiscal outlays) is not associated with the service of explicit debt but rather with spending promises,

[9] This section closely follows Calvo, Izquierdo and Talvi (2002).

most of which, particularly wages and pensions, are quoted in domestic currency and tend to be diluted in a high depreciation-high inflation scenario. As long as wages and pensions lag behind prices in their adjustment to the new exchange rate, we should expect the higher debt service to be partially offset (or, in some cases, even outweighed) by the improvement in the primary surplus as a result of the devaluation.[10]

Dealing with Uncertainty

From the previous discussion, it is clear that projected paths of output, interest rates, real exchange rates –as well as any additional determinant of the primary surplus– is critical for a fiscal sustainability assessment. How can one deal with the uncertainty surrounding these projections?

Two broad approaches have been applied in practice. The first one, popular among practitioners, consist in subjecting a particular debt sustainability scenario to "stress tests" that assume alternative extreme paths for the critical variables. These stress tests answer whether the debt would still be sustainable if, say, there is a sharp rise in international interest rates, a dramatic deterioration of terms of trade, or a sudden economic slowdown. In order to choose a "reasonably" adverse scenario, one can calibrate (permanent and transitory) shocks based on the stochastic behavior of the relevant variables in the past. The International Monetary Fund has extensively used this approach in recent years, and refined it in several ways (IMF, 2005c).

Although this approach is useful in giving a sense of the sensitivity of the debt sustainability analysis to a range of plausible scenarios, it falls short of using the whole joint distribution of shocks. Specifically, it disregards correlations among shocks, as well as the joint dynamic response of the relevant policy variables. In response to these shortcomings, a number of authors have recently attempted to estimate the variance-covariance structure of the shocks, and used these estimates to generate probabilistic forecasts of debt dynamics. These forecasts can then be used to estimate the probability that the debt ratio rise beyond a pre-specified threshold.

[10] Note that, even if real wages (measured in CPI units) are kept constant, fiscal revenues, ofeten proportional to the nominal GDP, will tend to outpace wages to the extent that the tradable component of GDP exceeds that of the consumption basket.

The approaches taken in these papers differ —in particular, with respect to whether and how the government's behavior is modeled. However, most of them share the basic methodological perspective: a vector autoregression is estimated to simulate the main exogenous drivers of debt dynamics, fiscal policy is treated as endogenous (either by including the primary balance in the vector autoregression, or by separately estimating a policy reaction function), and a probability distribution of the debt ratio is generated using Monte Carlo simulations. The results can be presented in highly intuitive ways; for example, Ferrucci and Penalver (2003) and Celasun, Debrun and Ostry (2005) use "fan-charts" familiar from the inflation forecasting literature to illustrate the distribution of paths of debt ratios, whereas Garcia and Rigobón (2004) report impulse-response charts to illustrate the trajectory of debt ratios in response to a variety of shocks—in the spirit of "stress tests" but on more solid econometric grounds. To varying degrees, these new approaches encompass and enrich the more traditional ones. A different strand, borrowing from the financial literature, has tried to extend the now standard Value at Risk approach to the case of a central bank (Blejer and Schumacher, 1998) or, closer to our agenda, to fiscal accounts (Barnhill and Kopitz, 2003).

With the exception of the static approach, all of these models pay due attention to the concept of vulnerability that stresses the importance of the negative tail of the distribution of the relevant variable –typically, the debt ratio–, in contrast with the emphasis on the expected (average) level placed by the traditional sustainability analysis. All of these models, however, relate debt ratios to either reduced forms of the underlying future primary surplus or, at best, to the composition of *explicit* liabilities (documented debt stocks).

While these stress tests could be easily incorporated within our balance-sheet approach, a critical methodological difference deserves to be noted. The first one refers to the use of historical data. The use of fiscal data from a long historical period (usually the previous ten or twenty years) amounts to assuming that the country would carry in the future the same fiscal policy as in the estimation period, whereas the analysis should in principle be concerned with *current* fiscal policy. Conversely, using data from a shorter period (as in Garcia and Rigobón, 2004, who focus on monthly data for the last three years) reflects accurately the underlying structure of fiscal accounts at the expense of masking most of the cyclical dynamics of the relevant shocks. [11]

III. The Balance sheet approach

In a recent analysis of sovereign debt statistics (which included the Americas as well as some other key emerging and developed economies), Cowan et al (2006) unveiled a number of cases in which governments have made an effort to bring their debt numbers closer to the net worth concept underlying our balance sheet approach. Brazil, for example, reports only net public debt, that is, debt net of international reserves. Argentina has recently moved to the same system, balancing out the debt owed to the national government by the provinces.[12] Mexico computes a net debt number by netting some off-balance sheet assets. Canada, in turn, reports a debt figure net of public assets, where the latter includes both liquid assets and other computable government claims such as student loans.[13] Finally, the US also reports a net debt concept.

Perhaps the clearer example in this regard is New Zealand, which, in compliance with the Public Finance Act of 1989 (Part III), must prepare annual consolidated financial statements in accordance with generally accepted accounting practices.[14] New Zealand's approach falls short of the comprehensive net worth concept that we propose here in that, while it considers liquid and physical *assets* –including items such as public roads or the national library that may be considered of little "redeeming value"– it ignores the present value of future government resources –less

[11] Our approach addresses this problem by estimating the individual components of the primary surplus based on the historical behavior of the relevant determinants, and aggregating them using the current tax and income structure.

[12] In 2002. the federal government offered subnational government a debt swap by which it took over provincial debt in exchange of new claims on the provinces.

[13] In an early precedent, Buiter (1985) has suggested that items typically excluded by the conventional approach should be an integral part of sustainability analysis,

[14] Specifically, they must include, in addition to financial statements, a statement of borrowings, a statement of no used expenses and capital expenditures, a statement of emergency expenses and capital expenditure, a statement of trust money administered by department and offices of Parliament, and any additional information and explanations needed to fairly reflect the consolidated financial operation and its financial position. They must also include the government's interest in all Crown entities, all organizations, state enterprises, parliament and the Reserve Bank of New Zealand, as well as that of any other entity whose financial statement must be consolidated into the financial statements of the Government to comply with generally accepted accounting practice.

straightforward to value but economically more important. It does come closer to our approach on the liability side, where they add the actuarial value of pension fund liabilities.

With the exception of New Zealand, it seems that governments accept that assets that have the necessary liquidity (reserves), were issued with an equivalent collateral (debt operations) or are one off deviations from normal behavior (Mexico's financial losses due to the 1995 bank bailout) should be netted out from the debt stock figure. In line with this, and to make debt numbers more coherent across countries, Cowan et al (2005) propose three debt concepts: one in which government debt held by the central bank is netted out, a second in which foreign currency reserves are netted out, and a third one (to attain comparability between countries that have and have not privatized their social security system) where the assets of privatized social security funds are netted out (under the assumption that these assets approximate the values of liabilities that the government will not have under a private regime whereas they exist when the system has not been privatized). At any rate, all these attempts are only halfway efforts that, while closer to a true depiction of the debt situation, fall short of providing a summary statistic of fiscal sustainability.

Table 1 presents a scheme of the government's balance sheet and the resulting net worth. Measuring each of these components is not straightforward and entails methodological decisions. For example: Should physical assets be treated as "marketable" in the sense that they can be used to finance liabilities? Should debt be valued at face or market value? Should contingent liabilities be taken at their actuarial value? Should the cash flow of state-owned-enterprises (SOE) –which typically includes a subsidy component–, social security or tax revenue be extended forward assuming today's legislation? [15] Last but not least, given that the balance sheet is the present value of future flows, what discount rate should be used to do such discounting?

[15] This appears to be the natural choice if sustainability is to be mixed under the current policy mix. Stress tests on net worth based on specific policy changes can be used to complement the analysis.

Table 1. The balance sheet

Assets	Liabilities
Liquid Assets	Explicit Liabilities
Physical Assets	Contingent Liabilities
NPV of taxes	(NPV Social Security)
Net worth of SOE	(NPV Health insurence)
	(NPV Other expenditures)
	Net Worth

The implementation of our methodology follows directly from the balance sheet in Table 3. The measurement of each of its components merits some comment. Within the asset side, liquid assets should be measured at their current market value. Because many countries have actually run down significantly their reserve levels at times –and more generally because they are liquid assets that can be disposed of almost immediately at any point in time– we choose to include the full value of reserves in our estimation of the value of assets. While physical assets are also valued at market value to the extent that they are assets that may be disposed of, we choose not to include physical assets that are unlikely to be sold on short notice at a reasonable price (roads, government buildings, IMF quotas, etc). Finally, the net worth of SOEs should come from its approximate market value whenever there is one.

Importantly, the main component of the asset side is also the most difficult to evaluate: the net present value of taxes. To compute it, we need to estimate a future path of tax revenues. To simplify our discussion, we deliberately abstract from potential changes in tax policy, and take the current tax structure as given and constant looking ahead. This means we discuss the sustainability of the *current fiscal* policy, although alternative scenarios where fiscal policy is changed going forward can also be assessed. More precisely, we estimate how tax revenues respond to key exogenous variables, project revenues as a function of the (projected) evolution of these variables and discount the revenue flow to obtain its present value. Regarding the liability side, with the exception of liabilities with a predetermined cash flow such as net social security outlays and debt payments (which are computed separately), government spending is estimated as a function of a few exogenous variables. In addition, we cannot ignore the fact that occasionally the government recognizes debts incurred in previous periods and that had not been officially acknowledged (the so-called contingent liabilities or "skeletons").

The methodology consists of the following four steps:

1. Define a set of exogenous variables (in our example, GDP, the real exchange rate and the international interest rate) and estimate a model that simulates their future evolution. [16] This set of variables can be country specific, and can be expanded at the discretion of the evaluator.
2. Estimate response functions for specific components of income and expenditures; in our case, standard OLS regressions of revenues and spending items on the exogenous variables of choice.
3. Generate paths for the exogenous variables bootstrapping the VAR residuals, and simulate income and expenditure flows by plugging the simulated paths for the exogenous variables in the revenue and spending functions obtained in (2), and compute the primary surplus.
4. Add the predetermined cash flows (typically social security liabilities and debt payments), and the estimated skeletons to obtain the government's cash flow, and discount everything to compute the government's net worth (the net present value of the government's cash flows) for each simulated path to obtain a distribution of net worth that represents the summary expression of fiscal sustainability according to the balance-sheet approach.

In what follows, we illustrate each of these steps by means of two practical applications: Argentina (a highly indebted country fresh from a default-cum-restructuring episode) and Chile (a fiscally sound investment-grade country). Despite the generality of the methodology proposed here, going over these individual cases in detail is important because it flags a series of practical, country-specific issues that arise when taking the conceptual framework to the data.

III. 1. *Modeling the environment*

[16] Notice that this implies that we assume that the evolution of output and the real exchange rate are independent of fiscal policy in the short run.

We model the macroeconomic environment by means of a simple VAR representation of three exogenous variables: the international interest rate, the level of the real exchange rate and the rate of growth of real GDP. The general specification has the form

$$y_t = A(L)y_t + BX_t + v_t,$$

where y stands for the vector of endogenous variables. Typically, these variables should be tested for stationarity, and the VAR specification could include a set of additional exogenous variables, X. The matrix $A(L)$ is constrained to reflect the case of a small open economy, assuming that the international interest rate is exogenous to the exchange rate and output. From the VAR we obtain the dynamic response function as well as an estimate of the shocks to the exogenous variables. These are then used to compute a stochastic future path for the endogenous variables, bootstrapping from the joint distribution of shocks implied by the residual matrix v.

Table A.1 in the appendix reports the VAR coefficients. The approach laid out here benefits from some degree of informed flexibility. To generate consistent estimates for Argentina we allow for a structural break in the level of the real exchange rate to capture the devaluation of the first quarter of 2002. In all cases, the international interest rate is introduced as an exogenous variable and modeled separately as an independent AR process. Finally, the specification for Chile includes a fourth exogenous variable, namely, the price of copper, a key country-specific determinant of fiscal accounts, which is modeled as exogenous to local output and real exchange rates, following two specifications: a random walk and an AR(1) process.

III. 2. Modeling fiscal accounts as a function of exogenous variables

III.2.1 Taxes and current expenditures

A critical part of our analysis refers to the sensitivity of income and expenditure lines in the balance sheet with respect to the exogenous variables in the VAR.[17] These sensitivities can be

[17] For brevity, we will refer to both the X´s and the y´s as "exogenous" variables, as they are assumed to be independent from the fiscal accounts calculated below.

computed from historical data assuming that there is a relatively stable relation between, say, output growth and the real exchange rate and the tax or expenditure base. As noted, we do not model the deficit as a function of our exogenous variables based on historical data; rather, we break down the fiscal accounts into its individual revenue and expenditure components, and estimate the elasticity of each of the latter with respect to the relevant exogenous variables. We then apply these elasticities to estimate future changes relative to the *current* value of the revenues and expenditures. In this way, we can estimate the deficit as a function of the exogenous variables for the *current* fiscal policy mix.

A general equation could be written for each source of revenue or expense:

$$R_{it} = GDP_t t_i e^{\alpha_i q_t} e^{\beta_i \Delta gdp_t} e^{X\beta} e^{\varepsilon_{it}}, \qquad (5)$$

$$E_{it} = GDP_t s_i e^{\alpha_i q_t} e^{\beta_i \Delta gdp_t} e^{X\beta} e^{\varepsilon_{it}},$$

where R (E) and GDP refer to nominal revenues (expenditures) and output, t (s) is the average *effective* tax (spending) rate which may change with real GDP (*gdp*), if tax compliance or public spending display cyclicality. Considering that $e\, p^*/p_{NT} = q$, the specification assumes that each tax revenue and expense has a certain "tradability", understood here as their elasticity with respect to the real exchange rate.[18] Both the elasticity with respect to the real exchange rate and to real growth can be estimated by running a log version of equation (5) for each line of the primary surplus. The estimation equation for revenues is

$$\ln\left(\frac{R_{it}}{GDP_t}\right) = \alpha_i q_{it} + \beta_i \ln \Delta gdp_t + \ln t_i + X\beta + \varepsilon_{it}, \qquad (6)$$

where X stands for other exogenous variables that affect tax revenues or expenditure decisions.[19]

[18] This elasticity will be critical when we estimate the balance sheet vulnerability to a real depreciation in the next section.
[19] Example may also include quarterly dummies if taxes are due on specific quarters, or time trends if the tax is converging to a new steady state.

In practice, the output and real exchange rate elasticities for income and expenditure data are estimated by studying the relationship between revenues and expenditures as percentage of GDP with output and the real exchange rate, correcting for seasonality. Additionally, where there has been a sharp change in tax collection (though not on tax rates, as the estimation was deliberately done over periods of stable rates), a time trend is included. For some few equations we included time dummies for the last period or the last four quarters to control for recent –possibly permanent– increases.

As an example, tables 2a and 2b show how income and expenditure relate to gdp growth and the real exchange rate in the case of Argentina (see Table A.2 in the appendix show the results for the case of Chile).[20] The tables show that fiscal components are strongly linked to the exogenous variables. Value added tax and income tax compliance increases with GDP, but their share in GDP falls with the real exchange rate, possibly as a result of the association of high real exchange rates with sharp economic downturns. Other income responds less to GDP, but in the same way to the real exchange rate, while the financial transaction tax is unresponsive to both. Export taxes are, predictably linked to the exchange rate to the extent that exports increase with the real exchange rate as shown in Table 2a. On the expenditure side government consumption and capital expenditure increase with the growth rate and decrease with a real depreciation, while transfers increase with the real exchange but are not affected by output growth.

[20] For Argentina, we used a modified version of (6) to estimate export tax revenues.

Table 2a. Income sources and economic variables

	Value Added Tax	Income Tax	Debits and Credits Tax	Other income	Exports
Log(real exchange rate)	-0.013** (0.002)	-0.015** (0.004)	0.002 (0.002)	-0.007* (0.003)	0.041** (0.002)
Growth of GDP	0.174** (0.047)	0.078 (0.045)	-0.005 (0.019)	-0.005 (0.052)	-0.149** (0.044)
Constant	0.071** (0.002)	0.018** (0.003)	0.014** (0.002)	0.053** (0.002)	0.086** (0.002)
Other control variables	No	Yes	No	No	No
R-squared	0.473	0.747	0.084	0.142	0.882

Table 2b. Expenditure and economic variables

	Government Consumption	Transfers	Capital Expenditures
Log(real exchange rate)	-0.003** (0.001)	0.016** (0.003)	-0.004** (0.001)
Growth of GDP	0.025* (0.012)	0.069 (0.066)	0.070** (0.024)
Constant	0.036** (0.001)	0.074** (0.004)	0.015** (0.001)
Other control variables	Yes	Yes	No
R-squared	0.674	0.418	0.230

Finally, as noted, for expenditure items such as financial expenses or social security future liabilities for which the actuarial value is known at the time of the computation, no estimation is needed –although the researcher may ponder whether or not to include the variations implied by possible changes in legislation (e.g., social security benefits).

III.2.3 Skeletons

Current fiscal operations entails the occasional recognition of debt that was not registered at the time the obligation was created and that originates in a number of possible factors –such as unfavorable litigation results, or the action of pressure groups on government resources. For Brazil, Garcia and Rigobón (2004) estimate these shocks as deviations (residuals) in a debt ratio equation similar to (1), and show that they are negatively correlated with real output growth. This appears to be at odds with the prior that skeletons are created in times of financial disarray and recognized in times of bonanza, which suggests that their estimated skeletons may also be capturing large measurement errors.

We can do a similar computation by estimating debt shocks as the residual from a debt decomposition exercise. Sturzenegger and Zettelmeyer (2006) show that when measured in dollar terms, the debt-to-GDP ratio evolves according to:

$$d_t^{\$} - d_{t-1}^{\$} = -\frac{P_t}{Y_t} + \frac{I_t}{Y_t} - \frac{d_{t-1}^{\$}}{(1+\pi_t)(1+g_t)}\left\{\left(\alpha \frac{s_t^e(1+s_t)}{1+s_t^e} - s_t\right) + \pi_t + g_t + \pi_t g_t\right\}.$$

The first term on the right hand side is the "primary balance contribution" to the increase in the debt to GDP ratio; the second term is the "interest contribution". By multiplying the factor outside the curly brackets by each of the terms inside, we obtain the "exchange rate contribution", "inflation contribution" and "real growth contribution", as well as a "theoretical residual" consisting of the cross-terms. If this equation does not capture the evolution of debt perfectly it signals that there is a "statistical residual" reflecting debt stock operations, non-debt financing, and measurement error. It is this statistical residual term that we are interested in, which we denote as "residual".

As an example, Table 3 shows the results of this simple exercise for Argentina. The residual line shows the extent to which skeletons added to the country's debt profile. As can be seen from the table, there is a sharp discontinuity in the series in 2002, the result of the collapse of convertibility, and in 2005, as a result of the debt exchange. Deliberately abstracting from this rather extraordinary events, we could estimate skeletons based on the "residuals" for the 1993-2001 period. Sturzenegger and Zettelmeyer (2006), which compute similar measures for a number of countries, argue that there is no systematic bias in debt dynamics arising from contingent liabilities.

If so, they should play no major role in our forecasts of debt dynamics going forward and we have omitted in what follows.[21]

Table 3 Argentina: Debt Dynamics, 1994-2005

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005 (proj.)
Federal Govermment Debt 1/	31.3	33.7	35.7	34.5	37.6	43.0	45.0	53.7	149.9	138.0	124.9	77.9
Change in Debt Ratio		2.4	1.9	-1.2	3.1	5.4	2.1	8.7	96.2	-11.9	-13.1	-47.0
attributable to …												
Primary Deficit		-0.6	0.8	-0.4	-0.9	-0.4	-1.0	-0.2	-0.9	-2.3	-3.9	-3.7
Real Interest Rate 3/		1.0	1.1	1.4	1.8	2.3	2.4	2.6	-0.1	-0.6	-1.9	-0.4
Real Growth		0.9	-1.7	-2.6	-1.3	1.3	0.3	2.0	6.5	-11.9	-11.1	-7.1
Real Depreciation		-0.3	0.6	0.7	0.9	1.3	0.5	1.6	58.4	-12.9	-7.1	-3.9
Cross-Terms		0.0	0.0	0.0	0.0	0.1	0.0	0.2	1.4	-0.5	-0.4	-0.3
Residual		1.5	1.2	-0.2	2.5	0.8	-0.3	2.5	31.0	16.4	11.3	-31.6
of which:												
debt stock operations 4/		0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.7	2.7	0.0	-22.3
interest arrears		0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5	5.1	4.3	-12.1

Source: Sturzenegger and Zettelmeyer (2006).

III. 3. Simulating the exogenous variables and income and expenditure flows

The third step follows directly from steps 1 and 2. The exogenous variables are forecast by bootstrapping the VAR residuals. Figure 1 shows the results of this exercise for Argentina and Chile, with the corresponding standard errors in a fan-chart graphical representation (where the outer area covers 95% of the distribution). When it comes to fiscal flows beyond the 20^{tth} year we use a perpetuity based on the steady state values of the exogenous variables.[22] These exogenous variables –more precisely, the 5000 simulations that underlie the charts– are used to generate a stochastic representation of the income and expenditure equations. Combining these scenarios with the response functions estimated in step 2, we simulate the fiscal flows consistent each of these simulated environments.

[21] Binghe (2007) has extended these exercise to a larger group of country and finds roughly the same results, with the sole exception of India for which she finds a steady increase in debt originating in contingent liabilities.

[22] Steady state refers here to the steady state values of the VAR estimation. In the case of Chile these values entailed a steady state growth rate higher than the interest rate, so we used an arbitrary "developed economy" growth rate of 3%.

Figure 1.a VAR representation of exogenous variables. Argentina

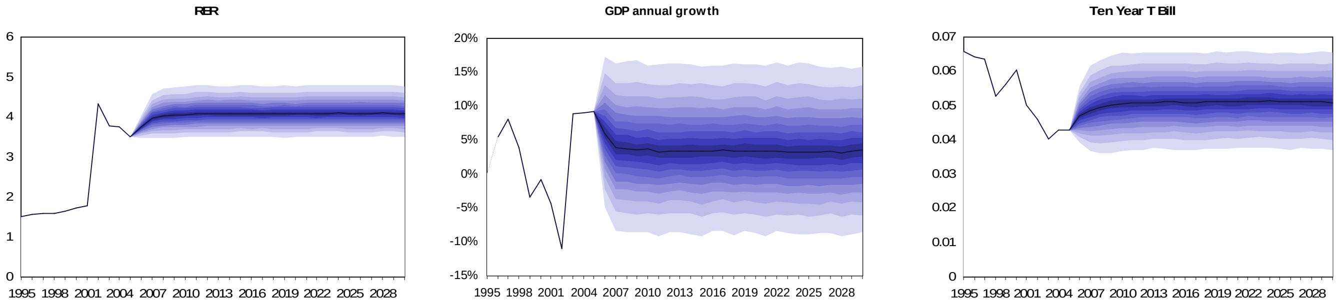


Figure 1.b.i VAR representation of exogenous variables (copper as RW)

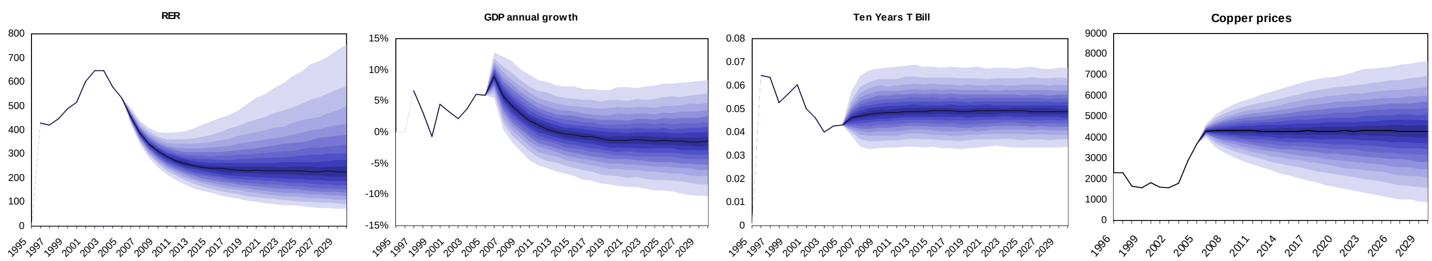
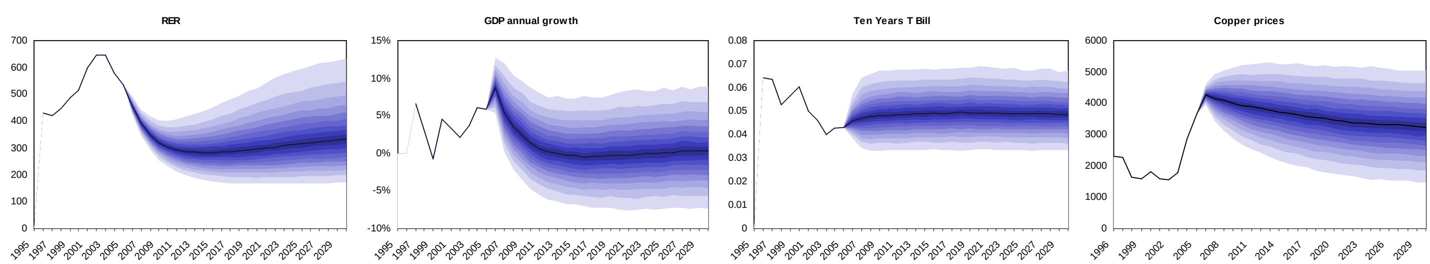


Figure 1.b.ii VAR representation of exogenous variables (copper as an AR)



III.4. Putting it all together: estimating net worth

A balance-sheet representation of the net worth breaks it down into its relevant components:

$$V_t(x) = \sum_t \sum_j \frac{a_{jt}(x)}{(1+r)^t} - \sum_t \sum_j \frac{l_{jt}(x)}{(1+r)^t}$$

where a and l denote, respectively, the different assets and liabilities identified in the balance sheet of Table 1, and x are the fundamental variables that determine the value of individual balance-sheet items. The net-worth can then be computed by aggregating the income and expenditure flows simulated in step 3 into a primary surplus series, and discounting it to obtain the net present value.

III.4.1 *The discount rate*

From a methodological point of view, the definition of the rate to be used to discount the stream of fiscal cash flows is crucial. The problem is to some extent analogous to that of discounting the cash flow of a firm in order to obtain its net worth. Firm valuation typically uses the risk-adjusted discount rate that can be inferred from a pricing model of financial assets –often different ones for different cash flows. What is the logical equivalent in the case of government cash flows? Should we use different rates according to the nature of the flow? How can we evaluate the solvency of the government ruling out insolvency due to a liquidity run?

The discount factor debate has a long tradition dating back to Ramsey's (1928) assertion that it was "ethically indefensible" for a social planner to discount the future. However, under the influx of revealed preference, it became traditional to assimilate the social welfare problem to that of a representative individual so that the social planner's discount rate became the representative agent's discount rate.[23] A priori, then, it seems reasonable to use the country's opportunity cost as the discount measure.

[23] Recently, the idea of building models with preferences that give particular weight to the present (as opposed to the past or the future) has come under substantial criticism. See Caplin and Leahy (2004) for a discussion.

For a closed economy (autarky) a good approximation would be given by the modified golden rule (even if it differs from the discount rate of an individual or of the social planner).[24] In a financially integrated economy, the social rate of return would in principle be equal to the rate at which the country can borrow or lend in international markets, being the relevant rate the one which is currently binding (the borrowing rate for a net borrower; the lending rate for a net creditor).[25]

However, this solution is still debatable. A borrowing rate that includes a sovereign credit risk premium (as it typically does in developing economies and in the standard debt sustainability evaluations) implicitly contradicts the question the exercise intends to answer, namely, what are the conditions under which the country never becomes insolvent? Clearly, in most cases there is an interest rate that, if high and persistent enough, makes debt dynamics explosive leading to insolvency.[26] To rule out the case of a self-fulfilling liquidity run that eventually evolves into an insolvency episode, we start by assuming solvency (hence, zero credit risk premium) and compute the distribution of net worth based on the international risk-free rate or, more precisely, the simulated path for the international risk-free rate.

III.4.2 *Computing net worth*

Note that the government's net worth should be computed based on the full simulated path for the relevant exogenous variables, and discounted using the simulated interest rate. To do that, we use the complete paths simulated in step 3 and compute the distribution of net worth at T=0,. More precisely, each of the 5000 simulated paths delivers a net worth figure.[27] A distribution of net

[24] Recall that the modified golden rule includes a term to account for the fact that population is growing so that in the case of no discounting, by using the modified golden rule the central planner would generate a steady consumption profile across generations by generating a consumption stream that increases at the rate of population growth.

[25] Note that this condition pertains to flows rather than stocks, and may be at odds with the net foreign asset position of the country. Assume a country with a fiscal surplus and a large debt maturing many years from now; if debt buybacks are not allowed or are too costly, the fiscal surpluses would be invested abroad at the international rate reducing the negative foreign asset position of the country.

[26] Note that traditional studies assume, at the same time, that new debt will continue to pay current risk-adjusted borrowing rates, and that all the debt is actually repaid (to obtain the primary surplus needed to satisfy this hypothesis). This entails an implicit contradiction since certain repayment should eliminate the credit risk premium incorporated in the interest rate.

[27] Since the VAR needs to be estimated jointly, all our estimates are based on quarterly data, the highest frequency at which real output is available. Each path consists of VAR simulated series of the exogenous variables up to time T, which are kept invariant thereafter.

worth is thus constructed based on these 5000 observations. The results are summarized in Figure 3, which reports the histogram for Argentina and Chile (expressed in terms of current GDP). For Argentina the curve has a mean at around 2.2 GDPs and does not reach negative territory. Government net worth is strongly skewed to the right indicating the presence of paths with exceptional growth and exceptional revenues. In the case of Chile, the mean is at 7.1 GDPs when copper is modeled as a random walk (4.5 GDPs with copper as a AR(1)), and no negative tail.

In the case of Argentina the exercise delivers a median net worth close to twice the GDP at end-2005 prices. A look at the main components of public finances (Figure 2a), which shows the baseline scenario and the distribution of outcomes resulting from the volatility of exogenous variables, sheds light on this high figure: in recent years Argentina has increased its primary surplus (mainly through new taxes and a reduction of real public wages) and reduced its liabilities through a debt restructuring.[28] However, it is the negative tail rather than the median that provides a measure of debt sustainability. In this regard, the figure shows that, under the *current* fiscal policy, Argentina is fiscally sustainable in almost all states of the world.[29] Needless to say, one could expect that, in light of these fiscal results, the government will be tempted to modify its fiscal stance in the future increasing expenditure or cutting taxes. A complete sustainability analysis cannot ignore these alternative scenarios, which could be easily assessed within this methodology.

Predictably, Chile shows an even stronger result with a median net worth of about 5.2 GDPs when copper is valued as a random walk and of 4.0 GDPs when copper prices are presumed to follow an AR(1).[30] The AR(1) process shows a slight decline in the price from the currently very high levels (see Figure 1), but because we find the coefficient of the autoregressive process to be

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[28] In the case of Argentina the debt numbers are the official estimates and thus do not include potential payments to holdouts or the Paris Club. Notice, however, that the estimated net worth is much larger than the NPV of this debt..

[29] Another factor that contributes to net worth is the declining share of social security liabilities currently planned. This results from the social security reform of 1994 that transferred most of the workers to a private pension scheme. While this increased the intertemporal solvency of the government, its low coverage of future pensioners anticipates the future creation of contingent liabilities to cover those that will not have any benefits in the future.

[30] Due to lack of data we estimated interest payments as equal to 5% of outstanding debt liabilities. Also, for brevity, we omit here the balance sheet the valuation of Chile's public sector enterprises (Codelco, Enap, etc) that, if anything, would increase net worth further.

very high (about 0.98) the results do not differ dramatically between the two specifications. The details are laid out in Figure 2b.

Figure 3 also highlights the large discrepancies in the volatility of fiscal results in each country. Argentina, which has revenue and expenditure closely correlated with the GDP, exhibits much less volatility than Chile, where income is subject to the volatility of copper prices that are largely uncorrelated with domestic prices.[31]

Another interesting implication that can be obtained from this methodology is the relatively minor role that explicit liabilities play in fiscal solvency. In the case of Argentina, for example, total liabilities add up to a present value of 4,700 billion pesos at 2005 prices, of which debt flows represent only 270 billion, or just 5.7% of total liabilities, which shows the extent to which the focus on explicit liabilities in sustainability analysis may lead to misguiding results.

Figure 4 shows how the model can be used to evaluate the fiscal sensitivity to large shocks in the exogenous variables. A decline in the price of copper is a logical stress test for a country like Chile that is heavily dependent on a single commodity export. The figure shows how the distribution of government's net worth sifts after a 42% reduction in the price of copper (arbitrarily chosen for illustrative purposes), even turning negative with a minor probability.

Certainly, in light of the recent debate on financial crises, the most natural stress test for developing countries is a large depreciation, the shock that underlie most recent episodes of financial distress in emerging markets. To this we turn next.

[31] Random walks entail growing and unbounded volatility and, as expected, increases the volatility of the estimates obtained for the different paths of the exogenous variables.

Figure 2.a Expenditures and income as % of GDP. Argentina

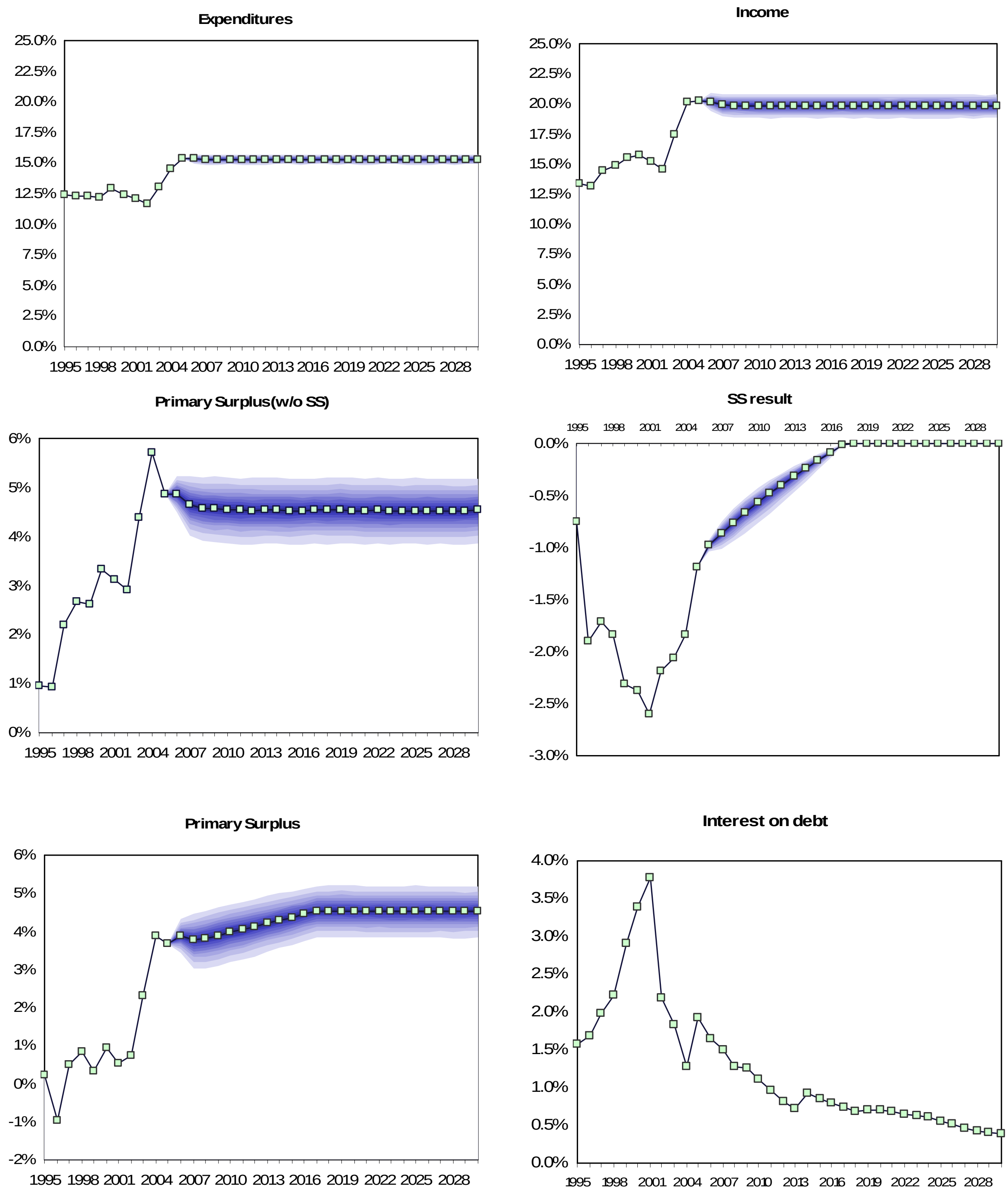


Figure 2.b.i Expenditures and income as % of GDP. Chile (with copper as RW)

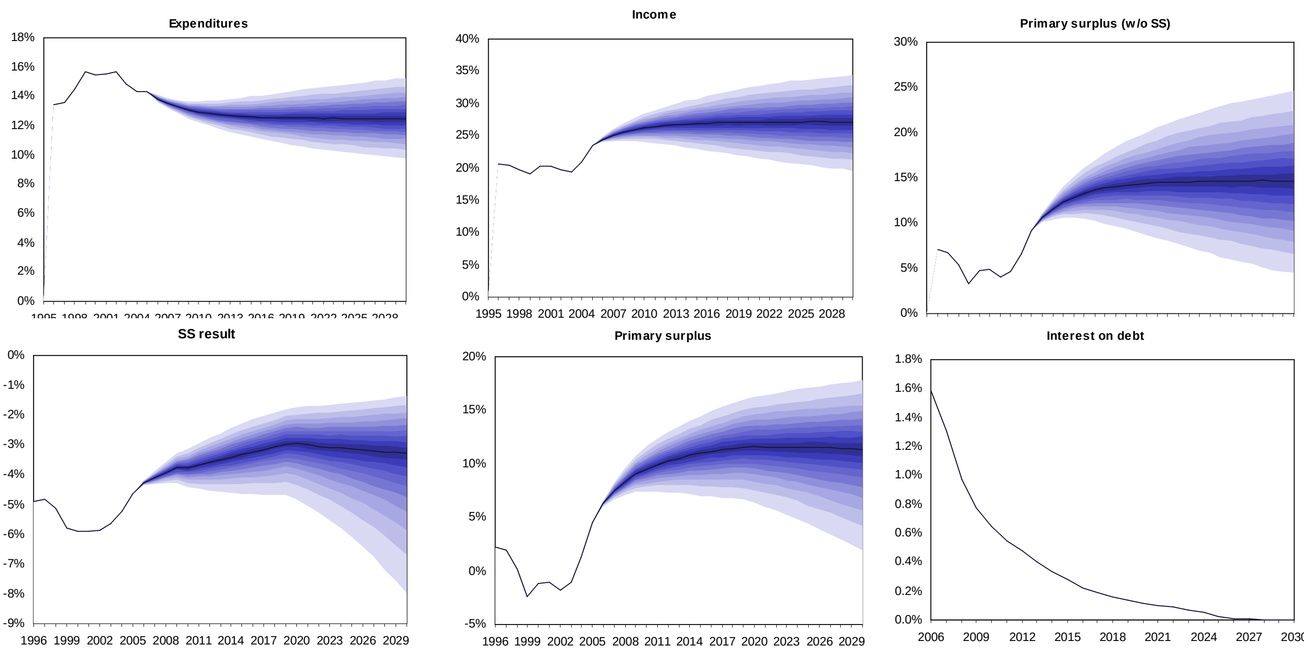


Figure 2.b.ii Expenditures and income as % of GDP. Chile (with copper as AR)

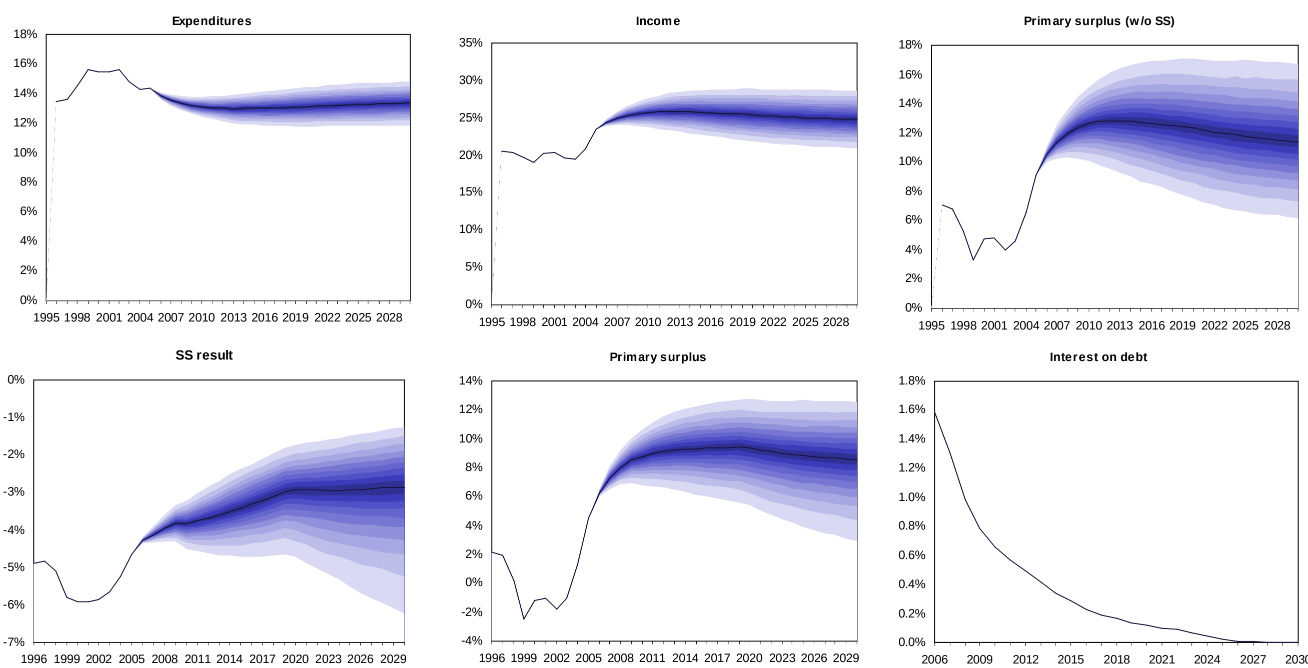


Figure 3. Histograms for net worth: Argentina vs. Chile

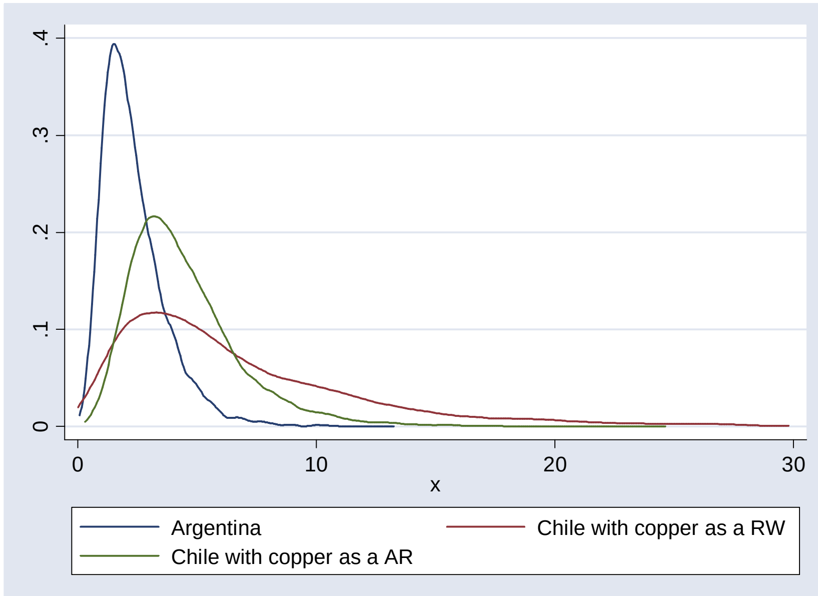


Figure 4a Change in the copper price (with copper as RW)

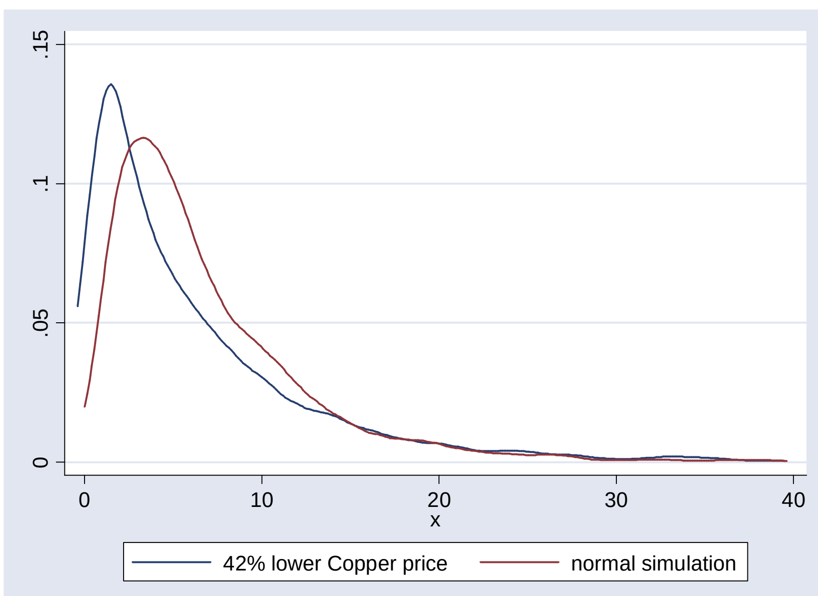
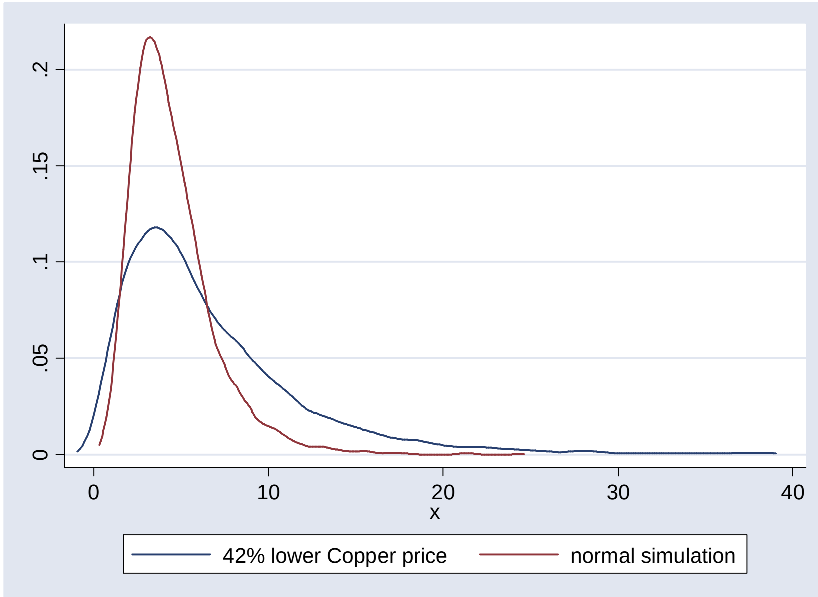


Figure 4b. Change in the copper price (with copper as AR)



Real depreciations and fiscal sustainability

An important part of our exercise is to show that the sensitivity of income and expenditure to the real exchange rate may differ squarely from what is implicitly assumed in the traditional analysis, since both expenditures and taxes are affected by changes in the real exchange rate making the overall effect uncertain. This can be readily done using the methodology described above, by stress-testing the system with a one-off large real exchange rate shock that phases out over time. The effect can be assessed dynamically in a simple way, as the resulting displacement of the distribution of net worth (Figure 5).

In the case of Argentina, the VAR analysis suggests little persistence of the real exchange rate shock, so rather than a temporary shock we simulate a *permanent* 20% real depreciation. We find that that Argentina's net worth barely moves, because the increase in debt payments associated to valuation changes in foreign-currency denominated debt is offset by the benign effect of the devaluation on taxes and expenditures (particularly, public sector wages and pensions).[32] Similarly,

[32] It deserves to be noted that the degree of dollarization of (private and public) debt in Argentina declined considerably in the aftermath of the 2001 financial crisis, a decisive factor underlying this result: a similar exercise calibrated to the Argentine context in 2001 would likely yield a large fiscal deterioration as a result of a devaluation.

Chile sees an important improvement in its net worth with a depreciation of the real exchange rate, albeit for different reasons: as a reflection of a large share of tradable fiscal revenues (copper export) combined with a balanced debt position. Table 4 summarizes the results.

Table 4. The effects of an exchange rate shock on Net Worth (as % of GDP)

	Argentina	Argentina	Chile(WR)	Chile(WR)	Chile(AR)	Chile(AR)
	Basic simulation	With exchange rate shock	Basic simulation	With exchange rate shock	Basic simulation	With exchange rate shock
Mean	2.225	2.214	7.087	8.390	4.471	5.249
Median	1.968	1.923	5.297	6.245	3.996	4.715
Maximun	11.131	14.426	113.035	173.683	24.628	33.162
Minimun	0.013	-0.103	0.002	0.036	0.304	0.492
Stand. Dev.	1.289	1.293	6.565	8.212	2.363	2.813

Figure 5a. Argentina: Histogram of net worth in response to a RER shock

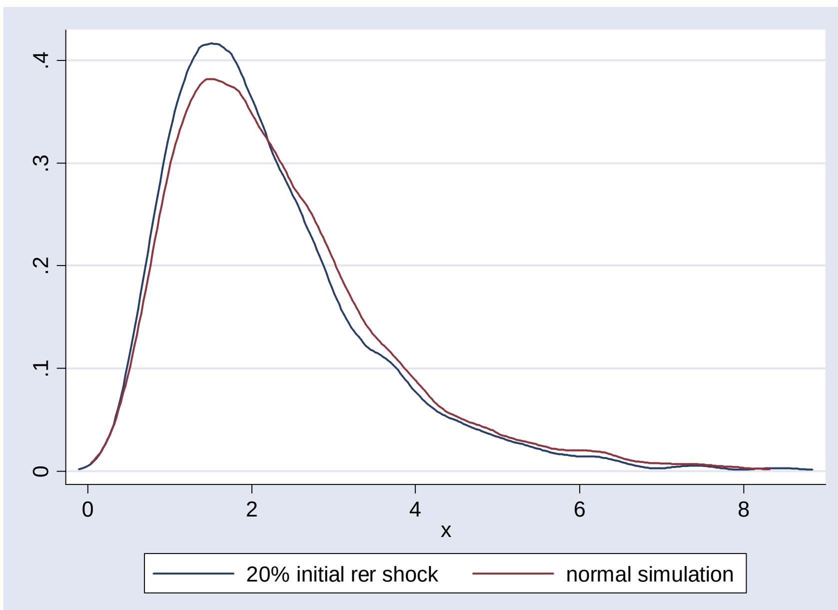


Figure 5.bi. Chile: Histogram of net worth in response to a RER shock (copper modeled as RW)

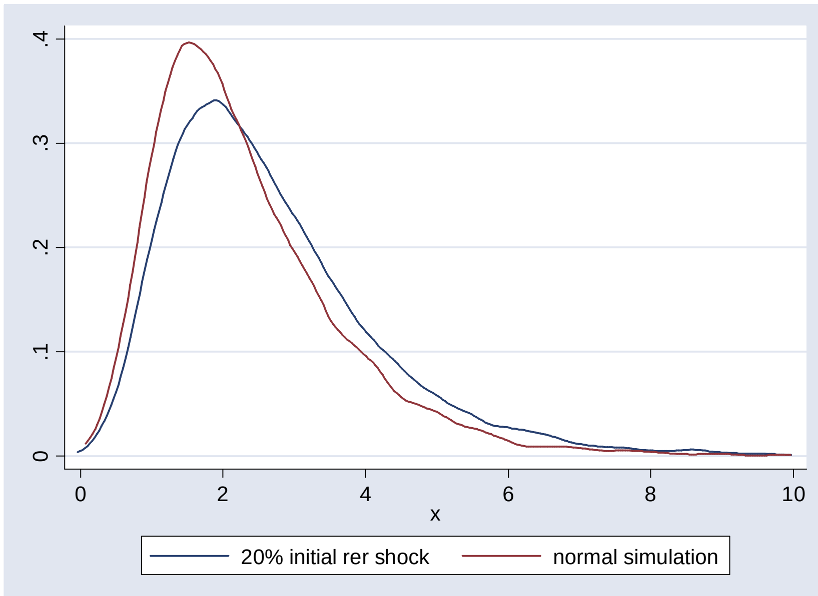
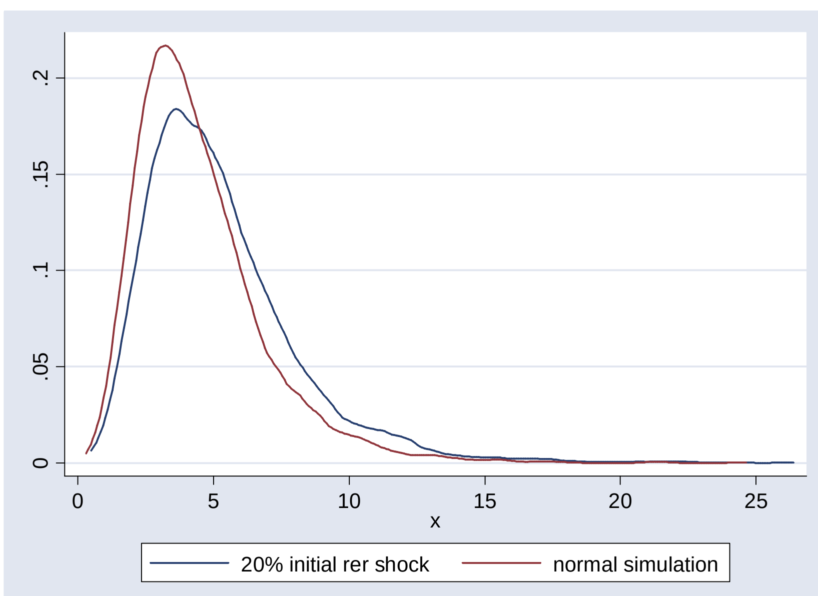


Figure 5.bii. Chile: Histogram of net worth in response to a RER shock (copper modeled as AR(1))



IV. Conclusions

In this paper, we made a case for a new methodology to assess fiscal sustainability based on the estimation of the country's net worth and its distribution as a function of a changing macroeconomic environment. We illustrated our methodology by applying the proposed balance-sheet approach to two countries: Argentina and Chile (which we find to be fiscally sustainable under current policies) and run specific counterfactual scenarios: the fiscal sensitivity to a decline in relevant commodity prices (which we find that Chile's fiscal accounts can significantly deteriorate with a decline in the price of copper) and a real devaluation (we found a large positive effect for Chile and a very minor negative effect for Argentina). The finding that a partially dollarized country like Argentina holds a roughly balanced dollar position illustrates how fiscal sustainability, rather than on the composition of explicit liabilities, ultimately depends in a complex way on the overall structure of revenues and expenditures, of which debt represents but a small fraction.

We believe that our analysis allows to evaluate public accounts within a framework that is at the same time stochastic and comprehensive of all the components of the government's balance sheet. By providing a comprehensive measure of fiscal policy it can usefully complement traditional approaches to price debt instruments or evaluate the benefits and scope of debt relief initiatives. The examples reported here, while preliminary and for presentational purposes,[33] provide sufficient indication of the relevance and replicability of this new methodology. In particular, they highlight the need to revisit the way in which the currency exposure and the sensitivity to real devaluations of partially dollarized economies is usually assessed.

[33] The computation is very intensive in country-specific information and should be conducted by analysts with a good knowledge of the institutional characteristics of each country.

Appendix *Table A.1 VAR Coefficients*

Real exchange rate equation	Argentina	Chile	Output growth equation	Argentina	Chile
Real exchange rate			Real exchange rate		
L1	0.693***	1.141***	L1+	0.000	-0.019
	(0.048)	(0.183)		(0.000)	(0.050)
L2	-0.355***	-0.481**	L2+	0.000	-0.045
	(0.068)	(0.242)		(0.000)	(0.066)
L3	0.136**	0.332	L3+	0.000	-0.015
	(0.067)	(0.241)		(0.000)	(0.066)
L4	-0.040	-0.003	L4+	0.000	0.085*
	(0.048)	(0.168)		(0.000)	(0.046)
Output growth			Output Growth		
L1	-1.446***	-0.106	L1	0.807***	-0.079
	(0.307)	(0.616)		(0.157)	(0.169)
L2	-0.247	-0.973**	L2	-0.114	-0.154
	(0.366)	(0.607)		(0.201)	(0.167)
L3	-0.436	0.354	L3	0.011	-0.137
	(0.334)	(0.648)		(0.190)	(0.178)
L4	-0.168	-0.828*	L4	-0.071	-0.200
	(0.276)	(0.533)		(0.148)	(0.147)
Post Convertibility dummy	0.547***		Post Convertibility dummy+	0.000	
	(0.024)			0.000	
Us rates L1	0.862	-2.126	Us rates L1	0.289	0.401
	(1.312)	(1.978)		(0.682)	(0.544)
Us rates L2	2.121	3.869**	Us rates L2	-0.471	0.640
	(1.320)	(1.972)		(0.684)	(0.542)
Constant	0.116	-0.024	Constant	0.012	-0.330**
	(0.072)	(0.541)		(0.014)	(0.149)
Copper L1		0.000	Copper L1		0.000
		(0.000)			(0.000)
Copper L2		0.024	Copper L2		0.000
		(0.541)			(0.000)

* significant at 10%; ** significant at 5%; *** significant at 1%
Standard errors in parentheses
+ for variables restricted to zero

Table A. 2. Coefficients for Expenditure and Income for Chile

	Value Added Tax	Income Tax	Exports Tax	Other income
Log(real exchange rate)	0.003**	-0.025	0.000	-0.005
	0.000	(0.013)	(0.000)	(0.006)
Growth of GDP	-0.002	-0.139	0.000	-0.122
	(0.006)	(0.120)	(0.000)	(0.078)
Constant	-0.006*	0.311**	0.013**	0.059
	(0.003)	(0.076)	(0.002)	(0.035)
Other control variables	No	Yes	No	No
R-squared	0.601	0.436	0.000	0.082

	Government Consumption	Transfers	Capital Expenditures
Log(real exchange rate)	0.005	0.022**	-0.001
	(0.002)	(0.004)	(0.007)
Growth of GDP	-0.092**	-0.069	0.002
	(0.032)	(0.060)	(0.098)
Constant	0.026	-0.082**	0.041
	(0.014)	(0.027)	(0.045)
Other control variables	Yes	No	No
R-squared	0.774	0.424	0.001

Table A. 3. Coefficients for Expenditure and Income for Argentina 2000

	Value Added Tax	Income Tax	Other income	Exports
Log(real exchange rate)	-0.047*	0.008	0.100**	0.151**
	(0.022)	(0.044)	(0.024)	(0.015)
Growth of GDP	-0.017	-0.01	-0.177**	-0.074
	(0.053)	(0.027)	(0.059)	(0.036)
Constant	0.089**	0.015	0.003	0.032**
	(0.011)	(0.017)	(0.012)	(0.007)
Other control variables	No	Yes	No	No
R-squared	0.241	0.903	0.579	0.845

	Government Consumption	Transfers	Capital Expenditures
Log(real exchange rate)	-0.023*	0.096**	-0.055**
	(0.008)	(0.016)	(0.009)
Growth of GDP	0.007	-0.041	0.024
	(0.020)	(0.039)	(0.021)
Constant	0.045**	0.033**	0.040**
	(0.004)	(0.008)	(0.004)
Other control variables	Yes	Yes	No
R-squared	0.680	0.646	0.680

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