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TOOLS FOR THE ANALYSIS OF DEBT PROBLEMS

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The purpose of this paper is to review a number of tools that may allow an independent observer to assess the likelihood of default, to provide the clues for an evaluation of likely restructuring scenarios and to be able to estimate possible financial and real implications of such an event. In this study we develop seven key measures for analyzing debt problems. The seven measures are mutually reinforcing in that each measure helps to shed lights on aspects of debt problems highlighted by the others. Depending on the nature of the problem some measures may be used alone.

Keywords: Default; restructuring; fiscal unsustainability; financial sector crisis.

1. Introduction

The decision to default is usually reached after a painful process in which the country or the country's authorities agonize over the decision. Fears of being ostracized from the international financial community, of being subject to trade sanctions, or to be repudiated economically and politically contribute to the perception of the costliness of default. Historical experience reinforces this view in light of the protracted negotiations that followed each default episode, at least prior to the 1990s.

Recent default experiences show an impressive common pattern.[1] In most cases, an extremely fragile political system, using a fixed exchange rate to gain credibility and stability, runs unsustainable fiscal policies. Eventually the exchange rate regime instability becomes banking sector uncertainty for two reasons. First, the fear of devaluation combined with balance sheet risk puts at risk the solvency of the balance sheets of the banks. Second, fears of default affect directly the asset side of banks balance sheets.[2] Eventually, the capital outflows resulting from the fears of a banking collapse trigger the collapse of the currency, forcing a bailout of the financial sector, which makes the government bankrupt and the run rational. The output collapse as a result of the financial sector crisis also contributes to the payment difficulties. In some cases, this vicious circle is fed by negative sentiment and negative market expectations that make the adjustment even more difficult and costly. Thus, while the specifics may differ in each case defaults are, in general, the result of a combination of serious mismanagement of local policies, fiscal imbalances, overvalued exchange rates, and financial crises.

In some cases, the process leading to default may be the realization of a bad equilibrium when other equilibria without default were also possible. If market participants become skeptical about a country paying its debt (due to sustainability fears or just the perception that the

[1] See Chuhan and Sturzenegger (2003) for a review.
[2] Powell and Sturzenegger (2002) have shown that balance sheet effects transform currency risk into country risk in dollarized economies, thus providing evidence on the relevance of the balance sheet effect.

country is unwilling to pay), this will immediately trigger a liquidity crunch. In the extreme, the country is unable to roll over the debt and is forced into default.

In what follows we discuss, each of the following seven tools of debt analysis in turn:

(i) establishing a set of early warning signals;
(ii) static solvency analysis;
(iii) estimating the probability of default;
(iv) understanding the basics of debt sustainability analysis;
(v) estimating possible debt restructuring scenarios;
(vi) assessing the financial costs of default;
(vii) evaluating the output effects of default.

2. Establishing a Set of Warning Signals

How to define the macroeconomic scenario that triggers a debt problem is one of the most important tasks in trying to anticipate possible restructuring events. As we mentioned above, there is a striking common pattern in debt problems during the 1990s: a weak fiscal situation, current account problems, and extensive liability dollarization, foster devaluation and default expectations, triggering a bank run which plunges the economy into recession, which, in turn, further aggravates the fiscal scenario. Eventually, the output contraction and the need for fiscal resources to keep the financial sector afloat lead to the default decision.[3] Thus an effective early warning system will probably have to start by looking at the external situation of the country (also assessing its vulnerability to external shocks), at the fiscal situation, and at the soundness of the banking sector.

While there are relatively standard techniques to study current account sustainability, fiscal soundness, or banking sector problems in isolation, we will focus here on how to bring together information from these and other dimensions for a systematic assessment of debt problems.[4]

Several papers have tried to provide a system of early warning signals of debt episodes.[5] These papers differ both in the variables considered as well as in the results obtained, and surprisingly all leave out banking crises and financial sector indicators.

The main papers in this field are Ades *et al.* (2000), Detragiache and Spilimbergo (2001), Menasse *et al.* (2003), and Pescatori and Sy (2003). Ades *et al.* construct a model of sovereign spreads (that can be directly linked to the probability of default), using data for 15 emerging market economies from 1996 onwards. The sample includes countries from Latin America, Asia, Emerging Europe, the Middle East, and Africa. Detragiache and Spilimbergo define debt crises when either or both of the following occur: (a) there are arrears of principal or interest on external obligations towards commercial creditors of more than 5% of total commercial debt outstanding and (b) there is a rescheduling or debt restructuring agreement with commercial creditors. Their database includes 69 countries over the 1971–1998 period. Menasse *et al.* define a debt episode, if a country is classified by Standard and Poor's as being in default, or if the country has access to non-concessional IMF financing in excess of 100% of quota. This second definition tries to capture the near misses, i.e., debt episodes that did not become a default because they were helped by sizable bailouts. Their database includes 47 countries since 1970. Pescatori and Sy (2003) define a debt episode when either a default as defined by Standard and Poor's or secondary market sovereign bond spreads are higher than a threshold (usually 1000 bps.).

Table 1 shows the variables found to be significant by each researcher and their effect on the probability of default.

[3]There is an ample literature that relates banking crises with currency crises. See Kaminsky and Reinhart (1999) and Glick and Hutchison (1999).

[4]On current account sustainability see Deutsche Bank (2000) and Edwards (2001). On banking soundness see Caprio *et al.* (2002). We develop an analysis of fiscal solvency further below.

[5]Which should not be confused with an early warning signal for currency crises.

Table 1. The literature on early warning signals.

	Ades	DS	MRS	PS
Solvency variables				
GDP growth	−	ns	ns	−
External debt to GDP	+	+	+	+
Budget balance as % of GDP	−	ns		
Exports to GDP	−			
Overvaluation	+	+		+
% Multilateral		+		
External debt/reserves			+	
Liquidity variables				
Global liquidity	+	ns	ns	
Amortizations/reserves	+			
Short-term debt/reserves			ns	+
Short-term debt		+		
Debt service due		+		
Reserves		−		
Interest on short-term debt			+	
Other				
Default variable	+			
Oppenness		ns	−	−
Inflation volatility			+	
Dummy for inflation >50%			+	
Year with presidential election			+	

Ades, Ades *et al.* (2000); DS, Detragiache and Spilimbergo (2001); MRS, Menasse, Roubini and Schimmelpfennig (2003); PS, Pescatori and Sy (2003).

The rationale for including these variables is relatively straightforward. GDP growth allows for more fiscal resources and thus increases sustainability, as does a lower debt ratio (as a percentage of GDP or as a percentage of reserves) and a higher fiscal surplus. The exports to GDP variable indicates how likely the country is to obtain the foreign resources to finance its external debt. A higher ratio of exports and nonfactor services to GDP diminishes the risks associated to debt. A smaller overvaluation works in the same way. The share of multilaterals signals difficulty in accessing the markets (even though this variable may be endogenous). Liquidity is improved by lower amortizations to reserves, lower short-term debt, lower debt service coming due, and higher reserves. High interest rate signal debt problems (again this variable may be endogenous). High interest rates abroad (the global liquidity variable) implies that capital flows may be more likely to remain in or flow back to developed economies thus increasing the rollover risk in emerging economies.

The default variable signals past history and therefore signals a higher chance of a new debt episode, openness is associated to lower risk, as countries that are more open have more trade at stake and care more about maintaining a good working relation with international financial markets. Finally, macroeconomic instability as measured by inflation volatility, high inflation, and presidential elections (this one maybe endogenous), all increase the risk of a debt episode.

3. Static Solvency Analysis

The most commonly used indicators of debt problems are known as debt ratios, which provide a first and direct glance at a country's possible debt problems. These indicators give an assessment of the burden imposed by the country's debt, but because they look at the situation in a specific moment in time we refer to them as "static" solvency analysis.

The two most commonly looked at debt ratios are the debt to GDP (Debt/GDP) ratio, that measures the size of the stock of debt relative to the economy, and the interest payment due each year, also as a percentage of GDP (I/GDP). The Debt/GDP ratio measures how big the debt is and is the most general proxy for debt problems. The I/GDP ratio looks at the burden imposed on the country that specific year in terms of interest payments. These variables, however, are just indicative of debt problems. A country with a relatively small debt but facing large interest payments in the near future may default on its debt in spite of it being able to repay its obligations had the maturity of the debt been different. Conversely, countries with high debt to GDP ratios may have low interest burdens if the debt was mostly granted on concessional terms, and therefore not have a debt problem.[6]

[6]When referring to public sector debt, debt numbers include "explicit" debt, i.e., that which is registered in the books of the public sector. However, many governments have hidden liabilities arising from social security dynamics or unfulfilled obligations. Most debt analyses omit these items. However, a careful assessment should not avoid looking into the potential obligations of the government in search of "skeletons."

The measurement of debt can be refined in several ways. Usually many analysts distinguish between external debt (that owed to non-residents) and domestic debt owed to residents. External debt ratios give a better assessment of the external resources the economy will have to generate in order to service its debt. Most of the time, external debt is measured by looking at dollar (or foreign currency) denominated debt, while domestic debt is measured by local currency denominated debt. This distinction, however, does not make much sense.[7] Many countries are not willing or cannot issue locally denominated debt; in those countries locals purchase and trade actively in foreign denominated debt.

In many countries, local residents hold considerable foreign assets. An important question is whether relevant debt stocks should be gross debt or net of foreign assets. Following Hausmann and Velasco (2002) we suggest disregarding foreign assets, when analyzing debt sustainability, as these assets seldomly are available in times of crises. Thus, when liquidity or solvency problems arise, countries cannot count on these resources to provide a counterweight to the burden of debt. An exception may be the assets of local firms abroad or those held by the foreign headquarters of local firms, as in both cases the firm may be willing to commit some resources in order to have the country avoid debt problems and thus avert harming the credit rating of the (global) corporation.

Another necessary distinction is between public and private debt. Total debt includes debt owed by the government (public debt) and by the private sector (private sector debt).[8] The interest to GDP ratio corresponding to public debt also determines the primary surplus the government has to attain in order to keep the total level of debt constant. While private debt should not be included in an assessment of sovereign defaults, many analysts include private debt burdens as part of the overall debt problem *of the government*. The reasoning behind this relies on the fact that a debt default may have consequences that go well beyond the interruption of debt payments and are usually associated to devaluations, capital controls and other disruptions in the normal operation of the economy. When this happens, many governments nationalize or take up part of the debt burden of the private sector. Anticipation of this requires adding the private sector debt burden in the assessment of debt problems.

The interest to debt ratio (I/Debt) measures the average cost of the debt. This number is obviously affected by the maturity and coupon structure of the debt, but provides a first approximation to the yearly cost of the debt. It should be distinguished from the marginal cost of debt, which is the cost of new indebtedness. As an economy approaches a debt default situation the marginal cost of debt skyrockets while average costs remain relatively stable.[9]

In order to measure potential liquidity problems it is common to use the financing requirement ratio. Financing requirements are usually measured in dollar terms rather than as a percentage of GDP. Financing requirements measure how much money the government, private sector or both will have to obtain in the market during a given period of time. Computing financing requirements implies knowing the amortization structure of the debt. A T-bill with a 3-month maturity of 3 billion will enter in the financing requirement numbers for the following year as 12 billion as it will have to be rolled over four times during that period. Financing requirements are a good indicator of potential liquidity problems. As long as the market rolls over automatically existing debt, amortizations are usually not considered an important part of the debt problem. However, once roll-over is under question, knowing how many resources the market will have to provide becomes essential.

[7] Similarly, while less common, non-residents also hold locally denominated debt.

[8] Public sector debt may be classified by level of government, and so on.

[9] Mussa (2002), for example, in his description of the Argentine crisis confuses the two terms, thus making a negative assessment of the debt situation that was not warranted by the facts.

In order to figure out the burden of the interest payments on the budget we use the ratio of interest to total revenue or taxes. If this ratio is very high, it indicates that a large fraction of government's income is being used for servicing the debt. Such a situation is worrisome, at least in terms of assuring creditors that the country will be able to maintain the political support for servicing the debt.

There are many other debt indicators such as Debt/Exports, Interests/Exports, Amortizations/Reserves, among others. Each of these ratios may be useful to analyze specific circumstances or issues. The Debt/Exports ratio, for example, is particularly relevant for a country that is relatively isolated from world capital markets and whose only source of foreign exchange are trade related activities. For countries better integrated, the ratio becomes less significant, etc.

Table 2 illustrates the usefulness and the drawbacks of debt ratios. The table includes two groups of emerging economies. The first includes the countries that defaulted on their debt during the 1990s.[10] The second corresponds to an arbitrarily selected group of non-defaulters.

Among the first group, Pakistan shows the largest debt burdens both in terms of debt to GDP ratios as well as in terms of the size of resources absorbed by interest payments. Ecuador shows a slightly smaller debt to GDP ratio, but its low average cost (the result of debt restructurings and concessional lending), reduces substantially the size of interest payments. Yet, as a percentage of tax revenues the cost remains sizable. The other countries, with differences, show a much more manageable picture, both in terms of debt ratios, required primary surpluses and share of taxes used for interest payments.

While these indicators allow us to identify most obviously problematic cases, it is clear from the table that it is difficult to assess a problem country from static indicators alone. For example, Table 3 shows no major difference in terms of debt burdens between the group of non-defaulting countries and the defaulters Argentina, Ukraine, and Russia.

Why do static debt indicators work so poorly? Debt problems, by definition have to do with an intertemporal problem. Debt burdens may be considered a problem or not depending

Table 2. Debt ratios of defaulter and non-defaulter countries.

Year end before the crisis	Defaulters					Non-defaulters			
	Argentina (2000)	Ecuador (1998)	Pakistan (1998)	Russia (1997)	Ukraine (1999)	Colombia	Mexico	Venezuela	Poland
Interest/GDP	3.4	3.2	7.1	4.8	2.4	5.0	2.6	3.3	2.9
Interest/Taxes	26.1	44.9	52.2	48.4	7.4	25.3	25.7	18.7	11.0
Interest/Public Debt	7.5	4.0	7.5	9.0	3.8	9.8	9.4	9.3	7.4
Public Debt/GDP	44.9	80.0	94.3	52.5	62.8	50.8	27.7	35.3	39.1

Source: IMF, GS estimates.

Table 3. Difference in terms of debt burders between the groups of defaulter and non-defaulter countries.

	Argentina, Ukraine, and Russia	Colombia, Venezuela, Mexico, and Poland
Interest/GDP	3.5	3.5
Interest/Taxes	27.3	20.2
Interest/Public Debt	6.8	9.0
Public Debt/GDP	53.4	38.2

Source: IMF, GS estimates, Global Development Finance (WB).

[10]To make the comparison meaningful for these countries we include the numbers prior to default.

on whether the market thinks that in the future the country will be able (or willing) to honor its obligations or not. Thus, it is less important where the country stands today, relative to where analysts and market participants think the country will be in the future. However, in spite of its limitations, the analysis of debt ratios remains one of the most important methods of analysis of debt problems.

4. Estimating the Probability of Default with a Fixed Recovery Value

Bond prices allow for a relatively easy computation of expected default probabilities. Consider a sovereign bond that matures in one period. No arbitrage opportunities between assets imply that, in a risk-neutral world, the default inclusive rate of return on the sovereign bond should equal to the rate of return from risk-free asset, i.e.,

$$(1+i)\times(1-\text{IPD})+R\times\text{IPD}=(1+r), \qquad (1)$$

where IPD refers to the implicit probability of default, i denotes the yield on the sovereign bonds, r is the yield on US treasury bills with identical maturity date and size as that of the sovereign bond, and R indicates historical recovery values of bonds in the event of default.

This equation indicates that the return (i) if there is no default (which happens with probability $1-\text{IPD}$) plus the recovery value (R) in the event of default (which happens with probability IPD), have to equal in expected value the risk-free rate r.

Equation (1) can be simplified to yield:[11]

$$\text{IPD}=\left[\frac{S(1+r)}{S(1+r)+(1+r-R)}\right], \qquad (2)$$

where the spread is defined as

$$S=\left[\frac{1+i}{1+r}\right]-1=\frac{i-r}{1+r}. \qquad (3)$$

Note that the spreads as defined here are the geometric spreads, i.e., the ratio of the rates of return on two assets. This definition of S is preferred to the usual approximation $i-r$, so that our probability of default is appropriately bounded between 0 and 1.[12]

In short, Eq. (2) indicates that the higher the spread, *given an expected recovery value*, the higher the probability of default. Thus, under the assumption of relatively stable and measurable recovery values spreads can be used directly to estimate default probabilities.

While the above assumes that the bond has a maturity of one period, the above computation extends to the case of a bond with longer maturities as long as the probability of default is distributed uniformly over the life of the bond.[13]

Assume a multiperiod bond with a constant probability of default that we will model as a Poisson process with parameter λ. The probability of no default from time zero until time t is then $\mathrm{e}^{-\lambda t}$. The annualized probability of default is $(1-\mathrm{e}^{-\lambda})$, which is approximately λ when λ is not too large.

Under the assumption of recovery value R for one dollar of principal, the market price of a bond paying annual coupon C should be

$$\begin{aligned}P&=\sum_{i=1}^{n}C\frac{1}{(1+r)^i}\mathrm{e}^{-i\lambda}+\frac{1}{(1+r)^n}\mathrm{e}^{-n\lambda}\\&\quad+R\sum_{i=1}^{n}\frac{1}{(1+r)^i}[\mathrm{e}^{-(i-1)\lambda}-\mathrm{e}^{i\lambda}]\\&=\sum_{i=1}^{n}C\frac{1}{(1+r)^i}\frac{1}{(1+\Lambda)^i}+\frac{1}{(1+r)^n}\frac{1}{(1+\Lambda)^n}\\&\quad+R\sum_{i=1}^{n}\frac{1}{(1+r)^i}\frac{\Lambda}{(1+\Lambda)^i}\end{aligned}$$

where $\Lambda=\mathrm{e}^{\lambda}-1$.

So $1/(1+\Lambda)^i$ is the probability of no default and $\Lambda/(1+\Lambda)^i$ is the probability of default from period 0 to period i.

Consider a par floater paying an annual coupon of $1+i=r+S+rS$.[14] Then the price

[11]The formula provides the probability of default corresponding to the time frame specified in the interest rate return.
[12]The approximation $i-r$ may lead to substantial mispricing if r is large.
[13]This presentation follows closely the exercise done in JP Morgan (2000).
[14]Remember we defined $S=[(1+i)/(1+r)]-1$, so $1+i=(1+S)(1+r)$ and $i=r+S+rS$.

of the par floater is

$$1 = \sum_{i=1}^{n}(r + S + rS)\frac{1}{(1+r)^i}\frac{1}{(1+\Lambda)^i} + \frac{1}{(1+r)^n}\frac{1}{(1+\Lambda)^n} + R\sum_{i=1}^{n}\frac{1}{(1+r)^i}\frac{\Lambda}{(1+\Lambda)^i}$$

$$1 = \underbrace{\sum_{i=1}^{n}(r + \Lambda + r\Lambda)\frac{1}{(1+r)^i}\frac{1}{(1+\Lambda)^i} + \frac{1}{(1+r)^n}\frac{1}{(1+\Lambda)^n}}_{=1}$$

$$+(S + rS - \Lambda + R\Lambda - r\Lambda)\sum_{i=1}^{n}\frac{1}{(1+r)^i}\frac{1}{(1+\Lambda)^i}$$

Upon cancellation of 1 on both sides, we obtain the coupon spread:

$$S(1+r) = \Lambda(1 - R + r)$$

$$\Lambda = \frac{S(1+r)}{(1-R+r)}$$

that gives, once again, an implicit probability of default

$$\text{IPD} = \frac{\Lambda}{1+\Lambda} = \left[\frac{S(1+r)}{S(1+r) + (1+r-R)}\right]. \quad (4)$$

Table 4 presents the computations in Eq. (4) for different assumptions regarding recovery values and spreads, given a risk free interest rate (similar tables can easily be computed with a different assumption on the risk free rate). For example, the table indicates that for a recovery value of 50% and a spread of 350 bps, the market is assigning a 6.2% probability of default over the upcoming year.[15]

The probabilities of default increase as we move to the right in the table. Higher recovery values imply that a given spread can only be rationalized if there is a higher probability of default. Likewise, the higher the spreads, the higher the probability of default.

4.1. *Using credit default swaps to estimate default probabilities*[16]

Default probabilities can also be calculated from information implicit in credit default swap spreads. To evaluate the risk premium (credit spread) of an instrument we have to compute the difference between the present value of the risky asset versus the risk-free investment of \$1 for one period.

This one period risk premium must be equal to the expected gain that the buyer of default protection would want to be compensated for in the event of default. In the event of default, the buyer would deliver a bond and would get paid \$100. In the event of no default, the buyer would get paid nothing. Thus, the net value of the default payment is the difference between the cheapest bond that the investor can buy in the market and the \$100 payment.

Call R the bond price within 30 days of a default. The swap value in the event of default is $100 - R$ (assume par = 100). Let P_{d} be the probability of default. For the swap contract to have zero initial value (fairly priced), the expected gain from default must be equal to the premium paid.

$$P_{\text{d}}(100 - R) = \text{Premium} \quad (5)$$

or,

$$P_{\text{d}} = (\text{Premium})/(100 - R). \quad (6)$$

An example may clarify. Since the credit default swaps are quoted on an annual basis, a spread of 3000 bps would cost \$15 in 6 months. Assume the bond price in the aftermath of default is \$20 per \$100. The probability of default over the 6-month time frame would be:

$$P_{\text{d}} = (\text{Premium})/(100 - R)$$
$$= (15)/(100 - 20) \approx 18.75\%.$$

[15]The probability of default is estimated for the time period corresponding to the interest rates considered.
[16]This section follows closely Merril Lynch (2002).

Table 4. Implicit probability of default.

Spread — in basis points i	7%								
	Recovery value (as a % of principal)								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
50	0.5	0.6	0.7	0.8	0.9	1.1	1.4	1.9	3.1
100	1.1	1.2	1.4	1.6	1.8	2.2	2.8	3.8	5.9
150	1.6	1.8	2.0	2.3	2.7	3.3	4.2	5.6	8.6
200	2.2	2.4	2.7	3.1	3.6	4.4	5.5	7.3	11.2
250	2.7	3.0	3.4	3.8	4.5	5.4	6.7	9.0	13.6
300	3.2	3.6	4.0	4.6	5.3	6.4	8.0	10.6	15.9
350	3.7	4.1	4.6	5.3	**6.2**	7.4	9.2	12.2	18.1
400	4.2	4.7	5.3	6.0	7.0	8.3	10.4	13.7	20.1
450	4.7	5.2	5.9	6.7	7.8	9.3	11.5	15.1	22.1
500	5.2	5.8	6.5	7.4	8.6	10.2	12.6	16.5	23.9
550	5.7	6.3	7.1	8.1	9.4	11.1	13.7	17.9	25.7
600	6.2	6.9	7.7	8.7	10.1	12.0	14.8	19.2	27.4
650	6.7	7.4	8.3	9.4	10.9	12.9	15.8	20.5	29.0
700	7.2	7.9	8.9	10.1	11.6	13.7	16.8	21.7	30.6
750	7.6	8.4	9.4	10.7	12.3	14.6	17.8	22.9	32.1
800	8.1	9.0	10.0	11.3	13.1	15.4	18.8	24.1	33.5
850	8.6	9.5	10.6	12.0	13.8	16.2	19.7	25.2	34.9
900	9.0	10.0	11.1	12.6	14.5	17.0	20.7	26.3	36.2
950	9.5	10.5	11.7	13.2	15.1	17.8	21.6	27.4	37.4
1000	9.9	11.0	12.2	13.8	15.8	18.5	22.4	28.4	38.6
1050	10.4	11.4	12.7	14.4	16.5	19.3	23.3	29.4	39.8
1100	10.8	11.9	13.3	14.9	17.1	20.0	24.1	30.4	40.9
1150	11.3	12.4	13.8	15.5	17.8	20.7	25.0	31.3	42.0
1200	11.7	12.9	14.3	16.1	18.4	21.5	25.8	32.2	43.0
1250	12.1	13.3	14.8	16.6	19.0	22.2	26.6	33.1	44.0
1300	12.5	13.8	15.3	17.2	19.6	22.8	27.3	34.0	45.0
1350	13.0	14.2	15.8	17.7	20.2	23.5	28.1	34.9	45.9
1400	13.4	14.7	16.3	18.3	20.8	24.2	28.8	35.7	46.8
1450	13.8	15.1	16.8	18.8	21.4	24.8	29.5	36.5	47.7
1500	14.2	15.6	17.2	19.3	22.0	25.5	30.3	37.3	48.6
1550	14.6	16.0	17.7	19.8	22.5	26.1	31.0	38.1	49.4
1600	15.0	16.4	18.2	20.4	23.1	26.7	31.6	38.8	50.2
1650	15.4	16.9	18.7	20.9	23.6	27.3	32.3	39.5	50.9
1700	15.8	17.3	19.1	21.4	24.2	27.9	33.0	40.3	51.7
1750	16.2	17.7	19.6	21.8	24.7	28.5	33.6	41.0	52.4
1800	16.6	18.1	20.0	22.3	25.3	29.1	34.2	41.6	53.1
1850	16.9	18.5	20.5	22.8	25.8	29.6	34.9	42.3	53.8
1900	17.3	18.9	20.9	23.3	26.3	30.2	35.5	43.0	54.5
1950	17.7	19.3	21.3	23.7	26.8	30.7	36.1	43.6	55.1
2000	18.1	19.7	21.7	24.2	27.3	31.3	36.6	44.2	55.7
2500	21.6	23.5	25.8	28.5	31.9	36.3	42.0	49.8	61.1
3000	24.9	27.0	29.4	32.4	36.0	40.6	46.5	54.3	65.4
3500	27.9	30.1	32.7	35.9	39.7	44.3	50.3	58.1	68.8
4000	30.6	33.0	35.7	39.0	42.9	47.7	53.6	61.3	71.6
4500	33.2	35.6	38.5	41.8	45.8	50.6	56.5	64.1	73.9
5000	35.5	38.1	41.0	44.4	48.4	53.2	59.1	66.5	75.9
5500	37.8	40.3	43.3	46.8	50.8	55.6	61.4	68.5	77.6
6000	39.8	42.5	45.5	48.9	53.0	57.7	63.4	70.4	79.1

Table 5 shows the sensitivity to the price of the cheapest asset within 30 days of default using the Brazil CDS spreads mid-June.

While the CDS market may be useful to provide an alternative estimation of the default probability, one should be aware that, on

Table 5. Sensitivity of recovery value.

Recovery values	Probability of default
0.15	28.3%
0.20	30.0%
0.25	31.5%
0.30	33.3%

Source: Bloomberg.

occasions, the market becomes extremely thin. Once trading stops CDS may provide a distorted view of default probabilities.

5. Debt Sustainability Analysis

Debt sustainability has become one of the most used and abused concepts in the recent discussion regarding international financial architecture. Because debt sustainability has to do with the possibility of paying debts over the infinite future, it is obvious that reaching an agreement as to when this is possible and when it is not is a daunting task. This difficulty is compounded by the fact that governments will claim that they can make the payments, and that they can generate the needed primary surpluses even when history or common sense tends to suggest that such primary surpluses are not attainable. The issue is further complicated by the fact that what is attainable or not depends squarely on growth forecasts, and here governments, international financial institutions (IFIs) and the markets are certainly not bound to agree.

Thus, we accept this truth openly: debt sustainability is an ill-defined concept. In what follows we provide, nevertheless, the most standard approximation to the issue of debt sustainability. To do so we start from the intertemporal budget constraint of the government. We show that if the debt is to be paid, current debt levels have to equal the present discounted value of future fiscal primary surpluses. With this fact, we implement two exercises. One is to find out, under the assumption that the economy is in steady state, what this primary surplus should be. Second, we allow for a transition phase. In this case we ask, given a possible long term primary surplus, what the maximum level of deficit allowed in the short run is. We also discuss the implications of exchange rate depreciations on sustainability.

5.1. *The arithmetic*

The basic equation describing the dynamics of debt accumulation is

$$D_{t+1} - D_t = i_{t+1} D_t - \mathrm{PS}_{t+1}, \tag{7}$$

where PS_{t+1} is primary surplus of period $t+1$, D_{t+1} is total end-of-period $t+1$ public debt stock (both domestic and external), D_t is total beginning-of-period $t+1$ public debt stock (both domestic and external) and i_{t+1} is period $t+1$ interest rate.

Expressing everything as a percentage of GDP, we have:

$$\frac{D_{t+1}}{\mathrm{GDP}_{t+1}} = (1+i)\frac{D_t}{\mathrm{GDP}_t}\frac{\mathrm{GDP}_1}{\mathrm{GDP}_{t+1}} - \frac{\mathrm{PS}_{t+1}}{\mathrm{GDP}_{t+1}}. \tag{8}$$

Thus, we obtain:

$$d_{t+1} = \frac{(1+i_{t+1})}{(1+g_{t+1})} d_t - ps_{t+1}, \tag{9}$$

where g_{t+1} is the GDP growth rate from period t to period $t+1$.

This is a standard difference equation. Solving it forward and imposing the transversality condition that debt stock as a percentage of GDP in present value converges to zero, we find the solution to be:

$$d_t = \frac{1+g_{t+1}}{1+i_{t+1}} \left[ps_{t+1} + \sum_{v=t+1}^{\infty} R_{t+1,v} ps_{v+1} \right], \tag{10}$$

where

$$R_{t+1,v} = \prod_{s=t+1}^{v} \frac{1+g_{s+1}}{1+i_{s+1}}, \tag{11}$$

i.e., the debt stock has to equal the present value of future primary surpluses.

If we assume that the interest rate and GDP growth rate are constant, then:

$$d_t = \frac{1+g}{1+i} \left[ps_{t+1} + \sum_{v=1}^{\infty} \left(\frac{1+g}{1+i} \right)^v ps_{t+1+v} \right]. \tag{12}$$

If the primary surplus is always constant, we solve the above equation assuming that the primary surplus is always equal to $\overline{\text{ps}}$ to yield:

$$\text{Target } \overline{ps} = d_t \left[\frac{1+i}{1+g} - 1\right] = d_t \left[\frac{i-g}{1+g}\right], \quad (13)$$

if $0 < \frac{1+g}{1+i} < 1$.

5.2. *A first pass at debt sustainability*

Our first exercise uses Eq. (13) and asks what primary surplus the government needs in order to make the debt sustainable. The results are presented in Table 6. The table assumes an annual interest rate of 7% but different GDP growth rates and initial debt stocks. The table should be read in the following way: given the expected rate of growth and the debt to GDP ratio, the table indicates the permanent primary surplus needed for that debt to be sustainable. For example if a country has a debt to GDP ratio of 130% and its expected growth rate is 2%, it needs to obtain a 6.4% primary surplus to honor its debt. If expected growth rate is 5% the number falls to 2.5%. Obviously, the higher the growth rate the smaller the required primary surplus, because the debt to GDP ratio becomes increasingly stable the faster GDP is growing.

Table 6. Necessary permanent primary surplus.

Public debt to GDP i (%)	7.0%					
	GDP growth rate					
	1.0	2.0%	3.0%	4.0%	5.0%	6.0%
35	2.1	1.7	1.4	1.0	0.7	0.3
40	2.4	2.0	1.6	1.2	0.8	0.4
45	2.7	2.2	1.7	1.3	0.9	0.4
50	3.0	2.5	1.9	1.4	1.0	0.5
55	3.3	2.7	2.1	1.6	1.0	0.5
60	3.6	2.9	2.3	1.7	1.1	0.6
65	3.9	3.2	2.5	1.9	1.2	0.6
70	4.2	3.4	2.7	2.0	1.3	0.7
75	4.5	3.7	2.9	2.2	1.4	0.7
80	4.8	3.9	3.1	2.3	1.5	0.8
85	5.0	4.2	3.3	2.5	1.6	0.8
90	5.3	4.4	3.5	2.6	1.7	0.8
95	5.6	4.7	3.7	2.7	1.8	0.9
100	5.9	4.9	3.9	2.9	1.9	0.9
110	6.5	5.4	4.3	3.2	2.1	1.0
120	7.1	5.9	4.7	3.5	2.3	1.1
130	7.7	**6.4**	5.0	3.8	**2.5**	1.2
140	8.3	6.9	5.4	4.0	2.7	1.3
150	8.9	7.4	5.8	4.3	2.9	1.4
160	9.5	7.8	6.2	4.6	3.0	1.5

What primary surplus may be considered feasible or not feasible is debatable. In general, what is feasible usually is determined by a historical comparison that, to some extent, factors in political and economic constraints. For example, Argentina has had trouble delivering primary surpluses above 1% of GDP, given this, a primary surplus of 6.4% would be dubbed unsustainable.

Of course, the above exercise is strongly influenced by the cost of debt and reducing the interest rate on the debt improves sustainability. Changing the interest rate requires reestimating the table using Eq. (13). Appendix A shows two other cases for debt sustainability using a 4% and a 12% interest rate.[17]

5.3. *Does a devaluation affect debt sustainability?*[18]

Key to the analysis of the impact on debt sustainability of a devaluation is to keep track of the denomination of debt in terms of tradables and non-tradables. The debt to GDP ratio (d) can be expressed as:

$$d = \frac{B + eB^*}{Y + eY^*} \quad (14)$$

where e is the real exchange rate (defined as the price of tradables relative to non-tradables), B is debt payable in terms of non-tradables, B^* is debt payable in terms of tradables, Y is output of non-tradables, and Y^* is output of tradables.

Mismatches between debt and output composition can lead to substantial differences in the debt/GDP ratio following a real exchange rate depreciation. For example, consider the case in which all debt is foreign denominated $d = eB^*/Y$. This is the worst scenario in which

[17]The interest rate that has to be used for this exercise is the average interest rate, and therefore quite isolated from sharp spikes in the marginal rates caused by liquidity crises.

[18]This section follows closely Calvo *et al.* (2002).

a real exchange rate depreciation hits fully on sustainability. Another case that is particularly relevant is that in which $(B/eB^*)/(Y/eY^*) = 1$, i.e., when the composition of debt and output is perfectly matched. When this condition holds, a depreciation has no effect on debt ratios. Table 7, taken from Calvo *et al.* (2002) shows how some countries ranked in terms of mismatch at the time of the Russian crisis. A value of 1 indicates a perfect match, and value of zero would indicate the highest degree of mismatch. Clearly, the highest mismatch holds for Argentina. On the other side of the spectrum lies Chile, the best matched economy, with a value of 0.45.

Table 7. Public sector debt mismatch measure.

	Argentina	Ecuador	Colombia	Brazil	Chile
B/eB^*	0.08	0.02	0.59	1.76	1.30
Y/eY^*	8.63	2.94	6.36	12.34	2.85
$(B/eB^*)/$ $(\mathrm{Y/eY^*})$	0.01	0.01	0.09	0.14	0.45

Source: Calvo *et al.* (2002), Table 6. Values are given for 1998.

Consider now the effects of a depreciation of the real exchange rate of 50%. Argentina and Ecuador, would be the hardest hit. Just because of the relative price adjustment (holding the assumption that interest rates on public debt and GDP growth remain unchanged), Argentina's debt/GDP ratio jumps from 36.5% GDP to 50.8%. Quite a different scenario plays out for Chile, where the debt revaluation effect is minimal: public sector debt as a share of GDP increases from 17.3 to 18.7%. The increase in the required primary surplus is shown in Table 8, also taken from Calvo *et al.* (2002).

5.4. *Sustainability in five real cases*

As a real-world example of the previous simulation consider the required primary surplus for five countries that did default during the

Table 8. Fiscal sustainability under a 50% real exchange rate depreciation.

	Argentina	Brazil	Chile	Colombia	Ecuador
Real Interest Rate	7.1	5.8	5.9	7.3	6.3
Real GDP Growth	3.8	2.0	7.5	3.6	2.6
Observed Public Debt (% of GDP)	36.5	51.0	17.3	28.4	81.0
i. Req. Primary Surplus (% of GDP)	1.2	1.9	n.a.	1.0	2.9
With 50% depreciation					
Imputed Public Debt (% of GDP)	50.8	58.1	18.7	34.9	107.2
ii. Req. Primary Surplus	1.6	2.2	n.a.	1.2	3.9
Extra primary surplus needed (ii − i)	14.3	7.1	n.a.	6.5	26.3

Source: Calvo *et al.* (2002) estimates. Values are given for 1998. n.a.: Not applicable given that the real interest rate is smaller than the growth of GDP, so sustainability is not a concern.

Table 9. Debt sustainability before and after default (all data as % of GDP).

	Country indicators before and after default									
	Argentina		Ecuador		Pakistan		Russia		Ukraine	
	Before (2000)	After (2002)	Before (1998)	After (2000)	Before (1998)	After (2000)	Before (1997)	After (2000)	Before (1999)	After (2000)
Government debt	44.9	130.0	80.0	106.8	94.3	98.0	52.5	64.3	62.8	44.1
Primary balance (actual data)	0.4	?	2.9	7.6	−0.3	1.2	−2.0	5.0	0.9	2.5
Required primary balance for sustainability	2.6	7.5	4.6	6.2	5.4	5.7	3.0	3.7	3.6	2.5

Source: IMF and author's computations.

1990s in Table 9. The required primary surplus is computed under the assumption of an annual interest rate of 10% and a GDP growth 4% per year and then compared with actual primary surpluses in the aftermath of default.

Noticeably, in spite of the devaluations that came with defaults which increased the burden on sustainability, with the exception of Pakistan, for which debt burdens were and remain unsustainable, all other countries have attained sustainability in the post-default period. For all countries, fiscal adjustment accommodated the larger pressure.[19]

The striking adjustments in the primary surplus point to another factor that has to be taken into account when considering the effect of a devaluation on debt sustainability: the fact that the devaluation may by itself increase the primary surplus. The reason for this increase arises, on the one hand, from the fact that the revenue base of the government is at least partially dollarized. In fact, the prices of the production of all tradables (not only exports) increase following the devaluation. On the other hand, the main liability of government spending are wages and pensions that are quoted in domestic currency. Thus, as long as wages and pensions lag behind prices and the exchange rate, there is an automatic improvement in the primary surplus as a result of a devaluation. Thus, what is relevant for determining if fiscal sustainability is compromised or not by a devaluation is to compare the effect of the devaluation on debt ratios on the one hand, with the effect of devaluation on primary surpluses on the other. The elasticity of the primary surplus relative to devaluation will be higher, the higher the wage bill in government spending. The degree of pass through of the economy (which measures how much local wages will change upon a devaluation of the currency) is critical for evaluating the scope for a fiscal improving nominal devaluation. The recent experience of crisis countries, particularly in Latin America, as well as the result in Table 9, suggest that there is significant scope for this effect to be very significant.

5.5. *Using the framework to estimate transitional feasible deficits*

If we assume in Eq. (13) that we arrive at the steady state primary surplus only after one period, then we can compute the primary surplus that can/should be obtained in the short run as:[20]

$$ps_t = d_t \frac{(1+i)}{(1+g)} - \overline{ps} \frac{(1+i)}{(i-g)}. \tag{15}$$

Assuming different steady state primary surpluses, we can calculate what primary surpluses a country has to run today to make its debt sustainable. The results are presented in Table 10.

A negative value implies that the debt is sustainable and therefore that the government can actually run a deficit in the short run. The table can help in assessing if a country that is not in steady state has a debt which is unsustainable. For this a feasible "long run" primary surplus has to be determined. Then an assumption on the growth rate should be made. Looking up the country, and choosing the row corresponding to the debt to GDP ratio of the country, the table will deliver the primary surplus/deficit that is compatible in the short run with debt sustainability. This value should be compared to actual primary surplus or deficit numbers.

6. Estimating the Haircut after Default

An important practical question when trying to estimate default probabilities relates to knowing what recovery value to use. One possibility is to use data from the US corporate bond market, where there is enough evidence on the recovery values obtained from past defaults. Table 11 shows the historical recovery rates included in Jarrow *et al.* (1997). As can be seen, recovery rates increase with the seniority of the debt with an average recovery rate of 39% for all US corporates.

[19]In the short run, it may very well represent an overshooting of its long-run level.

[20]The result can be extended to any period of undefined length by adjusting the interest rates to the new time set accordingly.

Table 10. Tolerable temporary primary surplus.

Public Debt to GDP i (%)	7%																							
Permanent PS	1%						2%						3%						4%					
GDP Growth Rate	1%	2%	3%	4%	5%	6%	1%	2%	3%	4%	5%	6%	1%	2%	3%	4%	5%	6%	1%	2%	3%	4%	5%	6%
35	19	15	10	0	−18	−72	1	−6	−17	−35	−71	−179	−16	−27	−44	−71	−125	−286	−34	−49	−71	−107	−178	−393
40	25	21	15	5	−13	−67	7	−1	−12	−30	−66	−174	−11	−22	−39	−66	−120	−281	−29	−44	−65	−102	−173	−388
45	30	26	20	11	−8	−62	12	4	−7	−25	−61	−169	−6	−17	−34	−61	−115	−276	−24	−38	−60	−96	−168	−383
50	35	31	25	16	−3	−57	17	10	−2	−20	−56	−164	−1	−12	−28	−56	−110	−271	−18	−33	−55	−91	−163	−378
55	40	36	30	21	3	−51	23	15	4	−15	−51	−158	5	−7	−23	−50	−104	−265	−13	−28	−50	−86	−158	−372
60	46	42	36	26	8	−46	28	20	9	−10	−46	−153	10	−1	−18	−45	−99	−260	−8	−23	−45	−81	−153	−367
65	51	47	41	31	13	−41	33	25	14	−4	−41	−148	15	4	−13	−40	−94	−255	−2	−17	−39	−76	−148	−362
70	56	52	46	36	18	−36	38	31	19	1	−36	−143	21	9	−8	−35	−89	−250	3	−12	−34	−71	−143	−357
75	62	57	51	41	23	−31	44	36	24	6	−31	−138	26	14	−2	−30	−84	−245	8	−7	−29	−66	−138	−352
80	67	63	56	47	28	−26	49	41	30	11	−25	−133	31	20	3	−25	−79	−240	13	−2	−24	−60	−132	−347
85	72	68	62	52	33	−21	54	46	35	16	−20	−128	37	25	8	−20	−74	−235	19	4	−19	−55	−127	−342
90	78	73	67	57	38	−16	60	52	40	21	−15	−123	42	30	13	−14	−69	−230	24	9	−14	−50	−122	−337
95	83	78	72	62	43	−11	65	57	45	26	−10	−118	47	35	18	−9	−64	−225	29	14	−8	−45	−117	−332
100	88	84	77	67	48	−6	70	62	50	32	−5	−113	52	41	24	−4	−59	−220	35	19	−3	−40	−112	−327
110	99	94	88	78	59	4	81	73	61	42	5	−103	63	51	34	6	−48	−210	45	30	7	−29	−102	−317
120	109	104	98	88	69	14	91	83	71	52	15	−93	74	62	44	16	−38	−200	56	40	18	−19	−92	−307
130	120	115	108	98	79	24	102	94	82	62	25	−83	84	72	55	27	−28	−190	66	51	28	−9	−82	−297
140	130	125	119	108	89	34	113	104	92	73	36	−73	95	83	65	37	−18	−180	77	61	38	1	−71	−287
150	141	136	129	119	99	44	123	115	102	83	46	−63	105	93	76	47	−8	−170	88	72	49	12	−61	−277
160	152	146	139	129	110	55	134	125	113	93	56	−52	116	104	86	58	3	−159	98	82	59	22	−51	−266

Table 11. Recovery values in previous restructurings.

Jarrow *et al.* (1997)	*US Corporates 74–91*	
	Senior secured	67.13
	Senior unsecured	46.53
	Senior subordinated	32.10
	Subordinated	26.44
	Junior subordinated	17.95
	Weighted average	39.22
Merrick (1999)	*Russian Eurobond*	13.0
	Pre-GKO Default: 07/23/1998–08/14/1998	27.3
	Post-GKO Default: 08/17/1998–12/14/1998	10.3
	Argentina	49.6
	Pre-GKO Default: 07/23/1998–08/14/1998	51.2
	Post-GKO Default: 08/17/1998–12/14/1998	49.3
Sosa Navarro (2002)	*Argentina*	
	12/10/01–12/20/01	21.7
	Post-Default: 12/21/01	20.8

Merrick (1999) using the additional information provided by looking at several bonds with cross default clauses (and thus the same default probability) obtained an independent estimator for the default probability and recovery values. He finds that for the Russian default, recovery values were substantially lower than those of US corporates, while Argentina's recovery values during the 1998 Russian crisis remained high and similar to a senior unsecured US corporate. Sosa Navarro (2002), using a similar framework, reestimated recovery values for Argentina in 2001, by then recovery values had fallen considerably.

Table 6 can also be used to estimate the haircut necessary to make the debt sustainable. To illustrate the workings of the exercise consider the case of Argentina. Assuming a debt to GDP ratio of 130%, a growth rate of 2% and an average interest rate of 7%, the table indicates that the country needs a primary surplus of 6.4% to pay its debt. Consider now that the maximum primary surplus attainable is 2% of GDP, an assumption that may be made as an informed guess which takes into account the political willingness and feasibility of delivering such a result. In order to figure out the necessary restructuring, we move up the column to find the debt to GDP ratio for which a 2% primary surplus is enough to ensure sustainability. Interpolating the figures in the table we find the number to be about 40%, in other words, under those assumptions, only a debt of 40% of GDP is sustainable. Given that the debt currently stands at 130% of GDP, the debt has to be reduced to 30.8% (40/130) of its original level delivering a haircut of about 69.2%.[21]

7. Estimating the Financial Impact of Default

Default entails two potential effects: it may increase financial costs and may potentially worsen growth performance. We explore these two issues in this section and the next.

The default decision will most likely change the future costs of indebtedness. However, there are two squarely different views on this issue. On the one hand, some argue that defaulting *reduces* financing costs because, by bringing the country closer to sustainability, it reduces the debt ratios, and improves the solvency of the country, enticing future creditors to offer financing at a lower cost. On the other hand, others argue that the reputational costs of the decision to default *increases* the financial cost looking forward, thus making future debt issues more costly, as new investors fear the recurrence of the default event. In addition to both of these effects, the haircut

[21]In the aftermath of a default the current debt to GDP ratio may be influenced by an overshooting of the exchange rate. In that case, the computations should more safely be done with an equilibrium level for the real exchange rate.

reduces by itself the financing costs directly from the lower level of debt.

One way to bring some structure to discussing this problem is using a model that estimates the equilibrium spreads for emerging market debt. Ades *et al.* (1998) do this. In that model, spreads are associated to debt levels as well as to previous default experiences. According to that model each percentage point reduction in the debt to GDP level implied a reduction of 7 bps in spreads. On the other hand, the same model estimated the reputational cost to be equal to 165 bps as identified by a restructuring dummy in the model. As a restructuring reduces the total amount of debt, the net effect is ambiguous.

In short, the financial impact of a restructuring, can be computed as

$$\begin{aligned}&\text{Change in debt payments (\% of GDP)}\\&= -\sum_{t=0}^{\infty}\left(\frac{1}{1+r^*}\right)^t\\&\quad\times(r_t^{\text{before}}d_t^{\text{before}} - r_t^{\text{after}}d_t^{\text{after}}).\end{aligned}\tag{16}$$

The interpretation of the formula is very simple. It just compares the stream of payments before and after default. The Ades *et al.* (1998) specification allows to compare the *before* and *after* restructuring cost of interest by the using the formula:

$$\begin{aligned}r_{\text{after}} &= r_{\text{before}} + 165\,\text{bps}\\&\quad - 7\times(\text{percentage debt reduction}\\&\qquad\text{in percentage of GDP}).\end{aligned}\tag{17}$$

Table 12 shows our estimates for (16) using (17). The table is computed for several restructuring scenarios and several maturity assumptions for the debt. If 50% of the debt has to be refinanced each year, debt structure is shorter and the change in costs kicks in quickly. In the case that only 12.5% has to be refinanced each year the costs change more slowly.

The numbers in Table 12 combine three effects. First, it is assumed that a debt restructuring implies a higher cost for more debt (in our case of 165 bps) due to reputational effects. This higher rate applies to new issues and therefore will be more significant when maturities are shorter. Second, this number may be compensated by a reduction of spreads due to the decline in debt ratios. As each percentage point, reduction in debt to GDP levels leads to 7 bps of spread declines we need a debt reduction of over 23% to compensate the reputational effect of the default on interest cost. Thus, small restructurings increase the financial cost, while large restructurings reduce the financial effort required to pay the debt. The third channel is the reduction in debt levels itself, which reduces the debt cost directly. All values are computed as PDV at the arbitrary rate of 10% and expressed as percentages of GDP.

The exercise is certainly mechanical but helps to illustrate the three mechanics by which debt payments can be reduced. It also highlights how, once the three effects are taken into account how relatively easy it is to attain sizable debt relief.

8. Assessing the Output Effects

Measuring the output implications of default decisions is difficult. Default decisions usually do not come isolated from a general mismanagement of the economy. Thus to assess the contributing role of defaults one should be able to factor out the impact of those other factors from the implications of the default decision itself. That is a daunting task. One possibility to approximate an answer to this question is to consider a standard growth regression cross-section format. To the usual growth literature specification we add the default decision. Comprehensive data since 1974 can be gathered for close to 100 countries. We condition growth performance in GDP per capita, by population (POP), the ratio of investment to GDP (INVGDP), the rate of growth of population (POPWDI), the initial level of GDP (GDPPC74), the growth of government consumption (GOV1), the initial level of education (SECB), an indicator of civil unrest (CIVIL), the change in terms of trade (DTIWDI), a measure of openness (OPENNESS), and yearly dummies.[22]

[22]See Barro and Sala-i-Martin (1995) for a description of why these are the variables to include.

Table 12. Debt reduction costs from restructuring (as percentage of GDP).

Original Debt as a % of GDP	Debt roll-over			Debt roll-over			Debt roll-over			Debt roll-over			Debt roll-over		
	50%	25%	12.5%	50%	25%	12.5%	50%	25%	12.5%	50%	25%	12.5%	50%	25%	12.5%
10	1.58	1.44	1.21	0.36	0.24	0.04	−0.84	−0.95	−1.11	−2.04	−2.12	−2.26	−3.22	−3.28	−3.40
15	2.36	2.16	1.82	0.49	0.32	0.03	−1.34	−1.49	−1.73	−3.16	−3.28	−3.47	−4.94	−5.04	−5.19
20	3.15	2.88	2.42	0.59	0.37	−0.01	−1.89	−2.09	−2.39	−4.36	−4.50	−4.74	−6.75	−6.86	−7.04
25	3.94	3.60	3.03	0.67	0.39	−0.07	−2.49	−2.73	−3.09	−5.62	−5.78	−6.06	−8.64	−8.76	−8.95
30	4.73	4.31	3.63	0.71	0.39	−0.15	−3.15	−3.43	−3.83	−6.96	−7.13	−7.43	−10.61	−10.73	−10.93
35	5.51	5.03	4.24	0.72	0.36	−0.25	−3.86	−4.17	−4.62	−8.36	−8.55	−8.86	−12.66	−12.77	−12.97
40	6.30	5.75	4.84	0.71	0.30	−0.38	−4.62	−4.96	−5.44	−9.84	−10.02	−10.34	−14.79	−14.89	−15.07
45	7.09	6.47	5.45	0.66	0.21	−0.53	−5.44	−5.80	−6.31	−11.38	−11.56	−11.87	−16.99	−17.08	−17.23
50	7.88	7.19	6.05	0.58	0.10	−0.71	−6.31	−6.69	−7.21	−13.00	−13.17	−13.46	−19.28	−19.35	−19.45
55	8.66	7.91	6.66	0.48	−0.04	−0.91	−7.23	−7.62	−8.16	−14.68	−14.84	−15.10	−21.65	−21.68	−21.73
60	9.45	8.63	7.26	0.34	−0.21	−1.13	−8.22	−8.61	−9.15	−16.44	−16.57	−16.80	−24.10	−24.09	−24.08
65	10.24	9.35	7.87	0.17	−0.41	−1.37	−9.25	−9.65	−10.18	−18.26	−18.37	−18.55	−26.63	−26.58	−26.49
70	11.03	10.07	8.47	−0.02	−0.63	−1.64	−10.34	−10.73	−11.25	−20.16	−20.23	−20.35	−29.24	−29.13	−28.96
75	11.81	10.79	9.08	−0.25	−0.88	−1.93	−11.49	−11.86	−12.36	−22.12	−22.16	−22.21	−31.93	−31.77	−31.49
80	12.60	11.51	9.68	−0.51	−1.16	−2.24	−12.70	−13.04	−13.51	−24.16	−24.15	−24.12	−34.70	−34.47	−34.08
85	13.39	12.23	10.29	−0.80	−1.46	−2.58	−13.96	−14.27	−14.71	−26.27	−26.20	−26.09	−37.55	−37.25	−36.73
90	14.18	12.94	10.89	−1.11	−1.80	−2.94	−15.28	−15.55	−15.94	−28.44	−28.32	−28.11	−40.48	−40.10	−39.45
95	14.96	13.66	11.50	−1.46	−2.16	−3.32	−16.66	−16.88	−17.22	−30.69	−30.50	−30.18	−43.50	−43.02	−42.22
100	15.75	14.38	12.10	−1.84	−2.55	−3.73	−18.09	−18.26	−18.53	−33.01	−32.75	−32.31	−46.59	−46.01	−45.06
110	17.33	15.82	13.31	−2.68	−3.41	−4.61	−21.14	−21.16	−21.29	−37.85	−37.43	−36.73	−53.01	−52.23	−50.92
120	18.90	17.26	14.52	−3.65	−4.37	−5.58	−24.42	−24.25	−24.21	−42.98	−42.37	−41.36	−59.75	−58.73	−57.03
130	20.48	18.70	15.73	−4.74	−5.45	−6.65	−27.95	−27.54	−27.30	−48.38	−47.57	−46.21	−66.82	−65.53	−63.39
140	22.05	20.14	16.95	−5.94	−6.64	−7.81	−31.71	−31.03	−30.55	−54.07	−53.02	−51.27	−74.20	−72.62	−69.99
150	23.63	21.57	18.16	−7.27	−7.94	−9.06	−35.73	−34.71	−33.96	−60.03	−58.73	−56.55	−81.91	−80.01	−76.84

To that specification we add DEF, a dummy variable that takes the value 1 if the country ever defaulted and 0 otherwise or DEFPLUS, a variable that counts the number of times a country defaulted. DEFPLUS takes the value 1 if the country defaulted in the 1980s *or* in the 1990s, 2 if the country defaulted in the 1980s *and* in the 1990s and 0 if the country never defaulted.[23] However, in order to disentangle the independent role of macroeconomic instability and of the default decision we introduce inflation (INF) and its volatility (VOLINF) and a banking crisis (BANK2) as independent variables in the previous specification.[24]

The cross-section regression uses the average values over the period 1974–1999 for the independent variables and delivers results fully consistent with traditional growth theory in Table 13. They indicate, in turn, a very significant and negative impact of defaults on growth. Specifically, the results indicate that countries that defaulted grow about 0.6% less than those that do not. For the period 1974–1999, this implies that defaulters lag no defaulters by about 14%. This is a sizable cost.

This estimation has two main drawbacks. First, the question may arise as to what extent the default coefficient is capturing the effect of other omitted variables, which are correlated to the default decision. If default comes together with a weak political system, other type of conflicts, weak institutions, etc. the default dummy may be capturing the effect of these other factors. Second, the question may arise as to whether the true effect of default may not be captured by other variables (for example, the investment variable). While multicollinearity should not be a problem in the interpretation of regression coefficients, we need to ensure that the investment variable is not endogenous to growth performance, which in turn depends on the default variable.

We address these two concerns in turn. To address the first we run a specification similar to that above but using annual data with fixed effects. The fixed effect should capture all the country's idiosyncrasies. As the default dummy shows no volatility it cannot be estimated in this model. Instead we construct a new default variable, that spans a certain period of time after the default decision. DEFPLUS1 is a variable that takes the value of 1 in the year of default and the following year. DEFPLUS5 incorporates the following 5 years. The dummy also takes a value of one for the year of the default and the year before, and are referenced to the decade in which the default occurred. For the case of DEF80PLUS1 and DEF80PLUS5, we believe these two dummies may not be subject to much endogeneity problems as debt defaults in the 1980s were to a great extent the result of exogenous liquidity shocks propagating after the Mexican default.

Table 14 implements this panel estimation, that uses the same variables as above, but where now each data point is country–year pair. As can be seen the default dummies have significant negative coefficients indicating that the default in the 1980s had significant and long lasting growth costs.

While Table 14 appears to indicate a negative impact of the default decision, it is true that following the default macroeconomic instability increases dramatically. This macroeconomic instability usually is the result of the default decision, the lack of alternative financing or

[23]The dependent variable is the rate of growth of real per capita GDP (Source: World Economic Outlook (WEO)); INVGDP is the investment to GDP Ratio (Source: IMF's International Financial Statistics); POPWDI is the population growth (annual %) (SP.POP.GROW) (Source: World Development Indicators (WDI)); GDPPC74 is the initial per capita GDP (average over 1970–1973) (Source: WEO); GOV1 is the growth of government consumption (lagged one period) (Source: IMF); SECB is the total gross enrollment ratio for secondary education (Source: Barro (1991)); CIVIL is the index of civil liberties (index measured on a 1 to 7 scale; 1 = highest degree of freedom) (Source: Freedom in the World — Annual survey of freedom country ratings); DTIWDI is the change in terms of trade — exports as a capacity to import (constant LCU) (NY.EXP.CAPM.KN) (Source: WDI); OPENNESS is the ratio of (export + import)/2 to GDP (Source: IMF). The default dummies were constructed from the listing in the Global Development Finance report published by the World Bank.

[24]The inflation data is taken from the IMF's IFS and banking crisis data from Glick and Hutchison (1999).

Table 13. Cross-section growth regressions (average 1974–1999).

	(I) Baseline w/def	(II) Baseline w/defplus	(I) Adding inflation and banking variables w/def	(II) Adding inflation and banking variables w/defplus
POPAV	0.003*	0.003*	0.003*	0.003*
	(0.002)	(0.002)	(0.002)	(0.002)
INVGDPAV	7.110*	7.139*	6.378	6.395
	(4.194)	(4.193)	(4.303)	(4.302)
POPWDIAV	−0.166	−0.156	−0.133	−0.119
	(0.154)	(0.157)	(0.216)	(0.220)
GDPPC74AV	−0.485***	−0.489***	−0.439***	−0.443***
	(0.095)	(0.095)	(0.112)	(0.111)
GOV1AV	−1.283	−1.322	3.302**	3.280**
	(1.168)	(1.156)	(1.558)	(1.550)
SECBAV	0.898	0.920	1.001	1.025
	(1.028)	(1.028)	(1.006)	(1.006)
CIVILAV	−0.538***	−0.547***	−0.484***	−0.493***
	(0.180)	(0.182)	(0.175)	(0.176)
DTIWDIAV	1.630***	1.636***	1.354***	1.352***
	(0.396)	(0.394)	(0.390)	(0.390)
OPENNESSAV	1.141*	1.117*	1.186*	1.167
	(0.630)	(0.633)	(0.710)	(0.715)
INFAV			−2.324	−2.320
			(1.435)	(1.425)
VOLINFAV			−0.002***	−0.002***
			(0.001)	(0.001)
BANK2AV			−0.479	−0.447
			(1.008)	(1.013)
DEF	−0.645*		−0.664*	
	(0.358)		(0.337)	
DEFPLUS		−0.604*		−0.635**
		(0.322)		(0.303)
Observations	99	99	98	98
R-squared	0.62	0.62	0.66	0.67

Robust standard errors in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1%.

both. However, when introducing inflation and its volatility as well as a banking crisis variable, to proxy for increased macroeconomic instability in the aftermath of the default, we find that the results remain robust, indicating that default decisions do have an independent negative effect. However, because the macroeconomic variables, in the short run, have a negative effect on output performance, the analysis allows to conclude that defaults that trigger banking crises and macroeconomic instability lead to far worse outcomes than those that do not.

Column (V) introduces a dummy for the default in the 1990s. The results show no significant effect. One could be tempted to infer that this implies that recent defaults had no growth implications. However, this conclusion is unwarranted. Due to lack of information on other variables, the 1990s default dummy includes very few observations and, given how recent the events are, it cannot span fully the effects of the default decision. Unfortunately, no improvement can be made at this stage in terms of an econometric assessment of this issue.

Finally, to address the concern regarding the endogeneity of some variables, such as investment, we present in Table 15 the same results but instrumenting the investment variable with its own value lagged. While the investment variable becomes insignificant the results

Table 14. Fixed effect growth regressions (1974–1999).

	(I) Baseline w/def80plus1	(II) Baseline w/def80plus5	(III) Adding inflation and banking variables w/def80plus1	(IV) Adding inflation and banking variables w/def80plus5	(V) Baseline w/def90
POP	0.002	0.002	0.003	0.003	0.004
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
INVGDP	12.475***	11.993***	10.583***	10.101***	10.243***
	(2.080)	(2.090)	(2.117)	(2.124)	(2.122)
POPWDI	0.803***	0.801***	−0.116	−0.121	−0.132
	(0.123)	(0.123)	(0.182)	(0.182)	(0.182)
GOV1	−1.082***	−1.016***	1.309***	1.349***	1.393***
	(0.314)	(0.315)	(0.434)	(0.435)	(0.434)
CIVIL	−0.089	−0.094	0.068	0.065	0.046
	(0.123)	(0.124)	(0.126)	(0.127)	(0.126)
DTIWDI	0.662***	0.667***	0.600***	0.604***	0.607***
	(0.055)	(0.055)	(0.054)	(0.054)	(0.054)
OPENNESS	2.017	2.215	2.498	2.737*	3.045*
	(1.637)	(1.646)	(1.611)	(1.617)	(1.610)
DEF80PLUS1	−2.105***		−1.852***		
	(0.532)		(0.526)		
DEF80PLUS5		−0.833**		−0.635*	
		(0.389)		(0.383)	
DEF90					−3.370
					(3.063)
INF			−2.721***	−2.706***	−2.782***
			(0.489)	(0.492)	(0.490)
VOLINF			−0.000	−0.000	−0.000
			(0.000)	(0.000)	(0.000)
BANK2			−1.561***	−1.599***	−1.601***
			(0.294)	(0.294)	(0.295)
CONSTANT	−3.650***	−3.624***	−1.811**	−1.805**	−1.927**
	(0.819)	(0.826)	(0.854)	(0.858)	(0.856)
Observations	2240	2240	2087	2087	2087
Number of code	99	99	98	98	98
R-squared	0.12	0.12	0.12	0.12	0.12

Standard errors in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1%.

regarding the default variables remain almost unchanged.

These results provide a first approximation as to the output effects of default. The length and deepness of the fall in output will depend, to a great extent, on the assessment of whether a financial crisis will ensue or not. The experience of the 1980s tends to suggest an accumulated 4% drop in output over the immediately following 4 years.[25]

9. Conclusions: Lessons from Recent Defaults

While we have reviewed a number of techniques to analyze debt problems, and while recent experiences have exhibited a fairly common pattern, the analysis of each particular case should be enriched by the observer's judgment in each case. For example, unsustainable fixed exchange rate regimes, combined with weak fiscal problems have been important determinants of recent

[25]Notably these numbers are similar to those found for currency crises. See Hutchison and Neuberger (2002) and Barro (2001).

Table 15. Fixed effect growth regressions w/investment instrumented (1974–1999).

	(I) Baseline w/def80plus1	(II) Baseline w/def80plus5	(III) Adding inflation and banking w/def80plus1 variables	(IV) Adding inflation and banking w/def80plus5 variables	(V) Baseline w/def90
POP	0.004	0.005	0.006	0.006	0.007
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
INVGDP	−2.558	−3.352	−4.086	−4.889	−4.675
	(3.049)	(3.068)	(3.001)	(3.017)	(3.011)
POPWDI	0.925***	0.924***	0.031	0.028	0.013
	(0.128)	(0.128)	(0.193)	(0.193)	(0.193)
GOV1	−0.729**	−0.655*	1.789***	1.819***	1.861***
	(0.337)	(0.337)	(0.458)	(0.460)	(0.459)
CIVIL	−0.059	−0.061	0.125	0.125	0.105
	(0.132)	(0.133)	(0.135)	(0.136)	(0.135)
DTIWDI	0.661***	0.662***	0.602***	0.603***	0.608***
	(0.061)	(0.062)	(0.060)	(0.061)	(0.060)
OPENNESS	5.655***	5.879***	5.389***	5.686***	5.965***
	(1.848)	(1.852)	(1.800)	(1.803)	(1.798)
DEF80PLUS1	−1.743***		−1.523***		
	(0.554)		(0.547)		
DEF80PLUS5		−0.826**		−0.606	
		(0.413)		(0.406)	
DEF90					−3.867
					(3.116)
INF			−2.655***	−2.632***	−2.722***
			(0.527)	(0.532)	(0.528)
VOLINF			−0.001**	−0.001**	−0.001**
			(0.000)	(0.000)	(0.000)
BANK2			−1.774***	−1.802***	−1.795***
			(0.305)	(0.305)	(0.306)
Constant	−2.106**	−2.022**	−0.211	−0.154	−0.278
	(0.911)	(0.920)	(0.951)	(0.957)	(0.953)
Observations	2064	2064	1932	1932	1932
Number of code	99	99	98	98	98

Standard errors in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1%.

experiences and their correction an important factor in the turnaround. However, this should not be interpreted as implying that a country with a floating rate would be able to avoid a default if its fiscal policies are inconsistent,[26] but that a country with fixed rates may be more vulnerable, both due to balance sheet effects and increased fragility of the financial sector. As of late, one should add the fact that the Fund and other multilaterals seem less willing to support fixed exchange rate regimes. All these factors feed into the instability of the situation, acting as a catalyst for the crisis. In any case, it is the combination of fiscal unsustainability and exposed financial sectors what combines to increase the probability of a crisis.

Needless to say, the best alternative to avoid the mess associated to defaults is for sensible macroeconomic policies: reasonable budgets, relatively low money printing and inflation, and the pursuing of a sensible growth agenda by pursuing deregulation, openness, reasonable tax systems and strong defense of property rights. However, for countries which are relatively exposed to

[26]Neither does this imply that a country with a floating rate cannot suffer a liquidity crunch or a run on its bond market.

default risk, and which do not have the internal consensus to steer course into safer waters, some safeguards need to be established.

A weak point in the link is the banking sector. Having strong prudential regulation is a good initial step but, as proven by the Argentine experience, it is not enough to insure stability. The problem with the financial sector is that, either because of internal moral hazard (banks expect to be bailed out) or because they are forced to, the domestic financial sector ends with substantial long positions in the defaulting countries' debt instruments. Once the government defaults on these instruments, the financial sector is bankrupt. The anticipation of this event triggers a financial crisis prior to the default. Compounded with the balance sheet effects of the devaluation the impact is extremely negative.

One solution to this problem is to limit bank's bond holdings. While in most countries government debt is considered among the safest and liquid of assets,[27] this is not the case for near default economies. In those cases it may be a sensible decision to limit bank exposure to default risk as default becomes more imminent. The implementation of this, however, is not trivial if it forces banks to sell its bond holdings in the running up to a default crisis. A clean solution would be to prohibit banks from holding government debt. Of course banks could sell government debt to their clients, but they could not hold it themselves. Thus, default risk would be taken fully by the households or private investors. This is certainly a massive change in banking regulation proposals, and could be restricted to countries without investment grade on their debt holdings.

More involved are the proposals to reduce the balance sheet problem of the financial sector. Countries with the original sin à la Hausmann will likely develop a financial sector that is strongly dollarized and governments will also be forced to issue debt in foreign currency, both to gain credibility and reduce costs. Both factors contribute to increasing the costs of a devaluation. One alternative is to move towards dollarization as in Ecuador.[28] However, if fiscal accounts remain unbalanced, dollarization risks the monetary that characterized Argentina during 2001–2002. A stringent monetary crunch led to the issue of subnational currencies.[29] In such a context, dollarization may be of limited use. Alternatively, financial restrictions as in Brazil that do not allow for a dollarized financial sector or as in Chile where an indexed financial unit of account is used may become more prevalent in years to come. While these measures may induce some capital flight if savers insist in holding dollar denominated assets, they may render a more stable financial sector than what is obtained by imposing capital controls at the moment in which the crisis emerges, a pervasive phenomenon in the experiences described in this paper.

In fact, Edwards (2003) and Guidotti *et al.* (2003), look at the characteristics of an economy that make the aftermath of a crises more bearable. While they focus on sudden stops and current account reversals, they provide certain clues as to how an economy can cope with a crisis. More open and less dollarized seem to respond better, delivering more growth in the aftermath of the crisis. While very preliminary, these are welcomed steps that should be carried on to the analysis of recoveries from default. In fact, sometimes preparation is as important as prevention. These are interesting lines for future research.

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[27] In fact, new Basle rules have started to take this into account, see Castro (2002).
[28] See Levy-Yeyati and Sturzenegger (2002) for a comprehensive discussion of dollarization.
[29] Once debt financing was not available any longer, provinces in Argentina started printing their own currency. As of early 2002 there were about 14 currencies circulating in the country.

Appendix A

Table A.1. Necessary permanent primary surplus.

Public debt to GDP i (%)	4.0%					
	GDP growth rate					
	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%
35	1.0	0.7	0.3	0.0	−0.3	−0.7
40	1.2	0.8	0.4	0.0	−0.4	−0.8
45	1.3	0.9	0.4	0.0	−0.4	−0.8
50	1.5	1.0	0.5	0.0	−0.5	−0.9
55	1.6	1.1	0.5	0.0	−0.5	−1.0
60	1.8	1.2	0.6	0.0	−0.6	−1.1
65	1.9	1.3	0.6	0.0	−0.6	−1.2
70	2.1	1.4	0.7	0.0	−0.7	−1.3
75	2.2	1.5	0.7	0.0	−0.7	−1.4
80	2.4	1.6	0.8	0.0	−0.8	−1.5
85	2.5	1.7	0.8	0.0	−0.8	−1.6
90	2.7	1.8	0.9	0.0	−0.9	−1.7
95	2.8	1.9	0.9	0.0	−0.9	−1.8
100	3.0	2.0	1.0	0.0	−1.0	−1.9
110	3.3	2.2	1.1	0.0	−1.0	−2.1
120	3.6	2.4	1.2	0.0	−1.1	−2.3
130	3.9	2.5	1.3	0.0	−1.2	−2.5
140	4.2	2.7	1.4	0.0	−1.3	−2.6
150	4.5	2.9	1.5	0.0	−1.4	−2.8
160	4.8	3.1	1.6	0.0	−1.5	−3.0

Table A.2. Necessary permanent primary surplus.

Public debt to GDP i (%)	12.0%					
	GDP growth rate					
	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%
35	3.8	3.4	3.1	2.7	2.3	2.0
40	4.4	3.9	3.5	3.1	2.7	2.3
45	4.9	4.4	3.9	3.5	3.0	2.5
50	5.4	4.9	4.4	3.8	3.3	2.8
55	6.0	5.4	4.8	4.2	3.7	3.1
60	6.5	5.9	5.2	4.6	4.0	3.4
65	7.1	6.4	5.7	5.0	4.3	3.7
70	7.6	6.9	6.1	5.4	4.7	4.0
75	8.2	7.4	6.6	5.8	5.0	4.2
80	8.7	7.8	7.0	6.2	5.3	4.5
85	9.3	8.3	7.4	6.5	5.7	4.8
90	9.8	8.8	7.9	6.9	6.0	5.1
95	10.3	9.3	8.3	7.3	6.3	5.4
100	10.9	9.8	8.7	7.7	6.7	5.7
110	12.0	10.8	9.6	8.5	7.3	6.2
120	13.1	11.8	10.5	9.2	8.0	6.8
130	14.2	12.7	11.4	10.0	8.7	7.4
140	15.2	13.7	12.2	10.8	9.3	7.9
150	16.3	14.7	13.1	11.5	10.0	8.5
160	17.4	15.7	14.0	12.3	10.7	9.1

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