IV Fiscal Sustainability: A Value-at-Risk Approach

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Recurring debt problems and high public debt have brought the issue of fiscal sustainability to the foreground in several Central American countries. Although public debt-to-GDP ratios have started to come down in recent years, they still exceed 50 percent in most of the region's countries, making the debt a source of vulnerability that deserves close attention. Over the past three decades, the region experienced a number of debt write-downs, and high debt levels have constrained implementation of effective policy responses in the case of adverse shocks (see Offerdal, 2004).

There has been no regional study on public debt sustainability in Central America. So far, sustainability assessments have been country specific, aimed at ensuring attainment of fiscal viability for the country in question. As a consequence, the results of existing sustainability assessments are less suited for comparisons across the region.

Although substantial progress has been made in recent years, the methodology of debt and fiscal sustainability assessments are still at an early stage of development.[1] Projections of debt dynamics, which are intrinsically uncertain and highly variable, are typically stable and deterministic with only a limited number of possible outcomes being explored. As stated by the International Monetary Fund (2002, p. 6), ". . . assessments of sustainability are probabilistic, since one can normally envisage some states of the world under which a country's debt would be sustainable and others on which it would not. Standard frameworks currently used do not supply these probabilities explicitly; rather, they trace the implications of alternative scenarios and leave the user to determine the respective probabilities."

To assess the degree of vulnerability posed by current debt levels in Central America, this study summarizes recent sustainability assessments and proposes a complementary probabilistic framework to evaluate sustainability. The traditional debt sustainability framework is taken one step further by estimating explicitly the probabilities of alternative scenarios using a common set of assumptions.[2] A Value-at-Risk (VaR) approach is utilized to calculate the probability distribution of the debt-to-GDP ratios of several Central American countries, the latter used as proxy for the degree of fiscal vulnerability. This VaR approach is in line with the stochastic simulation method suggested in IMF (2003). The approach is not, however, without drawbacks since the VaR approach is based entirely on historical data. This caveat applies, in particular, in the case of a regime change, like the one in El Salvador, which officially dollarized in 2001. Also, data limitations and potential problems of endogeneity make the results tentative. This is why the VaR approach should be seen as a complement to, and not a substitute for, the traditional debt sustainability approach. Nevertheless, the VaR framework allows a more explicit comparison of vulnerabilities across countries and ranks countries along a common vulnerability index. It offers additional information over traditional sustainability assessments by probabilistically computing the relative contribution of the different risk factors to the country's overall vulnerability.[3]

Analytical Issues and the Traditional Sustainability Approach

The IMF defines debt sustainability, as "a situation in which a borrower is expected to be able to continue servicing its debt without an unrealistically large future correction to the balance of income and expenditure."[4] The assessment of sustainability, as high-

[1]This refers to forward-looking assessments of fiscal sustainability, as opposed to the empirical tests of sustainability done by Corsetti and Roubini (1991), Hakkio and Rush (1991), Hamilton and Flavin (1986), Kremers (1989), Roberts (1991), Trehan and Walsh (1988), Wilcox (1989), and others, who concentrate on historical OECD country experiences.

[2]As it will become clear, the extension of the current framework comes at a cost, i.e., the probabilities are calculated using solely historical information. It should be noted, however, that this is not a limitation of the VaR technique, but rather the desire to perform cross-country comparisons with the greatest possible objectivity.

[3]While the traditional debt sustainability analysis includes stress tests, it does not explicitly calculate their corresponding probabilities.

[4]IMF (2002, p. 4, para. 7).

lighted in the definition, is intrinsically probabilistic and based on an expectation and judgment about what constitutes an unrealistically large future correction. Consequently, there is only a limited degree of objectivity in any analysis of sustainability. While experience has shown that unrealistically large adjustments are generally easier to determine ex post than ex ante, current sustainability analyses can be improved with respect to the expectational aspect of the definition.

The risk of default is proxied by the probability distribution of the debt-to-GDP ratio. Despite being a poor indicator of solvency, the debt-to-GDP ratio is the measure typically used to assess sustainability and is the focus of traditional sustainability assessments.[5] Comparability of analysis, then, calls for the use of the same indicator in the present study.

The traditional approach to assess fiscal sustainability is based on the following steps.

- In order to establish a baseline/"current-policy scenario," projections are made based on forecast of key variables from the real, external, monetary, and fiscal sectors, assuming policy continuity.[6] Although historical trends are commonly used as a basis for the projections, these are not mechanically followed. Instead, judgment is used to assess the most likely course of events going forward.
- These baseline/"current-policy" scenario projections are used to predict the path of the public sector debt-to GDP ratio. A resulting debt ratio judged to be uncomfortably high or vulnerable typically prompts the creation of an alternative adjustment scenario, that is, an "active policy" scenario.[7] In this case, adjusting the primary fiscal balance is the policy tool used to meet the targeted debt ratio.
- The robustness of the results is then analyzed by assuming alternative paths for the macroeconomic variables used in the exercise.

Table 4.1 summarizes the results of the most recent sustainability assessments done for the countries in the region:[8]

- In all countries, baseline/"current-policy" scenarios have assumed an improvement in the primary fiscal balance. The projected fiscal effort is largest for the Dominican Republic (3.8 percent of GDP), followed by Honduras (3.0 percent of GDP), Nicaragua (2.8 percent of GDP), El Salvador (1.7 percent of GDP), Guatemala (1.1 percent of GDP), Costa Rica (1 percent of GDP), and Panama (0.4 percent of GDP).
- As a result of the fiscal effort, debt ratios are projected to fall in all but one of the countries (El Salvador).[9] However, not all fiscal efforts produce equivalent reductions in the debt ratio.[10] A 1 percentage point of GDP improvement in the primary balance is forecast to reduce the debt-to-GDP ratio by 2½ percentage points in the Dominican Republic and by more than 5 percentage points in Guatemala.
- The standard sustainability assessments reveal that a shock in the form of a currency depreciation represents the largest risk. The risk of currency depreciation (a one-off 30 percent permanent drop in the value of the local currency) ranked first in six out of the seven countries in the region (second in the seventh, i.e., Guatemala).

The traditional approach used to assess fiscal sustainability in Central America has, however, a number of caveats when used for cross-country comparisons:

- Using the primary fiscal balance as a summary indicator for debt sustainability gives a spurious sense of consistency across debt sustainability exercises. As stated before, the underlying macroeconomic assumptions vary across the Central American countries, making the primary fiscal balance calculated for one country not comparable to that calculated for another. Hence, debt sustainability outcomes derived from independent sustainability calculations may not be strictly comparable.
- The stress tests performed in the traditional approach are somewhat arbitrary. Several metrics are used in the definition of the shocks in the

[5]The literature has found only a weak relationship between debt-to-GDP ratios and events of default, making this ratio a poor indicator of solvency. See Pattillo, Poirson, and Ricci (2002) and Reinhart, Rogoff, and Savastano (2003).

[6]The concept of "policy continuity" is defined in slightly different ways across scenarios, which therefore may not be fully comparable. Often the IMF staff also projects a "weak" or "low" scenario assuming a weaker policy effort than in the baseline/"current-policy" scenario to illustrate the risks of policy slippage. The variables that are most commonly projected are output growth, inflation, interest rates, fiscal revenues, noninterest expenditures, and interest payments. Detailed projections for these variables can be found in the respective country staff reports.

[7]It is commonly assumed that the macroeconomic environment is dependent on whether the debt dynamics are deemed sustainable or not, thus reinforcing the benefits associated with the proposed fiscal adjustment of the alternative scenario.

[8]For each country, the ratio of the 2003 public debt to GDP is reported in Column 2.

[9]It should be noted, however, that El Salvador's debt ratio, albeit increasing, is projected to remain below 50 percent until 2008.

[10]Debt dynamics are also affected by the projected paths for the real interest rate, the growth rate, the exchange rate, and the size of the debt ratio itself, all of which differ across countries.

Table 4.1. Results from Traditional Debt Sustainability Analysis

	Debt/GDP (*t*)	Average Historical Primary Balance	Projected Primary Balance	Debt/GDP (*t* + 5)	Stress Tests[1]
Costa Rica					
Baseline/"current-policy"[2]	54.5	0.4	1.4	50.2	Depreciation
Passive			0.0	62.0	Growth
Active			2.3	43.3	Contingent losses
					Interest rate
					Primary balance
Dominican Republic					
Baseline/"current-policy"[2]	54.3	–1.6	2.2	44.8	Depreciation
Passive			0.8	61.4	Primary balance
					Contingent losses
					Growth
					Interest rate
El Salvador					
Baseline/"current-policy"	46.1	–2.0	–0.3	47.2	Depreciation
Reinforced			0.5	43.7	Contingent losses
					Growth
					Interest rate
					Primary balance
Guatemala					
Baseline/"current-policy"	20.1	–0.7	0.4	14.3	Contingent losses
					Depreciation
					Primary balance
					Growth
					Interest rate
Honduras[3,4]					
Baseline/"current-policy"	64.1	–3.1	–0.1	52.2	Depreciation
					Primary balance
					GDP growth
Nicaragua					
Baseline/"current-policy"	160.0	–1.1	1.7	149.1	Depreciation
					Privatization
					Primary balance
					Growth
Panama					
Baseline/"current-policy"[5]	63.3	1.7	2.1	55.6	Depreciation
Low-scenario			0.6	67.2	Growth
					Contingent losses
					Interest rate
					Primary balance

Sources: IMF staff reports and debt sustainability assessments.
[1]Ranked from highest to lowest debt ratio at end of 2008.
[2]Assumes implementation of some fiscal-enhancing measures.
[3]Based on a 15 percent real exchange rate depreciation.
[4]Public external debt ratio reported instead of total public debt ratio.
[5]Described as active scenario in IMF staff report.

stress tests making comparability across countries and among shocks challenging.[11] Is a 30 percent real depreciation comparable with a two-standard deviation interest rate shock? Is the combination of two or three types of shocks in the form of one standard deviation of the parameters in question comparable to shocks of other parameters measured as two-standard deviations? Is the likelihood of a 30 percent currency depreciation the same for Guatemala as for Costa Rica? Is

[11]While some stress tests are defined in terms of standard deviations (making them comparable across countries and among risks), others are not.

a 10 percentage point increase in the debt-to-GDP ratio a good characterization of the expected realization of contingent liabilities across all countries? These limitations raise doubts about the information conveyed by the ranking of risks resulting from the stress tests.

- While the primary fiscal balance has been the most reliable tool when addressing issues of debt dynamics, other policy tools are ignored in standard debt sustainability assessments. In particular, the traditional approach does not easily lend itself to the analysis of the pros and cons of changes to the structure of the public debt.[12]
- The policy recommendations that can be distilled from the traditional approach are limited to the primary balance. Thus, countries with no obvious problems in their debt dynamics find little use for the traditional debt sustainability assessment. To complement the traditional analysis and to address the caveats discussed above, the following uses the VaR to assess fiscal sustainability in Central America.

Modeling the Debt-to-GDP Ratio Using VaR[13]

The VaR methodology was originally developed to calculate the market risk of a financial portfolio, that is, the probability distribution of returns of a given portfolio due to changes in market prices. More recently, Barnhill and Kopits (2003) have extended VaR to the analysis of fiscal accounts of sovereign countries. Their specific application of VaR assumes that a government's balance sheet is available. The objective of the approach developed in this section is to compute the probability distribution of the ratio of public sector debt to GDP at some future year using VaR. The advantage of this approach—as opposed to the one proposed by Barnhill and Kopits—is its direct comparability with current sustainability analyses. However, unlike the approach used by Barnhill and Kopits, this exercise does not explicitly provide information about the probability of default.[14]

The traditional approach projects the future path of the debt-to-GDP ratio based on subjective macroeconomic forecasts of key variables.[15] The technique proposed here, on the other hand, is strictly rooted on historical data and does not allow for judgment when projecting future outcomes. At the same time, the historical information is used more effectively than in the traditional approach because the correlation matrix of the risk factors is included in the calculation of the future path of the debt-to-GDP ratio. The departure from the traditional approach due to the application of VaR can be summarized as follows.

- *The set of primary risks*. While primary risks are roughly the same as those considered in the traditional approach (GDP growth, inflation, primary fiscal spending, the domestic short-term interest rate, the exchange rate, the medium-term foreign interest rate, and the sovereign spread), future projections for these variables are strictly derived from their historical performance, making the results comparable across countries.
- *The probability distribution and correlation matrix of the risk factors*. The traditional approach, as any deterministic approach, ignores probabilities. In this framework, the probability distributions and the interrelationship among risk factors are explicitly included.[16] The explicit formulation of the probability distributions and the interrelationship among risk factors reduces the arbitrariness in the rankings produced by the conventional stress tests.
- *The treatment of contingent claims.* The traditional approach requires the user to identify the size and timing of future implicit or contingent liabilities. Seeking uniformity of treatment while recognizing intrinsic differences across countries, the approach proposed here uses a stylized fact reported in the literature on crises—that is, the fact that foreign exchange crises have typically been associated with financial sector crises, the latter being among the

[12]As explained below, debt-service projections in the traditional approach are typically (though not always) based on historical debt-service information by type of debt. Debt service, however, is dependent on the debt structure that evolves over time and might be quite different from the historical composition of the debt.

[13]Owing to data limitations, only contemporaneous correlations among risk factors have been considered.

[14]Contrary to Barnhill and Kopits (2003), this paper uses VaR to estimate the probability distribution of the debt ratio instead of the probability distribution of the fiscal portfolio (balance sheet). The number of assumptions involved in constructing a "synthetic" balance sheet from expected future flows is significantly larger than the one proposed here.

[15]Using subjectivity in projecting the paths of key macroeconomic aggregates should not be regarded as inferior to the historical method proposed here. On the contrary, as long as subjective projections represent best assessments using all available data, they could be regarded as superior.

[16]Normal probability distributions are assumed for GDP growth, inflation, and real primary fiscal spending with mean and variance calculated from the last 10 years of data; log-normal distributions are assumed for interest rates and spreads; and a frequency table calculated from the last 50 years of real exchange rate data is used as proxy for the probability distribution of the real exchange rate. Additionally, the interrelationship among risk factors is appraised from the correlation matrix of risks.

most common sources of contingent liabilities of the public sector.[17]

- *The composition of debt.* Instead of using the series of interest payments to project future interest payments, which is the default mechanism used in the traditional approach that depends on the history of the debt structure, this approach uses the actual composition of the debt at present combined with alternative simulation of interest rates (domestic and foreign plus spread) to produce a forecast of future interest payments.[18] The stock of public debt is classified into two main categories: foreign currency debt (assumed to be fully denominated in U.S. dollars) and domestic currency debt. Each of these is then subdivided into short-term (with a remaining maturity of less than one year) and medium- to long-term debt. The stock of inflation-indexed domestic debt completes the stylized description of the debt composition, which is assumed to remain constant throughout the simulation exercise. This formulation allows for a more complete study of the consequences of alternative debt structures.

In every VaR analysis, the debt-to-GDP ratios are calculated assuming no "portfolio" change in reaction to the realization of the risks. This represents the passive scenario, that is, it is assumed that no policy adjustment takes place. Moreover, the correlation matrix of risks is also assumed to be invariant.[19]

Based on the assumptions outlined above, alternative debt paths are simulated and the probability distribution of the debt ratio is computed from 10,000 simulations. As a result, different measures of vulnerability can be calculated from the computed distributions.

- The VaR of the debt-to-GDP ratio for a common confidence interval across countries.
- The probability that a certain debt-to-GDP ratio will be surpassed.[20]
- The expected increase or decrease in the debt-to-GDP ratio from current levels.
- The relative contribution of the risks to the debt dynamics for each country.[21]
- In addition, a possible extension of the current framework for the analysis of policy options is exemplified by the simulation of an alternative debt structure.

The following table summarizes the first three vulnerability measures. A comparison between columns two and three in Table 4.2 highlights an important vulnerability of the Central American countries, namely, the expected increase in debt-to-GDP ratio under current trends. The expected increase in the debt ratio differs among the other countries. El Salvador's debt ratio deteriorates the most, followed by Guatemala, the Dominican Republic, and Costa Rica. The need for policy action to prevent an escalation of the debt ratios is consistent with the recommendations obtained from the traditional approach (Figure 4.1).

Relying purely on historical data negatively biases the results against the more active reformers. The effect of recent reforms, while probably important for debt sustainability, have not been incorporated into the vulnerability measures calculated above. This bias appears to be particularly relevant for El Salvador, which has been one of the most active reformers in recent years.[22]

The need for policy action, however, should be associated with the risk profile of the debt. The worse the risk profile the greater the urgency to act. The VaR (column three of Table 4.2) explicitly measures such risk by calculating the highest debt-to-GDP ratio by 2008 with a 95 percent confidence level. Based on this measure, Panama is the country in need of most urgent action. Its VaR (95.2) is the highest of the five Central American countries considered. That is, there is a 95 percent probability that Panama's debt-to-GDP ratio will not exceed 95.2 percent by 2008. The other countries do not follow very far behind though. The VaR for El Salvador is 94.8 percent of GDP, Costa Rica's is 94 percent, and the Dominican Republic comes in fourth at 81½ percent. The only country with a reasonably low

[17]As shown in Kaminsky and Reinhart (1996), balance of payments crises, most of which involve a large depreciation of the domestic currency, tend to overlap with banking crises that is a common type of contingent liabilities. Contingent liabilities associated with unfunded pension schemes are not considered in this exercise.

[18]Notwithstanding this, knowledgeable users can make the necessary adjustments to the traditional framework to produce a more realistic path for debt-service payments.

[19]Ideally, the exercise would use contingent correlation matrices, since the correlations among macroeconomic variables tend to vary between noncrisis and crisis periods (see Forbes and Rigobon, 2000). Because of data limitations, the exercise assumes that the correlation matrices of risk are constant.

[20]Reinhart, Rogoff, and Savastano (2003) have estimated threshold levels for ratios of external debt to GDP. However, no similar study exists on thresholds of public debt to GDP.

[21]Though not a stress test of the results per se, it is a better approximation to the relative risk exposure of the different countries than the traditional stress tests.

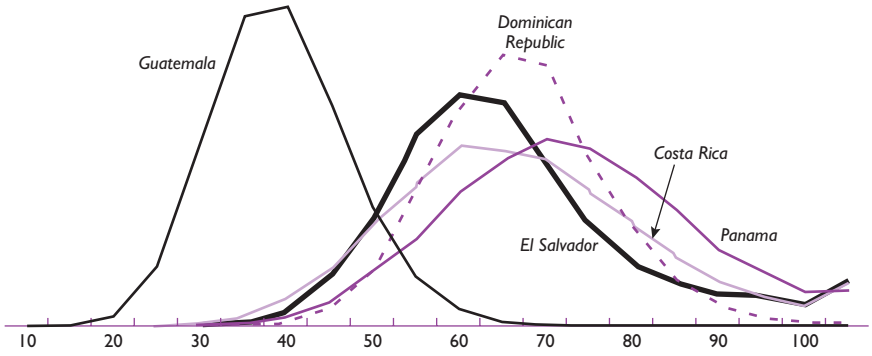
[22]In particular, the results presented for El Salvador reflect a history of very volatile real exchange rates (the variable used a 50-year time span), and the fiscal cost of reconstruction in the late 1990s (a 10-year time span was used for this variable). It ignores the effects of the ambitious tax reform approved only a few months ago.

Table 4.2. Main Vulnerability Measures

	Debt/GDP	$E(D)$[1]	VaR[2]	> 60 percent[3]
Costa Rica	54.5	65.5	94.1	60.1
Dominican Republic	54.3	64.5	81.5	66.9
El Salvador	46.1	64.1	94.8	54.3
Guatemala	20.1	36.7	50.6	0.5
Panama	63.3	70.4	95.2	76.2

Source: IMF staff calculations.
[1]Expected debt-to-GDP ratio by end-2008.
[2]Debt-to-GDP ratio four years out measured at 5 percent confidence level.
[3]Probability, in percent, that the debt-to-GDP ratio will surpass 60 percent by 2008.

Figure 4.1. Distribution of the Ratio of Public Debt to GDP in 2008



Source: IMF staff calculations.

VaR figure is Guatemala, which is slightly above 50 percent.[23]

Using the projected change to the primary fiscal balance of the traditional approach as an indicator of urgency of adjustment leads to different conclusions than the ones just discussed. Table 4.3 ranks the seven countries reported in Table 4.1 according to the projected fiscal effort measured for the baseline/"current-policy" scenario as the difference between column four and column three of that table. The Dominican Republic comes in first with an effort of 3.8 percent of GDP, followed by Honduras, Nicaragua, El Salvador, Guatemala, Costa Rica, and Panama.[24] The disparity of objectives and assumptions across traditional debt sustainability assessments makes the projected primary balance adjustments difficult to interpret across countries.

An alternative way to examine the results is to consider the probability that a certain debt threshold will be surpassed (a third alternative measure of vulnerability). Although the economic literature does not provide conclusive evidence on what that

[23]These VaRs result from the interaction of the seven risk factors reported above. For an analysis of the relative importance of the different risks please refer to Table 4.4.

[24]It turns out that the order presented in the previous paragraph, using VaR, is almost the opposite of the one in Table 4.1.

threshold is for the overall public debt, most of it seems to agree on a positive and nonlinear relationship between debt levels and the cost of borrowing. Work done by Pattillo, Poirson, and Ricci (2002) and Reinhart Rogoff, and Savastano (2003) suggests there is a level for the external debt/GDP ratio that, once surpassed, results in the cost of borrowing becoming prohibitive. They find that external debt ratios on the order of 30–40 percent have historically been associated with worsening growth conditions (Pattillo) and defaults (Reinhart). The 60 percent of GDP assumed in Table 4.2 appears to be a reasonable threshold for the public sector debt ratio for Central American countries; it is higher than most actual levels and fairly uncommon among emerging countries. The probability this level will be surpassed by 2008 is greatest in Panama (76 percent), followed by the Dominican Republic (67 percent), Costa Rica (60 percent), and El Salvador (54 percent). On the other end of the spectrum, Guatemala is the only country with less than a 50 percent probability of surpassing 60 percent of GDP by 2008.

Surpassing the 60 percent debt-to-GDP threshold is not necessarily associated with an imminent financial crisis. For example, Panama's public debt has been above 60 percent of GDP since the year 2000, yet it has not experienced a financial crisis despite the international and regional turbulence during the past four years. Its sovereign spread has remained stable throughout the period showing no clear positive relationship with its rising debt-to-GDP ratio. Notwithstanding the Panamanian experience, debt ratios above 60 percent of GDP are likely to be associated with increases in vulnerability.

The main drivers behind the expected increase in the debt ratios shown above are presented in Table 4.4.[25] GDP growth, for example, is expected to explain 10 percent of the debt dynamics for the Dominican Republic and 16 percent for Costa Rica, while the real exchange rate explains 32 percent of the change in the debt ratio for Costa Rica and only 15 percent for the Dominican Republic. The fact that the numbers reported in Table 4.4 are positive does not imply that all variables contribute positively to the debt ratio. GDP growth and inflation tend to reduce it. Table 4.4, then, only reports the relative contribution, positive or negative, that is expected from each variable on the change in the debt-to-GDP ratio.

Table 4.3. Projected Change in Primary Balance
(In percent of GDP)

	Change
Dominican Republic	3.8
Honduras	3.0
Nicaragua	2.8
El Salvador	1.7
Guatemala	1.1
Costa Rica	1.0
Panama	0.4

Sources: IMF staff reports and debt sustainability assessments.

While it is hardly surprising that primary spending is the largest contributor to debt buildup, there are noticeable differences among the relative contributions of the risk factors across countries. Most notably, the expected increase in the public sector debt for El Salvador has more to do with the real exchange rate than primary spending.[26] The contribution of real primary spending to debt accumulation varies across the remaining four countries. In Costa Rica, primary spending is expected to explain almost 40 percent of the debt buildup, whereas in Panama it is responsible for almost two-thirds of the increase in the debt ratio. This variation reflects the fact that in some countries, the debt has developed dynamics of its own, with more than 50 percent of the expected increase in the debt ratio explained by variables that are not under the direct control of the authorities. This compares to the results of the stress tests of the standard sustainability analysis where currency depreciation appears to be the largest risk factor to the debt dynamics of the Central American countries, with Guatemala being the notable exception (see Table 4.1).[27]

The second-largest risk to the debt dynamics according to this framework is a real exchange rate depreciation. Costa Rica, Guatemala, and the Dominican Republic all have this risk as the second largest,

[25]The table reports the partial R^2 of regressing the change in the debt-to-GDP ratio between 2003 and 2008 on the seven risk factors used in the simulation. Only the risk factors with contributions consistently above 5 percent are reported in Table 4.4. In particular, the contributions of the interest rate and inflation to the expected change in the debt ratio are quite low, both in this analysis and the traditional approach, and were thus excluded for presentational purposes.

[26]This apparent anomaly can be explained by El Salvador's rather volatile real exchange rate history. If El Salvador's real exchange rate becomes more stable as a consequence of official dollarization (2001), the relative contribution of this variable to the debt buildup will fall.

[27]Traditional debt sustainability analysis concludes that depreciation and contingent losses are the two main sources of risk to the debt dynamics of El Salvador. Both risks are combined in this section under the heading of the real exchange rate risk which, as shown in Table 4.4, is the largest contributor to the expected increase in the debt ratio for El Salvador.

Table 4.4. Relative Contribution by Risk Factor
(In percent)

	Costa Rica	Dominican Republic	El Salvador	Guatemala	Panama
Growth	16	10	1	1	15
Real primary spending	39	54	18	52	63
Real exchange rate	32	15	64	32	0

Source: Based on simulated data using current debt structures.

although the relative contribution to the debt dynamics is twice as large for the first two (32 percent) than for the latter (15 percent). The following subsection concludes, on a preliminary basis, that altering the composition of the public sector debt in favor of domestic currency debt would reduce the vulnerabilities of both Costa Rica and Guatemala, but increase it in the Dominican Republic.

Growth is a prominent factor affecting debt dynamics for Costa Rica, Panama, and Dominican Republic, contributing 16, 15, and 10 percent, respectively. For the other two countries the growth impact is insignificant, reflecting a relatively larger correlation between GDP growth and the other risk factors in these countries.

Assessment of Policy Options

The VaR framework can also be used for a stylized analysis of different policy options. In the following, a change in the debt composition is presented as an example: foreign currency liabilities tend to dominate emerging market debt structures, further limiting the capacity that these countries have to formulate policy responses.[28] Using the framework developed in this paper, the potential benefits of an alternative debt structure with a larger fraction of domestic currency debt are evaluated for the three nonofficially dollarized economies in Central America. The simulation of an alternative debt structure reveals a three-dimensional indifference curve among currency denomination, real interest rate, and maturity. Thus, the simulation of the alternative debt structures keeps the maturity and interest rates profiles of each currency-denominated debt unaltered, changing only the proportion of domestic currency debt vis-à-vis the external debt. Consequently, the alternative debt structure simulated in each one of the three countries is of shorter average maturity and subject to higher (and generally more volatile) real interest rates. In all three cases it has been assumed that foreign currency denominated debt falls to 30 percent of total debt, from 60 percent in Costa Rica, 73 percent in Dominican Republic, and 76 percent in Guatemala.[29]

As shown in Table 4.5 greater reliance on domestic currency debt appears to be a viable complement to fiscal adjustment for Costa Rica and Guatemala.[30] Reducing the composition of foreign currency debt to 30 percent of total debt decreases the 2008 debt-to-GDP ratio by more than 4 points in Guatemala's case, and by 2½ points in the case of Costa Rica. The risk profile would also improve in both cases. In contrast, Dominican Republic's current debt structure appears to serve that country better than one with greater reliance on domestic debt. Increasing the share of domestic currency debt to 70 percent of total debt would increase the debt-to-GDP ratio by almost 8 points by 2008, and worsen the risk profile from 81.5 percent to 88.5 percent.

Conclusions

The analysis presented in this section complements traditional sustainability assessments by providing a sense of the probability distribution of the debt-to-GDP ratio using VaR techniques. The pro-

[28]See Hausmann and Panizza (2003) for an in-depth analysis of the issue.

[29]It should be noted that increasing the share of domestic currency debt could negatively affect the incentives to repay, particularly in the context of flexible exchange rates, as inflation becomes an effective way to reduce the real value of such debt. Also, increasing the share of domestic currency debt could potentially increase the contingent liabilities of the public sector if private agents dollarized their portfolios further as a consequence of the government actions.

[30]For the estimation of the VaR, the period 1991–2003 is used. In the case of the Dominican Republic the crisis-free period 1993–2001 was used instead, entailing lower exchange rate volatility.

Table 4.5. Effect of Increased Reliance on Domestic Currency Debt
(In percent of GDP)

	Debt/GDP (2008)		VaR (at 5 percent)	
	Original	New	Original	New
Costa Rica	65.5	63.0	94.1	88.5
Dominican Republic	64.5	72.2	81.5	88.5
Guatemala	36.7	32.5	50.6	43.7

Source: IMF staff estimates.

posed framework confirms the main finding of the traditional approach, namely, that policy actions are required in all of the Central American countries, with the exception of Guatemala, to make their ratios of public debt to GDP sustainable. Nevertheless, the traditional approach provides a somewhat different characterization of the risk profiles of the debts, and the sensitivity of the debt ratios to the different risks appears to not be appropriately captured by conventional stress tests. Both of these shortcomings can be addressed using the VaR technique discussed in this section. This analysis reveals that the factors that contribute to the risks differ across countries. While government spending is a key factor in almost all countries, some countries are particularly vulnerable to changes in the real exchange rate, while others depend critically on the growth performance. Therefore, despite many commonalities, the emphasis and type of policy response may have to differ across countries.

Appendix. Value-at-Risk Methodology

The VaR methodology was originally developed to calculate the market risk of a financial portfolio—that is, the probability distribution of returns of a given portfolio due to changes in market prices. It was created to provide a numerical estimate of the potential loss in the value of the portfolio over a given time period. More recently, it has been extended to assess the risk characteristics of financial institutions around the world, and to the measurement and management of credit risk, liquidity risk, operational risk, and the analysis of natural disasters, among others. It is also used as a source of information and as a risk management tool, primarily by financial institutions and regulators, but increasingly by nonfinancial companies. VaR can be extended, in principle, to the analysis of any type of risk or combination of risks and to any type of institution. The VaR provides an estimate of "the worst possible loss over a target horizon with a given level of confidence.[31]

The technique, as originally developed, computes the potential loss from the variance of the portfolio returns, based on some assumption about the probability distribution of returns and a given confidence level. The technique, in its original form, consists of estimating the distribution of portfolio values based on the portfolio composition and a set of market risks.

The VaR methodology does not provide much structure on how to estimate the relationship between the actual realization of an outcome and the set of underlying risk factors; it provides a way to calculate the probability distribution function of the final outcome. To implement VaR, the underlying risk factors of the portfolio need to be identified, as do the interrelationships (covariance matrix) among those risk factors. This is done by decomposing the assets and liabilities of a given portfolio into a set of primitive securities, each exposed to a small number of risk factors. The function that describes the relationship between primitive securities and underlying risk factors is referred to as mapping in the VaR terminology. There are many ways in which this mapping can be done.

The probabilistic distribution of outcomes can be computed analytically or through simulation using as inputs the mapping matrix, the probability distribution of the underlying risks, and the covariance matrix of risks. The VaR is then computed from the probability distribution for a given confidence level.

The most general VaR formulation assumes normally distributed returns and uses the following expression to compute the VaR for a specific confidence level:

$$VaR = \alpha \sigma_P W, \qquad (1)$$

[31]Definition provided by Jorion (2001), p. 22.

where W is the initial value of the portfolio, α is the standard normal deviate for a given confidence level, and σ_P is the standard deviation of portfolio returns, calculated as

$$\sigma_P^2 = w'\Sigma w, \qquad (2)$$

where w is the vector of weights for the various securities in the portfolio and Σ is the variance-covariance matrix of returns. This approach, also known as delta-normal approach, has important drawbacks in its application to the fiscal accounts: it assumes normal distribution of fiscal outcomes and it requires the decomposition of the assets and liabilities into a set of primitive securities—that is, securities exposed to only one risk factor each.

In contrast to the delta-normal approach, simulation methods, also known as full-valuation methods, are better suited to the analysis of fiscal risks. These methods are less restrictive about underlying probabilistic functions and allow for the direct estimation of portfolio values from simulated financial and economic environments. Under the full-valuation methods, the portfolio valuations obtained from a large number of simulations are sorted from worst to best, and the VaR is the nth observation of the sorted results, where n is the confidence level defined in percent times the number of simulations that were carried out.[32]

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[32]For example, the VaR at a 99 percent confidence level in an exercise of 10,000 simulations is given by the 100th observation of the sorted portfolio returns (1 percent x 10,000).