

# Stress testing in the Debt Sustainability Framework (DSF) for Low-Income Countries

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May, 2011

Summary: This technical note describes in detail the propagation of standardized stress tests in the LIC DSA template using an analytical and graphical approach. It is intended to aid technical staff in low income countries as well as country teams at the IMF and WB by providing the intuition as well as mechanics of stress testing. This should enhance the understanding of the shocks in the DSF and help improve the conduct of debt sustainability exercises in low income countries.

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<sup>1</sup> The views expressed herein are those of the authors and should not be attributed to the IMF, its Executive Board, or its management.

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# 1 Introduction

1. **The objective of the joint Fund-Bank debt sustainability framework (DSF) for low-income countries (LICs) is to support LICs’ efforts to achieve their development goals without creating future debt problems.**<sup>3</sup> The DSF is built on three pillars: (i) a standardized forward-looking analysis of debt and debt-service dynamics under a baseline scenario, alternative scenarios, and standardized stress test scenarios; (ii) a debt sustainability assessment based on indicative country-specific debt-burden thresholds that depend on the quality of policies and institutions in the country; and (iii) recommendations on a borrowing (and lending) strategy to limit the risk of debt distress, while maximizing the resource envelope to achieve the Millennium Development Goals (MDGs). The DSF is operationalized through the joint Bank-Fund debt sustainability analysis (DSA) which is epitomized by the LIC DSA template.

2. **The LIC DSA template combines the assessment of external and public debt sustainability in one file.** Public DSA covers external and domestic public and publicly guaranteed (PPG) debt<sup>4</sup>, whereas the external DSA covers the country’s overall financing flows with the rest of the world – external PPG and private debt.

3. **To adequately inform borrowing and lending decisions, DSAs need to be based on realistic macroeconomic baseline scenarios.** The principal mechanism for promoting realism in DSAs is to scrutinize baseline projections by (i) subjecting them to reality checks and (ii) making use of precautionary features of the DSF. The reality checks and precautionary features are intended to provide safeguards against excessive borrowing and a return to debt distress, without constraining justified optimism about the effective use of external resources to promote growth, reduce poverty, and achieve the country’s development goals.

4. **The LIC DSA template contains 16 standardized shocks.** The standardized shocks are deterministic with simplified feedback effects to ensure cross-country comparability. To understand the underlying dynamics of the DSF, it is imperative to comprehend the propagation of individual shocks through the economy.

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<sup>3</sup> The LIC DSF was formally introduced in 2005. See “[Operational Framework for Debt Sustainability Assessments in Low-Income Countries—Further Considerations](#)” and “[Debt Sustainability in Low-Income Countries—Further Considerations on an Operational Framework and Policy Implications](#)”.

<sup>4</sup> PPG debt comprises: (i) debt of the public sector, defined as central, regional and local governments, central bank, and public enterprises—the latter subsumes all enterprises that the government controls, such as by owning more than half of the voting shares—and (ii) private sector debt guaranteed by the public sector. Excluding an SOE’s external debt from the external DSAs can be considered, if the company can borrow externally without a public guarantee and its operations pose a limited fiscal risk. For more information, please see “[Staff Guidance Note on the Application of the Joint Bank-Fund Debt Sustainability Framework for Low-Income Countries](#)”.

5. **The purpose of the paper is to provide a description of the stress tests.** It combines an analytical and graphical approach to describing the transmission mechanisms of the shock in the LIC DSA template.

6. **The paper proceeds as follows.** Section 2 describes the concept of debt burden indicators, which are central to the debt sustainability assessment. Section 3 discusses the interpretation of debt burden outcomes in terms of risks of debt distress. In Section 4, the baseline scenario is discussed, which is followed in Section 5 by a detailed description of the stress tests. Section 6 concludes.

## 2 Debt burden indicators

8. **Debt sustainability is assessed by undertaking a forward-looking analysis of the evolution of debt burden indicators under a baseline scenario, alternative scenarios, and standardized stress test scenarios.** Debt burden indicators compare a measure of indebtedness to a measure of capacity to repay:

$$\text{Debt burden indicator} = \frac{\text{Measure of Indebtedness}}{\text{Measure of capacity to repay}} \quad (1)$$

9. **Different measures of indebtedness are used to identify solvency and liquidity risks.** Liquidity problems arise when a country has short term difficulties meeting its financial obligations as they come due although its ability to pay is not affected under normal circumstances. Solvency problems, on the other hand, arise when a country's repayment difficulties are permanent or protracted. Put differently, insolvency is associated with policies that lead to ever-increasing debt levels in relative terms, which necessitate a shift in policies such as an increase in taxes, cuts in spending, recourse to monetization, or even repudiation.

10. **Indicators based on debt stocks are used to identify possible solvency problems.** For LICs, a debt stock measure based on the present value (PV) of debt is more informative than the nominal stock of debt<sup>5</sup>, reflecting the typical concessionality of loans contracted by LICs (equation 2). Concessional loans are characterized by below-market interest rates, a grace period, and a long maturity period. Clearly, the debt burden

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<sup>5</sup> The present value of debt is the sum of all future debt service payments (principal and interest) discounted using an appropriate discount rate. The PV represents the amount of money to be invested today (earning the discount rate) required to repay all the financial obligations stemming from the existing stock of debt. Given that the calculations assume no capital losses, the discount rate to be used in PV calculations should be the risk-free interest rate (r in equation 2). The discount rate in the LIC template is related to the six-month average of the U.S. dollar commercial interest rate (CIRR). The discount rate was initially set at 5 percent and is adjusted by 100 basis points, whenever the 6-month average of the U.S. dollar CIRR moves by at least 100 basis points for at least 6 consecutive months. This approach is intended to strike a balance between the desire to insulate PV calculations from cyclical movements, without de-linking it entirely from long-term market trends.

associated with an obligation to repay US\$100 million in 5 years at an interest rate of 7 percent is more onerous compared to the obligation to repay the same US\$100 million in 40 years, with a 10-year grace period and an interest rate of 0.75 percent. By discounting the debt service (principal and interest) using an appropriate discount rate, the PV captures the effective debt burden.

$$PV_t = \frac{DebtService_{t+1}}{(1+r)} + \frac{DebtService_{t+2}}{(1+r)^2} + \dots + \frac{DebtService_{t+n}}{(1+r)^n} \quad (2)$$

**11. Indicators based on debt service (interest payments and amortization) are used to assess liquidity problems.** They represent the share of a country’s resources used to repay its debt (and therefore resources not used for other public purposes). However, with the repayment of concessional loans usually increasing as a loan matures, debt service indicators are likely to be limited for predicting future debt servicing problems. Long projection periods can mitigate this problem, but the reliability of the projection tends to diminish with its length.

**12. Measures of capacity to repay include GDP, exports, and government revenues.** Nominal GDP captures the amount of overall resources of the economy, while exports provide information on the capacity to produce foreign exchange. Finally, government revenues measure the government’s ability to generate fiscal resources. In some specific cases, remittances may be added to GDP and exports to assess external debt sustainability.<sup>6</sup>

**13. By default, DSAs are done on gross debt.** For countries with significant assets, a net concept may be applied in the public debt framework; liquid asset accumulation is not taken into account in the external template.

**14. To appropriately identify solvency and liquidity problems, the LIC DSA focuses on different debt burden indicators depending on the coverage of PPG debt.**

For public and publicly guaranteed (PPG) external debt, the debt burden indicators include ratios to exports and are as follows:

- i. PV of debt-to-GDP
- ii. PV of debt-to-exports
- iii. PV of debt-to-revenues
- iv. Debt service-to-exports
- v. Debt-service-to-revenues

For public and publicly guaranteed external and domestic debt (i.e. total public debt), the debt burden indicators are as follows:

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<sup>6</sup> See “Staff Guidance Note on the Application of the Joint Bank-Fund Debt Sustainability Framework for Low-Income Countries”.

- i. PV of debt-to-GDP
- ii. PV of debt-to-revenues
- iii. Debt-service-to-revenues

### 3 Debt sustainability

**15. The DSF uses policy-dependent debt-burden thresholds to assess PPG external debt sustainability.** These indicative thresholds do not apply to other definitions of debt burden indicators.<sup>7</sup> Based on empirical findings, the DSF assumes that external PPG debt levels that LICs can sustain are determined by the quality of their policies and institutions.<sup>8</sup> A country with relatively good (weak) policies and institutions is more (less) likely to allocate resources effectively and is, therefore, better placed to manage a higher (lower) level of external PPG debt.

**16. Policy performance and institutional quality is measured by the three-year moving average Country Policy and Institutional Assessment (CPIA) index, compiled annually by the World Bank.** The three-year average is used to prevent volatility in the threshold level, and, thus, excess volatility in the risk of debt distress, which in turn determines the country's financing terms from IDA (and possibly other donors).<sup>9</sup>

**17. The DSF divides countries into three policy performance categories: strong, medium, and weak.** Table 1 depicts the associated external debt-burden thresholds. The risk classification depends, among other factors, on the indicative thresholds and therefore on the CPIA score.

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<sup>7</sup> Historically external borrowing has been the main source of financing for LICs. In addition, risk ratings are used to provide a signal to external creditors to possibly change their terms and conditions of financing in response to changes in external risk of debt distress.

<sup>8</sup> See "[Debt-Sustainability in Low-Income Countries-Proposal for an Operational Framework and Policy Implications](#)" and "[When Is External Debt Sustainable?](#)", Aart Kraay and Vikram Nehru, World Bank, Policy Research Paper, February 2004.

<sup>9</sup> In addition, for countries where, following the release of the new annual CPIA score, the updated three-year moving average CPIA rating breaches the applicable CPIA boundary, the country's performance category would change immediately only if the size of the breach exceeds 0.05. If the size of the breach is at or below 0.05, the country's performance category would change only if the breach is sustained for two consecutive years.

Table 1: Thresholds for external PPG debt

	Quality of policies and institutions		
	Weak	Medium	Strong
	CPIA $\leq$ 3.25	3.25 < CPIA < 3.75	CPIA $\geq$ 3.75
NPV of debt-to-GDP	30	40	50
NPV of debt-to-exports	100	150	200
NPV of debt-to-revenue	200	250	300
Debt service-to-exports	15	20	25
Debt service-to-revenue	25	30	35

18. Depending on the evolution of external PPG debt burden indicators compared with their respective thresholds under the baseline, alternative scenarios, and stress tests, a country is classified as:

- **Low risk.** All debt indicators are well below relevant country-specific debt-burden thresholds. Stress testing and country-specific alternative scenarios do not result in indicators significantly breaching thresholds. In cases where only one indicator is above its benchmark, judgment is needed to determine whether there is a debt sustainability problem or some other issue, for example, a data problem.
- **Moderate risk.** While the baseline scenario does not indicate a breach of thresholds, alternative scenarios or stress tests result in a significant rise in debt-service indicators over the projection period (nearing thresholds) or a breach of debt or debt-service thresholds.<sup>10</sup>
- **High risk.** The baseline scenario indicates a protracted breach of debt or debt-service thresholds but the country does currently not face any payment difficulties. This is exacerbated by the alternative scenarios or stress tests.
- **In debt distress.** Current debt and debt-service ratios are in significant or sustained breach of thresholds. The existence of arrears would generally suggest that a country is in debt distress, unless there are other reasons than debt-service burden for not servicing its debt.

## 4 Baseline Scenario

19. The baseline scenario, or most likely scenario, is typically based on a macroeconomic framework designed outside the LIC DSA template. The DSA is based on the evolution of debt burden indicators over the projection period (forward-looking exercise). This implies that the DSA needs a projection of: (i) the measures of indebtedness, the numerator; and (ii) the measures of capacity to repay, the denominator. The projection of the measures of indebtedness reflects either total public debt, including domestic debt, or total external PPG debt.

<sup>10</sup> Given the long maturity profiles of debt in many LICs, debt service is often backloaded. Thus, a steady increase in such ratios to near their thresholds could indicate the possibility of a breach of thresholds beyond the projection period.

20. **The evolution of public debt ( $Debt^{public}$ ) can be characterized in terms of the primary deficit (PD) trajectory.** Public debt is expressed in local currency units (LCU) and its evolution takes into account: government revenues (tax and non-tax revenues (T), and grants (G)) and expenditures (primary expenditures, that is, total expenditures excluding interest payments (S), and interest payments (INT)) as well as other non-recurrent factors (OTHER) affecting the stock of debt not taken into account in revenues or expenditures (equation 3). The latter would include: (i) privatization receipts; (ii) debt relief; (iii) recognition of contingent liabilities such as bank recapitalization costs. Finally, a residual component is added to capture any changes to the stock of public debt not explained by the variables mentioned above.

$$\begin{aligned}
 Debt_t^{public} &= Debt_{t-1}^{public} + \text{expenditures}_t - \text{revenues}_t + OTHER_t + residual_t & (3) \\
 Debt_t^{public} &= Debt_{t-1}^{public} + (S_t - (T_t + G_t)) + INT_t + OTHER_t + residual_t \\
 Debt_t^{public} &= Debt_{t-1}^{public} + PD_t + INT_t + OTHER_t + residual_t \\
 Debt_t^{public} - Debt_{t-1}^{public} &= PD_t + INT_t + OTHER_t + residual_t \\
 \Delta Debt_t^{public} &= PD_t + INT_t + OTHER_t + residual_t \\
 \Delta Debt_t^{public} &= \Delta Debt_t^{external} + \Delta Debt_t^{domestic}
 \end{aligned}$$

21. **In the LIC DSA template, equation (3) is expressed in percentage of GDP.** Once equation (3) is expressed in percentage of GDP to normalize the nominal amounts, the expression for the change in public debt will include terms describing the endogenous or automatic debt dynamics, such as the contribution from changes in the interest rate, real GDP growth, and prices and exchange rate changes. These contributions are calculated automatically in the template.<sup>11</sup>

22. **The usefulness of fiscal indicators depends on the coverage of the public sector and the quality of the debt data.** If the public sector is defined too narrowly (central government, rather than general government including public companies), then public sector debt may be understated and its capacity to repay may be inadequately measured. The accuracy of the sustainability assessment may also be impeded by data deficiencies such as incomplete domestic debt data or inappropriately measured cost of financing.

23. **Similar to the public debt template, the evolution of external debt can be characterized by the path of the non-interest current account deficit (NICA) together with non-debt creating flows.** The basic equation for the evolution of external debt ( $Debt^{external}$ ) takes into account a country's sources of foreign exchange "income/inflows" and "expenditures/outflows" (equation 4). A country's source of foreign exchange includes exports of goods and services (X), net transfers (NT), and net

<sup>11</sup> For a complete analytical exposition see Burnside (2005), Ley (2007) or the Appendix of the Staff Guidance Note on the Application of the Joint Bank-Fund Debt Sustainability Framework for Low-Income Countries.

income (NI).<sup>12</sup> A country's use of foreign exchange, meanwhile, includes imports of goods and services (M). These components (X, M, NT, and NI) form the current account (CA) in the balance of payments and can be rearranged into the current account deficit excluding interest payments (NICA) and interest payments (INT). The evolution of the stock of external debt takes also into account non-debt creating sources of financing from the balance of payments. In particular, the LIC DSA template accounts for the non-debt creating component of foreign direct investment (net FDI).<sup>13</sup> Other factors (residual) contributing to the evolution of the external stock of debt include debt relief (exceptional financing), drawdown of foreign exchange reserves, and errors and omissions. Another source of non-debt creating flows is capital grants, which are not explicitly taken into account in the LIC DSA template. As such, capital grants are captured by the residual.

$$Debt_t^{external} = Debt_{t-1}^{external} + M_t - X_t - NT_t - NI_t - netFDI_t + OTHER_t + residual_t \quad (4)$$

$$Debt_t^{external} = Debt_{t-1}^{external} + NICA_t + INT_t - netFDI_t + OTHER_t + residual_t$$

$$Debt_t^{external} - Debt_{t-1}^{external} = NICA_t + INT_t - netFDI_t + OTHER_t + residual_t$$

$$\Delta Debt_t^{external} = NICA_t + INT_t - netFDI_t + OTHER_t + residual_t$$

**24. If a country spends more than it earns (current account deficit), then foreigners accumulate net claims on residents - the country borrows externally.** This assumes that FDI and other factors do not compensate for the foreign income shortfall over spending. Note that the external borrowing can either be PPG or private. Note also that it can also be in domestic or foreign currencies, although external borrowing is almost exclusively done in foreign currency in LICs.

**25. The DSA must be based on a consistent projection of the fiscal and external accounts.** By construction, external borrowing is the sum of private and public external borrowing, providing a direct link between the fiscal and external accounts. Alternatively, public borrowing is the sum of public external and domestic borrowing.

## 5 Standardized stress tests

**26. Informed and prudent borrowing decisions require an assessment of the evolution of debt burden indicators under different assumptions compared to the baseline.** These different assumptions are called stress tests and they assess the robustness of the baseline. Stress testing therefore scrutinizes the realism of the baseline and reveals the country's vulnerabilities. What is the sensitivity of the evolution of debt burden indicators to different assumptions? For example, if real GDP growth is lower than anticipated, will it jeopardize fiscal sustainability?

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<sup>12</sup> Note that for simplicity, net transfers and net income are assumed to be sources of foreign exchanges but this may not be the case in reality.

<sup>13</sup> In addition to its equity and portfolio part, FDI also has a debt creating component, intercompany loans, which should be added to private external debt.

**27. The LIC DSA template stress tests the baseline scenario automatically.** The impact of stress testing is channeled in two ways: by changing the evolution of the measures of indebtedness and by changing the capacity to repay compared to the baseline scenario. In the DSF, stress tests are deterministic rather than stochastic. In other words, shocks of a certain magnitude are assumed to take place with certainty, based on a particular algorithm that will be discussed below.

**28. In the fiscal DSA, additional financing needs triggered by a shock to the baseline are always satisfied by new net (marginal) borrowing.** Shocks to government revenues, the primary deficit, or the exchange rate, *ceteris paribus*, impact the government financing needs. These additional financing needs, in turn, result in an identical change in borrowing. Accordingly, the template assumes that changes in financing needs arising from shocks (compared to the baseline) are met by changes in borrowing rather than adjustments in government policies.<sup>14</sup>

**29. In the external DSA, external PPG borrowing closes the balance of payments after a shock to the baseline scenario.** Changes in the following variables, *ceteris paribus*, will affect the evolution of the measures of external indebtedness: exports, net transfers, net FDI, net current account deficit excluding interest payments, and less concessional new external borrowing. As in the public DSA, changes to external financing needs result in a comparable change in external borrowing needs. In contrast to the public DSA, however, the composition of marginal borrowing is *a priori* unclear – both the public and the private sector could in theory change their borrowing needs. Given that the public sector is most likely to have greater access to external borrowing, the template assumes that all of the additional external financing needs ensuing from a shock are met with PPG external borrowing.<sup>15</sup>

**30. Shocks can be distinguished according to their duration.** The LIC DSA template distinguishes two types of stress tests: (i) alternative scenarios; and (ii) bound tests. Alternative scenarios represent permanent shocks, while bound tests are temporary shocks (one or two years) after which the altered variables return to their baseline values.

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<sup>14</sup> In the public DSA, the users are asked to provide information on how the terms and conditions (interest rate, grace period, and maturity) of the new borrowing will take place (external borrowing, domestic long-term or short-term borrowing). Marginal borrowing assumptions can be entered in the “Inp\_Outp\_debt” sheet of the LIC DSA template under cells J10-Q25.

<sup>15</sup> In the external DSA, the new borrowing requirement stemming from the standardized stress tests are financed according to the exogenously specified average terms (interest rate, grace period, and maturity) of new financing in the baseline. Marginal external borrowing assumptions can be found in the “Inp\_Outp\_debt” sheet of the LIC DSA template under cells C86-C88.

**31. The LIC DSA template calibrates the magnitude of the shocks using 10 years of historical data.**<sup>16</sup> This default period is used to calculate the historical averages and associated standard deviation of key macro variables. However, under certain circumstances, the standardized stress tests may not capture adequately the vulnerabilities of the country. For instance, structural breaks in the time series (i.e. discovery of oil or a civil war) or data deficiencies may require a change in the period used for calibration. Bound tests are calibrated so that the implied outcome for the long-term debt ratio (at a 10-year horizon) has a roughly 25 percent likelihood of occurring.<sup>17 18</sup>

**32. Stress testing should follow an asymmetric approach and be tilted toward adverse shocks.** To check its robustness, the user should stress the baseline with meaningful adverse shocks i.e. the DSF is interested in downside rather than upside risks. Thus, while it may occur that stress tests calibrated using 10-year averages and standard deviations deliver positive shocks, implying an improvement in debt burden indicators, such shocks could be altered to model downside risks.

**33. The LIC DSA template contains 16 different standardized stress tests in total.** The public DSA (PDSA) comprises 3 alternative scenarios and 5 bound tests; the external DSA (EDSA) encompasses 2 alternative scenarios and 6 bound tests. To simplify the description of the stress tests, comparable shocks will be described in the same section.

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<sup>16</sup> For the fiscal DSA average and standard deviations are calculated in cells AK16-AL55 in the “fiscal-baseline” sheet. For the external DSA average and standard deviations are calculated in cells B68-P73 in the “baseline” sheet.

<sup>17</sup> See “[Debt Sustainability in Low-Income Countries—Proposal for an Operational Framework and Policy Implications](#)”, IMF and IDA, February 2004.

<sup>18</sup> Note that, bound tests do not exhibit unsustainable debt dynamics within this framework, unless the baseline does. Stress tests are constructed in such a way that the interest rate, growth rate, and primary balance (or current account excluding interest payments) return to their baseline value after the shock dissipates.

Stress tests	Public DSA (PDSA)	External DSA (EDSA)
<b>Alternative scenarios (A1-A3)</b>  <i>Permanent shock over the entire projection period</i>	<b>A1. Historical</b> <i>The primary balance-to-GDP ratio and real GDP growth are set to their historical average.</i>	<b>A1. Historical</b> <i>Several key macroeconomic variables are set to their historical average.</i>
	<b>A2. Primary balance</b> <i>The primary balance-to-GDP ratio is set to last year of history.</i>	<b>A2. External financing</b> <i>Less concessional external borrowing (200 basis points)</i>
	<b>A3. Lower real GDP growth</b> <i>Real GDP growth is lowered by a fraction of its standard deviation.</i>	
<b>Bound tests (B1-B6)</b>  <i>Temporary shocks (second and third year of projection)</i>	<b>B1. Real GDP growth</b> <i>Real GDP growth is set to its historical average minus one standard deviation.</i>	<b>B1. Real GDP growth</b> <i>Real GDP growth is set to its historical average minus one standard deviation.</i>
	<b>B2. Primary Balance</b> <i>The primary balance-to-GDP ratio is set to its historical average minus one standard deviation.</i>	<b>B2. Exports</b> <i>Nominal exports (USD) growth set to its historical average minus one standard deviation.</i>
	<b>B3. Combination of B1 and B2</b> <i>Each reduced only by 0.5 standard deviations.</i>	<b>B3. Deflator</b> <i>Domestic GDP deflator (USD) is set to its historical average minus one standard deviation.</i>
	<b>B4. Depreciation</b> <i>One-time nominal depreciation of 30 percent (first year of the projection).</i>	<b>B4. Other flows</b> <i>Current transfers-to-GDP and FDI to-GDP set to their historical average minus one standard deviation.</i>
	<b>B5. Other Flows</b> <i>One-time increase of public debt by 10 percent of GDP (first year of the projection).</i>	<b>B5. Combination (B1-B5)</b> <i>Each reduced only by 0.5 standard deviations.</i>
		<b>B6. Depreciation</b> <i>One-time nominal depreciation of 30 percent (first year of the projection).</i>

## 5.1 Shock to real GDP growth (PDSA and EDSA)

*There are two temporary shocks (bound test B1 in PDSA and EDSA) and one permanent shock (alternative scenario A3 in PDSA) to real GDP growth.*

Description: Under the temporary shocks (B1), real GDP growth is set at its historical average minus one standard deviation over the second and third year of the projection period (t+1 and t+2). Real GDP growth returns to the baseline projection thereafter. Under the permanent shock (A3), the baseline real GDP growth projection is reduced over the entire projection period by roughly one-fifth of one standard deviation.<sup>19</sup>

**34. For both the PDSA and the EDSA, the shock to real GDP growth represents a shock to measures of capacity to repay.** The adverse shock to real GDP growth has a permanent impact on the level of real GDP ( $Y^r$ ) and nominal GDP ( $Y^n$ ). This is the consequence of two assumptions: (i) real GDP growth returns to the baseline projection after the shock; and (ii) inflation remains unchanged, as measured by the GDP deflator. The decline in nominal GDP (compared to the baseline) has in turn a proportional negative impact on the nominal level of government revenues because the revenues-to-GDP ratio is assumed to remain unchanged compared to the baseline.

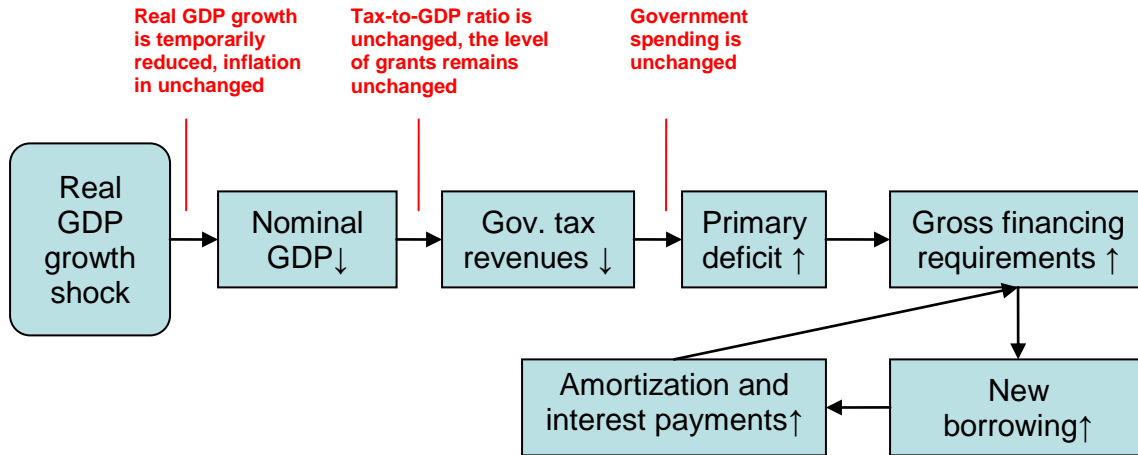
**35. In the PDSA (A3 and B1), the shock to real GDP growth also represents a shock to the measures of indebtedness (Figure 1).** While the real GDP shock affects adversely nominal revenues, it is not assumed to have an impact on the level of government spending. Smaller tax revenues with respect to the baseline and unchanged spending results in a wider non-interest (primary) fiscal deficit and increased financing needs, and thus additional borrowing. Note that grants are also assumed constant in nominal terms compared to the baseline, and, thus, increase in GDP terms. In the end, future financing needs are compounded by new marginal borrowing as it raises future debt servicing costs (principal and interest payments).

**36. In the EDSA, the shock to real GDP growth has no impact on the measures of indebtedness.** Variables affecting the evolution of the measures of indebtedness such as the level of net FDI inflows or the current account (exports, imports, net current transfers, other non-interest current account flows and interest payments) remain unchanged compared to the baseline scenario. With the current account and net FDI unaffected by the shock, the *level* of external debt, its NPV, and the *level* of debt service coincides with the baseline scenario. In other words, in the EDSA, the shock to real GDP growth affects debt burden indicators only through the impact on the denominators, that is, nominal GDP and government revenues.

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<sup>19</sup> Real GDP growth (scenario A3) = real GDP growth (baseline) -  $\frac{STD}{\sqrt{20}}$

Figure 1: Negative shock to real GDP growth (PDSA) - impact on the level of gross financing needs



## 5.2 Exchange rate depreciation (PDSA and EDSA)

*Depreciation shocks are present in both the fiscal and external DSA (bound tests B4 in PDSA and B6 in EDSA). This reflects the currency mismatch risks between the measures of capacity to repay (GDP and revenues are in local currency) and the measures of indebtedness (external debt is denominated in foreign currency).*

Description: The 30 percent depreciation shock takes place in the second projection year. During the third projection year, the change in the nominal exchange rate resumes its path in line with the baseline scenario. Given that domestic and foreign prices are not affected, the nominal depreciation can be interpreted as real exchange rate shock.

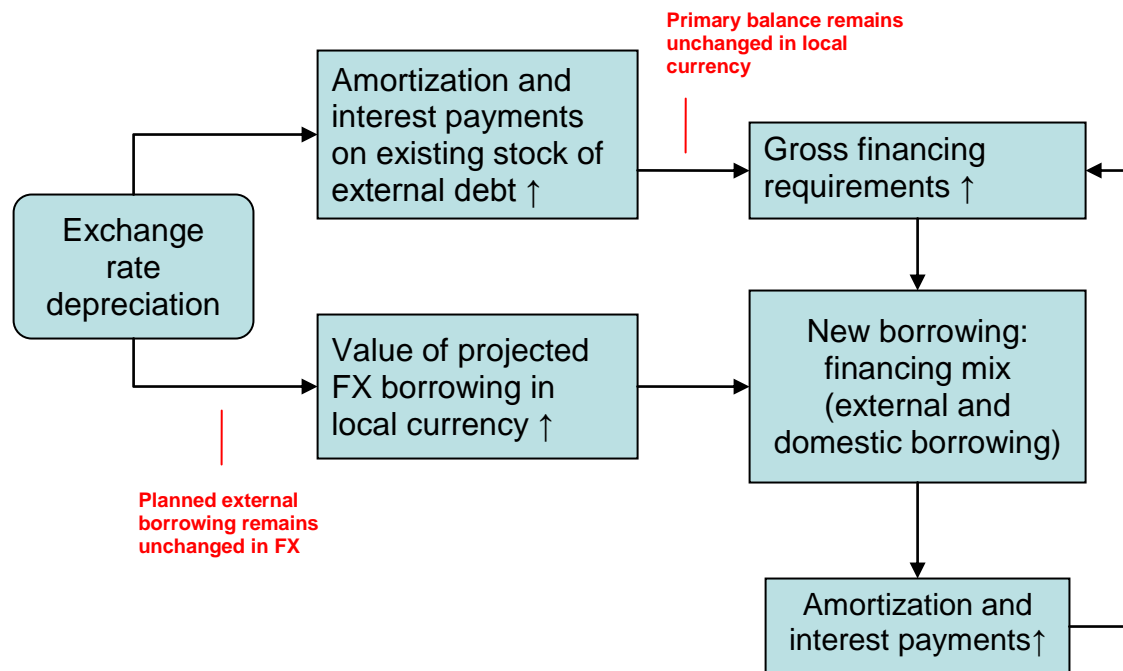
**37. In the EDSA, the nominal depreciation results in a concomitant decline in the GDP deflator denominated in USD.** Changes in the deflator lead to a proportional and permanent reduction in the value of domestic GDP in US dollars. However, real GDP growth (LCU) remains unchanged compared to the baseline. In addition, the level of all the components of the BoP are assumed to be unaffected by the shock. In other words, the exchange rate shock is a pure valuation shock. As discussed in the previous section (section 5.1), changes to nominal GDP will impact government revenues (expressed in foreign exchange) in the EDSA, which represents the denominator, but would not affect measures of indebtedness. Hence, while the level of external debt is unchanged (measure of indebtedness), the debt burden indicator is affected by smaller nominal GDP and government revenues (the capacity to repay). Meanwhile, debt burden indicators based on exports will remain unchanged compared to the baseline as the exchange rate shock is assumed not to affect trade.

**38. In the PDSA, the measures of repayment capacity (nominal GDP and government revenues in LCU) are not affected by the exchange rate depreciation.** In addition, government spending (excluding interest payments) or grants do not change

after the depreciation shock. Therefore, the primary deficit remains unchanged after the depreciation.

**39. In the PDSA, the nominal exchange rate depreciation affects only the measures of indebtedness and composition of new borrowing.** The depreciation has two direct effects on the level and composition of new borrowing (Figure 2): i) in local currency terms, it increases the cost of servicing the existing stock of foreign currency-denominated debt (level effect); and ii) the value of planned PPG foreign borrowing is assumed to remain constant in USD after the depreciation, which implies a larger value of foreign borrowing in local currency. Given that the primary balance is unchanged in local currency and foreign borrowing plans are unchanged in USD, the depreciation effectively leaves the country with more local currency from external borrowing to finance the same primary balance, which may reduce net domestic debt (composition effect).

Figure 2: Exchange rate depreciation (PDSA) - impact on the level of gross financing needs



### 5.3 Shock to the primary balance (PDSA)

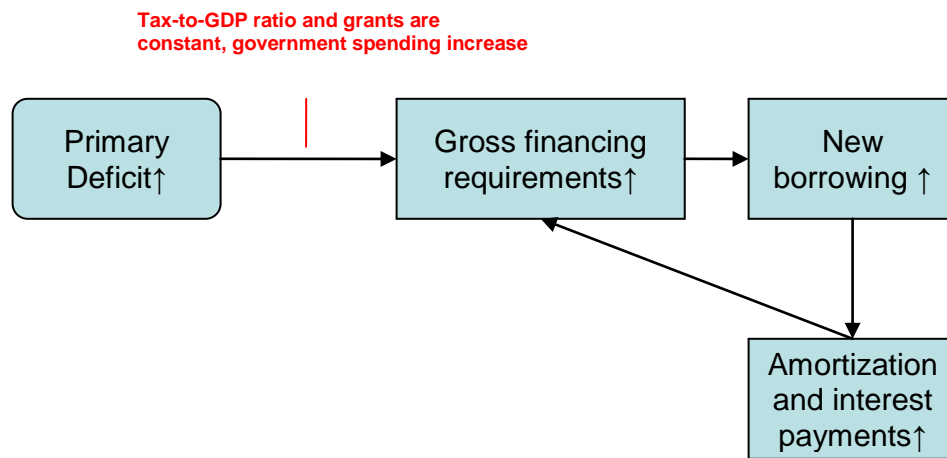
There are two primary balance shocks in the PDSA: one permanent (alternative scenario A2) and one temporary (bound test B2).

Description: Under the permanent shock (scenario A2), the primary deficit-to-GDP ratio is set at a level equivalent to the primary deficit in the first year of the projection over the entire projection period. This shock is also called the fiscal policy status quo. Under the temporary shock (bound test B2), the primary deficit-to-GDP ratio is set to equal its historical average minus one standard deviation during the second and third projection year.

40. Under both scenarios, it is assumed that the shock to the primary deficit occurs through changes in primary expenditures, rather than government revenues. The idea behind the permanent shock (A2) is to present the outcome of no policy changes to the current fiscal stance. The bound test (B2) demonstrates the impact of a temporary spending shock. The wider primary deficit increases the gross financing need (Figure 3) and, thus, public borrowing (external or domestic), which will further increase future financing needs through additional future interest and amortization payments.

41. Under both scenarios, the deterioration in the debt burden indicators reflects an increase in the measure of indebtedness, rather than a deteriorating repayment capacity. Despite an increase in government spending, nominal GDP and government revenues remain unchanged under both scenarios.

Figure 3: Shocks to the Primary Balance (PDSA) - impact on the level of gross financing needs



#### 5.4 Shock to the primary balance and real GDP growth (PDSA)

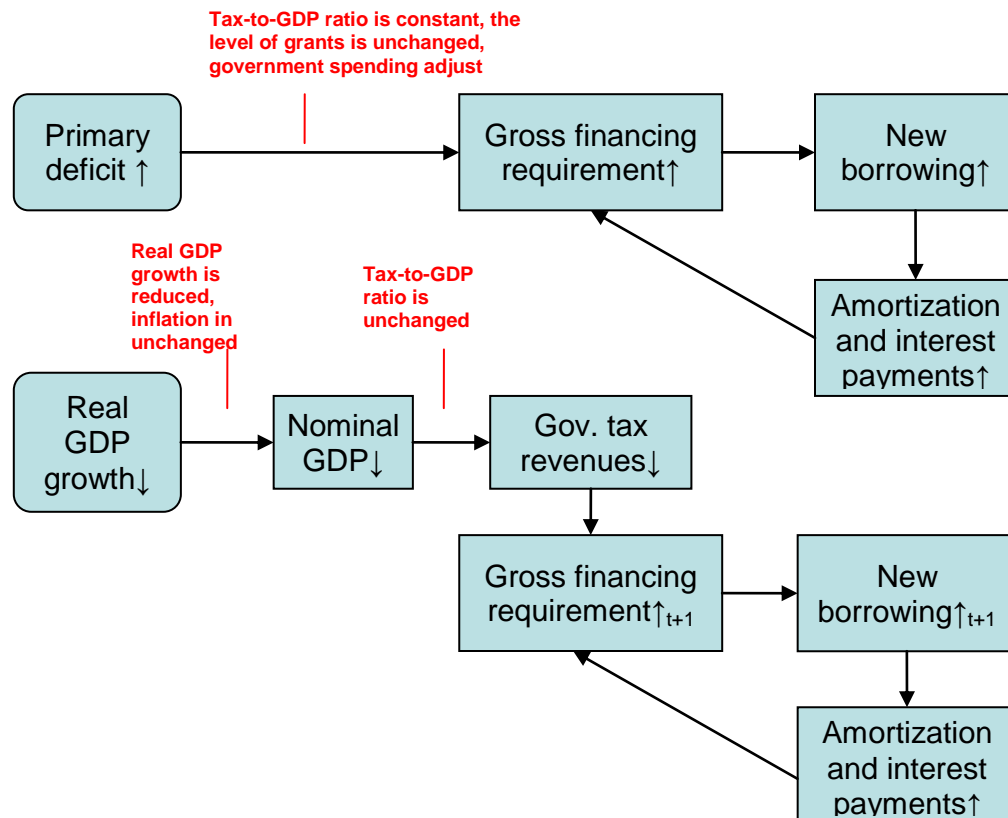
There are two standardized stress tests combining a shock to the primary balance and a shock to real GDP growth: one permanent (alternative scenario A1) and one temporary (bound test B3) shock.

Description: Under the permanent shock (alternative scenario A1), the primary balance-to-GDP ratio and real GDP growth are set to equal their historical average starting in the second year of the projection and lasting over the entire projection horizon. Under the temporary shock (bound test B3), real GDP growth and the primary balance-to-GDP ratio are set in second and third year of the projection to equal their historical averages minus half standard deviation.

42. Both stress tests (alternative scenario A1 and bound test B3) are a combination of individual shocks discussed above (section 5.1 and 5.2). The deterioration in the primary deficit in the second and third year of the projection reflects the shock to the primary balance. Thereafter, the adverse shock to real GDP growth (deterioration in repayment capacity), which in turn affects adversely nominal government revenues

(through the decline in nominal GDP), leads to a deterioration of the primary deficit and an increase in gross borrowing requirement (Figure 4).<sup>20</sup> The LIC DSA template assumes an unchanged level of grants implying a larger grant-to-GDP ratio. Note also that under the combo stress test, the magnitude of the shocks is smaller ( $\frac{1}{2}$  standard deviation) compared to the shocks to individual macro variables (1 standard deviation).<sup>21</sup>

Figure 4: Negative shock to primary balance and real GDP growth - impact on the level of gross financing needs



## 5.5 Shock to other debt creating flows (PDSA)

*One-off increase in other debt creating flows amounting to 10 percent of GDP reflects a contingent liabilities shock (bound test B5)*

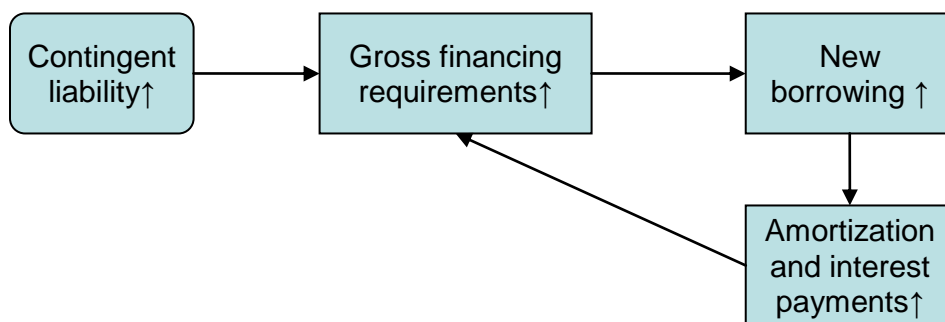
<sup>20</sup> Once new borrowing is assumed, the financing requirement will also reflect additional amortization and interest payments.

<sup>21</sup> The shock magnitude under the combo stress test is smaller as the probability that very large shocks hit the economy simultaneously is likely to be small and the DSF does not attempt to model extreme risks or scenarios. From a practical perspective, if the combo stress test were of equal size compared to other individual shocks to the same macro variables, then such individual shocks would always represent subsets of the large shock from a most extreme scenario perspective. t.

Description: During the second projection year, this generic shock to the financing requirement embodies, for instance, bank recapitalization costs or other private sector bail-outs. This realized contingent liability increases directly new borrowing during the year of the shock.

**43. The contingent liability shock augments the borrowing needs by 10 percent of GDP without affecting other variables** (Figure 5). The default value is set at 10 percent of GDP, but this can be changed if the recognition of implicit contingent liabilities is expected to exceed the default amount of 10 percent of GDP.<sup>22</sup> With nominal GDP and government revenues not affected by this shock, the now larger debt burden indicators are affected through the measures of indebtedness channel only, and not through the direct repayment capacity measure.

Figure 5: Contingent liability shock – impact on the level of gross financing needs



## **5.6 Historical scenario: shock to non-interest external current account, net FDI, real GDP growth, and GDP deflator in US dollar terms (EDSA)**

*A permanent shock (alternative scenario A1) to the non-interest external current account deficit, net FDI, real GDP growth, and GDP deflator in US dollar terms.*

Description: Starting in the second projection year and lasting over the entire projection period, the aforementioned four key variables are set to their 10-year historical average. This shock represents a benchmark against which the realism of the baseline assumptions is tested as it assumes a continuation of the average historical economic performance, which tries to capture the structural characteristics of the economy. In the following description, we assume that the historical averages are below the baseline trajectories.

**44. This stress test is a combination of individual permanent shocks**, some of which were described above (section 5.1). The shock to real GDP growth and to the GDP deflator impact nominal GDP expressed in foreign currency and, hence, affect the debt burden indicators through the measure of the repayment capacity (Figure 6). At the same time, the shock to the non-interest current account deficit (NICA) and net FDI is transmitted to debt burden indicators through the indebtedness channel as they affect directly the borrowing requirement.

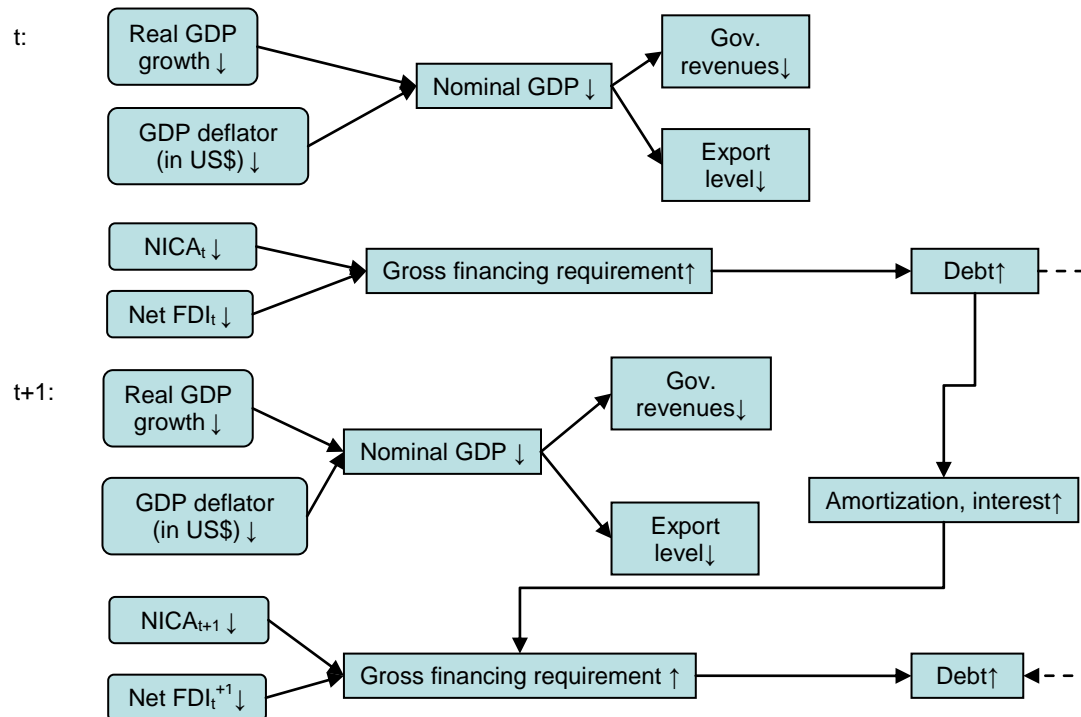
<sup>22</sup> An alternative scenario could also be designed to capture country-specific circumstances in which the contingent liability shock spreads over several periods and affects other variables.

45. **The historical scenario affects the repayment capacity through its impact on domestic nominal GDP in US dollar.** The permanent reduction in real GDP growth and the change in the domestic GDP deflator in US dollar terms (compared to the baseline scenario) results in a reduced growth rate of nominal GDP and, therefore, a smaller nominal GDP. In addition, the historical scenario assumes that all current account components and government revenues remain unchanged in percent of GDP, with respect to the baseline. Accordingly the reduction in nominal GDP implies a proportional reduction in exports and government revenues.

46. **Shocks to both the external current account and the net FDI impact the financing need and, therefore, external borrowing (measure of indebtedness).** The increase in debt leads to an increase in debt service payments as well as the PV of debt.

47. **All debt burden indicators are expected to deteriorate,** reflecting a decline in the measure of the capacity to repay (nominal GDP, exports and government revenues) in conjunction with larger indebtedness, which in turn leads to an increase in PV of debt and debt service payments.

Figure 6: Key variables set to historical averages - impact on the level of gross financing needs



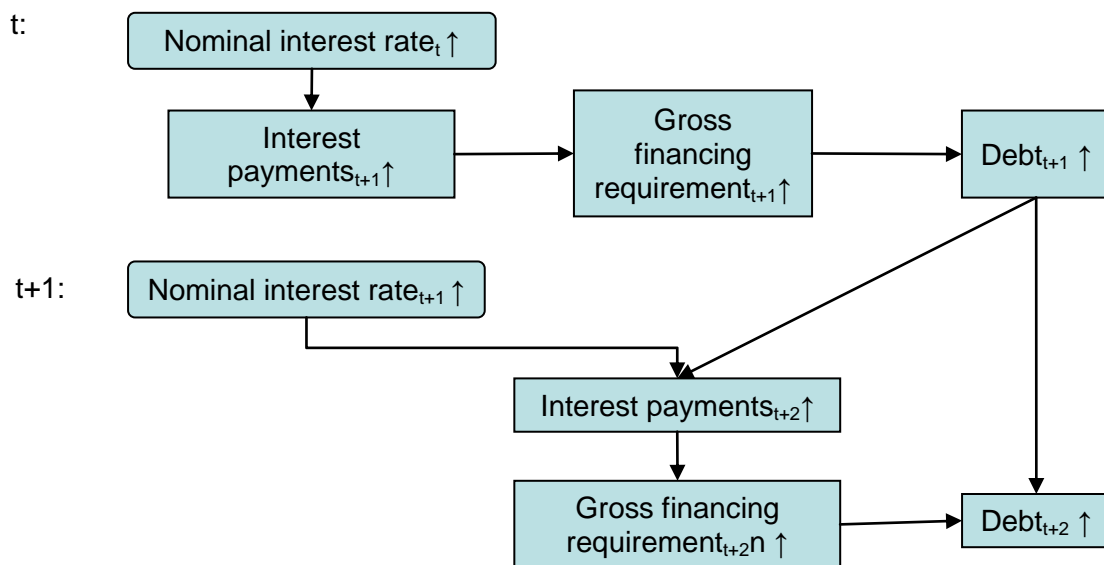
## 5.7 Shock to terms of foreign financing (EDSA)

*This is a permanent shock (alternative scenario A2) to terms of foreign financing for public sector borrowing*

Description: Starting in the second projection year, this permanent shock worsens the terms of foreign financing on public external borrowing through an increase in the interest rate of 2 percentage points<sup>23</sup> (compared to the baseline).

48. **The deterioration in the concessionality of new borrowing results in larger interest payments and, thus, transmits through the measure of indebtedness** (Figure 7). The rise in interest payments results in larger gross financing needs, and ultimately a rise in debt as debt service payments increase compared to the baseline. Measures of repayment capacity remain unchanged.

Figure 7: Shock to financing terms - impact on the level of gross financing needs



## 5.8 Shock to exports (EDSA)

*This is a temporary shock (bound test B2) to the growth rate of exports that lasts for two years*

Description: Nominal export growth (in USD) is set temporarily at its historical average minus one standard deviation. Commencing in the second projection year, this shock lasts for two periods after which export growth returns to the baseline trajectory. Thus, the temporary shock to export growth has a permanent effect on the level of exports. To achieve a temporary impact on

<sup>23</sup> This shock is located in the template in sheet PV Stress\_A2, cell: B5

the level of the non-interest current account, the level of imports is reduced from the third year onward of the projection period.

**49. The shock to nominal exports growth in dollar terms results in a deterioration of the current account deficit, and hence affects the measure of indebtedness** (Figure 8).

Under this bound test, imports are assumed constant during the shock and adjust thereafter to assure an external non-interest current account deficit equivalent to the baseline. The wider external deficit causes a rise in gross financing needs, which elevates the external debt level. During the second year of the shock, in addition to the decline in exports, larger debt service payments (amortization and interest payments) stemming from the higher indebtedness a year earlier contribute to a further rise in gross financing needs.

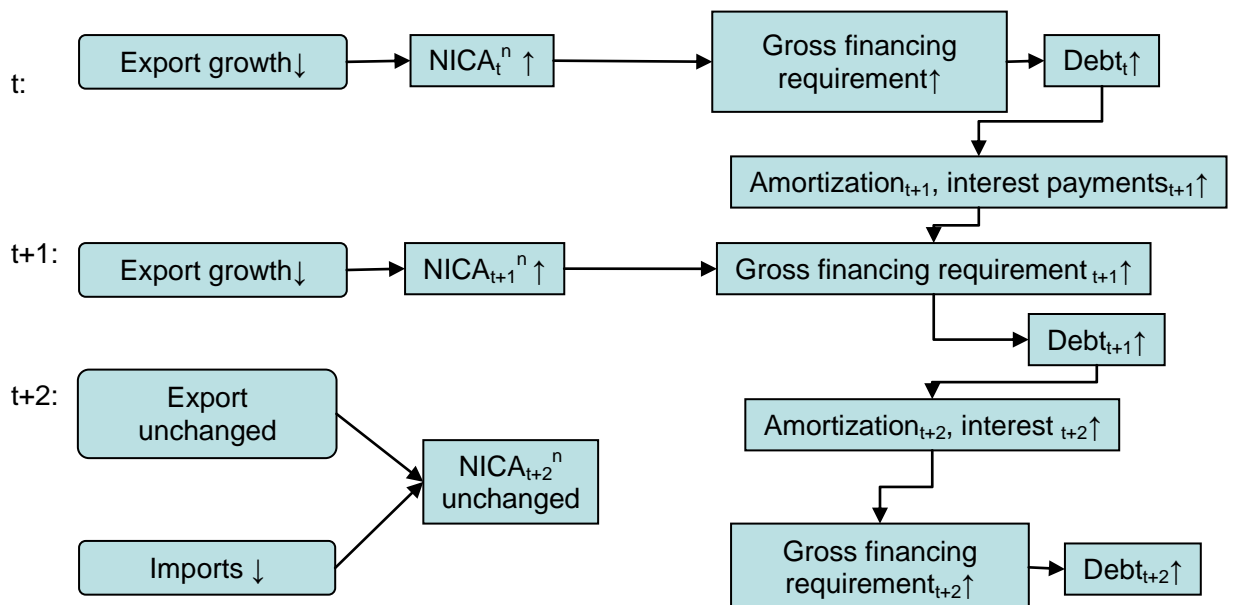
**50. A downward adjustment in the level of imports ensures that the non-interest current account deficit reverts to the baseline trajectory after the two-period shock.**

This adjustment in imports is permanent and in line with permanently lower export levels following the shock (compared to the baseline). External debt is, nevertheless, larger throughout the projection period due to larger current account deficits. The increase in debt service payments leads to an increase in the NPV of external debt.

**51. The decline in exports does not have an impact on the level of nominal GDP, nor government revenues.**

However, all debt burden indicators will be adversely impacted by a negative shock to exports through an increase in indebtedness. Debt burden indicators using exports as a measure of capacity to repay will show a greater deterioration given the reduction in exports.

Figure 8: Two-year shock to exports growth - impact on the level of gross financing needs



## 5.9 Shock to domestic GDP Deflator in dollar terms (EDSA)

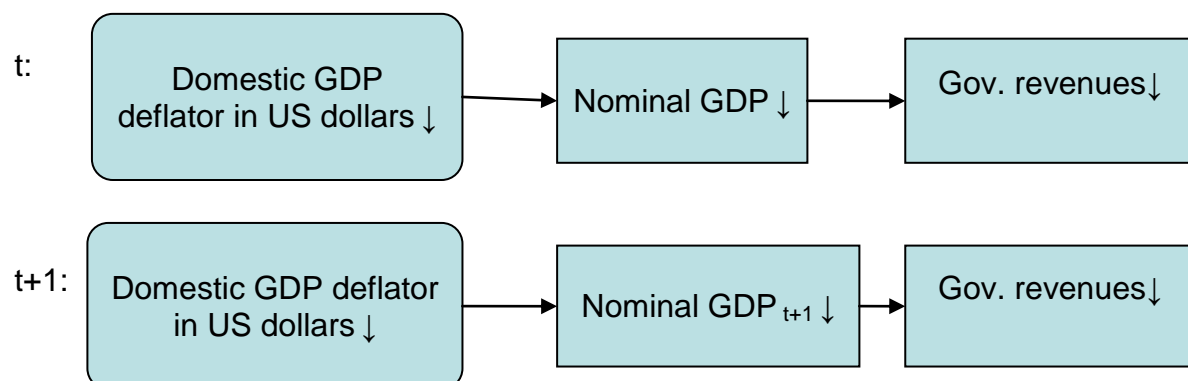
*This is a temporary shock (bound test B3) that reduces the growth rate of the domestic GDP deflator expressed in US dollar terms*

Description: Starting in the second projection year, the US dollar domestic GDP deflator is set to its historical average minus one standard deviation for two periods.

**52. The GDP deflator shock affects the debt burden indicators through the measure of repayment capacity (GDP and government revenues).** The decline in the deflator's growth rate reduces directly nominal GDP in US dollars terms (Figure 9). As the shock to the deflator is not compensated for in subsequent periods, it results in permanently smaller levels of nominal GDP. The reduction in nominal GDP, in turn, implies smaller nominal government revenues (section 5.1.), whereas the repayment capacity as expressed by exports is not affected.

**53. This shock to the GDP deflator has no impact on the non-interest current account or net FDI.** In line with the bound test B1, the borrowing needs remain unchanged (compared to the baseline) and, hence, the measures of indebtedness are not affected by the shock to the deflator.

Figure 9: Negative shock to the GDP deflator in US dollar terms – impact on the level of gross financing needs



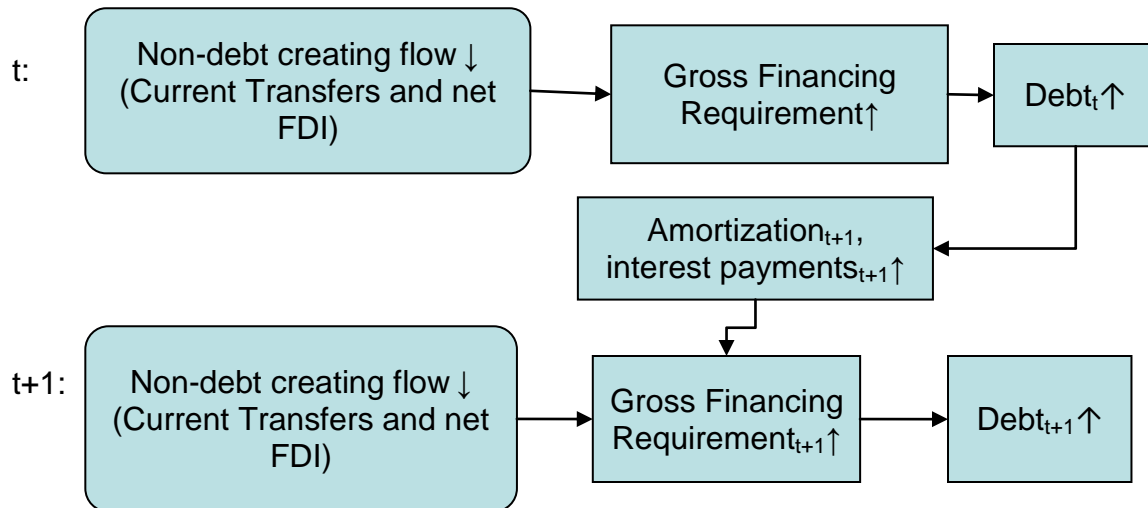
## 5.10 Shock to Non-debt creating flows (EDSA)

*This temporary shock (bound test B4) reduces the inflows of net FDI and net private transfers*

Description: The shock to net transfers and net FDI takes place in the second projection year and last for two periods; it reverts to the baseline trajectory thereafter. The size of the stress reflects the historical average of the two variables minus one standard deviation.

**54. The shock to non-debt creating flows impacts the debt indicators through the indebtedness channel, rather than through a deterioration of the repayment capacity** (Figure 10). It does so by widening the non-interest current account deficit. Given that the measure of indebtedness changes, all debt burden indicators will be affected by this shock.

Figure 10: Negative shock to non-debt creating flows - impact on the level of gross financing needs



### 5.11 Shock to real GDP, exports, GDP deflator, and non-debt creating flows (ESDA)

*This temporary shock (bound test B5) is the most comprehensive stress test in the template as it combines shocks to five variables: real GDP (B1) and exports growth (B2), the GDP deflator (B3), and net private transfers and FDI (B4).*

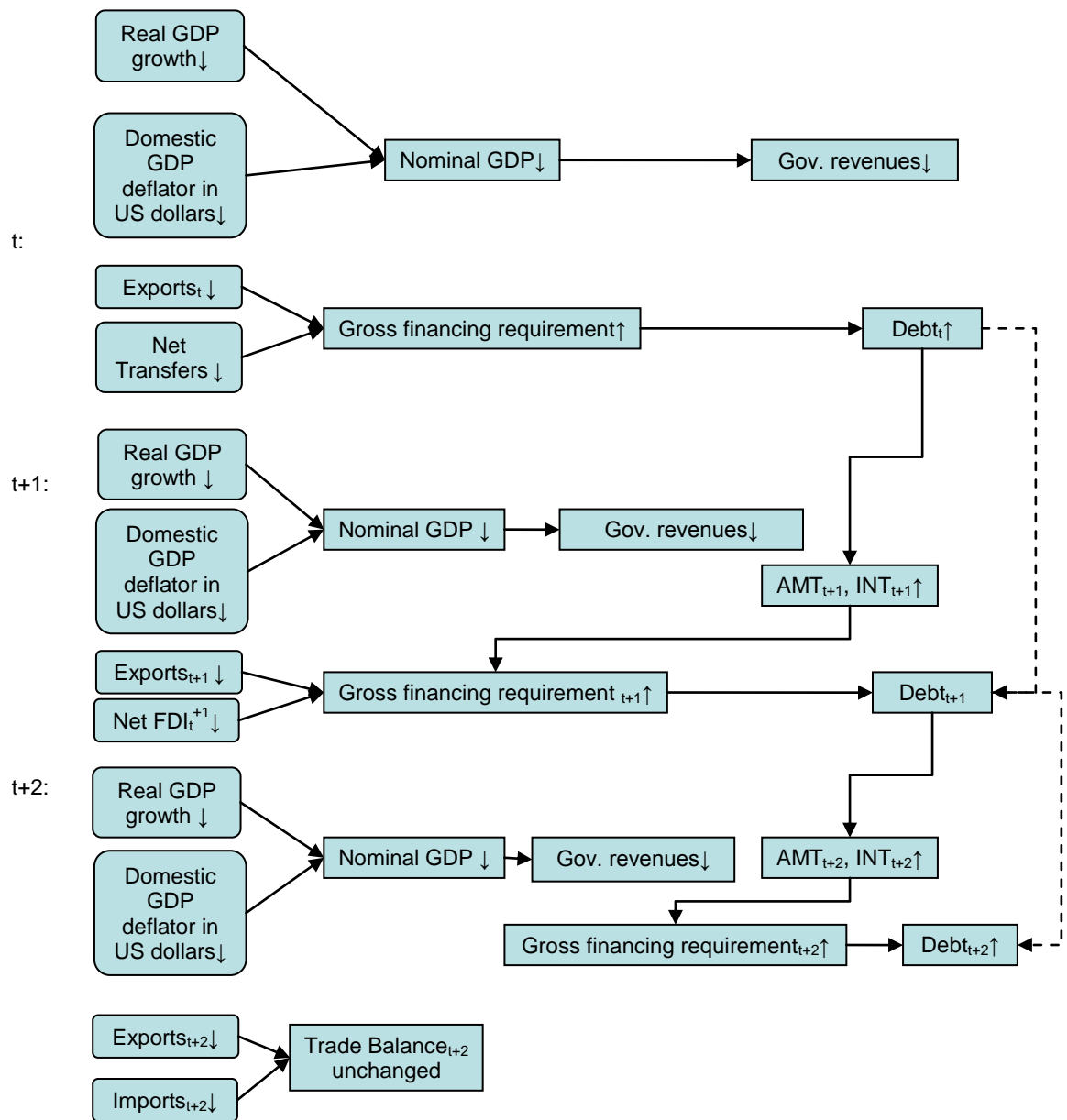
Description: This shock embodies the simultaneous impact of four bound tests (B1-B4) presented earlier (sections 5.1, 5.8, 5.9, 5.10). As opposed to other bound tests, however, the historical averages under this shock are reduced by one-half rather than a full standard deviations. Similar to other stress tests, this shock starts in the second projection period and lasts over two periods.

**55. This shock deteriorates all measure of the capacity to repay through the decline in real GDP, the deflator, and exports (Figure 11).** The temporary decline in real GDP growth and the growth of the GDP deflator in US dollar terms translates into a transitory reduction in nominal GDP growth in U.S. dollars. However, because the temporary deceleration in real growth and inflation (compared to the baseline) are not compensated by increases in subsequent years, the temporary shock to nominal GDP growth has a permanent impact on the level of nominal GDP. Consequently, nominal GDP in this stress test will be smaller than in the baseline scenario over the entire projection period. As in previous bound tests, the share of government revenues in GDP remains unchanged compared to the baseline. As a result, government revenues will also be permanently smaller compared to the baseline scenario. Finally, by reducing temporarily the rate of growth in exports (compared to the baseline), the shock permanently reduces the level of exports.

**56. The decline in exports growth, net private transfers and FDI worsens the measures of indebtedness.** The deceleration in the rate of growth of exports and the reduction in net transfers and FDI widen the non-interest current account deficit in absolute terms compared to the baseline. After the shock dissipates, net transfers revert to their baseline values in absolute terms, and imports decline to help the trade balance return to the baseline value in absolute terms.

**57. All debt burden indicators are expected to worsen compared to the baseline scenario.** This reflects the adverse impact of this shock on all measures of repayment capacity (GDP, revenues and exports) as well as on the measures of indebtedness (PV of debt and debt service).

Figure 11: Negative combination shock - impact on the level of gross financing needs



## 6 Conclusion

58. **This technical note describes in detail the intuition and propagation of deterministic standardized stress tests** in the LIC DSA template using an analytical and graphical approach. It is intended to aid technical staff in low income countries as well as country teams at the IMF and WB by providing the intuition as well as mechanics of stress testing. This should enhance the understanding of the shocks in the DSF and help improve the elaboration of debt sustainability exercises in low income countries.

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