



# IMF Working Paper

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## Measuring Fiscal Vulnerability and Fiscal Stress: A Proposed Set of Indicators

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**IMF Working Paper**

Fiscal Affairs Department

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April 2011

**Abstract**

This paper proposes a set of fiscal indicators to assess rollover risks using the conceptual framework developed by Cottarelli (2011). These indicators provide early warning signals about the manifestation of these risks, giving policymakers the opportunity to adjust policies before extreme fiscal stress events. Two aggregate indices are calculated: an index of fiscal vulnerability and an index of fiscal stress. Results show that both indices are elevated for advanced economies, reflecting unfavorable medium-term debt dynamics and aging-related spending pressures. In emerging economies, solvency risks are lower, but the composition of public debt remains a source of risk and the fiscal position is weaker than before the crisis.

JEL Classification Numbers: H63, H62, E62, E65, E66

Keywords: Fiscal vulnerability, fiscal stress, fiscal indicators

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<sup>1</sup> This paper was prepared under the supervision of Adrienne Cheasty and Abdelhak Senhadji. Research assistance was provided by Oriel Fernandes. Comments from Carlo Cottarelli, Phil Gerson, Manmohan Kumar, Mark Horton and participants in various internal seminars are gratefully appreciated.

| Contents   | Page |
|--|------|
| I. Introduction .....  | 3    |
| II. Conceptual Framework .....   | 4    |
| A. Basic Fiscal Variables .....  | 5    |
| B. Long-Term Fiscal Trends.....  | 7    |
| C. Asset and Liability Management.....   | 7    |
| III. Monitoring Fiscal Vulnerability and Stress .....                              | 9    |
| A. Fiscal Vulnerability Index.....   | 9    |
| B. Fiscal Stress Index.....  | 10   |
| IV. Empirical Application.....   | 11   |
| V. Concluding Remarks.....   | 13   |
| References.....  | 14   |
| Tables   |      |
| 1. Fiscal Monitoring Indicators.....   | 16   |
| 2. Data Definitions and Sources.....   | 17   |
| 3. Summary of Fiscal Stress Events.....  | 18   |
| 4. True Versus Predicted Occurrence of Crises .....                                | 18   |
| 5. Fiscal Risks in G-20 Advanced Economies, GIPS and Emerging Economies, 2010..... | 19   |
| 6. Fiscal Risks in Advanced and Emerging Economies, 2010 .....                     | 20   |
| Figure 1. Composite Risk Scores, 2010.....   | 15   |

## I. INTRODUCTION

This paper contributes to the development of a fiscal monitoring framework which has the primary objective of assessing rollover risk. Rollover problems emerge when government policies are perceived to have become unsustainable, meaning that expectations become widespread that the government will have short- or medium-term difficulties in demonstrating solvency. Understanding the extent of rollover risk is important, since difficulties in rolling over government liabilities are almost always followed by a fiscal crisis, with its associated dangers of disorderly fiscal adjustment.

According to the approach developed in Cottarelli (2011), the fiscal sustainability risks associated with a government's possible inability to roll over its outstanding stock of liabilities without further adjustment measures depend on the interaction between: (i) current level and baseline projections of key fiscal variables; (ii) shocks around this baseline (related to macroeconomic or fiscal policy changes, or the realization of contingent liabilities), which would lead to a deterioration of the fiscal outlook and an increase in the likelihood of rollover problems; and (iii) other factors, including country-specific non-fiscal variables (such as large current account imbalances and high private debt levels) and changes in global market sentiment that could trigger a crisis even though they do not affect fiscal aggregates directly. This paper focuses on indicators pertaining to (i).<sup>2</sup>

These fiscal indicators should provide early warning signals about rollover difficulties, thereby giving policymakers the opportunity to adjust policies before the accumulation of fiscal vulnerabilities leads to extreme fiscal stress events. However, the relationships between indicators and rollover risk are likely to be nonlinear.<sup>3</sup> These nonlinearities imply the existence of thresholds for these indicators beyond which a crisis becomes significantly more likely. Therefore, estimates of thresholds for individual indicators are key building blocks of early warning systems. Since thresholds vary across countries and time, available estimates must be interpreted with caution.<sup>4</sup> Hence, the paper complements an index of rollover risks based on a probabilistic approach, with an index based on "norms" for fiscal variables derived from historical averages across advanced and emerging economies.

The rest of this paper is organized as follows: section II develops the conceptual framework underpinning the selection of fiscal indicators. Section III presents two aggregate indices based on these indicators to assess fiscal sustainability risks under the baseline scenario: an index of fiscal vulnerability and an index of fiscal stress. Section IV presents an application

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<sup>2</sup> Ongoing background work for the Fiscal Monitor focuses on quantifying (ii) and (iii) of this framework.

<sup>3</sup> Nonlinear relationships between fundamentals and the probability of a crisis have been widely documented in rational expectations models of balance of payment and banking crises. These models typically exhibit multiple equilibria. Empirically, examples of nonlinear behavior abound: for example, sovereign ratings exhibit a nonlinear relationship with fundamentals (Caceres, Guzzo and Segoviano, 2010).

<sup>4</sup> Furthermore, these thresholds may not always be sufficiently robust as they could overly depend on extreme values of the distribution of the underlying fiscal variables.

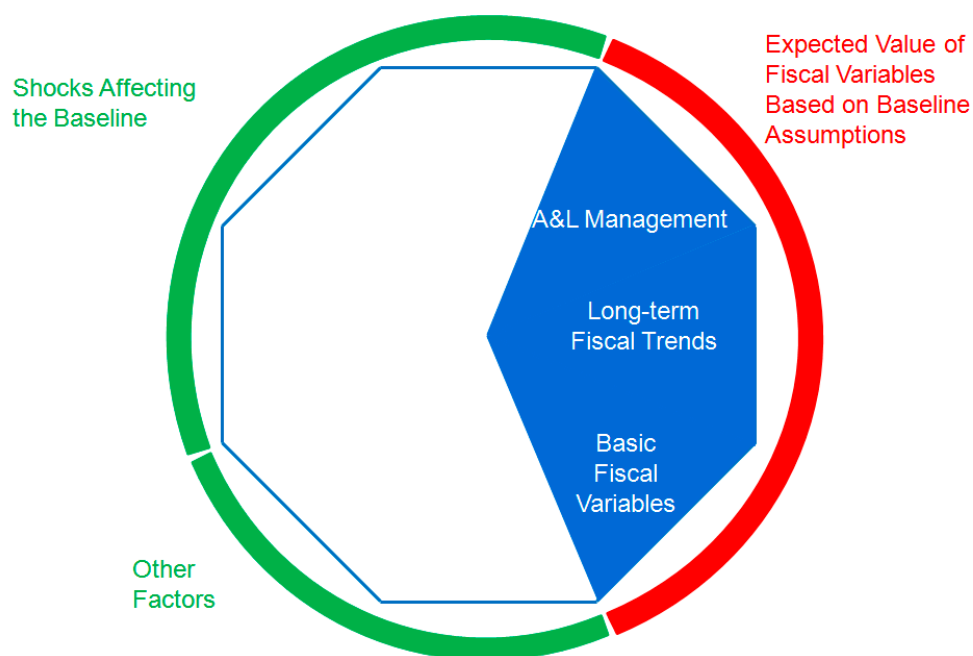
of the above methods to advanced and emerging economies during 2010-11, and section V concludes.

## II. CONCEPTUAL FRAMEWORK<sup>5</sup>

This section focuses on the methodology for determining the appropriate indicators to measure rollover risks associated with the fiscal baseline scenario. Factors affecting the baseline scenario can be grouped into three clusters:

- **Basic fiscal variables:** Are the debt dynamics based on current and expected medium-term policies consistent with fiscal solvency?
- **Long-term fiscal trends:** To what extent will long-term economic and demographic-related challenges affect projected fiscal variables and impact solvency risks?
- **Asset and liability management:** Given the outlook for fiscal solvency, does the composition of government's assets and liabilities expose countries to large rollover needs? Does it amplify (or reduce) financing risks?

The figure below depicts how the three clusters above fit into the comprehensive framework developed in Cottarelli (2011) to assess fiscal sustainability risk:



<sup>5</sup> In principle, the fiscal monitoring framework should apply to the widest possible coverage of government activities. Data availability constraints mean that for most countries it is not possible to monitor the public sector. Instead, monitoring the general government is a more feasible option.

The choice of indicators included in each cluster is influenced by operational factors and the need to avoid reliance on financial market indicators. The latter suffer from three main shortcomings: (i) they already incorporate perceptions of risks to the fiscal baseline, while this framework seeks to disentangle rollover risks under the baseline scenario from potential shocks to this scenario; (ii) they already reflect the likelihood that governments access non-market financing to avoid solvency crises; and (iii) they tend to lag rather than lead the deterioration of the fiscal outlook. Fiscal indicators have been selected on the basis of several criteria. Each indicator is widely used, easily accessible over time and available for a broad range of countries. Many other conceptually attractive indicators were considered but discarded on the grounds of complexity, data availability, or the need to apply subjectivity. A summary of the selected indicators, along with information on their data sources, is provided in Tables 1 and 2.

### A. Basic Fiscal Variables

The fundamental building block for understanding government rollover risk is solvency. The solvency condition requires that the intertemporal budget constraint be met, which happens when the net present value of the future stream of primary fiscal balances is at least equal to the initial stock of public debt. Hence assessing the first dimension of rollover risk associated with the baseline scenario entails examining fiscal indicators such as the stock of public debt, current and projected primary fiscal balances, and the growth-adjusted interest rate on public debt (Escolano, 2010).<sup>6</sup>

What is the best indicator to measure government debt? A preferred measure of public debt is net debt as a ratio to GDP.<sup>7</sup> This takes into account both government liabilities and assets that could be used to repay debt. However, measuring net debt raises difficult issues in most countries due to differences in the definition of assets (Baunsgaard and Shin, 2011). In contrast, a comparable measure of **gross debt** is more widely available. A practical solution

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<sup>6</sup> The growth-adjusted interest rate plays a crucial role in the stability of the debt-to-GDP ratio and fiscal solvency: if the interest rate on debt exceeds the GDP growth rate, it can be shown that the stability of the debt ratio ensures that the intertemporal budget constraints is met (see Bartolini and Cottarelli, 1992 for this and for a discussion of the case when the interest rate is lower than the GDP growth rate)

<sup>7</sup> A related issue is the coverage of public debt. As with the other fiscal indicators in this note we use general government fiscal variables. In principle, public debt could be calculated for the consolidated central bank and general government to eliminate from the count government debt held by the monetary authority (which would be a liability of the public sector to itself). However, this may introduce an inconsistency with the flow fiscal variables (which typically do not consolidate central bank operations) in so far as transfers of profits/coverage of losses between the central bank and the government do not achieve this consolidation. Consolidating central bank and general government gross debt may also mask the extent to which central banks buy government securities to finance the budget. An alternative would be to exclude debt instruments held by the central bank for monetary policy purposes, but this approach is more difficult to adopt given data constraints and definitional problems.

is to use net debt in those countries where it is available and where government assets are significant and clearly identified, but otherwise to use a gross debt measure.<sup>8</sup>

Current and projected primary fiscal balances are key to assessing the extent to which fiscal policy is consistent with the intertemporal budget constraint. Primary surpluses are typically required in countries with high debt to ensure that this is stabilized, when nominal interest rates on sovereign debt exceed nominal output growth.<sup>9</sup> The **cyclically adjusted primary balance** as a ratio of potential GDP is a suitable indicator of fiscal solvency, as it reflects the fiscal stance independent from the effects on the budget of the output cycle.<sup>10 11</sup> While the current value of the cyclically adjusted primary balance is important in assessing the extent to which countries may need to adjust to fulfill the intertemporal budget constraint, it would seem a priori that this could usefully be complemented by the projected medium-term cyclically adjusted primary balance which incorporates government future policies under the baseline. However, including projected values of the primary balance failed to enhance our framework's ability to predict rollover risks, reflecting perhaps the significant noise associated with projections.<sup>12</sup> The **projected growth-adjusted interest rate**—the difference between the projected imputed nominal interest rate on government debt and the projected nominal growth rate of GDP (Escolano, 2010; IMF, 2010)—affects debt dynamics. The higher the interest rate–growth differential, the larger the primary balance required to ensure fiscal solvency.<sup>13</sup>

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<sup>8</sup> With countries migrating to the new classification system based on the Government Finance Statistics Manual (GFSM) 2011, new information on the sovereign balance sheet, including the government's net financial and total worth may become available, allowing a more comprehensive assessment of solvency risks.

<sup>9</sup> However, when public debt is stabilized at high levels it could harm growth and limit the government's ability to respond to shocks through countercyclical fiscal policies. When long-run growth is above interest rates on public debt, stabilizing the debt as a ratio to GDP (although not necessary to ensure solvency) would ensure that government liabilities are stable with respect to the maximum "potential tax base" (i.e., GDP). Of course, the ability to raise taxes falls when tax pressure (as a share of GDP) become too high, because of the distortions associated with high tax rates that discourage investment and reduce labor supply.

<sup>10</sup> In principle, structural primary balances, which take into account cycles of factors beyond GDP, such as commodity prices as well as one-off factors (Bornhorst et al., 2010), would need to be used. However, in practice uncertainty about the definition of one-off factors, as well as difficulties in assessing the impacts on revenue of other cycles beyond GDP, such as asset prices and domestic absorption, limit the information content and the cross-country comparability of this indicator at this stage. Further work would be needed to calculate structural balances that are comparable across countries (Bornhorst et al., 2011).

<sup>11</sup> When using net debt in the intertemporal budget constraint, the appropriate measure of the primary fiscal balance is one that excludes net interest expenses from the overall balance. Net interest expenses are given by gross interest spending minus interest receipts.

<sup>12</sup> Further work is ongoing to incorporate forward-looking fiscal indicators in this framework, taking into account data availability constraints.

<sup>13</sup> See Appendix 1 in IMF (2010b) for a discussion on how to measure the interest rate–growth differential and what factors contribute to its dynamics.

## B. Long-Term Fiscal Trends

Fiscal solvency also depends on the extent to which long-term demographic and economic trends will put pressure on the budget. Since solvency depends not only on the current fiscal position but also on expected future primary balances, current projections of long-term fiscal challenges could affect solvency perception and raise rollover risk today. Therefore, additional indicators are needed to capture long-term change in fiscal trends.

Demographic-related spending is generally the most important source of long-term fiscal pressures, especially in advanced economies. Many countries have been experiencing a major demographic transition due to population aging. While this demographic transition is common to most industrial countries, there are sizable differences across countries.

Therefore, the following indicators have been added:

- **Future expenditure pressures:** The projected change over the coming twenty years in key age-related expenditure items, such as *health and pensions*, gives important information on the likely fiscal costs of demographic trends.
- **The current total fertility rate** is a forward-looking indicator of future demographic changes. These changes can have profound effects on economic activity and the fiscal position of a country, not all captured by 20-year ahead health and pension projections. For instance, a fertility rate below the replacement level could lead to a significant decline in the labor force in the absence of large migratory flows even if there is some room for increasing participation in most countries. Therefore, the current fertility rate provides a leading indicator of the potential tax base available to finance increasing spending pressure from population aging.
- Two countries with the same current and future fertility rate will have different old-age dependency ratios in the future reflecting the initial age structure of the population. The projected **old-age dependency ratio** combines long-term demographic trends with the initial population structure and provides an indicator of countries' capacity to bear the costs of supporting the old.<sup>14</sup>

## C. Asset and Liability Management

Given the fiscal solvency outlook based on the indicators described above, risks could be higher for countries more exposed to the need to roll over large amounts of debt in the near future. Further, countries with a large share of public debt held by non-residents could be perceived as being more likely to address solvency problems by “taxing foreigners” through default rather than through corrective actions. Thus, given the set of fiscal indicators

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<sup>14</sup> Given projected spending increases, this variable captures the likelihood that reforms aimed at containing pension and health cost increases are ultimately not sustainable, as they may result in extremely low benefit levels.



discussed above, the composition of the government's assets and liabilities can expose countries to large rollover needs and amplify (or reduce) financing risks.

The following three groups of indicators are used to capture risks stemming from asset and liability management, some of which are principally relevant only for emerging economies or advanced economies: (i) rollover needs; (ii) maturity structure; and (iii) global markets risk.

**Gross financing needs**, the sum of the overall balance and the stock of maturing public debt, is a measure of the government's rollover requirement.<sup>15</sup> Other things equal, a greater need to access the market in the short term means a higher risk of adverse market reactions when solvency risks are high and/or risk appetite low.

A large share of short-term debt means more exposure to rollover risks in the near term. This is particularly true if current financial market conditions are not favorable. The **share of short-term public debt as a ratio of total public debt** indicates the magnitude of this risk. The **weighted average maturity of outstanding government debt** is a summary measure of the maturity structure of the entire public debt stock.<sup>16</sup> For emerging economies, the **ratio of short-term external debt to gross international reserves** gives also information on the likely claim on foreign currency resources required to meet short-term foreign currency debt service. This indicator has less practical value in advanced countries, especially euro area countries, where central banks do not hold large international reserves for intervention purposes.<sup>17</sup> Therefore, the use of this indicator is limited to emerging economies.

Highly integrated capital markets pose particular challenges for asset and liability management. These challenges are different for advanced and emerging market economies. Advanced countries can issue their debt in domestic currency, while many emerging economies have so far been constrained by investors' risk aversion to currency risks. A high level of foreign currency-denominated public debt increases the probability that exchange rate shocks adversely affect the government's ability to service debt. The **proportion of debt denominated in foreign currencies, as a percent of total debt**, provides a measure of this exposure to foreign exchange risk. As mentioned above, a large proportion of debt held by non-residents is generally perceived by markets as more risky. We use general **government debt held by non-residents as a proportion of total debt** to capture the perceived greater risk of default on debt held by non-residents than that held by residents.

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<sup>15</sup> In principle, this indicator should exclude the issuance of government securities for monetary policy purposes. In practice, it is difficult to separate this portion of government debt from gross borrowing needs.

<sup>16</sup> Many countries issue variable rate securities, but data on the share of the latter are not available on a cross-country basis.

<sup>17</sup> Emerging economies have been typically exposed to risk of "sudden stops" and have been more prone to speculative attacks. As a result they have tended to accumulate precautionary reserves.

### III. MONITORING FISCAL VULNERABILITY AND STRESS

An effective monitoring system should provide adequate warning for fiscal vulnerability and assess the likelihood of rollover problems for advanced and emerging economies. This section proposes two signaling tools:

- A fiscal vulnerability index, summarizing the fiscal indicators presented in this paper. The index measures the degree of fiscal vulnerability on a continuous basis as departure from historical “norms”, defined as 10-year cross-country averages. The key advantage of this index is its simplicity. Its main shortcoming is that the economic meaning of the historical “norms” and deviations from them is less straightforward than in model-based indices.
- A fiscal stress index<sup>18</sup> which offers an assessment of country susceptibility to extreme “tail events” such as debt defaults, and large spikes in interest rate spreads. The index maps the fiscal indicators into a summary score that depends on endogenous thresholds. These are derived by minimizing the errors made in using each indicator to predict fiscal stress episodes. This model-based approach has a clear interpretation and provides a “natural” weighting system of the fiscal indicators into the summary index using their predictive power. Its main shortcoming is its dependence on the specific definition of crisis events used to identify the episodes from which indicator thresholds are derived, as well as the relatively weak statistical power of these indicators to explain crises.

#### A. Fiscal Vulnerability Index

To build the fiscal vulnerability index, each indicator  $x_t^i$  is transformed into a standardized score  $z_t^i$ :

$$z_t^i = \frac{x_t^i - \mu}{\sigma}$$

where  $\mu$  is the 10-year peer group average (calculated separately for advanced and emerging economies) for the indicator  $x_t^i$  and  $\sigma$  is the corresponding standard deviation. This z-score has a straightforward interpretation. A score close to zero indicates that a particular variable is close to the historical peer-group average. We use a sign convention such that a high positive number implies a worse performance.

For each of the three clusters of indicators discussed above, the unweighted average of the z-scores is calculated. To derive the index for each cluster, the z-scores are transformed into a

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<sup>18</sup> This is based on the methodology used in the IMF for the Vulnerability and Early Warning Exercise (IMF, 2007 and 2010a). The approach used here defines crisis episodes as cases when the government is unable to roll over debt at reasonable market conditions. Other applications within the IMF have used a different definition of crisis episodes (e.g., “sudden stop” episodes in emerging economies or growth decline in advanced and low-income countries).

cumulative normal distribution, ranging from 0 to 10, with a mean of 5. Index values close to 10 indicate high levels of vulnerability, while values close to 5 are assumed to indicate a “normal” degree of vulnerability. In order to arrive at an aggregate measure of fiscal vulnerability for advanced and emerging economies, each country score is weighted by the relative PPP-adjusted GDP.<sup>19</sup>

## B. Fiscal Stress Index

This index measures the likelihood of extreme fiscal events, when rollover risks mature into a full-blown fiscal crisis.<sup>20</sup> The calculation comprises three stages:

- **Defining a fiscal crisis** - A series of crisis events is defined by any of four criteria: (i) public debt default or restructuring; (ii) an IMF-supported program exceeding 100 percent of a country’s quota; (iii) excessively high inflation rate; and (iv) exceptionally high sovereign bond yields. A set of 176 episodes is identified among advanced and emerging economies over the past four decades (Table 3). Crisis events in advanced countries are identified mainly by government bond yield spikes, with only few countries showing episodes of exceptional financing. Crisis events in emerging markets frequently involve multiple definition categories. Prior to the financial crisis of 2009, several advanced economies experienced fiscal stress as a result of the oil crisis of 1973 and the recession of the early 1990s. Crisis episodes among emerging economies were clustered around the debt crisis in the early 1980s, the Asian crisis in the late 1990s, and the financial crisis of 2008.<sup>21</sup>
- **Assessing signaling power** - Once the crisis events are identified, the signaling power of each of the indicators can be evaluated, using a standard approach applied in other early warning systems.<sup>22</sup> The threshold is estimated using a univariate nonparametric method, discriminating between predicted crisis periods and predicted non-crisis periods. If a variable exceeds its threshold, the model issues a signal of an upcoming fiscal crisis. The thresholds aim to minimize the sum of Type I (false positive,  $FP(C)$ ) and Type II (false negative,  $FN(C)$ ) errors (Table 4). Under this method, for each cut-off point  $C$ , the total misclassified errors ( $TME$ ) can be expressed as the sum of type I and type II errors,

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<sup>19</sup> We calculate this index separately for the advanced and emerging market economies included in the Statistical Annexes of the Fiscal Monitor (IMF, 2010b) for which data were available and for a subsample of G-20 countries also including Greece, Ireland, Portugal and Spain.

<sup>20</sup> See Baldacci et al. (2011) for a discussion of the methodology and the identification of the fiscal stress events.

<sup>21</sup> Since advanced and emerging economies have marked differences in observed extreme values, different criteria for the levels of inflation were used to identify crises for the respective groups. The differences also mean that a clear delineation between advanced and emerging economies is important when evaluating the signaling power of the indicators and constructing the fiscal stress index.

<sup>22</sup> See IMF (2007 and 2010a).

$$TME(C) = \frac{FN(C)}{N_C} + \frac{FP(C)}{N_{NC}}$$

The optimal threshold  $C^*$  is the value at which  $TME(C)$  is lowest.<sup>23</sup> This procedure is applied to advanced and emerging market economies separately so that two sets of group-specific thresholds are obtained.

- **Calculating the fiscal stress index** - A stress index is calculated on the basis of the number of fiscal indicators exceeding these thresholds, weighted by their signaling power separately for advanced and emerging economies. This index ranks countries according to their estimated vulnerability. The robustness of the results and the signaling power of the index were tested through a series of exercises, including removal of outliers (Baldacci et al., 2011). An aggregate index is calculated separately for advanced and emerging economies using PPP-adjusted GDP weights and rescaling the index so that it ranges between zero and 10 on the basis of an exponential distribution.<sup>24</sup>

#### IV. EMPIRICAL APPLICATION

Rollover risks under baseline policies in 2010 can be compared for advanced and emerging economies using the Spring and Fall 2010 Fiscal Monitor databases.<sup>25</sup> A combined rollover risk score is also calculated by taking the simple average of the fiscal vulnerability and fiscal stress index values for each of the three clusters discussed in the paper.<sup>26</sup> Figure 1 shows results of the composite risk score for a sample of G-20 countries and Greece, Ireland, Portugal and Spain (GIPS), separately for advanced and emerging economies.

Overall, baseline rollover risks are significantly higher in advanced economies than in emerging economies. This reflects weaker fiscal fundamentals and higher long-term pressures due to population aging in mature economies. However, rollover risks are more

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<sup>23</sup> Due to the small number of fiscal crisis events relative to non-crisis periods, the TME methodology places greater weight on misclassifying fiscal crisis events, thereby yielding relatively conservative thresholds compared to other methods.

<sup>24</sup> The latter is a better fit of the underlying distribution of the fiscal stress index, which is asymmetric, than the normal distribution. As for the fiscal vulnerability index, calculations are made for a larger sample of advanced and emerging economies and for a restricted sample of G-20 countries plus Greece, Ireland, Portugal, and Spain.

<sup>25</sup> For indicators drawn from sources other than the Fiscal Monitor, the cut-off date is the closest available date to the data cut-off period in the corresponding edition of the Fiscal Monitor.

<sup>26</sup> The rank correlation between the fiscal vulnerability and the fiscal stress indices ranges between 0.6 and 0.7 and it is significantly different from zero. Furthermore, the indices also move in the same direction during 2010 and 2011. Taking the average of the two indices to assess rollover risks may give a more robust assessment of fiscal sustainability risks under baseline policies.

elevated than in pre-crisis times in emerging economies, reflecting exposure to maturity and exchange rate risks, higher debt levels, and larger fiscal imbalances.

During 2010 there was a small reduction in rollover risks faced by advanced economies, while fiscal risks increased in emerging economies. In advanced economies, rollover risks associated with basic fiscal variables remained elevated, reflecting increasing public debt and uneven fiscal consolidation efforts across countries. However, corrections to the estimate of potential output for some advanced economies in the Fall 2010 Fiscal Monitor led to an upward revision in the cyclically adjusted primary fiscal balance, improving the solvency outlook for the sample (compared to the Spring 2010 estimates).<sup>27</sup>

In emerging economies, basic fiscal variables moved in different directions, resulting in an overall weaker solvency risk outlook. While better growth prospects and fiscal adjustment in some emerging economies helped reduce debt sustainability concerns, the underlying fiscal position weakened in resource-rich economies, as commodity prices started to pick up during 2010 but revenue windfalls were not saved. Solvency risks related to long-term fiscal pressures were high and above “normal” levels in advanced and putting pressure on solvency risks in emerging economies. However, these risks did not change between Spring and Fall 2010 as demographic trends persisted and planned entitlement reforms were not yet reflected in the spending projections. Rollover risks linked to asset and liability management increased modestly in advanced economies on account of large gross financing needs resulting from increasing borrowing costs. These risks are also higher in emerging economies due to higher financing needs and increases in short-term debt in some large economies.

This risk outlook is confirmed by the fiscal vulnerability and fiscal stress indices reported in Table 5. There are, however, two main differences between fiscal vulnerability and fiscal stress trends for emerging economies: (i) risks from basic fiscal variables have increased slightly according to the fiscal stress index, but remained stable if the vulnerability score is used. This reflects a deterioration in debt ratios for a few emerging economies close to the fiscal stress threshold; and (ii) asset and liability management risks have remained broadly stable during 2010 (and are significantly lower than in advanced economies) when measured by the fiscal stress index, while they increased modestly (and are at levels similar to advanced countries) on the basis of the fiscal vulnerability score. The main reason for these differences is that the fiscal stress index captures the probability of a tail event associated with abnormally high risks in asset and liability indicators, while the fiscal vulnerability index captures more linear departures from medium-term, cross-country averages. Results for a larger sample of advanced and emerging market economies included in the Fiscal Monitor are also reported for comparison in Table 6.

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<sup>27</sup> Net of this correction, however, rollover risks related to basic fiscal variables would have remained broadly unchanged between Spring and Fall 2010.

## V. CONCLUDING REMARKS

The risks associated with fiscal policy, principally large deficits, and high debt levels, have long been acknowledged by economists and policymakers. The response to the global financial crisis has successfully averted a global financial sector meltdown and a depression, but at the expense of a sharp deterioration in the public sector's balance sheet in many countries. As a result, heightened perceptions of rollover risks have emerged even in advanced economies.

Hence, when monitoring fiscal developments, the emphasis needs to shift to a wider set of variables that more accurately capture rollover risk under the baseline scenario. This paper has presented an approach for selecting the most appropriate indicators that could be included in a monitoring framework. The indicators are clustered around three themes: solvency based on current and expected future fiscal policies, long-term fiscal trends, and the characteristics of governments' assets and liabilities.

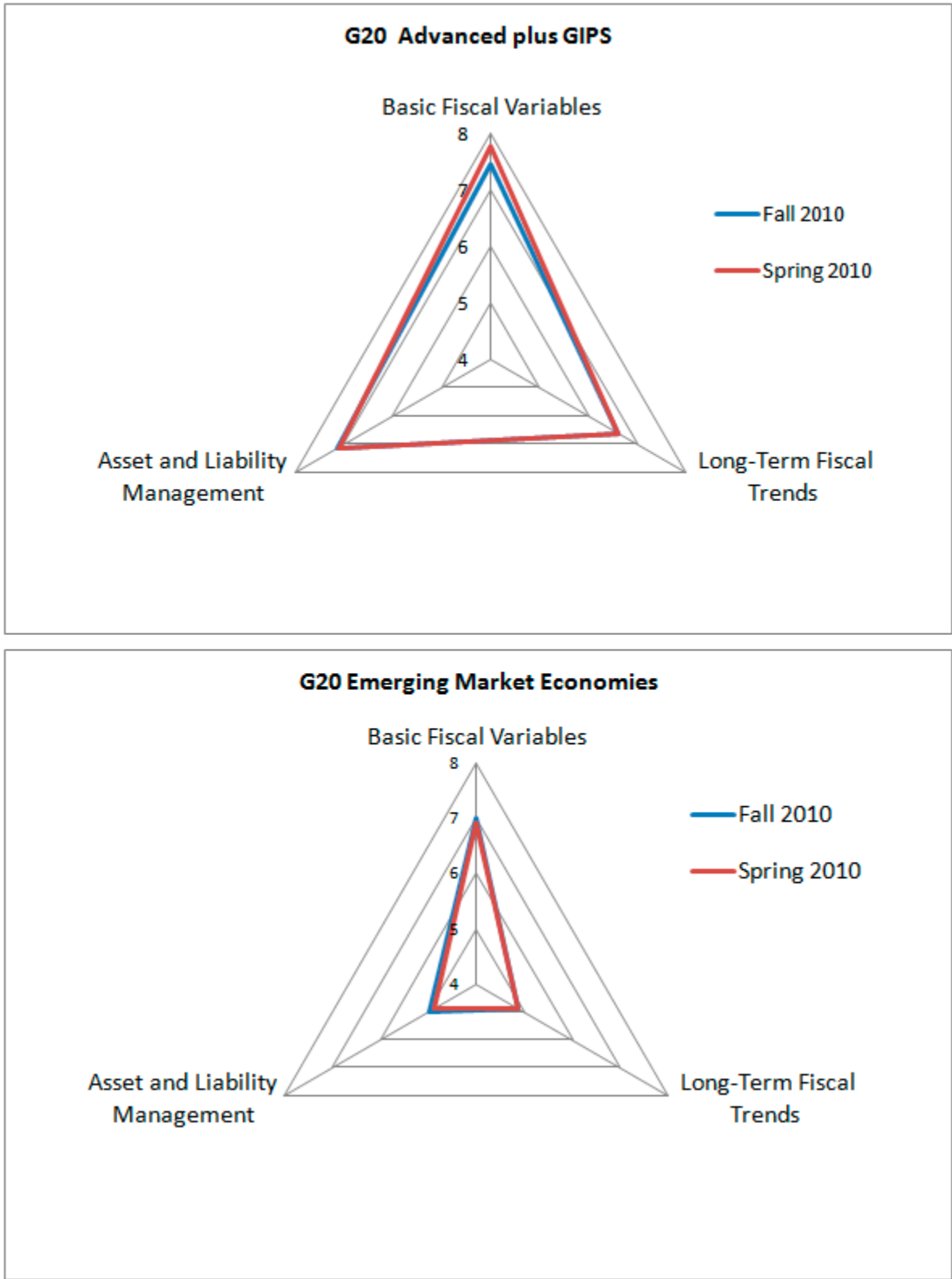
Going further, the paper proposes two complementary tools for assessing rollover risk: a fiscal vulnerability index and a fiscal stress index. Averaged together, the indices measure the extent to which variables within each cluster have diverged from historical peer group averages as well as the risk that countries may face a fiscal crisis.

For illustrative purposes, this framework was applied to two groups of advanced and emerging market economies comparing fiscal risks in 2010 as measured in the Spring and Fall editions of the Fiscal Monitor in that year. The framework suggests that rollover risks remain elevated for advanced economies, as a result of weakened fiscal fundamentals and long-term aging-related budget pressure. It also indicates that these risks are lower in emerging economies, reflecting stronger fiscal balances, lower public debt ratios, more favorable demographic conditions, and positive growth prospects. However, risks from asset and liability management have increased slightly during 2010 in these economies and fiscal balances remain worse than in the pre-crisis period.

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Figure 1. Composite Risk Scores, 2010



Source: IMF staff estimates.



Table 1. Fiscal Monitoring Indicators

| Indicator   | What the indicator measures   |
|---|---|
| <b>Basic Fiscal Variables</b>                                     |   |
| r-g (10 year average)   | Indicates the effect on fiscal solvency of the interest rate-growth differential  |
| General government gross/net debt                                 | Debt burden   |
| Cyclically adjusted primary balance                               | Corrects overall balance for cyclical and one-off factors   |
| <b>Long-Term Fiscal Trends</b>                                    |   |
| Total fertility rate  | Indicates the population aging momentum   |
| Old age dependency ratio projections                              | Measures future burden of population aging  |
| Long-term projections of the change in public pension expenditure | Measures projected budget pressures from pension expenditures   |
| Long-term projections of the change in public health expenditure  | Measures projected budget pressures from health expenditures  |
| <b>Asset and Liability Management</b>                             |   |
| Current gross financing need                                      | Measures the government's rollover and new borrowing requirement  |
| Share of short-term debt as a ratio of total debt                 | Indicates vulnerability to rollover risk  |
| Debt denominated in foreign currencies                            | An indicator of exposure to foreign exchange risk; applies only to emerging market economies; expressed in percent of total debt.   |
| Debt held by non-residents as a proportion of total debt          | An indicator of global market risk  |
| Weighted average maturity of general government debt              | A forward looking indicator of the vulnerability changes in market sentiment; expressed as years  |
| Short-term external debt  | Provides information on the likely claim on foreign currency resources available to meet short term foreign debt servicing costs; applies only to emerging market economies |

Table 2. Data Definitions and Sources

| Indicator   | Additional Data Clarifications   | Data Source         |
|---|--|---------------------|
| <b>Basic Fiscal Variables</b>                                     |  |                     |
| r-g (5-year average)  | Imputed interest rate on general government debt, deflated by the GDP deflator, minus real GDP growth rate; five year forward moving average | WEO                 |
| Cyclically adjusted primary balance                               | Expressed as a percent of potential GDP  | WEO                 |
| General government gross/net debt                                 | Expressed in percent of GDP. Net debt used for Japan and Canada, gross debt for all other countries  | WEO                 |
| <b>Long-Term Fiscal Trends</b>                                    |  |                     |
| Total fertility rate  | The average number of children per woman   | UN                  |
| Old age dependency ratio  | 30 years ahead projections of the ratio the population over 65, divided by the number of adults  | UN                  |
| Long-term projections of the change in public pension expenditure | Expressed as in percent of GDP, the change in projected expenditures 40 years ahead relative to to the base year                             | Staff estimates     |
| Long-term projections of the change in public health expenditure  | Expressed as in percent of GDP, the change in projected expenditures 40 years ahead relative to to the base year                             | Staff estimates     |
| <b>Asset and Liability Management</b>                             |  |                     |
| Current gross financing need                                      | Projected general government overall balance plus general government debt with a maturity of one year or less; expressed in percent of GDP   | WEO, Bloomberg      |
| Share of short-term debt as a ratio of total debt                 | Short-term debt is defined as general government debt with a maturity of one year or less. Total debt is general government gross debt       | WEO                 |
| Debt denominated in foreign currencies                            | General government debt, expressed in terms of total debt  | VEE                 |
| Debt held by non-residents as a proportion of total debt          | Includes both domestic and foreign currency issued debt; expressed as a proportion of total debt   | BIS                 |
| Weighted average maturity of general government debt              | Historical date calculated by staff; current data available from Bloomberg   | Bloomberg, Dealogic |
| Short-term external debt  | Short-term debt is defined as general government debt with a maturity of one year or less  | WEO, IFS            |

Table 3. Summary of Fiscal Stress Events

| Start of Crisis           | Fiscal Stress Events | Default or Restructuring | IMF-Supported Program | High Inflation | Bond Yield Pressure | Duration of Fiscal Stress (in years) |
|---------------------------|----------------------|--------------------------|-----------------------|----------------|---------------------|--------------------------------------|
| <b>Advanced Economies</b> | <b>41</b>            | <b>0</b>                 | <b>6</b>              | <b>5</b>       | <b>29</b>           | <b>2.5</b>                           |
| 1970-79                   | 14                   | 0                        | 1                     | 4              | 7                   | 2.6                                  |
| 1980-89                   | 8                    | 0                        | 2                     | 1              | 5                   | 2.5                                  |
| 1990-99                   | 8                    | 0                        | 2                     | 0              | 6                   | 2.3                                  |
| 2000-10                   | 11                   | 0                        | 1                     | 0              | 11                  | 2.6                                  |
| <b>Emerging Economies</b> | <b>135</b>           | <b>52</b>                | <b>79</b>             | <b>6</b>       | <b>15</b>           | <b>3.6</b>                           |
| 1970-79                   | 15                   | 8                        | 9                     | 1              | 0                   | 3.1                                  |
| 1980-89                   | 41                   | 26                       | 22                    | 0              | 0                   | 6.6                                  |
| 1990-99                   | 37                   | 12                       | 20                    | 5              | 5                   | 2.6                                  |
| 2000-10                   | 42                   | 6                        | 28                    | 0              | 10                  | 1.6                                  |

Source: Baldacci et al. (2011).

Table 4. True Versus Predicted Occurrence of Crises

|                  |                       | State of the world          |                                    |
|------------------|-----------------------|-----------------------------|------------------------------------|
|                  |                       | Crisis                      | No crisis                          |
| Predicted result | Signal (crisis)       | True Positive (TP(C))       | False Positive (FP(C))             |
|                  | No signal (no crisis) | False Negative (FN(C))      | True Negative (TN(C))              |
|                  | Total                 | Total crises obs. ( $N_C$ ) | Total non-crisis obs. ( $N_{NC}$ ) |

Table 5. Fiscal Risks in G-20 Advanced Economies, GIPS and Emerging Economies, 2010

|                             | Spring 2010            |                         |                                |               | Fall 2010              |                         |                                |               |
|-----------------------------|------------------------|-------------------------|--------------------------------|---------------|------------------------|-------------------------|--------------------------------|---------------|
|                             | Basic Fiscal Variables | Long-term Fiscal Trends | Asset and Liability management | Overall Score | Basic Fiscal Variables | Long-term Fiscal Trends | Asset and Liability management | Overall Score |
| <u>Aggregate Score</u>      |                        |                         |                                |               |                        |                         |                                |               |
| G20 Advanced plus GIPS      | 7.8                    | 6.6                     | 7.1                            | 7.1           | 7.5                    | 6.6                     | 7.2                            | 7.0           |
| G20 Emerging economies      | 6.9                    | 4.9                     | 4.9                            | 5.4           | 7.0                    | 4.9                     | 5.0                            | 5.5           |
| <u>Fiscal Vulnerability</u> |                        |                         |                                |               |                        |                         |                                |               |
| G20 Advanced plus GIPS      | 8.0                    | 6.0                     | 5.9                            | 6.6           | 7.7                    | 6.0                     | 6.0                            | 6.5           |
| G20 Emerging economies      | 6.9                    | 5.0                     | 5.8                            | 5.9           | 6.9                    | 5.0                     | 6.0                            | 6.0           |
| <u>Fiscal Stress</u>        |                        |                         |                                |               |                        |                         |                                |               |
| G20 Advanced plus GIPS      | 7.6                    | 7.3                     | 8.3                            | 7.5           | 7.2                    | 7.3                     | 8.3                            | 7.4           |
| G20 Emerging economies      | 6.9                    | 4.8                     | 3.9                            | 4.9           | 7.1                    | 4.8                     | 3.9                            | 5.0           |

1/ Weighted averages based on constant GDP-PPP values.

Source: IMF Staff estimates.

Table 6. Fiscal Risks in Advanced and Emerging Economies, 2010

|                             | Spring 2010            |                         |                                |               | Fall 2010              |                         |                                |               |
|-----------------------------|------------------------|-------------------------|--------------------------------|---------------|------------------------|-------------------------|--------------------------------|---------------|
|                             | Basic Fiscal Variables | Long-Term Fiscal Trends | Asset and Liability Management | Overall Score | Basic Fiscal Variables | Long-term Fiscal Trends | Asset and Liability management | Overall Score |
| <u>Aggregate Score</u>      |                        |                         |                                |               |                        |                         |                                |               |
| Advanced economies          | 7.5                    | 6.5                     | 7.0                            | 7.0           | 7.2                    | 6.5                     | 7.0                            | 6.9           |
| Emerging economies          | 7.0                    | 4.9                     | 5.1                            | 5.5           | 7.1                    | 4.9                     | 5.1                            | 5.6           |
| <u>Fiscal Vulnerability</u> |                        |                         |                                |               |                        |                         |                                |               |
| Advanced economies          | 7.8                    | 6.0                     | 5.9                            | 6.6           | 7.6                    | 6.0                     | 5.9                            | 6.5           |
| Emerging economies          | 7.1                    | 5.0                     | 5.9                            | 6.0           | 7.0                    | 5.0                     | 6.1                            | 6.0           |
| <u>Fiscal Stress</u>        |                        |                         |                                |               |                        |                         |                                |               |
| Advanced economies          | 7.1                    | 7.1                     | 8.1                            | 7.5           | 6.8                    | 7.1                     | 8.1                            | 7.4           |
| Emerging economies          | 6.9                    | 4.8                     | 4.3                            | 5.1           | 7.2                    | 4.8                     | 4.2                            | 5.1           |

1/ Weighted averages based on constant GDP-PPP values.

Source: IMF Staff estimates.