

I. INTRODUCTION

The global crisis has rekindled interest in tools to anticipate potential crises.

Historical experience suggests that crises result from the collision between economic or financial vulnerabilities and specific trigger events. Underlying vulnerabilities are thus a necessary, but not a sufficient, condition for a crisis.

While early warning exercises have typically found crisis triggers to be inherently unpredictable, they have found value in attempting to identify underlying vulnerabilities.

Predicting the timing of a crisis has widely been considered to be challenging, and crisis models have a weak record in this regard. However, the level of underlying vulnerabilities can be used to estimate the *likelihood* that one could occur and forecast the worst possible outcomes.¹

However, the traditional focus of risk analysis on emerging markets and typical reliance on single models resulted in limited attention to other types of countries and their specific vulnerabilities. Following the Latin American debt crisis, early warning analyses tended to focus heavily on sudden stops of capital flows into emerging markets in the context of an empirical model-based approach. There was no similar analysis for advanced economies, which were considered less vulnerable, given better fundamentals and policymaking capacity. Moreover, there were few attempts to identify and analyze new and evolving sources of sectoral vulnerabilities and systemic risk that could precipitate a financial crisis in either advanced or emerging economies, or on channels of internal and cross-border contagion.

Even as more risk models have become available, “connecting the dots” remains a key challenge. Fragmented analyses are likely to underestimate risks and to miss how shocks can spread across markets, sectors, countries, or regions. For instance, while many analysts cautioned against “risk concentrations” in U.S. housing prior to the crisis, few foresaw that they could lead to dire macroeconomic consequences, particularly at the global level. Similarly, combined risks across sectors, the possibility of spillovers, and the importance of macrofinancial feedback loops remained a blind-spot. As a result, policy recommendations proved to be too optimistic even as vulnerabilities were building up.

Against this backdrop, Fund staff embrace a multi-sectoral approach to detecting risks that could make a country vulnerable to crisis. Risk assessment is at the center of the IMF’s surveillance mandate. As part of this assessment, every country is evaluated by Fund staff for underlying vulnerability in its fiscal, external, and domestic non-financial sectors, and for financial and asset pricing risks where appropriate. In addition, countries are also assessed for fragility to potential trigger events, susceptibility to spillovers and contagion, as well as policy implementation weaknesses related to political instability or political gridlock that could impede adequate response to an emerging crisis.

¹ See fuller discussion of this distinction in Ghosh et al. (2009) and IMF (2007).

Fund staff’s risk assessment toolkit covers the three country groups—advanced (AE), emerging (EM), and low-income (LIC). Owing to the consensus in the literature on the dangers of sudden stops in emerging markets, the assessment mainly relies on variables from all sectors of the economy to predict their vulnerability to such events. For low-income countries, a similar approach is used to assess vulnerability to sudden growth declines, which is widely acknowledged to be their chief susceptibility. Conversely, given the lack of experience with crises in advanced economies, a suite of models is used to identify vulnerabilities across their different sectors, rather than focusing on any one type of specific crisis.

Final assessments are made by IMF country teams, with the models described in this note used as an input to that assessment. Model results are the first step in a two-step process. In the second step, country teams combine the results of the model-based assessments with their country-specific background knowledge and judgment. This integration with desk assessment is a critical strength of the approach, and helps the assessments rise above being a purely mechanical or theoretical exercise. The risk assessment methodologies continue to evolve with economic circumstances, better data, and new risk models. As new approaches are developed, they are added to the toolkit or substituted for older models.

This note describes some of the approaches used by Fund staff to assess country risk. It provides a high-level overview of the theory and methodologies employed, with an on-line companion guide providing more technical details of implementation. The on-line guide will be updated as Fund staff’s methodologies for assessing country risk continue to evolve with experience and feedback. The results of these approaches are not published by the IMF for market sensitivity reasons. However, they inform the Fund’s risk assessments featured in bilateral surveillance as well as in the World Economic Outlook (WEO), Global Financial Stability Report (GFSR), and Fiscal Monitor—the IMF’s flagship publications on global surveillance.

The rest of the note is organized as follows. Section II provides a brief conceptual overview. The specialized toolkits for assessing underlying vulnerabilities in emerging markets, low-income countries, and advanced economies are described in Sections III-V. Supplementary methodologies for assessing susceptibility to event risks, including country risk models and scenario analyses, as well as policy implementation risk assessments are discussed in Section VI. Section VII concludes.

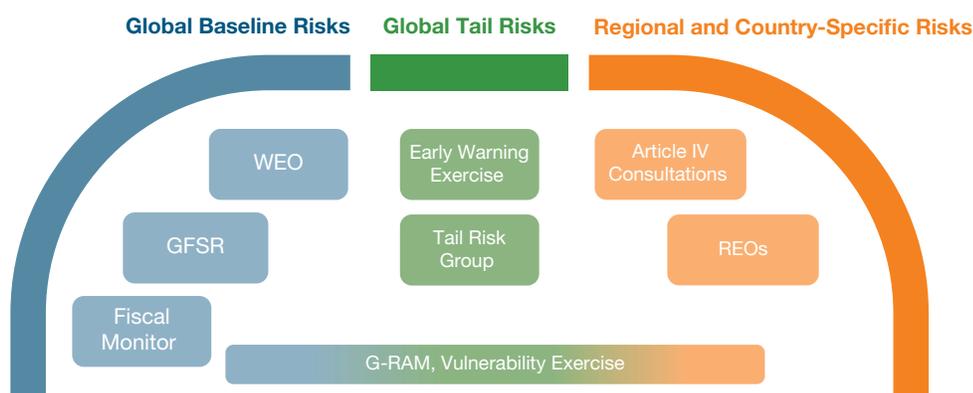
II. AN OVERVIEW OF RISK ASSESSMENT BY IMF STAFF

Fund staff’s surveillance of risks rests on a well-developed architecture (Figure 1).²

- The *World Economic Outlook* (WEO) focuses on baseline forecasts, while taking a broad view of global economic developments, including risks, which are covered thematically.

² For more on the types of Fund surveillance touching on risk topics see IEO (2014), including Chapter 3 section C, and background paper IV, IMF (2014b), including Chapter 1 of the background studies.

Figure 1: Risk Architecture at the IMF



- The *Global Financial Stability Report* (GFSR) and *Fiscal Monitor* consider globally-relevant vulnerabilities in their specific sectors of specialization, i.e., financial and fiscal, respectively.
- The *Early Warning Exercise* (EWE) assesses selected tail-risks and considers risk-specific contingency plans.
- The internal *Global Risk Assessment Matrix* (RAM) presents a consolidated list of key global risks, together with an assessment of their likelihood and expected impact. It is the prime source of the global risks discussed in Article IVs.
- The *Tail Risk* group is composed of relatively junior Fund staff and focuses on out-of-the-box thinking about risks in the extreme tails of the distribution.
- *Bilateral surveillance* documents, notably Article IV staff reports, address each country's vulnerabilities in context and great detail, including in the context of country risk assessment matrices (RAMs).
- The internal Vulnerability Exercise straddles bilateral and multilateral surveillance, providing a link between risks identified in a top-down way by the Fund's multilateral products and the bottom-up assessment provided by country teams.³ It is a cross-country risk exercise, which seeks to identify emerging risks using a bottom-up approach across all sectors of the economy and a consistent cross-country approach across advanced, emerging, and low-income economies. The methodologies described in this note relate most closely to this leg of the Fund's risk surveillance architecture.

The particular sources of vulnerability that Fund staff's risk surveillance monitors are motivated by past experiences and the empirical literature:

- **Many crises have roots in external imbalances.** Over-reliance on short-term funding, persistent current account deficits, and high level of foreign currency debt have been frequent sources of vulnerabilities in emerging markets; and more recently also in advanced

³ Previously, the apparatus was referred to as the Early Warning Exercise (EWE). Since 2010, the EWE has been recast as a separate and distinct exercise.

economies. In turn, the buildup of such external sector vulnerabilities may reflect unsustainable consumption, asset price booms, or a loss of competitiveness. The risk is that a collapse in investor confidence could lead to a sudden stop of capital inflows or a rush for the exit, triggering a crisis that entails large output and welfare losses.

- **Concerns over fiscal solvency can also precipitate a crisis.** Persistent fiscal imbalances lead to high levels of public sector debt that could raise solvency concerns, threaten macroeconomic stability, and weigh on economic growth. Left unaddressed, countries could face difficulties in market financing, resulting in a large financing gap; and in the worst case, lose market access altogether. Again, the eventual adjustment could entail sharp losses in output and employment.
- **In addition, unsustainable booms and overheating can bring about downturns with devastating consequences in terms of economic activity, financial stability, and employment.** Such booms can be associated with imbalances in private financial and non-financial balance sheets, such as excess overall or short-term leverage, over-stretched credit extension, dwindling bank capital, worsening repayment capacity, or excessive foreign currency exposure. Conversely, expectations of deflation and a persistently negative output gap may reflect overcapacity and sustained weak demand, leading to an adverse debt-deflation feedback loop that carries its own risks.

Fund staff's toolkit continues to evolve with economic circumstances, better data, and new risk assessment models. As new tools are developed, they are added to the suite of assessments or substituted for older models.⁴ The toolkit also responds to new emerging sources of risk in the global landscape. For example, in response to the recent bond market boom and rising debt levels for non-financial corporates and households in emerging markets, better coverage is now given to vulnerabilities in these balance sheets, including the composition of debt. Analysis of contagion risks and spillbacks from emerging markets has also been strengthened, using tools like network analysis, and the assessment of financial risks has been revamped by including forward-looking indicators, such as credit cycles.

A number of supplementary indicators provide additional color to cross-country risk assessment. Scenario analysis, policy implementation risk, and a suite of alternative crisis risk models are used to provide additional context for the consideration of country teams. Scenario analysis, in which the materialization of prominent global risks is simulated, is a valuable tool to frame specific coordinated risks and adds an additional forward-looking element to the assessment. Policy implementation risk assesses the capacity of a country to effectively address emerging crises, including potential constraints from political gridlock and limited technical capacity. Finally, alternative crisis models are also considered to assess the robustness of signals emerging from the main toolkit.

⁴ Papers documenting some of this evolution include IMF (2007, 2010, and 2011).

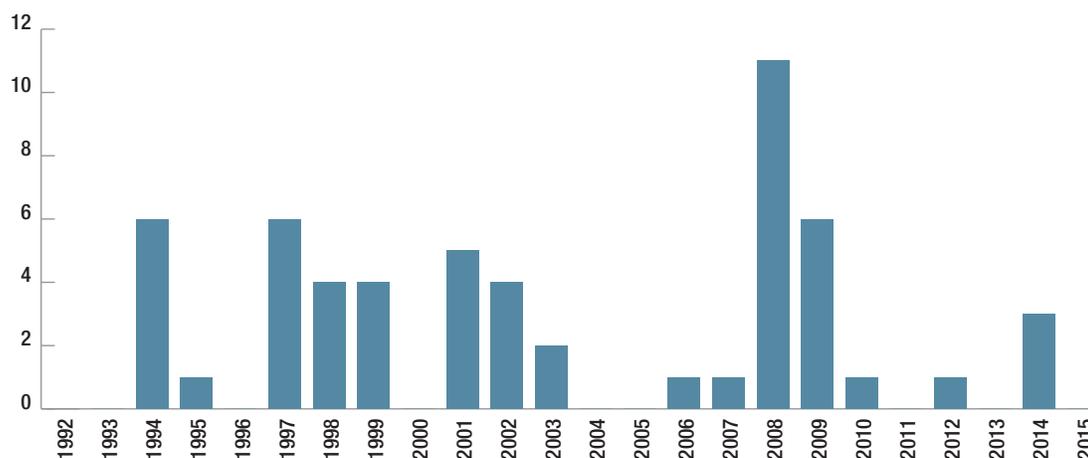
III. ASSESSING RISK IN EMERGING MARKETS: A SUDDEN STOPS MODEL

Emerging market-specific risk assessments focus on vulnerability to a sudden and significant stop of capital inflows—a prevailing feature of EM crises. The risk assessment presented here focuses on the likelihood that macroeconomic or financial shocks combined with underlying vulnerabilities could lead to a sudden stop in capital flows.

A. Empirical Modeling

A core set of indicators provide early warning of potential sudden stops when they breach certain estimated thresholds. These thresholds are identified through a signal extraction model of crisis vulnerability that minimizes the chance of false alarms and missed crises (Box 1). Fifty-six crisis episodes have been identified by combining quantitative indicators and analysis of the narrative record based on a data set of 49 countries during 1993-2015 (Figure 2). To select the best predictors of a sudden stop, indicators in five sectors—external, public, financial, real, and contagion—are assessed over a sample that includes crisis and non-crisis episodes (Table 1). Vulnerability thresholds are set at levels determined by the identified capital account crises.

Figure 2. Sudden Stop Episodes in EMs

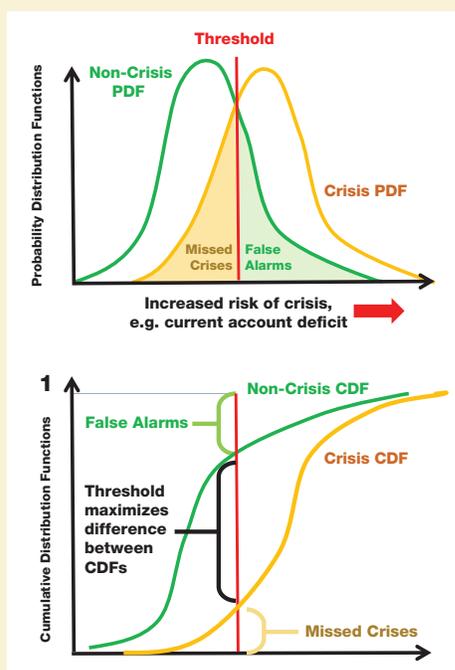


This model and the indicators used have evolved significantly over time. Fund staff have extended the dataset used to identify sudden stop episodes, refined thresholds and weights, and incorporated financial cycle and corporate sector balance sheet indicators into the model. Since risks can emanate from various economic sectors, the model uses a broad set of underlying indicators to identify weaknesses in economic and financial fundamentals, as described below.

Box 1. Crisis Vulnerability Assessment: A Signal Extraction Model

EM- and LIC-specific risk assessments discussed in this note are based on a common signal extraction approach.¹ The model assesses

vulnerability to a crisis by establishing thresholds for key indicators in the data, and aggregating over the indicators which exceed their thresholds. The definition of a crisis in the data and the indicators that are most informative for that type of crisis are different for each use of the model. The sudden stop model used for some EMs, for example, naturally defines crises in terms of capital flows and emphasizes external indicators. By contrast, the food decline vulnerability index used for some low-income countries (see Section IV) examines natural events paired with declines in food production and uses food-dependence and governance indicators. This box describes only those elements common across all the signal-extraction-based models discussed in the note.



Threshold choice. For each indicator, a threshold is defined to flag elevated vulnerability. The threshold is chosen to minimize the sum of the percentage of crises missed and the percentage of non-crises falsely flagged as a crisis (false alarms). This is equivalent to maximizing the difference between the cumulative distribution functions of the crisis and non-crisis samples. Crises are relatively rare in the data, so this definition captures the notion that missing a crisis observation is much more costly than issuing a false alarm (e.g., if crises are 5 percent of the sample, missing one crisis is as costly as issuing 19 false-alarms). Countries receive a 1 if their value of the indicator falls on the risky side of the threshold and a zero otherwise.

Aggregation. Ones and zeros for each indicator are typically averaged with weights given by their signal to noise ratio – defined as $(1-z)/z$, where z is the sum of the fractions of false alarms and missed crises. When there is an extensive literature on the relative importance of different crisis indicators, judgment can also be used to determine the weights for aggregation.

The model is well-tailored to the exercise. The use of thresholds keeps results robust to outliers as the center of the distribution determines the risk assessment. The aggregation procedure also easily accommodates missing data, allowing the inclusion of additional indicators where available without limiting country coverage.

¹ Building on the work, among others, of Kaminsky, Lizondo, and Reinhart (1998).

Table 1. Sudden Stops Model: Variables for Risk Assessments

EXTERNAL	PUBLIC	FINANCIAL	REAL	CONTAGION
<ul style="list-style-type: none"> • Current Account Balance • REER Misalignment • External Debt to Exports • Private Sector External Debt to GDP • Reserve Coverage as % of ARA Metric • Change in Reserve Coverage as % of ARA Metric • Change in external debt to exports 	<ul style="list-style-type: none"> • Gross Public Debt • Primary Balance Gap • Average Maturity of Debt • Average Effective Interest Rate • Interest Expense • Gross Financing Needs • Short-term Gross Public Debt • Public External Debt • Foreign Currency share of debt • Cyclically adjusted primary balance 	<ul style="list-style-type: none"> • Foreign Liability as % of Domestic Credit • Capital Adequacy Ratio • Return on Assets • Loan to Deposit • 3-year cumulative credit to GDP • End of period gap - Equity • End of period gap - Loan to deposit ratio • End of period gap - Credit to the private sector • End of period gap - Property prices 	<ul style="list-style-type: none"> • Interest coverage ratio • Real GDP Growth • Non financial corporation foreign currency debt • Household total debt • FX share in total NFC and Household debt outstanding • Non-inv grade debt in total stock of debt securities 	<ul style="list-style-type: none"> • Regional EMBI spreads • Change in export demand growth • External banking liabilities x VIX • External banking liabilities x partner GDP growth • Correlation of EMBI spreads x equity price growth • Deviation from trend banking liabilities

B. External Sector

The current account balance and the degree of real effective exchange rate misalignment provide useful information about external sustainability. The level of external debt, particularly private sector debt, as a share of exports and a rapid build-up in debt when viewed against reserve buffers (reserves relative to the IMF ARA metric)⁵ are informative indicators of vulnerability to sudden stops.

C. Public Sector

Underlying vulnerability to a sudden stop can stem from weak fiscal fundamentals.

A suite of public sector indicators covering various types of fiscal risk exposures, including solvency, liquidity, duration (interest rates), currency, and macro-fiscal stance, helps improve overall risk assessment. Gross public debt and the primary balance gap (i.e., the deviation of the actual primary balance from the debt stabilizing primary balance) focus on solvency concerns. To help capture potential liquidity stress, gross financing needs (i.e., short-term debt plus the overall balance) and duration risk indicators are included, e.g. average effective interest rates, average maturity of debt, and interest expense as a share of GDP. The cyclically adjusted primary balance helps evaluate the adopted macro-fiscal stance. Finally, the currency aspects of fiscal risks are captured by the shares of public external debt and foreign currency debt in GDP.

D. Financial Sector

The analysis of financial sector health relies on indicators of underlying banking sector health, external and domestic risk, as well as credit cycle indicators, where available.

In all cases, bank capital adequacy and return on assets are complemented by foreign liability

⁵ See for example IMF (2013).

exposures and measures of financial overheating that may precipitate a capital account crisis. In cases where data are sufficient, these signals are complemented by financial boom-bust analysis, focused on four indicators: credit to the private sector, loan to deposit ratio, equity prices, and real estate prices. Useful information can be gleaned from the varied phases and amplitudes of the financial cycles associated with these indicators.⁶ The estimated financial cycle gaps (deviations from trend) are used to identify capital account crisis vulnerability thresholds.

E. Real Sector

The real sector analysis covers risks arising from household and non-financial corporate sector balance sheets, as well as from slower growth. The variables used are based on recent observed trends. On the household side, the rise in EM debt stocks since 2010 mainly reflects increased domestic rather than foreign currency borrowing. Conversely, on the corporate sector side, banks have provided significant cross-border financing to EMs, and a broader variety of corporate borrowers have gained access to bond markets at unprecedented volumes and low rates. As a result, the share of issuers with below investment-grade ratings has surged, and both domestic and foreign currency debt issuance has increased sharply in most major EMs. To reflect these developments, the analysis complements the corporate sector's interest coverage ratio and real GDP growth with the following indicators to capture leverage developments and vulnerabilities associated with debt composition: (1) foreign exchange denominated corporate debt to GDP, (2) total household debt to GDP, (3) the share of foreign exchange denominated debt in total corporate and household debt, and (4) the share of non-investment grade debt securities in total stock of outstanding debt securities.

F. Contagion

The contagion analysis captures risks arising from a country's exposure to the rest of the world. This analysis aims to detect cross-country correlations in economic developments and vulnerabilities, accounting for the fact that sudden stops may come in waves that hit a number of countries at the same time. It includes variables that capture major channels of shock transmission, such as growth in trading partners' demand, domestic banking liabilities to foreign financial institutions, global volatility, and regional spillovers from bond and equity markets possibly related to contagion from other EMs due to portfolio re-allocation within that asset class.

G. Aggregation

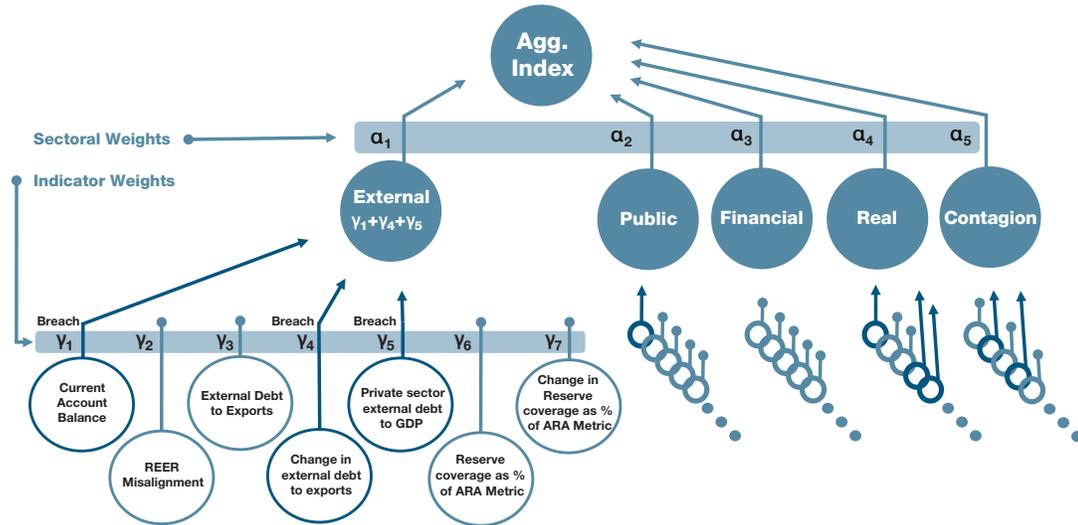
For each sector, a vulnerability index is constructed as a weighted average of individual indicators, with weights derived from the indicator's signal-to-noise ratio. This index ranges between zero (low vulnerability) and one (high vulnerability). Figure 3 illustrates the aggregation method for a hypothetical country with generic weights. Each sector's index is a weighted average of zeros and ones – the sum of the weights for each variable which breached its threshold.

⁶ For instance, empirical analysis suggests that equity and property price gaps tend to peak one and two years ahead of a crisis, respectively, making them potentially useful as leading indicators.

The weights are given by each variable's signal-to-noise ratio, rescaled to sum to one. Finally, the overall index is a weighted average of the sectoral indices. Weights at this level of aggregation reflect sectoral signal-to-noise ratios along with staff judgment based on the wider literature.

Figure 3. Sudden Stops Model: Index Aggregation

An overall index can be constructed as a weighted average of sectoral indices, themselves weighted averages over dummies for indicator threshold breaches. In the example below the external sector for a simulated country had three indicators which breached their thresholds (calculated as described in Box 1), with other sectors seeing additional unspecified breaches.



IV. ASSESSING RISK IN LOW-INCOME COUNTRIES: GROWTH SHOCKS

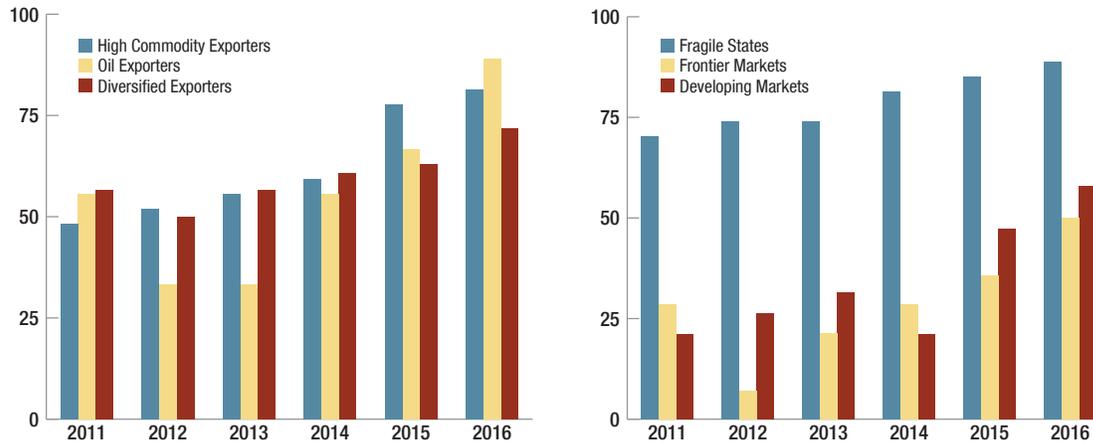
Low-income countries (LICs) are most exposed to a different type of risk—output growth volatility—which tends to be significantly higher relative to more developed countries. This amplified growth volatility in turn stems mainly from a deterioration in the terms of trade, reduced foreign aid and remittance flows, and natural disasters. These shocks are further amplified by weak institutional capacity, political and social instability, and undiversified economic structures. The scope for risk diversification and intertemporal consumption smoothing is also limited due to underdeveloped financial sectors. At the same time, increasing trade and financial integration result in growing spillovers from the global economy to LICs. For these reasons, a model which focuses on the risks of a growth shock is well-suited to low income countries. To incorporate additional risks faced by LICs with significant external financial integration, financial risks are also considered in frontier economies, a set of countries which increasingly resemble emerging market economies.⁷

⁷ See IMF (2014a), Appendix II, for a definition and list of frontier market economies.

Figure 4. Growth Decline Vulnerability Index by Sector and Region

(High Vulnerability LIDCs as a percent of total; PPP-GDP Weighted)

The growth decline vulnerability index, an aggregated measure of vulnerability to a growth crisis caused by exogenous events, can be tracked over time and across country types. Vulnerabilities have been rising across all categories during 2012—16 but are most pronounced among oil exporters and fragile states.



Sources: WEO; IFS; DSA; and IMF staff reports, World Bank and EM-DAT.

A. Growth Decline Risk

A growth decline vulnerability index (GDVI) is constructed to measure a country’s vulnerability to sudden growth declines in the event of a large exogenous shock (Figure 4), employing the same signal extraction model of crisis vulnerability that is used for emerging markets, as described in Box 1. The event identification methodology is based on the following steps:⁸

- **First, “large” negative exogenous shock events are identified in each country.** A shock is considered large if the annual percentage change of any one of the following variables falls below the lower 10th percentile of the country-specific distribution: (i) external demand; (ii) terms-of-trade; (iii) FDI; (iv) aid; (v) remittances; (vi) climatic shocks (large natural disasters);
- **Second, within this sample of shock events, sharp growth decline episodes are defined** as a large real output drop that meets the following two conditions: (i) the 2-year average level of real output per capita post-shock falls below the pre-shock 3-year average level; and (ii) output per capita growth is negative in the year of the shock.

Table 2. Growth Decline Vulnerability: Variables for Risk Assessments

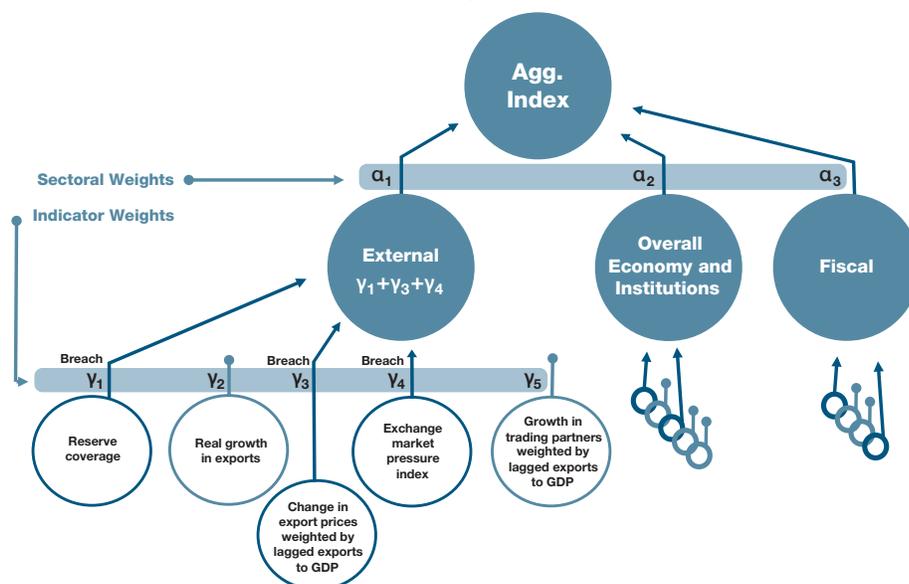
OVERALL ECONOMY AND INSTITUTIONS	EXTERNAL	FISCAL
<ul style="list-style-type: none"> • Real GDP Growth • Country Policy and Institutional Assessment (CPIA) • GINI Coefficient • Real GDP per capita growth • Number of affected from natural disaster 	<ul style="list-style-type: none"> • Reserve coverage (GIR/Imports G&S) • Real growth in exports of goods and services • Exchange market pressure index • Lagged export-weighted trade partner growth • Lagged export-weighted export price growth 	<ul style="list-style-type: none"> • Government balance • Public debt (% GDP) • Real government revenue • Government tax revenue

⁸ See Dabla-Norris and Gündüz (2012) for further technical details.

As with the sudden stops model, a number of indicators are developed and thresholds defined to maximize the crisis risk signal from each. Specifically, a core set of variables based on empirical analysis of information content is used to construct three sector-level indices (Table 2 and Figure 5).

Figure 5. Growth Decline Risk: Index Aggregation

An overall GDVI index can be constructed as a weighted average of sectoral indices, themselves weighted averages over dummies for indicator threshold breaches. In the example below, the external sector for a simulated country had three indicators that breached their thresholds (calculated as described in Box 1), with other sectors seeing additional unspecified breaches.



B. Financial Risk: Frontier Economies

For frontier economies, a financial vulnerability index (FVI) is also constructed to capture the likelihood of a country experiencing severe banking system stress. Adverse shocks, resulting for example from the growing integration of frontier countries into global capital markets, coupled with weak regulation and supervision, can trigger large deterioration in loan quality and drying-up of liquidity, imposing substantial strains on banking systems. The FVI is constructed by applying the financial sector vulnerability approach in the sudden stops model to frontier LICs, where financial systems increasingly show similarities with those of emerging markets. Based on existing studies of frontier economies, vulnerability in the financial sector is captured by: (i) capital adequacy ratio; (ii) return on assets; (iii) bank credit over bank deposits; (iv) cumulative 3-year growth of credit-to-GDP; and (v) foreign liabilities measured as cross-border loans and deposits over domestic credit. Similar to the GDVI, these variables are each turned into a score of 0 or 1 based on estimated thresholds and then aggregated to the overall FVI, using the signal extraction approach.

V. ASSESSING RISK IN ADVANCED ECONOMIES: A SUITE OF MODELS

Advanced economies face a wide range of risks and require a pluralistic approach.

For this group of countries, instead of estimating thresholds associated with a particular type of crisis, a variety of stand-alone tools are used to assess specific risks in greater detail. Unlike those presented above, the collection of models in this section do not lend themselves to a natural aggregation and serve to provide a more generalized sectoral perspective on risks.

Advanced economy risk assessment takes stock of macro-financial risks across all key sectors, while also capturing key channels of risk transmission associated with financial interconnectedness and sovereign-bank linkages (Table 3). In addition, risks from asset price misalignment and contagion, both of which played an important role in the global crisis, are also considered.

Table 3. Advanced Economies: Suite of Models for Risk Assessments

EXTERNAL	MACRO	FISCAL	FINANCIAL	ASSET PRICE	CONTAGION
<ul style="list-style-type: none"> External imbalances Exchange rate misalignments External balance sheet exposures 	<ul style="list-style-type: none"> Inflation/Deflation risks Risks to growth 	<ul style="list-style-type: none"> Rollover and financing risks Market perceptions of sovereign default risk MLT fiscal adjustment needs MT risk to public debt dynamics Sensitivity of public debt to adverse shocks Contagion risk from partner fiscal distress 	<ul style="list-style-type: none"> Interbank access Fundamentals-implied CDS Credit cycle indicator Balance sheet soundness 	<ul style="list-style-type: none"> Residential real estate market Equity market Corporate sector vulnerabilities 	<ul style="list-style-type: none"> Cross-border financial sector exposure Exposure to emerging markets Contagion through trade channels

A. External Sector

External risks are assessed with models of external imbalances, exchange rate misalignments, and external balance sheet exposures:

- External imbalances.** Trends in the level and composition of saving and investment can reflect disequilibria in domestic asset markets, implying risks to growth and financial markets from a potentially costly unwinding. For instance, a decline in household saving could signal an unsustainable boom in consumption; a fall in corporate saving and investment could indicate loss of competitiveness; or growing public sector imbalances could have implications for the debt path and complicate the ability to manage macro-financial distress.

- **Exchange rate misalignments.** The main tool for assessing degrees of current account and exchange rate misalignments in a multilaterally consistent manner is the External Balance Assessment (EBA).⁹ For economies not covered by the EBA, a variant on its methodology termed EBA-lite is used which extends the methodology to the rest of the sample countries.
- **External balance sheet exposures.** This tool applies the signal extraction approach to evaluate vulnerabilities to external and financial crises by identifying sectoral external balance sheet indicators that provide early warning of past crises in advanced economies. It focuses on the net foreign ‘other investment’ assets (in the BOP sense) of the banking sector, the non-bank private sector, and the economy as a whole, covering assets and liabilities that are neither publicly traded nor constitute genuine ownership (e.g. shares in private companies smaller than ten percent, non-transferrable loans). These series have proven to be good crisis predictors in the past.

B. Macroeconomic Imbalances

Macroeconomic imbalances are assessed using models capturing key macro risks:

- **Inflation and deflation risks** are assessed using a one-year-ahead inflation forecasting model. Risks are higher the greater the likelihood of experiencing deflation or inflation above the central bank’s established target bands, which could compromise monetary policy’s ability to respond to other shocks and de-anchor inflation expectations. These probabilities are generated from a Bayesian vector autoregression (BVAR) model, which relates inflation to the world oil price, output growth, policy interest rates, and ten-year term spreads.¹⁰
- **Risks to growth** are assessed using two indicators. The first is the monetary conditions gap, which is the estimated deviation of actual policy interest rates from those implied by a Taylor-type rule. Sustained negative (positive) gaps imply that monetary policy may be too loose (tight), contributing to the accumulation of excess demand (supply) pressure. The second indicator tracks changes in underlying growth rates, estimated by a high-frequency dynamic factor model in a data-rich environment, with more than 100 series for each country in the sample, including activity, trade, financial and labor market conditions, price and cost time series.¹¹

⁹ The EBA is a suite of assessment methods. The principal methods are panel regression-based, taking into account a broad set of factors—and policies—that may influence the current account and real exchange rate. In the first stage, these regression methods focus on understanding current account and real exchange rate developments. The second stage estimates the contributions of several “policy gaps” to current accounts and real exchange rates, providing a normative evaluation. In addition, EBA retains from its predecessor, the CGER, a model-free method focused on sustainability analysis. Here, current account imbalances are assessed as the difference between the current account balance needed to stabilize net foreign asset position at a benchmark level and the medium-term projection for the current account in the WEO. The exchange rate gap is the estimated change in the exchange rate needed to achieve the stabilizing current account balance. For more details on EBA, see Philips et al. (2013). and on CGER, see Lee et al. (2008).

¹⁰ This model’s forecast has been shown to outperform those from random walk and standard VAR models over a long period.

¹¹ For a full description of the growth tracking model see Matheson (2011).

C. Fiscal Sector

Fiscal risks are assessed based on the following analytical components:

- **Rollover and financing risks.** In order to capture short and medium-term financing vulnerabilities, the risk that a sovereign borrower will be able to borrow only at unusually high cost, or in extreme cases, will not be able to borrow at all is assessed by comparing government gross financing needs and debt to maturity to benchmarks
- **Market perception of sovereign debt default risk.** Sovereign credit default swap (CDS) spreads and relative asset swap (RAS) spreads are used to capture investors' concerns about fiscal solvency. These high-frequency indicators—the former measuring the direct cost of seeking insurance against sovereign default, and the latter the spread between bond yields and corresponding fixed interest rates—capture the risk premium charged by investors on government bonds, and their expected losses in the event of sovereign defaults. Given that these fiscal solvency risk indicators can also reflect the influence of global risk aversion and domestic financial factors, they are complemented with a tool to capture excessive movements in term premia.¹²
- **Medium- and long-term fiscal adjustment needs.** Rising debt levels or even stabilization of debt ratios at high levels may put pressure on interest rates and economic growth prospects, jeopardizing public debt sustainability. An indicator used to assess this type of fiscal vulnerability is the required adjustment in the cyclically-adjusted primary balance to achieve targeted gross public debt ratios over the medium term. The second indicator is the required adjustment in the primary balance to satisfy the intertemporal budget constraint and stabilize the debt ratio in the long term, taking into account demographic trends and costs associated with aging.
- **Medium-term risk to public debt dynamics.** Policy makers face significant uncertainty about the future path of macroeconomic conditions as well as real interest rates. This tool captures how such uncertainty can affect future debt levels.¹³
- **Sensitivity of public debt to adverse shocks.** Recognizing the central role of the interest rate-growth differential, this tool assesses the impact of adverse growth and interest rate shocks on debt dynamics. It analyzes a low growth scenario—a one percentage point lower growth than the WEO baseline over five years.¹⁴ A high interest rate scenario—a permanent increase of 100 basis points over the baseline—is also analyzed.

¹² This metric is motivated by the work in Alper et al. (2012).

¹³ A fiscal reaction function is estimated, establishing the relationship between a country's primary balance and the output gap, the debt level, and previous primary balances. A VAR is estimated to capture future variability in macroeconomic outcomes. The VAR is then simulated going forward with each country's debt path determined by their fiscal reaction function. Debt vulnerability is assessed as the probability that debt levels exceed an established threshold over a five-year horizon. The methodology follows the stochastic simulations approach of Celasun et al. (2006), which marries the approach to fiscal reaction functions in Abiad and Ostry (2005), and the stochastic analysis of debt issues in Garcia and Rigobon (2005).

¹⁴ Assuming no impact on potential GDP and no countervailing discretionary fiscal action, the shock affects the fiscal balance and debt-to-GDP ratios through automatic stabilizers and change in the GDP base. In countries with large debt-to-GDP ratios, the GDP base effects would explain the deterioration of debt dynamics well, while in countries with lower debt but relatively large expenditure ratios, automatic stabilizers would worsen the fiscal balances, and in turn, debt.

- **Contagion risk from fiscal distress in other economies.** Sovereign CDS spreads tend to increase simultaneously during crises, reflecting contagion, which could be channeled through trade and financial linkages. This tool measures distress dependence, which extracts information from CDS spreads to compute the probability of sovereign distress in one country given distress in another, a so-called measure of market-implied contagion or the “spillover coefficient”.

D. Financial Sector

In a highly integrated global financial system, overall market sentiment and volatility can be important sources of vulnerability and spillovers. During times of elevated market uncertainty, even a temporary shock can lead to market turmoil and trigger adverse feedback loops through macrofinancial linkages. The assessment of such financial sector vulnerabilities is based on the average of a range of current and forward-looking signals:

- **Interbank access.** This indicator captures signs of difficulties in accessing wholesale funding by banks, a potential liquidity challenge. For Euro area countries, reliance of the banking systems on ECB funding are compared to the pre-crisis norm to signal challenges in accessing deposits or other market funding sources to support their asset bases. For other advanced economies, a composite measure of vulnerability is computed, focusing on the behavior of the LIBOR-OIS spread (the difference between LIBOR and the overnight indexed swap rates).¹⁵
- **Fundamentals-implied credit default swaps (CDS).** Shadow CDS spreads for a wide range of individual banks are estimated, and aggregated into a country-level indicator using an asset-weighted average. These spreads are constructed from bank-level financial indicators, such as the net interest margin, the share of trading income in revenues, the efficiency ratio (all increasing the risk premium), and the return on assets (lowering the risk premium).
- **Credit cycle indicator.** The change in aggregate credit-to-GDP ratio and the deviation of credit-to-GDP ratio from its medium-term trend are compared against their respective crisis-signaling thresholds. Breaching the thresholds signals excessive credit expansion.
- **Balance sheet soundness.** This tool captures the aggregate exposure of the banking system to potential funding stability, foreign currency repayment problems, and the quality of bank buffers. It compares reported financial soundness indicators against relevant thresholds analyzed by Fund staff and the Basel Committee on Banking Standards (BCBS). Balance sheet risks are assessed based on the loan-to-deposit ratio and the shares of foreign currency assets and liabilities. Bank buffers—the capacity of the overall system to absorb losses given past decisions—are assessed using the leverage ratio, and profitability and asset quality indicators.

¹⁵ This composite measure is based on (1) the probability of the interbank market being in a low, medium, or high volatility state as estimated by a Markov regime switching model, and (2) whether the level and volatility of the spread is high relative to the pre-crisis mean.

E. Asset Prices and Market Valuations

Asset price bubbles can be fueled by excessive financial leverage and easy credit standards, and can inflict severe damage on real economic activity when they burst. Market participants may not act to eliminate them since riding the bubbles for some time may prove more profitable than trading against it. When a bubble eventually bursts, credit deleveraging and impaired business and household balance sheets depress economic activity and increase financial sector risks. Such risks are assessed with the following tools:

- **Residential real estate market.** Vulnerability to adverse developments in residential real estate depends on the extent of the price misalignment and linkages with the financial sector and the broader economy. This tool analyzes three key dimensions: price misalignment,¹⁶ household debt burden,¹⁷ and mortgage market characteristics.¹⁸
- **Equity market.** The risk of an equity market correction is higher the more prices deviate from their estimated “fair value,” which is gauged by a combination of standard techniques. The first is the equity valuation multiples approach, which assesses current price multiples of forward earnings and book value against their long-run averages. An arbitrage pricing model is also used to establish fair value. This model recognizes that equity prices can change based on market surprises, reflecting shocks to various economic and financial fundamentals, including risks to earnings, investor confidence, time horizon, inflation, output, exchange rate, commodity price, and market liquidity. The fair value is constructed by accumulating the monthly equity returns explained by the observed market surprises.
- **Corporate sector risks.** Representative indicators for each category of corporate vulnerability are computed at the firm level, and then their market-capital-weighted averages used to gauge corporate sector risks. The indicators used are measures of default probability, stock valuation, profitability, leverage, and liquidity.

F. Contagion

Cross-border contagion and spillover analysis are crucial to understand how macrofinancial shocks are transmitted and amplified. The assessment captures trade, bank, and portfolio flow exposures using high-frequency market data from financial transactions or data that capture networks of exposures among countries, financial institutions, and markets:

¹⁶ Misalignments in house prices relative to fundamentals are estimated using an error correction model, relating short-term changes in house prices to a long term equilibrium relationship, interest rates, and to changes in income per capita, credit growth, equity prices, and the fraction of working-age population, with consideration given to supply side factors. These estimates are supplemented by deviations of price-to-income and price-to-rent ratios from their historical averages.

¹⁷ A household indebtedness index is measured based on household credit to GDP levels and past two years' household credit growth rates. The index is then compared with values during boom phases that precede a bust.

¹⁸ Based on characteristics such as loan-to-value (LTV) ratios, share of variable rate mortgages, and recourse law (the absence of which is typically associated with higher default risk).

- **Cross-border financial sector exposure.** A bank contagion tool provides a comprehensive assessment of a country's vulnerabilities arising from cross-border banking channels, based on two quantitative exercises. First, it measures risks stemming from downstream exposures (i.e., a lender country's exposures to default risk in countries that borrow from its banks) and upstream exposures (i.e., a borrower country's exposures to funding risk due to crises in its creditor countries). Second, it performs scenario analysis to capture the propagation of financial sector shocks across borders through bank losses and deleveraging.
- **Contagion through trade channels.** Trade vulnerability indicators are computed for each country using a two-step process, in a manner that is analogous to the upstream and downstream indicators of bank contagion. A country's exposure to a downturn is constructed using data on bilateral trade flows from the IMF's Direction of Trade Statistics. One measure captures its exposure to a downturn in countries that supply imports and the other captures its exposure to a downturn in its export markets.
- **Exposure to emerging markets.** Exposure to vulnerable emerging markets is assessed using public BIS data of advanced economy bank claims on emerging markets. The metric captures downstream exposures to EM turbulence and spillbacks.

VI. SUPPLEMENTARY INDICATORS: EVENT AND POLICY IMPLEMENTATION RISKS

Salient global risks are simulated to better represent the wide variety of economic effects they entail. These simulations are motivated by the global risks identified in the IMF's Global Risk Assessment Matrix (G-RAM)¹⁹ and are implemented with one of several global models used in the IMF, including G20MOD, FSGM,²⁰ and GFM,²¹ depending on the types of shocks in the scenario. Past scenarios have considered a sharp growth downturn in China, financial volatility in Europe, risks associated with monetary policy normalization in the US, and rising geopolitical fragmentation. The implications of these scenarios are determined through the simulation models and forecast paths for growth, exchange rates, bond yields, trade flows and many other major financial variables are circulated to IMF country teams.²² Country teams are asked to take these effects into account in assessing country risk.

To help assess the robustness of the signals emanating from the main toolkit, supplementary approaches are also considered. This includes alternative crisis risk models that quantify countries' overall vulnerability to a broader range of crises, including those to fiscal,

¹⁹ These risks are presented in the Risk Assessment Matrices (RAMs) in IMF country staff reports.

²⁰ Andrieu et al. (2015).

²¹ Vitek (2015).

²² Simulation results are extended to countries outside the sample of the models used depending on the model and the structure of the economy in question. The impact is extrapolated using elasticities estimated from regression analyses tailored to the variable in question.

financial, growth (AEs and EMs), and food supply (LICs). Currently, these models rely on the same signal extraction methodology described in Box 1. These supplementary approaches can provide a useful cross-check on the country risk assessments and stress-points derived from the main toolkit.

The capacity of policy-making institutions to respond effectively is an additional important element of risk assessment. Constraints to effective policy response vary from divided political landscapes preventing effective democratic coalitions to deep capacity constraints, political upheaval, or military conflict in the most extreme cases. Political dysfunction and underlying political instability are aggravated in tough economic times. This part of the toolkit is in its infancy, with alternative measures and sources of data continually being explored. At the moment, it relies on a variety of external measures from a diverse set of sources, including indicators for government stability and socioeconomic conditions, political unrest and volatility, and governance.

VII. CONCLUSION

This note has provided a high-level view of some of the approaches used by Fund staff to assess country risk. These approaches are a core part of the IMF's efforts to strengthen surveillance, especially the analysis of economic, financial, fiscal, and external risks as well as cross-sectoral and cross-border spillovers. While the results of these approaches are not published by the IMF, they inform risk assessments featured in the Fund's bilateral surveillance as well as in the IMF's flagship publications on global surveillance.

Notwithstanding the sophistication of the tools described in this note, any early warning exercise is certain to face challenges in generating “hits” rather than “misses”. The *timing* of a crisis is difficult to predict, although the level of underlying vulnerabilities can be used to estimate the *likelihood* that one could occur and forecast the worst possible outcomes. Indeed, in a complex global economy, there is almost no limit to the range of conceivable risks, and IMF staff are under no illusion that its toolkit can capture all those to which policymakers should remain alert. There is clearly always a possibility that global developments could take an unexpected turn, despite the best intentions and efforts behind the exercise. In addition, limitations also stem from the availability of timely, high quality, internationally comparable data series.

This does not mean, however, that the effort expended on early warning exercises is fruitless. Most fundamentally, it is better to be prepared for risks that do not materialize than to count on good fortune to see one through. Beyond this, the approaches outlined in this note have been successful in making important contributions to the IMF's core analytical work. Specifically, they have helped strengthen the IMF's bilateral and multilateral surveillance activities by bringing risks into sharper focus and disseminating innovative approaches to such assessments.

Indeed, the toolkit helps to generate a useful summation of major outstanding risks across the world, using a consistent methodology. Better models for identifying risks are always coming on line. As they do, the quality of the toolkit improves. Further, cross-cutting indicators will never manage to paint a complete picture, and judgment is required to place the results in context. In this context, a major strength of Fund staff's approach to assessing country risk is the primacy of staff judgment: the model results are used as inputs to inform final assessments by country economists, benefiting from their detailed country-specific knowledge.

The methodology underlying Fund staff's risk toolkit is being made more accessible, and will continue to be refined over time. This note, and its companion technical descriptions available online, will help bring greater transparency to the analysis and accelerate the process of improving the methodology. Better understanding of the toolkit also facilitates more meaningful discussion with policy makers about risk assessments by country teams. It is hoped that such an approach will spur useful discussion among academics and practitioners about how to further improve the global monitoring of risks.

REFERENCES

- Abiad, Abdul, and Jonathan D. Ostry, 2005, "*Primary Surpluses and Sustainable Debt Levels in Emerging Market Countries*," IMF Working Paper No. 05/6 (Washington: International Monetary Fund).
- Alper, C. Emre, Lorenzo Forni, and Marc Gerard, 2012, "*Pricing Sovereign Credit Risk: Evidence From Advanced Economies During the Financial Crisis*," IMF Working Paper No. 12/24 (Washington: International Monetary Fund).
- Andrle, Michal, Patrick Balgrave, Pedro Espallat, Keiko Honjo, Benjamin Hunt, Mika Kortelainen, René Lalonde, Douglas Laxton, Eleonora Mavroeidi, Dirk Muir, Susanna Mursula, and Stephen Snudden, 2015, "*The Flexible System of Global Models – FSGM*," IMF Working Paper No. 15/64 (Washington: International Monetary Fund).
- Celasun, Oya, Xavier Debrun, and Jonathan D. Ostry, 2006, "*Primary Surplus Behavior and Risks to Fiscal Sustainability in Emerging Market Countries: A 'Fan-Chart' Approach*," IMF Working Paper No. 06/67 (Washington: International Monetary Fund).
- Dabla-Norris, Era, and Yasemin Bal Gündüz, 2012, "*Exogenous Shocks and Growth Crises in Low-Income Countries: A Vulnerability Index*," IMF Working Paper No. 12/264 (Washington: International Monetary Fund).
- Garcia, Marco, and Roberto Rigobon, 2004, "*A Risk Management Approach to Emerging Market's Sovereign Debt Sustainability with an Application to Brazilian Data*," NBER Working Paper No. 10336 (Cambridge: National Bureau of Economic Research).
- Ghosh, Atish, Jonathan Ostry, and Natalia Tamirisa, 2009, "Anticipating the Next Crisis," *Finance and Development*, vol. 46, no. 3, pp 35-7.