Assessing Country Risk: Selected Approaches[1]

C. Fiscal Risks

I. Public Finances' Vulnerability to Growth and Interest Rate Shocks[2]

Motivation

This tool assesses the sensitivity of the stock of public debt to an adverse growth and interest rate shocks. The interest rate-growth differential is key for debt dynamics and countries are therefore assessed according to their susceptibility to changes in both variables.

- The uncertainty around the future path of growth underlines the importance for assessing the fiscal tail risks that a worse-than-expected growth scenario over the medium term might pose to the countries' public finances.

- At the same time, with the increase in debt levels across much of the world, many economies have become more sensitive to interest shocks, although yields are still low for many economies.

Data

Data relative to macroeconomic variables (nominal and real GDP growth, primary balance, interest expenditure and gross general government debt) are drawn from the WEO. The elasticity of expenditure and revenues to the output gap are available from Girouard and André (2005) for OECD member states and European Commission (2005) for non-OECD Member states. When the estimates for the revenue and expenditure elasticity are not available, unitary elasticity for revenue and zero elasticity for expenditure are assumed. For the interest rate shock, the latest structure of total marketable debt is used to calculate rollover needs over the next five years. The source of this data is Bloomberg. For countries with fiscal deficits, the rollover needs will also be affected by the maturity structure of new financing, which is assumed to remain at the latest actual maturity distribution of debt.

[1] This document provides technical background and extended descriptions of the cross-country risk assessment tools discussed in the IMF reference note "Assessing Country Risk: Selected Approaches." It should not be reported as representing the views of the IMF. The views expressed are those of the authors and do not necessarily represent those of the IMF or IMF policy. The document describes research in progress as of June 2017, and is intended to elicit comments and to further debate.

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Methodology

Growth shock

This module includes two scenarios: the baseline scenario, where growth is as projected in the WEO baseline, and a low growth scenario, where growth is 1 percentage point less than in the baseline over the next five years. It is assumed that potential GDP is not affected by the growth shock and that governments do not take any corrective discretionary action to smooth its impact. As a consequence, the shock affects the deficit and debt GDP ratios through higher automatic stabilizers and the change in the GDP base.

In the low growth scenario, the public debt-to-GDP ratio d_t is assumed to evolve as follows:

$$d_t = d_{t-1}(1+r_t) - pb_t$$

Where pb_t is the primary balance and r_t is the growth adjusted interest rate[3]. In turn the primary balance is calculated as follows:

$$pb_t = pb_t^{WEO} + (\eta_R - \eta_G)\Delta og_t$$

Where pb^{WEO} is the primary balance to GDP ratio of the baseline scenario; η_R and η_G are semi-elasticity of revenues and expenditures to changes in the output gap and Δog_t is the change in output gap between the baseline and the low growth scenario. The interest rate is derived by dividing the amount of interest payments by the stock of debt observed at the end of the preceding year. (For background methodological details see Escolano, 2010).

Interest rate shock

The goal is to assess how an interest rate shock would affect the fiscal balances of countries in the short to medium run. The vulnerability of a country to interest rate shocks depends on its gross financing needs. For any given maturity structure of debt, countries with higher debt levels or higher fiscal deficits will face higher financing needs, thus exposing them to higher interest rate risk. The nature of interest rate shocks also matter in assessing the vulnerability of a country. In particular, the persistence of the shock and whether there are feed-back effects from higher debt

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[3] The growth adjusted interest rate is defined as $r = \frac{i-\gamma}{1+\gamma}$, where i is the nominal interest rate and γ is the growth rate of nominal GDP.

levels or higher gross financing needs to interest rates in the form of a risk premium can potentially be very important.

In this exercise, an increase of 100 basis points in interest rates is assumed for all countries to facilitate a cross-country comparison of the impact. Although countries may be susceptible to shocks of different magnitudes given differences in their debt and fiscal variables, applying country-specific shocks would require assumptions on the determinants of interest rates and risk premiums.

To assess the vulnerability to interest rate shocks, the following indicator is used:

- **The average level of financing costs over the next five years after a permanent increase in interest rates as percent of total revenues:** An increase of 100 basis points is assumed for all countries, which applies to all debt that is financed over the next five years. The implied average increase in financing costs (as percent of revenues) over the course of the next five years, relative to the baseline WEO projections, is computed. This indicator reflects both the impact of a permanent increase in interest rates and the initial absolute level of financing costs. It captures the magnitude of resources that needs to be channeled towards financing the debt as opposed to other types of government expenditures.[4] The level of financing costs under the shock scenario depends on the baseline projections as well as the impact of the interest rate shock. Therefore, countries with high financing costs in the baseline will tend to be assessed to be in a weaker position under this measure.

The impact of the interest rate shock over time depends on the amount of new borrowing that becomes subject to the higher interest rates, which is related to the gross financing needs and the structure of issuance. The impact of the shock is computed as:

$$\tilde{c}_{i,t} = nf_t \times \tilde{i}_t$$

Where $\tilde{c}_{i,t}$ is the difference in net financing costs relative to the baseline, nf_t is the accumulated amount of debt as share of total revenues that has been financed since the beginning of the shock and $\tilde{i}_t$ is the deviation in interest rate relative to the baseline (i.e. the interest rate shock). The impact of the interest rate shock accumulates over time as a larger fraction of debt becomes subject to the higher interest rate. The total impact over time is calculated by keeping track of the amount of debt that becomes subject to the higher interest rates, using data on the gross financing needs

[4] Some rating agencies also consider the financing costs to revenues as one measure of default risk. If financing costs increase beyond a certain point, governments may become less able or less willing to service their debt. We also report the impact of interest rate shock in terms of percent of GDP (see Table 1) for comparison purposes, but use the relevant financing cost indicators in computing rankings.

and the structure of issuance. The gross financing needs are defined as the rollover of existing debt plus the budget deficit. The rollover needs are estimated using the maturity structure of outstanding marketable debt from Bloomberg. This maturity structure is applied on the outstanding total gross debt to calculate rollover needs over the next five years. The rollover needs are also affected by the structure of gross issuances during the next five years as some of the debt that is financed during this period is projected to be rolled-over during this horizon. The maturity structure of gross issuance is also based on the latest observed maturity structure of debt.

The projected path of budget deficits are based on WEO projections; however, the feedback from higher financing costs to the fiscal balance is incorporated in calculating the gross financing needs. Finally, the fact that some countries hold assets which generate interest income is also accounted for. Depending on the nature and the term to maturity of these assets, higher interest rates would also have an effect on interest income. The same magnitude of interest rate increase (100 basis points) and an average maturity of 5 years for the outstanding financial assets are assumed. The level of financial assets at the end of the period is computed using projections of gross and net debt in the WEO.

References

Debrun, Xavier, Kinda, Tidiane (2013), "That Squeezing Feeling: The Interest Burden and Public Debt Stabilization", IMF WP/13/125.

Escolano, Julio (2010), "A Practical Guide to Public Debt Dynamics, Fiscal Sustainability, and Cyclical Adjustment of Budgetary Aggregates", *Technical Notes,* International Monetary Fund.

European Commission, DG ECOFIN (EC), 2005 "New and Updated Budgetary Sensitivities for the EU Budgetary Surveillance", *Information Note for the Economic and Policy Committee.*

Girouard, Nathalie, and Christophe André, 2005, "Measuring Cyclically-Adjusted Budget Balances for OECD Countries," OECD Economics Department Working Paper No. 434 (Paris: Organization for Economic Cooperation and Development.

II. Sovereign Debt Financing and Rollover Risks[5]

Motivation

This tool assesses sovereign debt rollover and financing risks.[6] The experience of several euro zone periphery countries has illustrated that major economies are no longer immune to serious funding problems. Before the euro area crisis, the possibility that advanced economy governments would be unable to raise the needed funds was considered as remote. It was recognized, that some borrowers may have to pay higher yields—particularly smaller economies with less liquid bond markets and weaker fiscal positions. This model assesses financing risk from rollover requirements, a topic of broad interest which has recently proven relevant for major economies.

Methodology

To assess the rollover and financing risk in year *t*, two indicators are used. First, the governments' gross funding needs (GFN) (in percent of GDP) in year *t* is calculated, which is the sum of projected general government deficits, and of short, medium and long-term government debt maturing in period *t*.[7] Second, the stock of gross general government debt at the end of *t-1* (measured in percent of GDP) is divided it by the average maturity of the government debt. This gives the average amount of debt as of *t-1* that needs to be redeemed or refinanced annually. The overall rollover risk is calculated as the average of these two indicators.

While the GFN indicates the vulnerability to financing pressures in the short term, the government debt-to-maturity ratio serves as an indicator of medium-term vulnerability. Note that this ratio combines two indicators—debt stock and average debt maturity—that in themselves would not necessarily provide good information about the rollover risk. An economy could have a high stock of government debt but also a very long average maturity; or it could have a very short average maturity but also a low stock of debt. It is the combination of high debt and low maturity that could be particularly risky.

To assess country vulnerability these values are compared to historical values across a sample of major economies in 2010, a period of marked debt distress for some countries in this sample. The GFN and debt-to-maturity percentiles for a country can be averaged for a summary statistic.

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[6] Rollover risk is defined in the IMF/World Bank Guidelines for Public Debt Management as the risk that debt will have to be rolled over at an *unusually high cost* or, in extreme cases, *cannot be rolled over* at all. Similarly, financing risk could be defined as the risk that the borrower will be able to borrow only at high cost, or in the extreme cases, not be able to borrow at all. For highly rated sovereign issuers, the risk is mainly of high borrowing costs.

[7] Data for maturing debt are from Bloomberg. By including the overall deficit, the tool abstracts from the possibility that financing through deposit draw-down or privatization proceeds affects the GFN. This is a simplification, but both measures can reduce financing needs only temporarily.

Data sources

For maturing government debt and average debt maturity data are from Bloomberg. All other data—fiscal balance, gross general government debt stock, nominal GDP, and the exchange rates to convert fiscal and GDP data into U.S. dollars—are from the *WEO database*.

III. Market Perception of Sovereign Default

This tool is composed of two sub-modules, one based on CDS and RAS spreads, and one based on term risk premia.

CDS and RAS Spreads[8]

Motivation

This section discusses the methodology for assessing perceived sovereign default risk based on two indicators: sovereign credit default swap (CDS) and relative asset swap (RAS) spreads. CDS and RAS spreads are used as indicators that capture investors' concern about fiscal sustainability issues. The assessment of economies based on these indicators should be interpreted as a relative assessment of countries' sovereign default risk, where the risk not only depends on narrowly defined fiscal vulnerabilities, but also on financial and global factors. A recent empirical analysis, undertaken for a panel of 22 advanced economies over the period 2008-11, highlights the patterns of dynamic interactions between CDS and RAS spreads and identifies factors that account for their changes.[9] In addition to changes in expected fiscal deficits, growth and debt, these factors include short-term interest rates, large scale sovereign bond purchases of major central banks, relative perceived strength of financial sectors as evidenced by relative stock price movements, expected global growth and volatility of equity prices as measured by the VIX index. Changes in long-term government bond yields are also considered. However, compared to CDS and RAS spreads, they depend on an even wider range of economic and financial developments, including the current position in the business cycle, inflation expectations and exchange rate risks. Therefore, caution is warranted in interpreting the level of bond yields as a measure of sovereign default probability.

Methodology

The methodology consists of computing an index that reflects the average classification of countries according to sovereign CDS and relative asset swap (RAS) spreads. The former indicator stands for the direct cost of seeking insurance against a sovereign credit event, including

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[8] Contributing authors: Emre Alper, Lorenzo Forni, and Marc Gerard.

[9] Alper, E., L. Forni, and M. Gerard (2012).

debt restructuring, missed payments and other types of breaches of the original contract, while the latter corresponds, for each country, to the spread between bond yields and fixed interest rates involved in interest swap transactions in the corresponding currency.[10]

CDS spreads are quoted as a percentage of the notional amount insured. For sovereign issuers, this spread is often considered as the default risk premium associated with a specific type of government bond. Indeed, in deep competitive markets, CDS spreads should reflect the expected default-related loss, i.e. the probability of default times the loss given default. Specifically, the assessment uses the 5-year sovereign CDS spreads compiled on a daily basis by CMA (Markit), averaged over a two-week period.[11]

The RAS spread indicator corresponds to the spread between sovereign bond yields and the fixed interest rate arm in interest rate swap contracts. The assessment is informed by the yield on benchmark bonds with a constant 10-year maturity and interest swap rates from contracts of identical maturity and currency. Both daily series are taken from Datastream and averaged over a two-week period. The RAS indicator is computed for each economy according to the following formula:

$$RAS_i = R_i - RSW_i$$

where:

R_i : yield on 10-year government bonds issued by *country i*

RSW_i: 10-year fixed rate on interest rate swaps in the currency of *country i*

The RAS indicator allows a comparison of the risk premia specifically attached to government bonds across countries without some of the drawbacks associated with comparing bond yields directly, notably because it is not affected by the exchange rate risk or other currency-specific factors. This is because the swap rate and the bond yield are applied to (actual or notional) principals denominated in the same currency. Thus, any currency-specific factors (e.g., exchange rate risk or expectations of future policy rates) are likely to be the same for the two rates used in the RAS indicator for each currency, and therefore cancel out each other when computing the spread between them.

To assess risk based on these signals from the RAS and CDS spreads, thresholds are identified using prior information on tranquil and tumultuous episodes. In the absence of a model linking the two spreads to sovereign events, the tool adopts a pragmatic approach and uses prior

[10] Interest rates on swaps are effectively free from the risk of default of sovereign issuers. Swap contracts specify agreements to exchange a flow of interest payments at a fixed rate for one at a floating rate.

[11] All sovereign CDS contracts are quoted in U.S. dollars, except for the United States for which they are quoted in Euros.

information on episodes of high stress and tranquil periods to determine the thresholds. In the pre-crisis period, financial markets did not perceive and price sovereign default risks.

Term Risk Premia[12]

Motivation

Term risk premia embedded in sovereign bonds are also estimated as part of the risk assessment. Excessive movements in the difference between the premia predicted by a f information model and the premia predicted by a macro-information-only model can serve as a leading indicator of the build-up of macro-financial vulnerabilities. This analysis is based on a framework—akin to an arbitrage-free dynamic term structure model—that accommodates a role for macroeconomic information in explaining the temporal variation in excess returns. It is based on an extension of recent research by Joslin, Priebsch and Singleton (JPS) (2009), who find evidence of an abnormal behavior in the term risk premium in the run-up to the dot-com crisis of the early 2000s and the current financial crisis.

Methodology

Following JPS (2009), a series of term premia, ER, is constructed for each country. These are the realized excess returns to a hypothetical portfolio that "mimic" the second principal component of a set of nominal, zero-coupon, government bond yields, of different maturities. By construction, ER is based on a portfolio that traces changes in the slope of the yield curve. The analysis focuses on the slope-mimicking portfolio as it appears to be a better predictor of past episodes of financial market distress and/or recessions than portfolios mimicking the level or curvature of the yield curve, consistent with the literature confirming that the slope of the yield curve contains information about the likelihood of a recession.

The ER is then modeled as a function of financial information (contained in the country-specific principal components of bond yields) **and macroeconomic information** (as reflected by the respective core inflation and the growth rate of industrial production). This full information model—the "true model"—assumes that excess returns are driven by both financial and macroeconomic information:

$$ER_{k,t}=c + b_1 PC1_t + b_2 PC2_t + b_3 PC3_t + b_4 INF_t + b_5 IPG_t + e_t$$

Here PC1, PC2 and PC3 are the first, second and third principal components of the set of bond yields. They are, respectively, the level, slope and curvature factors that summarize variations in the sovereign yield curve. Serving as a proxy for macroeconomic fundamentals that have bearing on the

[12] Contributing author: Jair Rodriguez (RES). The Term Risk Premium does not enter into the overall fiscal assessment produced by FAD. It is used when needed to supplement the assessment on market perception on sovereign default risk.

slope of the yield curve, INF is a filtered series of core consumer price inflation, and IPG is a similarly filtered series of the rate of industrial production growth.

By contrast, the "macroeconomic-information model" simply assumes that excess returns are a function of macroeconomic variables only:

$$ER_{k,t}=c + d_1 INF_t + d_2 IPG_t + u_t$$

The difference in the predicted values of excess returns from the two models,

$$D = ER^1_k - ER^2_k$$

may provide evidence of an abnormal behavior of the risk premium. When it is positive, the full information model predicts higher excess returns than are accounted for by the macroeconomic factors. This can be interpreted as evidence of "*market awakening*"—rising market concerns about underlying vulnerabilities, even though these vulnerabilities are not yet reflected in the incoming macroeconomic data. When D is negative, the macroeconomic fundamentals imply higher excess returns than the full information model, and this may be an instance of underpricing of risks or "*irrational exuberance*" in financial markets.

Data sources

The sample period for each country is determined by their data availability. For the bond data, the nominal, zero-coupon government bond yields at maturities 6 months, and 1, 2, 3, 4, 5, 7 and 10 years from Bloomberg are used. Core CPI and industrial production index series are taken from the IMF's Global Data Source, and used to construct the year-over-year core inflation and industrial production growth monthly series. Then, following JPS (2009) and Kim (2008), these are filtered by estimating for each country and series an ARMA(1,1) model, and using the estimated coefficients to express the series as an exponentially weighted moving average of past values with a decay coefficient equal to the moving average parameter of the ARMA process.

Variables	Source
Zero coupon government bond yields	Bloomberg
CPI	IMF's Global Data Source
Industrial Production	IMF's Global Data Source

Application

For each country in our sample and for the yield-curve-slope tracing portfolio, one can construct the difference series, and standardize them by their respective standard deviations. Then, the degree of abnormality in the risk premium is determined as follows. For each country, the monthly difference in risk premia are converted to a 6 month-moving average. Its value at the last month of the sample can be taken as the metric of the degree of countries' vulnerabilities. Vulnerability levels in this assessment are then determined by the deviation from the model-projected risk premium. For example, countries with the indicator above or below specific standard deviations could be grouped into one category while those outside into another.

Reference

Alper, E., L. Forni, and M. Gerard (2012), "Pricing of Sovereign Credit Risk: Evidence from Advanced Economies During the Financial Crisis," WP/12/24.

IV. Medium-Term Risks to Public Debt dynamics[13]

Motivation

This tool provides a probabilistic assessment of risks to medium-term public debt dynamics in an economy. Gross general government debt levels in many advanced economies rose sharply since 2007 due to declining economic activity and extraordinary policy measures to stimulate the economies and stabilize financial markets. In the medium term, uncertainty about the magnitude, timing and composition of the future course of fiscal policies leads to uncertainty in the path of the general government debt levels. Whether growth-adjusted effective interest rates would be fundamentally different in the aftermath of the crisis is an additional outstanding issue that fundamentally affects sustainability assessments.

Methodology

To assess risks to medium-term public debt dynamics, an indicator measuring the probability that the debt level exceeds a critical debt threshold five years ahead is used. The debt threshold is derived from the standard definition of long-term fiscal solvency:

$$d^* = \frac{p}{(r-g)}$$

To derive the upper limit for debt, medians over time and across countries are used[14]. p and $(r-g)$ are primary balance and interest growth differentials averaged across major economies using actual data and WEO projections, respectively.

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[13]Contributing authors: Constant Lonkeng Ngouana and Mariusz Jarmuzek. This tool is based on the forthcoming IMF working paper "Against All Odds? Stabilizing Public Debt in Selected Advanced Economies" by Emre Alper, Xavier Debrun, and Anna Shabunina.

[14] Country specific historical average or maximum values for the primary balance and growth adjusted effective interest rate did not produce meaningful debt thresholds, especially for commodity exporters with upper limits in excess of 200 percent of GDP.

The risk of breaching this debt threshold is then estimated. A risk-based approach to debt sustainability involves first an estimation of a fiscal reaction function followed by an unrestricted VAR model to derive the stochastic path of the general government debt for each economy. The approach follows the stochastic simulations method of Celasun, Debrun and Ostry (2007) 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).

Fiscal reaction function. First, a representative "fiscal reaction function" for major economies is estimated. For instance, using annual data for a panel of 33 advanced economies and historical data, the fiscal reaction function is estimated as[15]

$$\widehat{pb}_{i,t} = \hat{\propto}_i + 0.74pb_{i,t-1} - 0 \times ygap_{i,t}D_{it} + 0.58ygap_{i,t}(1 - D_{it}) + 0.04d_{i,t-1}$$

where pb_{it} is the ratio of the primary fiscal balance to GDP in country i and year t; $d_{i,t-1}$ is the gross general government debt to GDP ratio at the end of the previous year; $ygap_{i,t}$ is the current WEO estimated output gap; D_{it} are dummy variables that take the value 1 when the output gap is positive and zero otherwise; and $\hat{\propto}_i$ are the country fixed effects. The estimated simple fiscal reaction function suggests that while current fiscal policies were *persistent* (0.74), they were also *sensitive to economic conditions* (countercyclical with 0.58 percent of GDP increase in primary deficit for each 1 percentage point of output gap widening during recessions) but *asymmetrical* (there is no budget tightening during booms) and, more importantly, the policymakers attempted to take *corrective fiscal actions* to rising debt (0.04 percent of GDP), on average in advanced economies.

Calibration exercise. Simulations are constrained to show a median debt path consistent with WEO projections. Shocks to real GDP growth, the real interest rate and the real exchange rate are random draws from a joint normal distribution with zero-mean and the variance-covariance matrix of an unrestricted VAR estimated with quarterly historical data and comprising real output growth, the (log of the) real effective exchange rate, real long-term domestic bond yields and real long-term foreign bond yield.[16] The same VAR is used to generate macroeconomic projections consistent with each series of shocks and the underlying economic dynamics. In addition, the algorithm incorporates an endogenous response of the primary balance to the output gap (reflecting mostly automatic stabilizers) and to the debt level (an increase in debt triggers tighter fiscal policy). Finally, debt trajectories are also subject to random primary-balance shocks assumed to be zero-mean, normally distributed, and orthogonal to economic shocks. The variance of the primary balance shocks corresponds to the country-specific variance of the reaction function's residuals.

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[15] Estimates are obtained using fixed effects regression specification. Except for the coefficient of positive output gap, all coefficients are significant at 5 percent level of significance using robust standard error estimates. Other than the fixed effects specification, limited information maximum likelihood as well as generalized method of moments with instruments for output gap is also estimated. Based on various diagnostics, fixed effects specification is chosen.

[16] The United States real long-term bond yield is used to proxy foreign rates for all countries excluding the United States and European Union economies (with the exception of Germany). For the latter economies, the German real rate is used.

Changes in growth-adjusted effective interest rates. The baseline model simulations discussed above use the steady-state interest rates and growth estimated by VAR, while the medium-term interest and growth rate projections are likely different than the past in the aftermath of the financial crisis.

In many major economies, excluding those subject to fiscal distress, growth-adjusted effective interest rates are projected to fall in the medium term compared to historical averages. The unrestricted VAR model is run based on the projected adjustment corresponding to each economy.

Data sources and country coverage

Quarterly non-fuel price commodity price index, long-term bond yield and Treasury bill data are from the *International Financial Statistics* while quarterly real effective interest rate data is from the *Information Notice System*. All other annual and quarterly data— primary fiscal balance, gross general government debt stock, nominal GDP, interest payments, output gap are from the *World Economic Outlook*.

IV. Medium and Long-Term Fiscal Adjustment Risks[17]

Introduction and Motivation

This tool uses two indicators to assess the fiscal risk of an economy based on its fiscal consolidation needs. The first one (I_1) provides an assessment of the required *medium-term fiscal adjustment* for the debt ratio to reach a selected medium-term target. The second indicator (I_2) presents the *long-term fiscal adjustment* to stabilize the debt ratio in the very long-run.[18]

More precisely, I_1 shows the cyclically-adjusted primary balance, to be maintained over the decade following the WEO forecast period[19] (i.e., from year t+6 to t+15), to reduce the debt ratio to 60 percent of GDP (or its current level for countries with a debt ratio below 60 percent) by year t+15.[20] The methodology assumes a gradual fiscal adjustment over years t+1 to t+5.

I_1 (achieved in year t+5 and maintained during years t+6 to t+15) is a function of:

- The initial debt ratio and the selected target;
- The projected path for the cyclical component of the primary balance;
- The projected increase in age-related spending; and

[17] Contributing authors: Lorenzo Forni and Joao Jalles.

[18] The very long-run is assumed to be after year t+34.

[19] The WEO forecast period is five years into the future.

[20] As in the Fiscal Monitor one can use net debt for Australia, Canada, Japan and New Zealand.

- The initial level of the cyclically adjusted primary balance.

The second indicator ***(I_2)*** is defined as the primary balance required in the first year after the end of the WEO forecast period (year t+6) to satisfy the government's intertemporal budget constraint (which would stabilize the debt ratio in the long run).

The two indicators are not strictly comparable: ***I_1*** shows the primary balance to be sustained from years t+6 to t+15 to achieve the debt target in year t+15; ***I_2*** illustrates the primary balance that needs to be achieved in year t+6 to satisfy the government's intertemporal budget constraint and incorporates future age-related expenditures. Hence, ***I_2*** gives more weight to the long-run projections of age-related expenditures than ***I_1***. Moreover, the ***I_1*** calculation shows the sustainability requirements until year t+15 and for ***I_2*** over an infinite horizon. Consequently, ***I_1*** and ***I_2*** are interpreted as medium and long-term assessments of the required fiscal adjustment needs.

Methodology I_1

For the calculation of ***I_1***, which shows the primary balance needed to be achieved in year t+5 and maintained until year *t+15* so as to reach a given debt ratio by year *t+15*, two time horizons are identified: T_1 (5 years) during which the primary balance-to-GDP ratio is adjusted gradually each year by a factor equal to α and T_2 (10 years, from year *t+6* to year *t+15*) during which the primary balance-to-GDP ratio is kept constant at its level at the end of T_1 (see Alper et al. (2012) for further details). Importantly, the fiscal path between year *t+1* and year *t+5* does not correspond to the WEO projections but is derived from the algorithm.

The derivation of the adjustment factor α is as follows:

$$\alpha = \frac{-B_T + \lambda^T B_0 - \left(\frac{1-\lambda^T}{1-\lambda}\right)\pi_0 - \sum_{\tau=1}^{T}(\gamma(\tau)-\psi(\tau))\lambda^{T-\tau}}{\sum_{\tau=1}^{T} f(\tau)\lambda^{T-\tau}}$$

Where

$$f(\tau) \equiv \begin{cases} \tau, \forall \tau \le T_1 \\ T_1, \forall \tau > T_1 \end{cases}$$

$$\forall t \quad \pi_t = \pi_0 + \alpha f(\tau) + \gamma(\tau)$$

π_t is the primary balance in period *t*, $\gamma(.)$ is the cyclical component of the primary balance as projected in the WEO, $\psi(.)$ is the change in age-related expenditures relative to year *t* and $\lambda = 1 + r$, where *r* is the growth-adjusted interest rate.[21] The growth-adjusted interest rate *r* for the ***I_1*** indicator

21 $r = \frac{R-G}{1+G}$ where R and G are, respectively, the nominal interest rate and the nominal GDP growth rate.

is assumed to be equal to 1 percent starting from year t+6 and zero during the WEO forecast period (broadly in line with the WEO projections for advanced economies)[22]. B_T is the target level of the debt-to-GDP ratio, B_0 is the GDP ratio of public debt at t_0 (the starting date of the adjustment).[23] Data on primary balance and government's debt come from the latest WEO. Estimates of pension expenditure projections are based on internal Fund estimates.

To decompose the contributions of different factors to the required primary balance in year t+6, we first rewrite the equation above to link the present value of the required primary surpluses that the country needs to run (left hand side) to finance the debt gap ($-B_T + \lambda^T B_0$) and the combination of the cyclical component of primary balances and age-related costs ($-\sum_{\tau=1}^{T}(\gamma(\tau)-\psi(\tau))\lambda^{T-\tau}$) (on the right hand side):

$$\alpha\left(\sum_{\tau=1}^{T} f(\tau)\lambda^{T-\tau}\right)+\left(\frac{1-\lambda^T}{1-\lambda}\right)\pi_0 = -B_T + \lambda^T B_0 - \sum_{\tau=1}^{T}\gamma(\tau)\lambda^{T-\tau}$$

Manipulating this equation, the required primary balance in year *t+6* ($\pi_0+T_1\alpha$) can be decomposed into four components that reflect:

1. The size of debt at the beginning and at the end of the adjustment period (B_0 and B_T) (the first term in the equation);
2. The size of the ageing costs during years *t+1* to *t+5* (the second term);
3. The level of the cyclically-adjusted primary balance at the beginning of the adjustment period (the third term);
4. The projected path of the cyclical component of the primary balance (the last term).

Thus, the above equation can be rewritten as:

$$\pi_0 + \alpha T_1 = \left(\frac{T_1}{\sum_{\tau=1}^{T} f(\tau)\lambda^{T-\tau}}\right)(-B_T + \lambda^T B_0) + \left(\frac{T_1}{\sum_{\tau=1}^{T} f(\tau)\lambda^{T-\tau}}\right)\sum_{\tau=1}^{T}\psi(\tau)\lambda^{T-\tau}$$
$$-\left(\frac{T_1\left(\frac{1-\lambda^T}{1-\lambda}\right)}{\sum_{\tau=1}^{T} f(\tau)\lambda^{T-\tau}} - 1\right)\pi_0 - \left(\frac{T_1}{\sum_{\tau=1}^{T} f(\tau)\lambda^{T-\tau}}\right)\sum_{\tau=1}^{T}\gamma(\tau)\lambda^{T-\tau}$$

[22] For the group of emerging market economies, the same set of assumptions on the growth-adjusted interest rate are used for the purpose of computing the relevant indicators.

[23] The gross debt target is set at 60 percent of GDP by year t+15 (which corresponds to the pre-crisis median of advanced economies) or the latest actual level if the gross debt-to-GDP ratio that year is less than 60 percent.

Note that the adjustment path and in particular the value of T_1 affects the required primary balance. A larger value implies a slower adjustment and, hence, would require a higher primary balance in year *t+6*. The initial primary balance π_0 also plays a role in determining the required primary balance in year *t+6*, since it affects the adjustment path. The coefficient associated with it is positive, which suggests that a higher initial balance implies a lower required primary balance in year *t+6*. A larger starting balance implies that the primary balance will be higher during years *t+1* to *t+5*, lowering the primary balance that needs to be maintained during years *t+6* to *t+15*. Thus, I_1 is defined as the level of the cyclically-adjusted primary balance to be maintained between years *t+6* and *t+15* to reach the medium-term debt target.

Methodology I_2

To calculate I_2 - which shows the required primary balance in year *t+6* that is consistent with stabilizing debt level in the very long-run (in order to satisfy the inter-temporal budget constraint) and taking into account long-term ageing cost pressures. The analysis adapts the S_2 indicator formula developed by the European Commission:[24]

$$S_{2,2022} = rD_{2021} - r\sum_{i=2022}^{\infty} \frac{PB_{2021} - IAC_i}{(1+r)^{i-2022+1}}$$

$$I_2 = PB_{2021} + S_2$$

where *PB* is the primary balance-to-GDP ratio and *D* is the debt-to-GDP ratio at the end of the year. The primary balance and debt projections in year *t+5* come from the latest WEO. *IAC* are the cumulative incremental budget costs related to ageing[25] (public pension and health spending) as a share of GDP. From year *t+6* until *t+34* the primary balance is calculated by adding the flow of age-related expenditure (expressed as ratio to GDP) to the year *t+5* primary balance-to-GDP ratio. From year *t+34* on, the primary balance ratio is assumed to remain constant. *r* is the growth adjusted interest rate. The calculation intends to take into account any adjustment that governments plan to undertake until year *t+5*, which is the last year of the WEO projections. Moreover, ageing costs after year *t+34* are assumed equal at the year *t+34* value as projections after that date are not available.

[24] The reason for using I_2 as opposed to the S_2 indicator is due to the fact that S_2 indicator can understate the fiscal risks for countries that already have a significant fiscal adjustment in the baseline since this reduces the degree of further needed adjustment. However, as in the I_1 indicator, a more valid measure of fiscal effort is the level of the required primary balance that needs to be maintained for debt sustainability.

[25] $IAC_t = AC_t - AC_{2021}$ for all t>2021.

S_2reflects the necessary adjustment after year $t+5$ such that the government meets its inter-temporal budget constraint. $S_2$is also being decomposed into 4 components:

1. The effect of the initial level of debt (the first term in the equation above);
2. The projected path of the increase in ageing related costs;
3. The projected path of cyclically adjusted primary balance using the baseline assumptions as discussed before; and
4. The projected path of the cyclical component of the primary balance.

Main Outputs

The previously described assessments provide three main outputs:

- I_1 : the required cyclically adjusted primary balance to be achieved in year $t+5$ and maintained between years $t+6$ and $t+15$ to bring the level of the debt ratio back to 60 percent of GDP, and
- S_2: the required adjustment to be maintained indefinitely starting in year $t+6$ to satisfy the government's inter-temporal budget constraint including age-related expenditures and to ensure that the debt ratio is stabilized in the very long-run;
- $I_{2,}$: the required primary balance in year t+6 consistent with S_2 that satisfies the government's inter-temporal budget constraint.[26]

Finally, the indicators $\boldsymbol{I_1}$ and $\boldsymbol{I_2}$ are compared to the historical distribution of the largest average primary balances that countries were able to maintain for a decade since 1950, which were presented in the Spring 2013 Fiscal Monitor. More precisely, if a country has a fiscal adjustment need (measured by the average of $\boldsymbol{I_1}$ and $\boldsymbol{I_2}$) that is well below the median of the historical distribution of the largest primary balances that were sustained for a decade (2.8 percent of GDP) it is considered to be at lower risk, while adjustments one or two standard deviations above the median present greater risks.

V. Fiscal Contagion Risk: Distress Dependence Among Sovereigns[27]

Motivation

Since the beginning of the crisis in 2008, sovereign CDS spreads have exhibited a significant degree of volatility as well as high synchronicity across major economies. Specifically, sovereign CDS spreads in most countries rose exponentially after the collapse of Lehman Brothers, and remained at historically high levels well into 2009. Following a period of tightening in the sovereign

[26] Note that the results for the I_1 and I_2 indicators are not fully comparable, as they assume different paths of adjustment and reflect debt sustainability pressures based on different time horizons.

[27] Contributing author: Joao Jalles. This note is based on joint work done by Carlos Caceres (FAD), Vincenzo Guzzo (MCM), and Miguel Segoviano (Mexican Financial Authority). See Caceres et al. (2010).

CDS spreads that took place throughout most of 2009, the latter had been rising again in tandem in 2010 owing to concerns about the short-term financing needs and long-term sustainability of public sector balance sheets. In 2011 and the first half of 2012, CDS spreads in a number of European periphery countries reached levels well above those observed during the market turbulence in 2010 due to continued concerns about the resolution of the European debt crisis. Since late July 2012, CDS spreads have generally tightened significantly in most major countries, reflecting positive investors' sentiment on developments in the euro area.

Part of the explanation for this co-movement may be that sovereigns entail strong links to one another. That is, an increase in the distress level of one country can be accompanied by an increase in the distress level of other countries: in other words, there has been contagion. This distress dependence among sovereigns might be due to several factors. For instance, trade linkages might play an important role in an environment of slowing global demand. Capital flow linkages represent another possibility. The financial crisis impacted significantly the banking sectors in most developed economies simultaneously. Furthermore, financial institutions tend to engage in important cross-border activities, and can therefore be another channel of contagion. In fact, several of these sovereigns were required almost simultaneously to provide support to banks and other systemic financial institutions operating on their domestic markets. Nevertheless, there are common factors, such as an increase in global risk aversion (or risk appetite), that could have affected the different sovereign CDS markets concurrently.

Methodology

In an attempt to quantify the dynamics of the distress dependency between the different sovereigns, this tool computes the probability of sovereign distress in one country given default in another country. The methodology is based on estimating empirically the linkages between different countries using sovereign CDS spreads as inputs.

The probability of sovereign distress in country A given a default by country B—P (A|B)—is obtained in three steps:

- First, the marginal probabilities of default for countries A and B, P (A) and P (B) respectively, are extracted from the individual CDS spreads for those countries;

- Second, the joint probability of default of A and B, P (A, B), is obtained using the CIMDO methodology developed by Segoviano (2006). This is a non-parametric methodology, based on the Kullback (1959) cross-entropy approach, which estimates the joint probability of default without imposing a (pre-determined) distributional form whilst at the same time it is constrained to characterize the data. That is, the individual probabilities of default obtained from integrating the CIMDO joint probability of default must match the observed probabilities of default (extracted from the CDS spreads);

- Finally, the conditional probability of default P(A/B) is obtained by using Bayes' law:

$$P(A \mid B) = P(A,B) / P(B), \text{ and similarly for } P(B \mid A).$$

The distress dependence of each country to all the other countries in the sample is then constructed. This distress dependence measure—the "Spillover Coefficient" (SC) —was used and developed in Caceres et al. (2010). For each country Ai, the SC measure is computed using the formula:

$$SC(Ai) = \sum P(Ai/Aj) \cdot P(Aj) \qquad \text{for all } j \neq i$$

which is the weighted sum of the probability of distress of country Ai given each of the other countries in the sample (weighted by the probability of default of each of these countries).
A country's exposure to contagion is assessed based on the size of its "Spillover Coefficient" relative to the historical distribution of the spillover coefficient across countries.

Data

The data used consists of sovereign CDS spreads for individual economies obtained from Bloomberg and Markit. Note that some of these daily CDS spreads series are only available for the last few years.

References

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