

Online Annex 1.1. Technical Note¹

A. Indicator-Based Framework²

This section of the annex describes the quantitative framework used for analyzing aggregate *financial vulnerabilities* in the global financial system. The systematic analysis of quantitative indicators complements the market-driven, higher frequency conjunctural financial stability analysis that is also presented in Chapter 1 of this report. Continuous monitoring of quantitative indicators helps identify and track financial vulnerabilities across sectors and countries, and thus assess their potential role as shock amplifiers and ultimately their impact on financial stability. This systematic monitoring, by identifying specific areas where vulnerabilities are building, should also help prioritize and sharpen policy recommendations aimed at containing such a buildup. The conjunctural analysis may identify new vulnerabilities or indicators that should be included in the systematic framework. Importantly, the framework needs to be flexible to adapt to continuously evolving financial markets, changes in market structure, and financial innovation.

The underlying philosophy behind this work is the distinction between shocks and vulnerabilities. Shocks are, by nature, unpredictable in terms of both timing of materialization and magnitude. Financial vulnerabilities magnify and propagate the impact of shocks and can be identified and tracked over time. The framework is agnostic with respect to specific triggers or shocks, that is, it does not attempt to assign odds to the materialization of specific shocks. Rather, the objective is to identify and monitor those financial vulnerabilities that may amplify shocks once they materialize, and recommend policy actions that may mitigate them as they build.

The analysis of *balance-sheet vulnerabilities* is complemented by an assessment of *asset price misalignments*—deviations of asset prices from ‘fair value’ (as implied by underlying fundamentals). Such misalignments may signal the potential for sharp and sudden asset price adjustments *in the future* that may amplify the impact of a shock. *Financial conditions*, by contrast, represent the *current* price of risk in asset markets and reflect the risk environment in which corporations raise funding and on which they base longer term investment decisions and in which households make decisions on their level of consumption and savings. The *Growth-at-Risk* framework brings together all these components: it aims to assess how changes in financial conditions, as filtered through financial vulnerabilities, ultimately affect the estimated probability distribution of future economic growth outcomes.

¹ This is an annex to Chapter 1 of the April 2019 *Global Financial Stability Report*. © 2019 International Monetary Fund.

² This section was prepared by Sergei Antoshin, Peter Breuer, John Caparusso, Frank Hespeler, Henry Hoyle, Rohit Goel, Robin Koepke, Will Kerry, Sheheryar Malik, Rebecca McCaughrin, Thomas Piontek, Jeffrey Williams, and Akihiko Yokoyama.

Framework

The IMF's Indicator-Based Framework (IBF) is a quantitative framework to monitor, in a systematic manner, key financial vulnerabilities of the global financial system. Vulnerabilities arise from leverage, liquidity, maturity and currency mismatches. In absence of available off-balance-sheet data for a cross-section of countries the focus is restricted to on-balance-sheets vulnerabilities in six sectors: sovereigns, firms, households, banks, insurance companies, as well as other financial institutions.³

The framework is guided by a few key principles. First, the objective is to focus on the build-up of balance sheet vulnerabilities in a systematic way. Second, the framework integrates to some extent the *level* of vulnerabilities with the *pace* and intensity of their deterioration. That is, it is not just the distance from historical levels that matters, but the speed with which vulnerabilities evolve. Third, the framework seeks to be parsimonious so as to provide summary measures and be operational on an ongoing basis. Finally, the framework is intended to be broad, forward-looking and sufficiently flexible to adapt to changing circumstances. To this point, the framework will continue to evolve due to further performance testing, the evaluation of new indicators, and in response to financial innovation and other structural changes in the global financial system.

Broad sets of indicators are aggregated and summarized by financial vulnerability indices (FVIs), which aim to provide a parsimonious assessment of balance sheet vulnerabilities across different sectors, geographic regions, and time. The FVIs are organized based on dimensions of vulnerabilities that could arise in institutions and sectors which participate in the financial system across 29 advanced and emerging market economies deemed systemically important (see Table A.1). These jurisdictions account for roughly 90 percent of global financial system assets (for criteria determining systemic importance see [IMF 2013 Decision on Mandatory FSAPs for 29 Countries with Systemically Important Financial Sectors](#)). The taxonomy of

Table A.1. Country Coverage

<u>Advanced</u>	<u>Emerging</u>
Australia	Brazil
Austria	China
Belgium	India
Canada	Mexico
Denmark	Poland
Finland	Russia
France	Turkey
Germany	
Hong Kong	
Ireland	
Italy	
Japan	
Korea	
Luxembourg	
Netherlands	
Norway	
Singapore	
Spain	
Sweden	
Switzerland	
United Kingdom	
United States	

³ The other financial institutions sector aggregates data from investment funds, money market funds, trusts, broker-dealers, finance companies, funding companies, holding companies, securitization/structured finance vehicles and any residual categories, exclusive of financial auxiliaries and captive financial institutions, reported in national flow of funds data. Aggregate data is used where countries report it. For Euro Area countries aggregate data available from the European Central Bank were used. For China, data on asset managers have been aggregated from data on funds, wealth management products and trusts. Double entries have been eliminated as far as they could be identified.

vulnerabilities used here (see Table A.2) builds on the framework proposed by Adrian, Covitz, and Liang (2015).

Table A.2. Vulnerability Matrix

Vulnerability Category	Definition
Leverage	Measures the extent to which entities in each sector supplement own funds with borrowed funds to enhance returns, grow assets, or finance credit extension
Liquidity Mismatch	Examines the ability of an entity to meet a liability by liquidating assets
Maturity Mismatch	Broadly assesses rollover risk arising from the funding of longer-dated assets with short-term liabilities which may be fragile
Foreign Exchange Mismatch	Seeks to measure the sensitivity of an entity's balance sheet or flows to changes in the exchange rates between domestic and foreign currencies

Indicator Selection

Specific indicators of balance-sheet vulnerabilities across major advanced and emerging markets were drawn from the literature on early warning indicators of banking and financial crises, on the determinants of the likelihood of distress in specific sectors (banking, corporate, etc.), as well as from IMF surveillance and past GFSR analyses.⁴ The selection of underlying indicators depends on a number of factors, including data availability, comprehensiveness of coverage, and structural characteristics of the financial system, among other factors. Series were also chosen based on availability over a long-enough time period (from 2000 onward if possible) to provide appropriate context—that is, to differentiate between "normal" and "stress" periods. In addition, while there is some unavoidable overlap in the indicators across categories, a large enough set of indicators was included to avoid weighting biases and differing signal types (see Table A.3). In some cases, indicators beyond those falling into one of the four vulnerability categories were considered.

⁴ Aikman et al (2018), Aikman et al (2015), Lee et al (2018), Office of Financial Research (2018).

Table A.3. Matrix of FVI Indicators by Sector and Vulnerability

FVI Underlying Indicators	Leverage	Liquidity Mismatch	Maturity Mismatch	FX Mismatch	Other
Nonfinancial Corporates	Net Debt to EBIT; EBIT to Assets; Interest Coverage Ratio; Corporate Debt to GDP; Demeaned Corporate Debt to GDP; Share of BBB-rated Bonds in IG index (US); Share of CCC-rated Bonds in HY index (US); Share of CCC-rated Bonds in HY new issuance (US); Leverage ratio for the Leveraged Loans Market (LLM) (US); Share of Cov-lite in LLM (US)	Cash to Short Term Debt; Fixed Assets to Total Assets	Short-term Debt to Total Debt; IG Corporate Bond Maturities; HY Corporate Bond Maturities (US)	N/A	
Households	Household Debt to GDP; Demeaned Household Debt to GDP; Debt Service Ratios (HH for AE and PNF for EM)	N/A	N/A	N/A	
Banks	Tier 1 Capital Ratio; Buffer ratio; Market-adjusted capitalization; Volatility of market-adjusted capitalization; Asset growth	Liquid Assets to Short-term Liabilities	Deposit to Loan Ratio; Deposit to Loan Gap	Net Open FX Position to Capital	
Sovereigns	Gross Public Debt to GDP; Primary Gap	Share of Foreign Holdings in Public Debt	Remaining Maturity of Central Government Debt	N/A	External Financing Requirements as a Percent of GDP
Insurers	Ratio of Debt to Assets; Ratio of Assets to Equity; Securities rated BBB or lower in Bond Portfolio; Percentage Gap to HP trend in Ratio of Credit Assets to Assets	Ratio of Broad Illiquid Assets to Total Assets	N/A	N/A	
Other financial institutions	Ratio of Debt to Assets; Ratio of Assets to Equity; Ratio of Loans to Assets; Ratio of Credit Assets to Total Assets; Percentage Gap to HP trend in ratio of Loans to Assets; Percentage Gap to HP trend in Ratio of Credit Assets to Assets	Ratio of Narrow Illiquid Assets to Total Assets; Ratio of Broad Illiquid Assets to Assets	Short-term Liabilities /Short-term Assets (Long-term Assets - Long-term Liabilities - Equity)/Asset	N/A	Ratio of Liabilities to Banks over Assets; Ratio of Claims on Banks over Assets; Percentage Gap to HP trend in above two ratios

Normalization and Aggregation

For each sector, indicators were normalized for cross-country comparability purposes and then aggregated into FVIs. Indicators were separated into advanced and emerging market economy categories to facilitate comparisons across peer groups and to take into account structural differences and different degrees of financial development. Each indicator was normalized within its advanced or emerging market economy reference group using a pooled z-score by subtracting the cross-regional time series mean and dividing by the standard deviation for the basket.⁵

The normalized indicators were then aggregated within each category of vulnerabilities.⁶ Within each of the six vulnerability categories, an unweighted arithmetic average of the z-scores of the indicators was used.⁷ For example, US household leverage is obtained by averaging the z-scores of debt-to-GDP, demeaned debt-to-GDP, and debt service ratios. This step was repeated for each country and each vulnerability category.

Next, a *sector financial vulnerability indicator (FVI)* was calculated for each country that represents the country's vulnerability in a particular sector. For this step, a weighted average is used with leverage assigned a weight of 50 percent, and the other mismatches receiving an equal weight across the remaining 50 percent.⁸

Regional FVIs were then calculated for each sector, representing vulnerabilities in a particular sector for a geographic region. This is a nominal weighted average of the country level FVI across the countries in each region. Nominal GDP was used for the weights in most cases, though for the banking sector, bank assets were used (see Figure A.1 for an illustrative example of the steps of the aggregation process).⁹

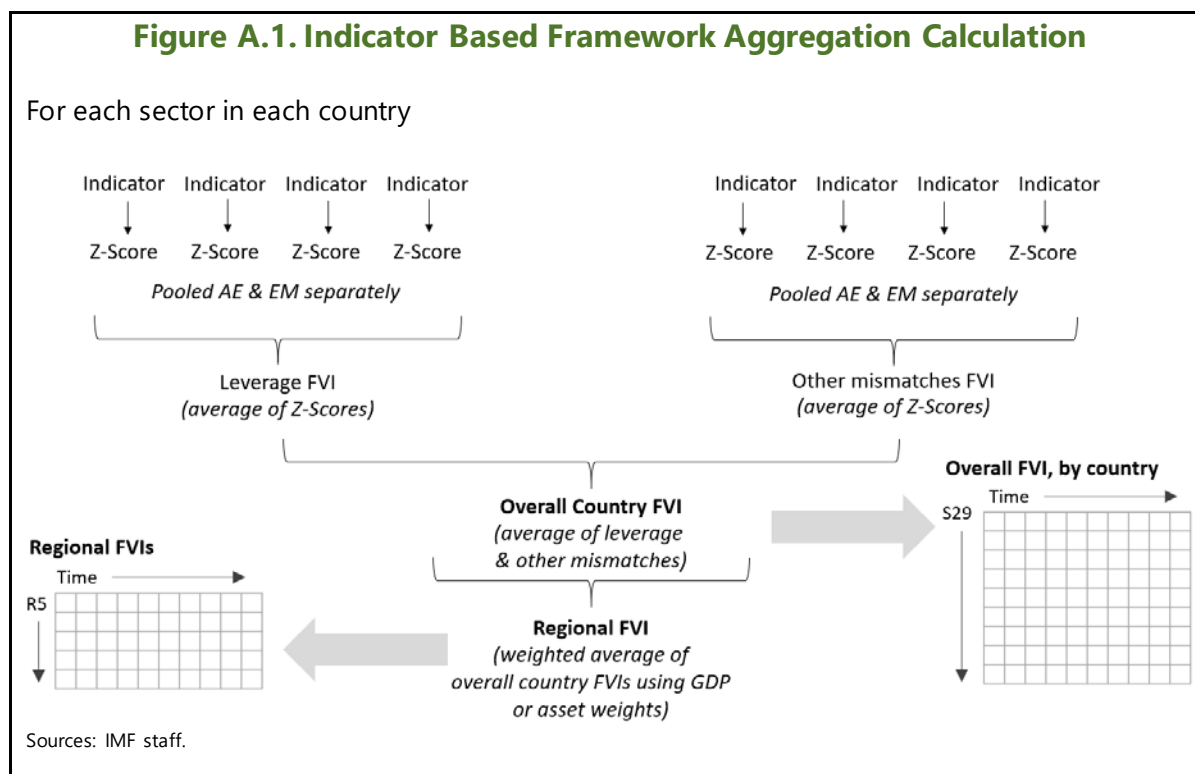
⁵ The z-score methodology preserves skewed or tail events that are relevant for stability analysis and is also the most commonly used technique for standardizing large datasets in other similar frameworks.

⁶ The insurance and other financials sectors incorporate a rescaling step subsequent to the z-score transformation and before the aggregation process to make data from different sources more homogenous. In particular, each individual z-score is rescaled to fall in a range between -1 and +1 using the following procedure: (i) calculate the absolute value for each data point in the time series; (ii) calculate the maximum of these absolute values across the time series; and (iii) for each z-score data point, divide by the maximum absolute value from the previous step.

⁷ An unweighted simple average within each vulnerability category is employed as the source of a future crisis is unknown. The risk of overfitting by using pre-determined weights based on the last crisis is high, given uncertainty around future stress events. There is evidence that simple average weights can outperform Bayesian model averaging in the forecasting literature. See, for instance, Graefe et al. (2014) and Green and Armstrong (2015).

⁸ Across vulnerability categories, leverage is given a higher weight due to better data availability both across time and geography, more consistent measurement across sector, and overall strong performance in providing advanced warnings of the buildup of risks in the financial system (see Aldasoro, Borio, and Drehmann 2018).

⁹ For the other financials sector, subsector-specific metrics are aggregated across all subsectors within each country, such as broker-dealers, finance companies, investment funds, etc., using weights based on assets relative to GDP. The resulting country level FVIs are subsequently aggregated across countries using weights based on nominal GDP figures.



Positioning and Threshold Determination

The regional FVIs were then compared to the entire historical range to produce heat-maps illustrating the scale of vulnerabilities in the financial system. Each quarterly observation in the regional FVIs for each sector are color-coded using percentiles to convey increasing degrees of potential vulnerability based on each observation’s position within the long-term range across the advanced and emerging market economy pools.¹⁰ The percentiles are then translated to heat-map colors such that each color represents an equal quintile share of the distribution.

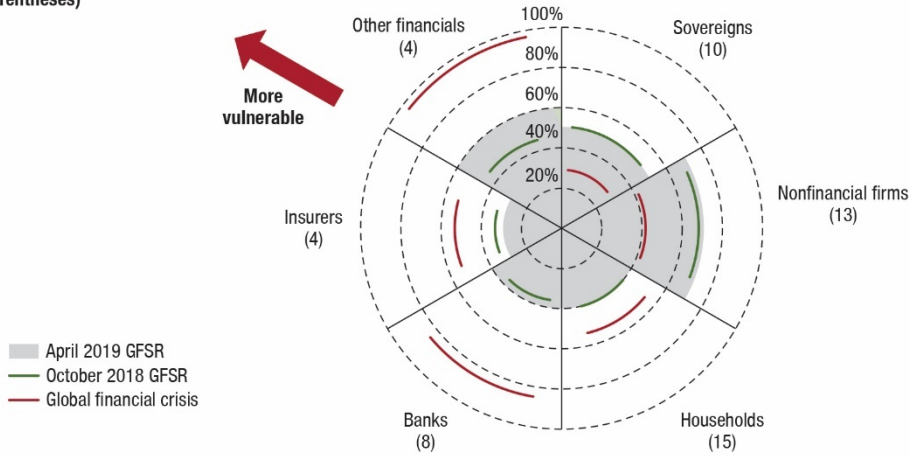
To make the heat-map colors consistent at the regional and the country level, the thresholds determined at the regional level are then applied to the country level FVIs separately for advanced and emerging market economies. This process is used to identify the share of countries with elevated vulnerabilities in Figure A.2. Overall, the more countries that cross a critical threshold, the more the underlying indicator, and ultimately the vulnerability, signal a divergence from normal or safe levels and towards a more vulnerable state for that sector in the region or country. Figure A.3 depicts a of summary heat map of the sector-level vulnerabilities by region, aggregating across leverage and other mismatches to get the composite vulnerability measure.

¹⁰ For example, at the regional level, China is only compared or “pooled” with the Other Emerging Markets region. Similarly, the US is only compared with the Euro Area and Other Advanced Economies.

Figure A.2. Global Financial Vulnerabilities

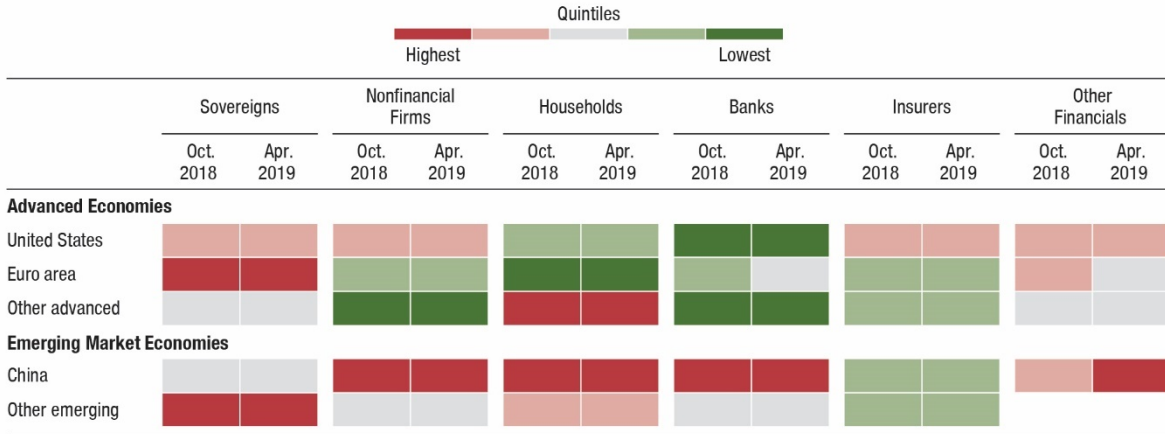
Sovereign and corporate sector vulnerabilities have increased since the global financial crisis, while vulnerabilities remain elevated in other financial sectors.

1. Proportion of GDP of Systemically Important Countries with Elevated Vulnerabilities, by Sector (Percentage of countries in sample with high and medium-high vulnerabilities by GDP [assets for banks]; number of vulnerable countries in parentheses)



Sovereign vulnerabilities are elevated in many countries, and in China vulnerabilities are elevated in a number of sectors.

2. Financial Vulnerabilities by Sector and Region



Sources: Bank for International Settlements; Bank of Japan; Bloomberg Finance L.P.; China Insurance Regulatory Commission; European Central Bank; Haver Analytics; IMF, Financial Soundness Indicators database; S&P Global Market Intelligence; S&P Leveraged Commentary and Data; WIND Information Co.; and IMF staff calculations.

Note: In panel 1, the global financial crisis reflects the maximum vulnerability value from 2007 to 2008. In panel 2, red shading indicates a value in the top 20 percent of pooled samples of advanced and emerging market economies for each sector from 2000 through 2018 (or longest sample available), and dark green shading indicates values in the bottom 20 percent. In panels 1 and 2, for households, the debt service ratio in emerging market economies is based on all private nonfinancial firms. Other systemically important advanced economies comprise Australia, Canada, Denmark, Hong Kong SAR, Japan, Korea, Norway, Singapore, Sweden, Switzerland, and the United Kingdom. Other systemically important emerging market economies comprise Brazil, India, Mexico, Poland, Russia, and Turkey. GFSR = Global Financial Stability Report.

Figure A.3. Financial Vulnerabilities by Sector and Region



Sources: Bank for International Settlements; Bank of Japan; Bloomberg Finance L.P.; China Insurance Regulatory Commission; European Central Bank; Haver Analytics; IMF, Financial Soundness Indicators database; S&P Global Market Intelligence; S&P Leveraged Commentary and Data; WIND Information Co.; and IMF staff calculations.

Note: Red shading indicates a value in the top 20 percent of pooled samples of advanced and emerging market economies for each sector from 2000 through 2018 (or longest sample available), and dark green shading indicate values in the bottom 20 percent. Other systemically important advanced economies include Australia, Canada, Denmark, Hong Kong SAR, Japan, Korea, Norway, Singapore, Sweden, Switzerland, and the United Kingdom. Other systemically important emerging economies include Brazil, India, Mexico, Poland, Russia, and Turkey.

Limitations of the Financial Vulnerability Indices

Indicator selection: Identifying the appropriate set of indicators to assess financial vulnerabilities across a wide range of countries is challenging. The list of indicators included in most financial stability frameworks is typically based on prior empirical research and judgment, informed by the history of financial crises and the need to capture as broad range of vulnerabilities as possible. There are trade-offs that can complicate the selection process when selecting indicators and data inputs. One trade-off is data frequency: higher-frequency data may facilitate real-time policy action, but often this comes at the expense of a shorter time horizon. In addition, higher frequency data tend to be more volatile and yield a greater proportion of false signals.¹¹ Moreover, the number of variables used in the framework needs to be large enough to cover a broad range of financial market activities so that no single indicator receives a higher weight, skewing the aggregate assessment. However, with too many indicators, the clarity of the overall message from the framework could be reduced and affect the ultimate communication of results to policymakers.

Data gaps: Data availability is another limitation. The IBF and FVIs may miss vulnerabilities that are hard to quantify. Certain indicators may be unavailable, unreliable (e.g., distorted by structural breaks, show bias), partial, not comparable, or confidential.¹² First and foremost, balance sheet data are available only with considerable lag and may not always reflect the current state of vulnerabilities. Second, institutions may have considerable exposures not captured by balance sheet data, such as financial leverage, derivatives and other off-balance sheet commitments. Third, there are limitations to quantifying new, emerging vulnerabilities, such as vulnerabilities related to cyber risks, among others. In addition, there are specific areas of the financial system where data opacity is especially problematic. The data limitations are most severe for those institutions, activities, and market segments that lie outside of the regulatory perimeter or are less regulated. For example, notable gaps are evident in the nonbank financial sector, where data coverage on activities such as securities lending, bilateral repos, and derivatives transactions is inadequate. Visibility into potential risks tied to funding mismatches or the build-up of financial market leverage is limited or partial. The lack of timely, granular, and comparable measures of market liquidity is another significant gap, limiting visibility into liquidity risks. Similarly, the lack of information on currency mismatches in the nonfinancial corporate sector and most household vulnerabilities significantly limit the analysis in those areas. These gaps highlight the need to improve data coverage.

Signaling quality: Because most of the FVIs are calculated relative to historical norms within advanced and emerging market economies, they cannot account for out of sample events. As such, some of the indicators are available only with a lag they may suffer from the inability to provide an early-enough warning or reliable thresholds to signal to policymakers that policy action needs to be taken. The difficulty in providing early warnings or reliable turning points may not provide policymakers with ample time to mitigate the buildup of vulnerabilities or to implement crisis

¹¹ See Kliesen, Owyang, and Vermann 2012.

¹² This is particularly relevant to the other financials and insurance sectors where data coverage for emerging market economies is limited, and reliable data is in many cases not available until the global financial crisis.

management measures. More work is needed to test for forward-looking characteristics of the underlying FVI indicators.

Complexity: The IBF and FVIs do not currently take into account system-wide feedback effects or breaks in historical relationships. Each sector and vulnerability in the FVI framework cover a particular aspect of financial stability, but there are complex linkages across sectors, vulnerabilities and countries that cannot be fully captured by sector-specific vulnerability indicators. Further, the financial system is dynamic and evolves over time. Vulnerabilities in the financial system may build from many sources, not all of which are well understood or quantifiable. The introduction or tightening of financial regulations may also shift risks to other areas or introduce new channels through which risks are transmitted. Tracking this risk migration and interconnectedness is a challenge. Thus, the analysis of sector-specific vulnerabilities should be complemented by the analysis of interconnectedness which could amplify systemic distress.

As a result of these limitations—related to the constraints of the framework, as well as data gaps—the IBF should be viewed as one of the tools used to monitor the health of the financial system. Going forward, the IBF framework is expected to evolve to keep up with the changes in the financial system, data availability and further research on financial stability issues.

B. Euro Area Banks' Sovereign Exposures and Nonperforming Assets¹³

This section explains the methodology behind the analysis of euro area banks, specifically: (1) mark-to-market losses on banks' sovereign exposures; (2) potential losses on bank nonperforming loans (NPLs); (3) a "stock-and-flow" model for estimating NPL disposals and the formation of new NPLs over time; and (4) a forward-looking analysis of the potential impact on banks of provisioning and disposing of NPLs.

Sample Construction

Most of these analyses (items (1), (2) and (4) above) are based on the sample of banks in the EBA's annual Transparency Exercise (hereafter, the 'EBA banks') for 2018:Q2. This sample is similar to the list of institutions supervised by the Single Supervisory Mechanism.

The stock-and-flow NPL analysis (item (3) above), which relies much more on time series comparability and which (unlike the sovereign exposures exercise) can draw on information from bank annual reports, uses a balanced panel that includes all banks for which the required financial data are continuously available over the period 2013 through 30 June 2018.

Estimating Capital Losses on Sovereign Exposures

The impact of a sovereign pricing shock is calculated as:

$$\Delta \text{Book Value} = \sum_{i=\text{Countries}} -(Exposure_i \times Price\ sensitive\ proportion_i \times Duration_i \times \Delta Yield_i)$$

'Exposure' is the book value of sovereign bond assets on banks' balance sheets. The 'price sensitive proportion' indicates the proportion of sovereign bonds that are held in accounts ('held for trading', 'mark to market' or similar designations) requiring that changes in bond prices be reflected in book values and therefore in shareholders' equity. Duration is the weighted average tenor of cash dividend and principal payments. Yield is the market yield on a bond, which can differ from the contractual coupon as the bond price changes.

EBA Transparency Exercise disclosures include granular information regarding each EBA bank's sovereign exposures, including:

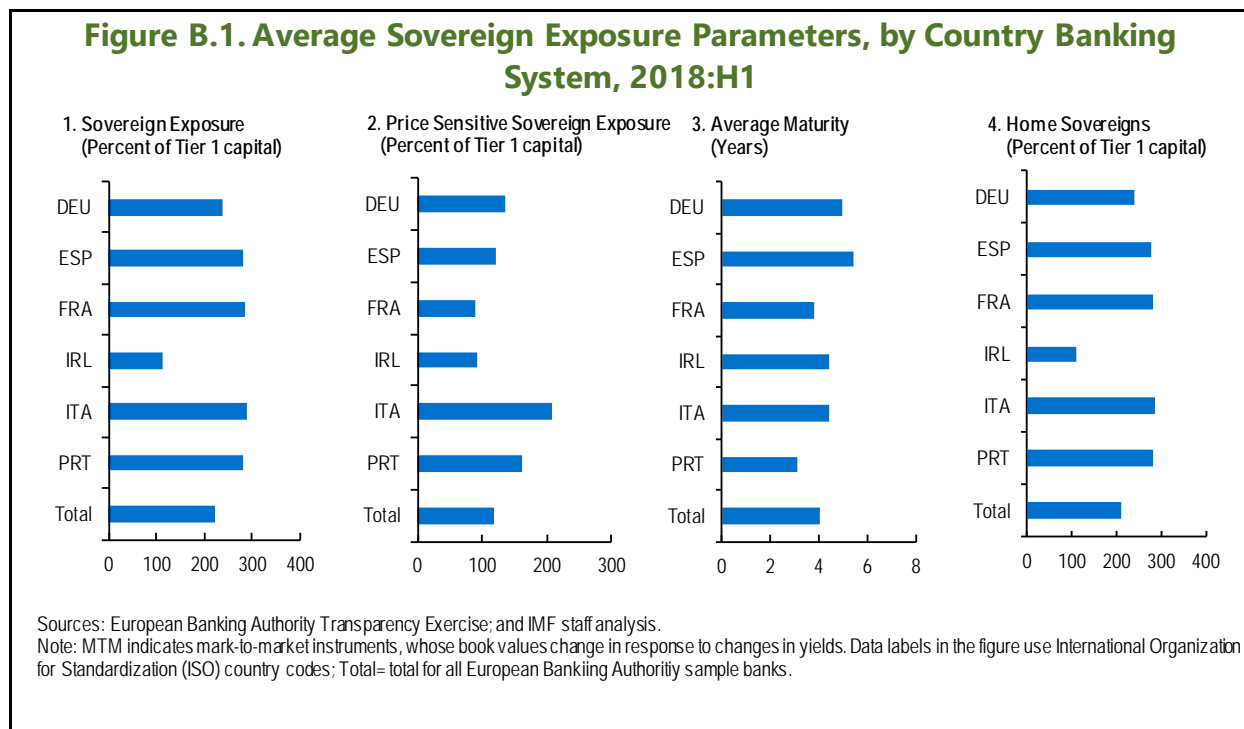
- *Total holdings of sovereign bonds* of each European Union country, the United States, Japan and a few other countries. Some countries, to which EBA banks have small exposures, have been grouped into an 'Other' category for the purpose of estimating losses.
- *Grouping of sovereign exposure to each country into six maturity buckets* by remaining maturity of: (1) less than 1 month; (2) 1 to 3 months; (3) 3 to 12 months; (4) 1 to 3 years; (5) 3 to 5 years;

¹³ This section was prepared by John Caparusso.

and (6) 5 to 10 years. The weighted average maturity is calculated based on the mid-point maturity of these buckets; and this weighted average maturity is used to estimate the duration of the government bond portfolio (since these are generally not amortizing bonds and interest rates are low, the distinction between duration and weighted average maturity should be relatively small).

- *Classification of sovereign exposures by accounting treatment.* Classifications have evolved with changes in accounting principles, but in each period the exposures can be grouped into portfolios whose accounting valuation is sensitive to changes in bond pricing (whether changes are recognized through the P&L or directly against equity), and those that are insensitive to bond price changes.¹⁴

The banking systems likely to be most affected by changes in government bond yields are those with large sovereign exposures (Italy, Portugal, France and Spain stand out) and where a high proportion of those exposures are booked as price-sensitive assets (Italy and Portugal) (Figure B.1, panels 1 and 2).



Banks' sensitivity to capital loss from interest rate moves is exacerbated when sovereign positions are of relatively long duration. This risk factor appears relatively benign across most of the countries

¹⁴ Bonds' book value sensitivity to underlying price changes depends on their accounting treatment. For bonds held in trading accounts or in 'mark-to-market' positions, book values respond to changes in underlying prices that reflect either changes in the broad interest rate environment or changes in the riskiness of specific bonds. The balance sheet values of bonds in 'held to maturity' accounts do not respond to changes in the yield on those instruments.

with large sovereign positions (Figure B.1, panel 3), Finally, it is worth noting that most banking systems are focused on holdings of domestic sovereigns. (Compare Figure B.1 panel 4 with panel 1). This concentrates sovereign-banking system linkages and risks within countries but may ameliorate cross-border spillovers from sovereign yield increases in one country to the capital positions of banks elsewhere.

We stress-tested bank sovereign exposures under a mild downside scenario and a severe downside scenario. These shocks are assumed to vary according to the rating of sovereign bonds (Figure B.2) and are calibrated according to past changes in yields in periods of stress. The mild (severe) scenario correspond to the 90th (99th) percentile of 3-month changes in 5-year sovereign yields over the period 2000–18. The scenarios assume a flight to quality for AAA-rated bonds, where changes correspond to the 10th (1st) percentile of 3-month changes over the same period. For comparison, the Bank of Italy’s most recent Financial Stability Report (Bank of Italy, 2018) calibrated banks’ sovereign sensitivities against a 100 basis point increase in sovereign yields.

Figure B.2. Change in Sovereign Yield by Scenario and Country Credit Rating

Scenario	Sovereign credit rating				
	AAA	AA	A	BBB	BB
Mild	-50	0	25	50	75
Severe	-100	50	150	250	425

Sources: Bloomberg Finance L.P.; and IMF staff analysis.

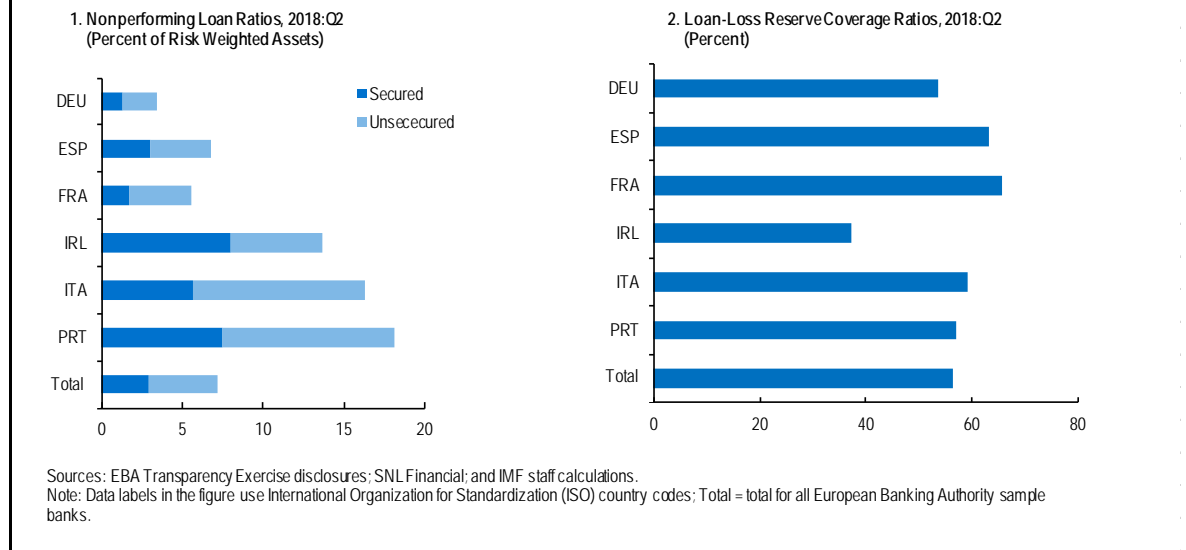
Techniques for Analysis of Nonperforming Loan Portfolios

The analyses presented in this chapter deploy three distinct techniques for assessing NPL portfolios: (1) Estimation of potential losses on the stock of NPLs; (2) an NPL stock-and-flow model to estimate NPL disposals (sales, write-offs) and new NPL formation (net of recoveries); and (3) estimates of the impact on banks’ reported financial performance of provisioning and disposing bad debts.

Estimating potential losses on NPL balances

Banking systems’ asset quality differs materially across countries, with Portugal, Italy and Ireland all maintaining very large stocks of non-performing loans (Figure B.3, panel 1). Loan-loss reserve ratios are more homogeneous, with most countries’ banks holding reserves at about 50 to 65 percent of NPLs (Ireland, perhaps because it has a higher proportion of secured NPLs, has a lower reserves coverage) (Figure B.3, panel 2).

**Figure B.3. Nonperforming Loans and Reserves -
Country Averages for EBA Banks**

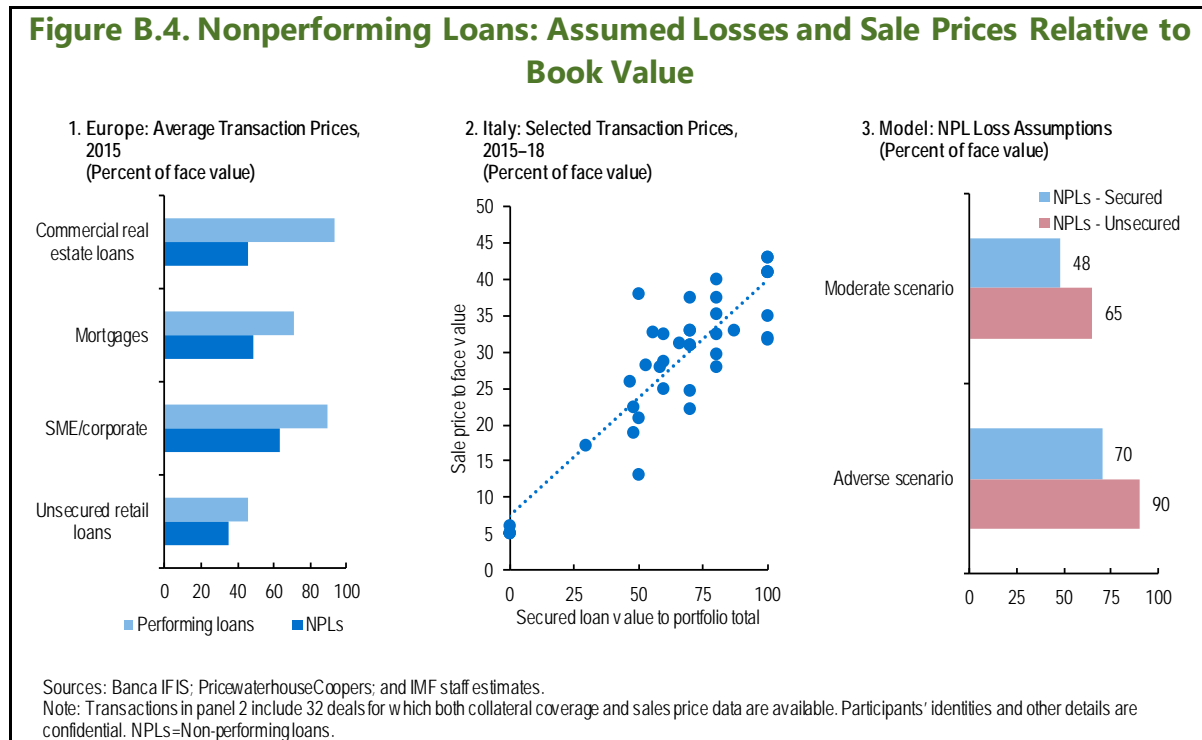


Most countries' NPL portfolios are also skewed toward unsecured credits, which generate relatively low recoveries. The distinction between secured and unsecured NPLs is important because their loss ratios differ sharply. Loss ratio estimates should in theory be based on the secondary market prices for NPL portfolios. This information is sparsely available. A survey of distressed debt investors across Europe conducted from 2012 through 2015 suggests prices between 45 and 60 percent of book value for secured NPLs and around 35 percent of book for unsecured NPLs (Figure B.4, panel 1). The pan-European survey information forms the basis for the moderate scenario loss assumptions in Figure B.4, panel 3.

Many investors have cautioned that this aggregate information may not reflect the diversity in actual prices. It masks considerable variation across countries, much of which is attributable to very significant differences in the expected (and variation in) elapsed time necessary for investors to recover cash from a purchased portfolio: less than a year on average in the UK and Ireland, roughly two years in Germany and Spain, and on average seven years (with significant variation and uncertainty) in Italy. These variations in recovery times, which reflect the strength of creditor rights and insolvency processes, have a significant impact on loan pricing. For example, selected transaction data from Banca IFIS, a prominent market participant, suggest that in Italy fully secured NPL portfolios generally sell for 30 to 40 percent, and totally unsecured portfolios fetch less than 10 percent, of book value (Figure B.4, panel 2).

These lower NPL portfolio transaction prices form the basis for the loss assumptions on secured and unsecured NPL sales underlying the 'adverse' scenario shown in Figure B.4, panel 3. An important implication of this finding is that the very low assumed recovery rates in the adverse scenario are primarily responsible for these countries' loan-loss reserves shortfalls and hits to capital on bad debt losses. Simply put, reserves are sufficient to cover estimated losses in the moderate scenario,

but the higher estimated losses in the adverse scenario that are in excess of loan-loss reserves are deducted from the estimated capital position.



While the deduction of losses on NPLs from banks' capital is straightforward, the impact on bank capital ratios is less so. When a bank realizes a loss through disposal of NPLs, its risk-weighted assets (RWAs), the denominator of the capital ratio, also declines. The exercise conducted here assumes that *unsecured* NPLs are 100 percent risk-weighted, but that *secured* NPLs are zero percent risk-weighted. While this assumption may appear to understate RWAs associated with disposed NPLs, we also assume that all NPLs are weighted using standardized models. In practice, large banks apply internal models that may apply risk-weightings below 100 percent for a significant proportion of their NPLs. RWA reduction can exert a significant effect on the Tier 1 ratios of high-NPL banks. In some cases, the combined effect of high loan-loss reserves and the positive effect of denominator reduction can cause even loss-making disposals to generate a rise in banks' Tier 1 capital ratios. Losses on sovereign bond positions reduce total assets and therefore exert a similar, though less pronounced, effect on a bank's simple capital-to-assets leverage ratio. However, because sovereign bond positions are zero risk-weighted, losses on these bonds do not reduce risk-weighted assets.

Estimating NPL disposals and new NPL formation

Time series estimates of NPL disposals and new NPL formation in each period are not required to estimate adjusted book value at a point in time, but they help to understand the dynamics underlying the current NPLs and reserves at each point and gauge banks' capacity to reach policy targets (for example, gross NPL ceilings or loan-loss reserves coverage levels) in the future.

The first equation below is used to estimate NPL disposals (elimination of gross NPLs through all means, including sales, write-offs, transfers to state asset managers, or others) during a period. The values for disposals are then substituted into the second equation to estimate new NPLs in a period.

$$\mathbf{LLR}_{EOP} = \mathbf{LLR}_{BOP} + \mathbf{Provisions} - \widetilde{Disposals}$$

$$\mathbf{NPL}_{EOP} = \mathbf{NPL}_{BOP} + \mathbf{New\ NPLs} - \widetilde{Disposals}$$

where LLR = loan-loss reserves (balance sheet). Provisions are the income statement charge for loan losses. EOP = end of period and BOP = beginning of period. Terms in bold font are reported figures, those capped with ~ symbols are derived estimates.

This framework is approximate—it essentially assumes that disposed loans have been fully reserved—but it appears to be the most accurate approach available in the absence of detailed information on the loan-loss reserve coverage of loans disposed.

Forward-looking analysis of bank NPL provisioning and disposals

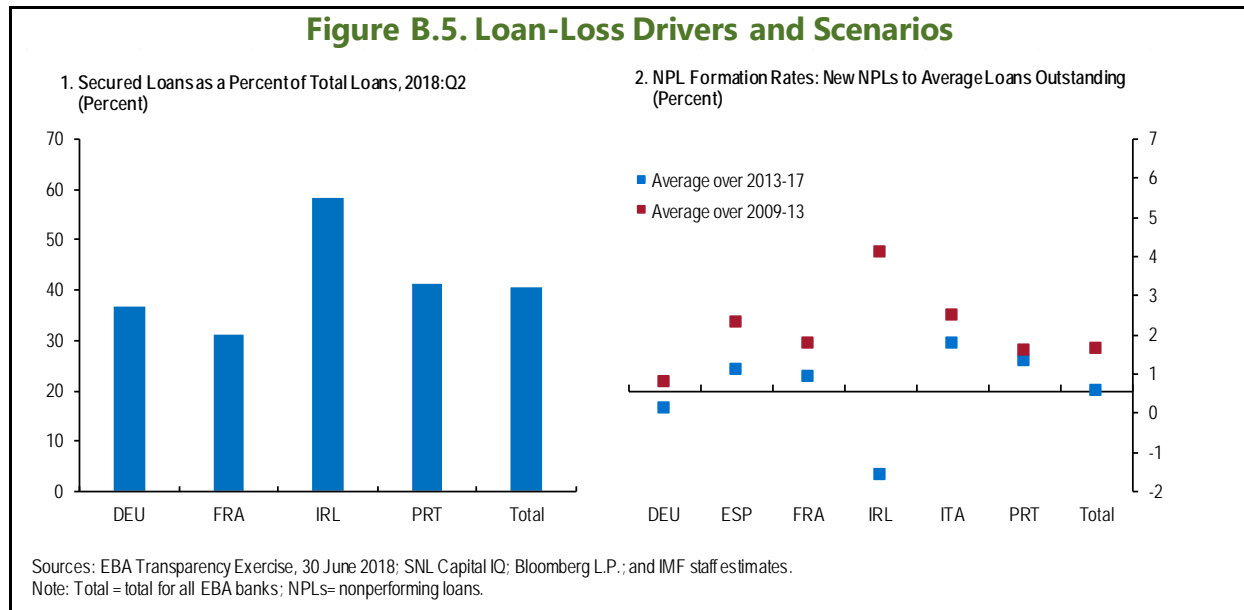
European authorities are introducing new policies intended to reduce the stock of NPLs and to build buffers against possible future episodes of heightened NPL formation. Most importantly, the ECB has introduced Pillar 2 (advisory, not compulsory) guidance for banks to raise loan-loss reserve coverage on new NPLs incurred after 1 April 2018. Specifically, the ECB has issued guidance for banks to build a 100 percent provision coverage on unsecured loans within two years and on secured loans over seven years (ECB, 2018). In addition, the EBA has introduced guidelines advising banks with a gross NPL ratio above 5 percent to establish a strategy to manage and mitigate nonperforming exposures (EBA, 2018). While these policies are needed to help banks reduce the burden of NPLs on their balance sheets, this analysis looks at the impact that the required disposals and provisions on NPLs could have on bank profitability.

Analysis of both policies makes several common assumptions:

- Total loans will remain at current levels through 2023.
- The mix of both new NPL formation and of loan disposals between secured and unsecured NPLs over the next five years will be in line with the mix on its balance sheet at 30 June 2018. (Figure B.5, panel 1)
- Two scenarios for new NPL formation are considered: (1) new NPL formation will be at its average level over the last five years (2013-17 inclusive); and (2) new NPL formation is set at the average rate over 2009-13 inclusive (Figure B.5, panel 2).

The financial effect of building reserves to 100 percent coverage of new NPLs is expressed as the incremental income statement provision charges relative to pre-provision operating profits. The analysis estimates average annual provision charges over the five-year period 2019 through 2023, inclusive, relative to earnings over 2013 through 2017, inclusive. Though expressed as an annual average, provision charges will likely not be the same every year, but will increase over the early years of the policy as new annual layers of NPL formation add to losses carried over from prior

years' new NPLs. These charges vary by new NPL formation scenarios and according to the mix between secured and unsecured new NPLs, as discussed above.



The estimate of incremental loss on disposals includes both the losses on the disposal of legacy NPLs necessary to attain a 5 percent gross NPL ratio, and on disposals related to new NPL formation over 2019 to 2023. Disposal of legacy NPLs (those on the balance sheet at 30 June 2018) is assumed to occur at an even pace necessary to reduce the balance to 5 percent by the end of 2023. Achieving a 5 percent overall gross NPL ratio also requires the disposal of all new NPLs incurred in future periods (the overall stock of NPLs, legacy or new, must fall to 5 percent of a static loan balance), based on the two NPL formation scenarios discussed earlier. The analysis further assumes that losses on NPL disposals remain consistent with the moderate scenario loss rates used earlier to estimate loss-adjusted capital levels (48 percent for secured and 65 percent for unsecured loans). These losses on disposals over 2019 through 2023 are expressed relative to pre-provision operating profit pre-provision operating profits over the period 2013 to 2017.

C. Downside Scenarios for Euro Area Insurance Companies¹⁵

The analysis in this report includes two downside scenarios (mild and severe) where euro-area insurers are subject to simulated mark-to-market shocks to their assets. This section explains the assumptions and mechanics behind each scenario, which is based on the exercise conducted in Chapter 1 of the October 2017 GFSR.

The analysis uses aggregate data for euro-area insurers from the European Insurance and Occupational Pension Authority (EIOPA).¹⁶ The data are for life and non-life insurance companies from eleven euro-area countries.¹⁷

These scenarios are based on shocks to insurers' sovereign and corporate bond portfolios, as well as their equity and real estate investments. The scenarios incorporate a flight to quality assumption, where yields of the highest-rated sovereign bonds fall contemporaneously to the increase in those of lower rated sovereign and corporate bonds. The shocks are calibrated as follows:

- Sovereign bond shocks are the same as used in the scenarios for banks (see Section B above).
- The corporate bond shocks are based on bond credit ratings. Similar to sovereigns, the mild (severe) scenario approximates to the 90th (99th) percentile of 3-month changes in corporate bond yields over the period 1999–18 (Figure C.1, panel 1). ICE Bank of America Merrill Lynch euro corporate bond indices by credit rating are used for these calculations. The expected mark-to-market impact on assets is calculated from the change in bond yields in each scenario and the estimated average duration of each credit rating bucket for each country insurers' corporate bond portfolio. This calibration also takes into account expected increases in capital charges for credit downgrades from rating migration probabilities, conditional on economic contractions, estimated by Fei *et al.* (2012) (Figure C.1, panel 2). Under Solvency II, the capital charge for credit risk increases significantly when a corporate bond investment is downgraded, particularly for lower ratings and longer durations (Figure C.1, panel 3).

¹⁵ This section was prepared by Fabio Cortes and Piyusha Khot.

¹⁶ The analysis uses two distinct sets of data from EIOPA: aggregate sector balance sheet statistics for solo insurers and representative portfolio data used for the calculation of the volatility adjustment. The latter crucially includes data on the average duration of insurer's investments in each jurisdiction of their sovereign holdings by country and their corporate bond holdings by credit rating.

¹⁷ Including France, Germany, Italy, Netherlands, Spain, Belgium, Austria, Ireland, Luxembourg, Portugal and Finland. These eleven jurisdictions account for €7.9 trillion of insurance assets, over 99 percent of the entire euro-area.

Figure C.1. Corporate Bond Yields, Rating Transition Probabilities and Spread Risk

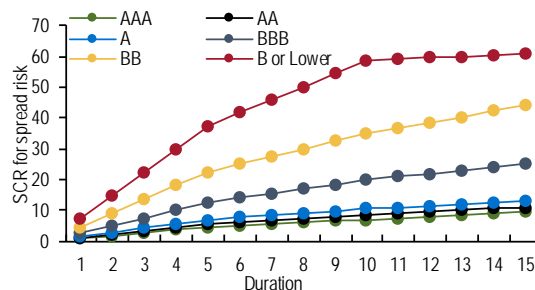
1. Corporate Bond Yield Scenarios (Basis points)

Downside Scenario	Credit Rating		
	A to AAA	BBB	BB or Less
Mild	50	50	200
Severe	75	125	1075

2. Rating Transition Probabilities (Percent)

From/To	AAA to A-	BBB+ to BBB-	BB or Less
AAA to A-	93	6	2
BBB+ to BBB-	8	81	11
Below BBB-	5	6	89

3. Solvency Capital Ratios Required for Spread Risk of Corporate Bond Investments (Percent)



Sources: Aegon Asset Management; Bloomberg Finance L.P.; European Insurance and Occupational Pension Authority (EIOPA); Fei et al (2012); and IMF staff calculations.

Note: Panel 2 is based on Fei et al (2012). SCR= Solvency capital ratio.

- In the mild downside scenario, equities and real estate investments fall by 2 percent, while in the severe downside scenario there is a 10 percent decline in equities and a 6 percent fall in real estate prices (the same assumptions were used in similar analysis published in Chapter 1 of the October 2017 GFSR).
- For all other investments, including shares in collective investment schemes, there is little detail on the actual investments. Given this, the shocks used in the scenarios are equivalent to the assumed change in the yield of an investment in an average AAA-A rated euro area corporate bond, again using a similar assumption to the October 2017 GFSR.¹⁸

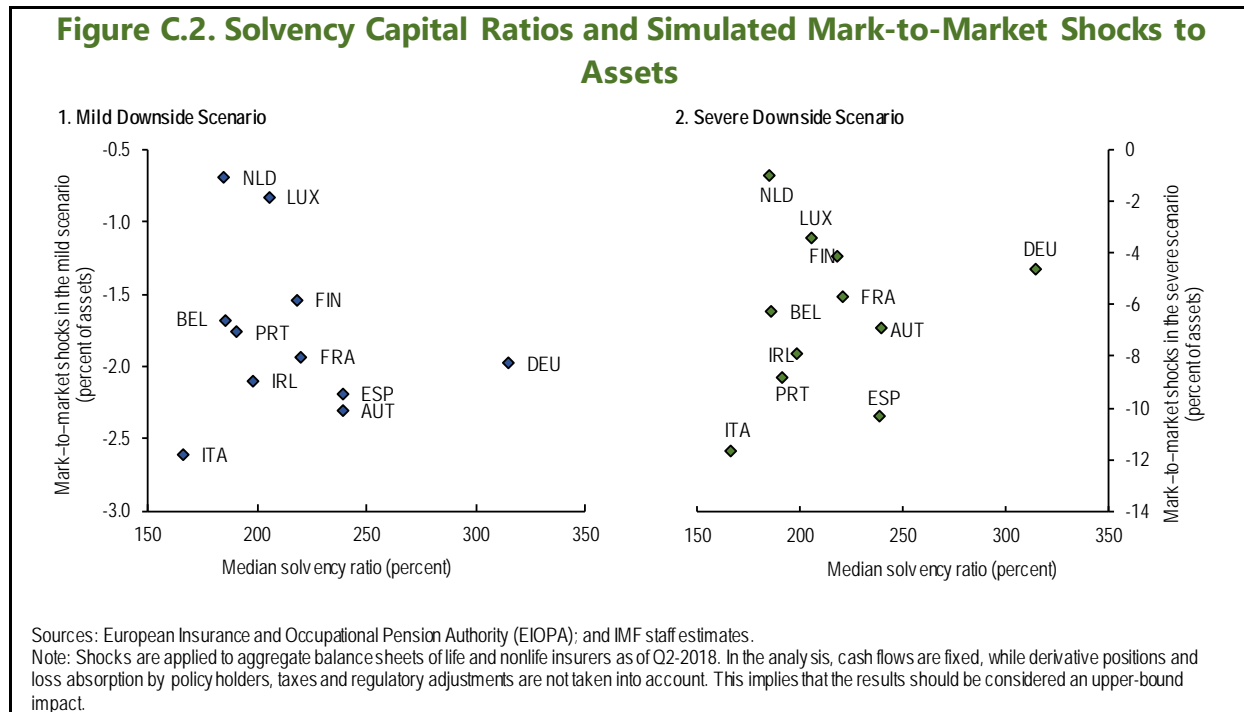
The results suggest that these scenarios would generate significant losses to euro-area insurers' assets, particularly for those from countries with more highly indebted sovereigns. This is because these insurers hold a greater amount of lower rated sovereign and corporate bond holdings that are expected to suffer more in stressed markets.

Most euro-area insurers remain well capitalized, with solvency capital ratios exceeding 200 percent in over half of the euro-area countries, double the minimum regulatory capital requirement.¹⁹

¹⁸ The duration is assumed to be the highest between AAA-A corporate and sovereign bonds for each jurisdiction.

¹⁹ A Solvency II capital ratio of 100 percent means that an insurer's capital is such that it will still be able to meet its obligations in the event of a severe shock that is expected to occur once in every 200 years. The target confidence level for insurers has been set at 99.5 percent over a one-year horizon.

However, a severe scenario would put particular pressure on those insurers that already have lower solvency ratios (bottom left corner of Figure C.2, panels 1 and 2).

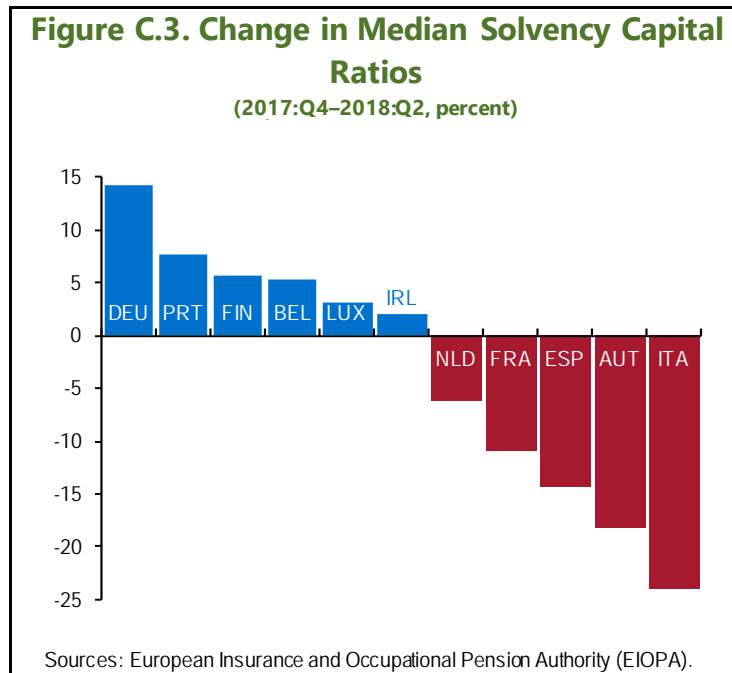


In reality, Solvency II offers a series of transitional measures for insurers to weather periods of volatility and illiquidity and therefore the ultimate impact of these scenarios on insurers would depend on whether these transitional measures are used. These measures include a “volatility adjustment” that helps absorb losses from a widening in credit spreads, which is associated with changes in the market value of bond investments other than default risk (e.g., changes in market liquidity). This volatility adjustment is built on an average reference portfolio and therefore the greater the divergence of an insurer’s portfolio from this reference portfolio, the less effective the volatility adjustment will be. Also, in some European countries, insurers are allowed to adjust the discount rate of their liabilities upward when the sovereign spread exceeds a trigger level specified by the national regulator.

However, the solvency ratios of insurers in some of the more highly indebted countries were already sensitive to increases in bond yields last year (Figure C.3). This is of particular concern in Italy where median solvency capital ratios are lower than average and decreased the most in the first half of 2018.²⁰ Domestic sovereign bond yields rose by a maximum of 120 bps at the 10-year maturity during this period, which is about half of the expected increase in the severe scenario for a BBB-

²⁰ Italian insurers median solvency capital ratios were at 166 percent as of 2018:Q2, down from 190 percent in 2017:Q4.

rated sovereign.²¹ This means that such scenario could put additional pressure on insurers' solvency and impact their ability to act as marginal buyers in financial markets during periods of stress.



²¹ Later in the year—October 2018—domestic corporate bond yields with a BBB rating rose sharply in tandem with domestic sovereign spreads. See the latest Bank of Italy Financial Stability Report (2018) for further detail.

D. The Rise of Benchmark-Driven Investors in Emerging Markets²²

The past decade has seen a significant rise in the importance of asset managers for portfolio flows to emerging markets and a commensurate increase in the importance of various benchmarks. Over that period, foreign investors doubled their notional holdings of emerging market government debt to more than \$1.5 trillion, an increase of 50 percentage points of emerging markets GDP. More than 60 percent of the increase was from foreign asset managers (Figure D.1, panel 1). This group comprises retail investors—typically mutual funds and exchange-traded funds (ETFs)—as well as institutional investors, such as insurance companies and pension funds. Latin American countries (especially Argentina, Brazil, and Mexico) were the largest recipients of flows from asset managers.

Benchmark indices play a greater role in determining country allocation for these portfolio flows. Recent estimates suggest that benchmarks explain around 70 percent of country allocations of investment funds, after controlling for industry, macroeconomic, and country-specific effects (Raddatz, Schmukler, and Williams 2017). The amount of funds benchmarked to the most widely-followed emerging market bond indices has quadrupled since the global financial crisis, reaching nearly \$800 billion (Figure D.1, panel 2).

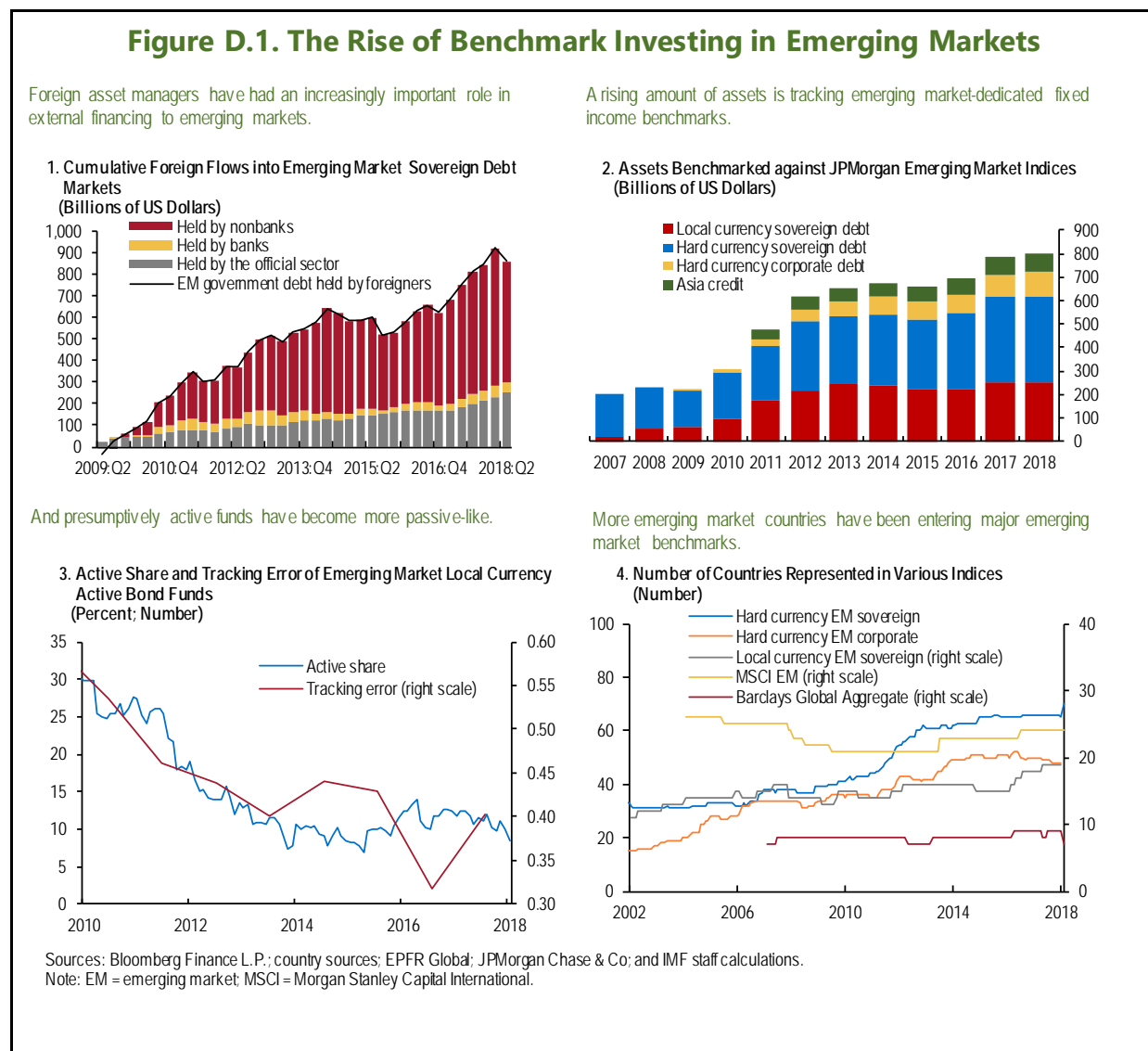
Active funds have been behaving more like passive funds in recent years. While both passive and active funds typically track some benchmark indices, active funds can in theory deviate substantially from the benchmark allocation and, in some cases, use it more as a comparative performance measure. There is evidence, however, that even active managers have become more passive. The average tracking error of active emerging market bond funds—the deviation of the performance of a fund from the performance of an index—has declined substantially over the past several years. Additionally, the active share—the percentage of holdings that deviate from the benchmark weightings—has declined substantially over the past decade (Figure D.1, panel 3).²³

Benchmark effects are affecting a greater number of countries as more enter various indices. Since 2007, the number of countries in the J.P. Morgan Emerging Market Bond Index (EMBIG) has doubled to more than 70 with the inclusion of many countries that have issued in international bond markets for the first time. In addition, the easing of capital controls in many emerging markets has allowed the number of countries in the benchmark local currency bond index—the J.P. Morgan Government Bond Index for Emerging Markets (GBI EM)—to increase from 11 to 19 (Figure D.1, panel 4). By contrast, even though many emerging market economies have been upgraded to investment grade, the number of countries with local currency debt represented in global investment grade bond

²² This section was prepared by Dimitris Drakopoulos, Rohit Goel, and Jeffrey Williams.

²³ The most widely followed fixed income indices specific to emerging markets are the J.P. Morgan EMBI Global for hard currency sovereign debt; GBI-EM (Government Bond Index-Emerging Markets) for local currency sovereign debt; and CEMBI (Corporate Emerging Bond Market Bond Index) for hard currency corporate debt.

indices has been relatively stagnant, given the more demanding investability criteria by these indices (Table D.2).



The different inclusion criteria between indices lead to a varying composition of investor types, exposing issuers to diverse portfolio flow dynamics. These criteria help determine the universe of investors attracted to a given country (Table D.2). Investors tracking global bond benchmarks, for example, are less likely to react to risks mostly impacting emerging markets given their broader portfolio, relatively small exposure to emerging markets as a whole, and concentration in only higher-grade sovereigns whose spreads tend to be less affected by moves elsewhere. However, countries that are part of global investment grade bond benchmarks tend to have a larger share of rating-sensitive investors and can face large outflows in the event of a loss of investment grade rating. Smaller local currency sovereign issuers that satisfy the GBI-EM criteria—but are not necessarily also investment grade—can have a disproportionate amount of foreign participation in their local markets driven by emerging market benchmarks. This is partly due to the fact that the

most commonly followed version of this index uses a weighting method that reduces the weight of larger issuers and redistributes the excess to smaller countries.

Table D.2 Summary of Main Characteristics for Global and Emerging Market Bond Indices

Index	Global Bond Benchmarks			EM Bond Benchmarks			EM Equity Benchmark
	Bloomberg-Barclays Global Aggregate Index (Global AGG)	Bloomberg-Barclays US Aggregate Index (US AGG)	FTSE World Government Bond Index (WGBI)	JP Morgan Emerging Markets Bond Index (EMBI®)	JP Morgan Government Bond Index-Emerging Markets (GBI-EM)	JP Morgan Corporate Emerging Markets Bond Index (CEMBI)	MSCI Emerging Markets
Relevance to EM	HC and LC Sov and Corp	HC Sov and Corp	HC and LC Sov	HC Sov ¹	LC Sov	HC Corp	EM equities
Minimum Market Size	No formal minimum ²		Yes	No formal minimum			Yes
Minimum Issue Size	Yes			Yes			Yes
Weighting *	Market Capitalization			Modified market capitalization ³			Market Capitalization
Rating criteria	Investment grade rating required as a minimum to remain in index			No minimum rating			No minimum rating
Other key Criteria	More demanding criteria that EM indices on local market investability criteria including settlement and clearing, capital controls and tax regimes.			Bespoke criteria to determine EM status. Less demanding investability criteria			Bespoke criteria to determine EM status.
Liquidity Criteria	Yes		Yes	Yes	Yes		Yes
Minimum Maturity Criteria	At least 1yr remaining maturity			2.5 years; Exit when less than 24 months to maturity	2.5 years; Exit when less than 13 months to maturity	5 years; Exit when less than 13 months to maturity	NA
AUM benchmarked to the index (\$)⁴	About 2 trillion each			370 billion	228 billion	105 billion	About 2 trillion
Taxes	Clarity on tax regime	Only fully taxable issues are eligible	No taxes	Taxes are okay if it doesn't impair index replicability			
Capital Control and Investment Restrictions	No capital controls, quotas, investment restrictions		No capital controls, quotas; Sustainable issuance; transparent monetary policy	No capital controls, quotas, investment restrictions			Expect significant ease of capital flows; Modest stability of the institutional framework

Sources: Analyst estimates; Bloomberg Finance L.P.; JPMorgan Chase & Co; MSCI; and IMF staff estimates.

Note: AUM = assets under management; EM = emerging market; EMBI = J.P. Morgan Emerging Market Bond Index; HC = hard currency; LC = local currency; corp = corporate; NA = not applicable; sov = sovereign.

¹ J.P.Morgan's family of EMBI indices also includes state-owned enterprises that are 100 percent owned by the government.

² While there is no specified minimum market size for inclusion in these indices, market size is listed as a criterion for determining country eligibility.

³ The most commonly followed versions of these indices are those labeled "Diversified," which use lower weights than would be implied from pure market weights.

⁴ J.P. Morgan estimates of assets under management are from surveys and may underestimate the actual amount benchmarked. For non-J.P. Morgan indices, the amount benchmarked is estimated based on analyst reports.

References

- Adrian, Tobias. Daniel M. Covitz, and Nellie Liang. 2015. Financial Stability Monitoring. Annual *Review of Financial Economics*, Vol. 7, pp. 357–395.
- Aikman, David, Michael T. Kiley, Seung Jung Lee, Michael G. Palumbo, and Missaka N. Warusawitharana. 2015. "Mapping Heat in the U.S. Financial System," Finance and Economics Discussion Series 2015-059. Washington: Board of Governors of the Federal Reserve System, <http://dx.doi.org/10.17016/FEDS.2015.059>.
- _____, Jonathan Bridges, Stephen Burgess, Richard Galletly, Iren Levina, Cian O'Neill, and Alexandra Varadi. 2018. "Measuring risks to UK financial stability," Bank of England Staff Working Paper No. 738. <https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2018/measuring-risks-to-uk-financial-stability>
- Aldasoro, Inaki, Claudio Borio, and Mathias Drehmann. 2018. "Early warning indicators of banking crises: expanding the family." Bank for International Settlements, *Quarterly Review* March. https://www.bis.org/publ/qtrpdf/r_qt1803e.pdf
- Bank of Italy. 2018. *Financial Stability Report*. Rome: Bank of Italy. November.
- European Banking Authority. 2018. "Final Report: Guidelines on management of nonperforming and forborne exposures." Frankfurt. October.
- European Central Bank. 2018. "Addendum to the ECB Guidance to banks on nonperforming loans: supervisory expectations for prudential provisioning of non-performing exposures." Frankfurt. March.
- European Parliament. 2018. "Nonperforming loans in the Banking Union: Stocktaking and Challenges." Brussels. October.
- Fei, F., Fuertes, A.M. and Kalotychou, E. 2012. Credit Rating Migration Risk and Business Cycles. *Journal of Business Finance and Accounting*, 39 (1–2): 229–263.
- Graefe, Andreas, Helmut Kuchenhoff, Veronika Stierle, and Bernhard Riedle (2014). "Limitations of Ensemble Bayesian Model Averaging for Forecasting Social Science Problems," *International Journal of Forecasting*.
- Green, Kesten C. and J. Scott Armstrong. 2015. "Simple Versus Complex Forecasting: The Evidence," *Journal of Business Research*, 68, 1678–1685.
- International Monetary Fund. 2017. *Global Financial Stability Report* October 2017, Chapter 1: Is growth at risk? October.

- Kliesen, Kevin L., Michael T. Owyang, and E. Katarina Vermann. 2012. "Disentangling Diverse Measures: A Survey of Financial Stress Indexes." *Federal Reserve Bank of St. Louis Review*, September/October, 94(5), pp. 369–97.
<https://files.stlouisfed.org/files/htdocs/publications/review/12/09/369-398Kliesen.pdf>
- Lee, Seung Jung, Kelly E. Posenau, and Viktors Stebunovs (2018). "The Anatomy of Financial Vulnerabilities and Crises." *International Finance Discussion Papers* 1191.
<https://doi.org/10.17016/IFDP.2017>
- McLaughlin, Joe, Adam Minson, Nathan Palmer, and Eric Parolin (2018). "The OFR Financial System Vulnerabilities Monitor" The Office of Financial Research Working Paper 18–01.
https://www.financialresearch.gov/working-papers/files/OFRwp-18-01_Financial-System-Vulnerabilities-Monitor.pdf
- Raddatz, Claudio, Sergio L. Schmukler, and Tomás Williams. 2017. "International Asset Allocations and Capital Flows: The Benchmark Effect." *Journal of International Economics* 108 (C): 413–30.