Growth at Risk: Concept and Application in Surveillance

CEMLA: IX Meeting on Financial Stability

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The views expressed in the presentation are those of the author and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.
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Outline

I: Growth at Risk (GaR)

A. Definition, Key Features and Policy Insights
B. Empirical Framework Overview

II: GaR Tool for Macrofinancial Surveillance

A. GaR Tool: Overview
B. Main Elements
What Did We Learn From the GFC?

Financial conditions…

Asset price returns and their volatilities, spreads (corporate, interbank, term)…

Macrofinancial vulnerabilities…

Leverage (household, corporate, financial sector, sovereign); liquidity, maturity, and FX mismatches

Have implications for growth prospects

Shocks can be amplified and transmitted across multiple channels
Financial conditions and risks to growth

Macrofinancial vulnerabilities increase in good times...

Vulnerabilities (leverage; mismatches) tend to increase when financial conditions are accommodative.

Financial conditions and macrofinancial vulnerabilities signal risks...

Tighter financial conditions, amid elevated vulnerabilities, pose downside risks to economic activity.

Monitoring these conditions and vulnerabilities can inform policy

Tracking financial conditions and vulnerabilities can provide valuable information for policymakers.
Growth at Risk: Definition

- Quantifies macrofinancial risks to future GDP growth
- Financial and economic indicators used to identify macrofinancial linkages and gauge financial vulnerabilities
- Flexible, parsimonious, forecasting framework, that can, inter alia, estimate the severity and the likelihood of a future recession
- Idea: Adrian, Boyarchenko, Giannone (2019) AER
  Tool and operationalization for IMF surveillance: IMF WP/19/36
Growth at Risk: Teaser
I: Growth at Risk (GaR): Concept
Growth at Risk: Definition

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Growth at Risk: Key Features and Policy Insights

Differences with existing approaches:

- Enables discussion on the *entire* growth distribution at different horizons
- Estimates relative importance of key drivers of future growth
- Distribution of future growth depends on current state of financial and macroeconomic conditions

Policy insights:

- Helps generate scenarios based on statistical analysis
- Facilitates quantification of alternative scenarios linked to key risks
- Allows policymakers to better monitor and deploy policies to mitigate downside risks
- Identifies risk-return and intertemporal policy tradeoffs
- Tailored to individual country risks and vulnerabilities
Growth at Risk: Empirical Framework Overview

GaR compromises three steps:

1. Macrofinancial variable selection
2. Quantile regression analysis
3. Fitting conditional growth distributions
Step 1: Macrofinancial Variables Selection

Goal:

• Select variables that are likely to influence growth prospects,…
• …choose appropriate (groups of) variables for the following equation:

\[ \text{growth}_{t+h} = \beta_1 \times X_{1,t} + \beta_2 \times X_{2,t} + \beta_3 \times X_{3,t} + \gamma \times \text{growth}_t + e_t \]
Step 1: Macrofinancial Variables Selection

Goal:

- Select variables that are likely to influence growth prospects,…
- …guided by theory,…
- …country-specific circumstances, and…
- …expert judgement.
Step 1: Macrofinancial Variables Selection

Financial Conditions:

- Large body of empirical work showing have financial conditions can improve growth *point* forecasts
- Asset price growth
- Stock return volatility
- Spreads (corporate, term, interbank)
Step 1: Macrofinancial Variables Selection

Macrofinancial Vulnerabilities:

- Leverage (financial accelerator models)
- Maturity, liquidity, and FX mismatches
- Fragile balance sheets (elevated NPLs)
- Asset price misalignments
Step 1: Macrofinancial Variables Selection

Other Factors:

- Commodity prices
- Market sentiment
- Behavioral finance: neglect of downside risk
Step 1: Macrofinancial Variables Selection

Too many variables?

- Important to organize variables into groups or “partitions”
- Facilitates estimation and intuition
- Importantly, these partitions should be guided by theory
Step 1: Macrofinancial Variables Selection

How to construct a “partition”?

- Choose a set of variables such as spreads, asset prices and volatilities
- These price-based indicators could be a natural grouping
- Principal component analysis (PCA) extracts underlying “trends”
Step 1: Macrofinancial Variables Selection

PCA intuition…

• Instead of 10 variables, can now include a single variable capturing the common information
Step 1: **Macrofinancial Variables Selection**

Macrofinancial variables can be grouped along the following partitions:

- **Financial conditions ("price of risk"):**
  - Credit and term spreads, valuation ratios, volatility measures…

- **Macrofinancial vulnerabilities:**
  - Credit growth, leverage metrics, FX and maturity mismatches…

- **Other relevant factors:**
  - Commodity prices, global risk appetite, and external demand…
Forecast of growth $h$ quarters ahead, conditional on current growth and a macrofinancial variable ($X_t$) of interest—e.g., financial conditions index (FCI)

Can be generalized:

$$
growth_{t+h} = \beta_1 \cdot X_{1,t} + \beta_2 \cdot X_{2,t} + \beta_3 \cdot X_{3,t} + \gamma \cdot growth_t + e_t$$

where $X_{1,t}$, $X_{2,t}$, $X_{3,t}$ could be the three partitions discussed above…
Step 2: Quantile Regressions

\[ growth^q_{t+h} = \beta^q_1 \times X_{1,t} + \beta^q_2 \times X_{2,t} + \beta^q_3 \times X_{3,t} + \gamma^q \times growth^q_t + e^q_{t+h} \]

• Mapping between the current macrofinancial variables \((X_{1,t}, X_{2,t}, X_{3,t})\) and future growth \((growth^q_{t+h})\) across quantiles (superscript “q”).

• Typical application:
  • \( h = 1\ldots12 \) (quarters),
  • \( q = 0.1\ldots0.9 \) (quantiles)
  • \( X_{1,t}, X_{2,t}, X_{3,t} \): indices of financial conditions, vulnerabilities, and other macroeconomic factors, respectively.
Step 2: Quantile Regressions
Step 2: Quantile Regressions

\[
growth_{t+h}^q = \beta_1^q * X_{1,t} + \beta_2^q * X_{2,t} + \beta_3^q * X_{3,t} + \gamma^q * growth_t + e_{t+h}^q
\]

- Mapping between the current macrofinancial variables \((X_{1,t}, X_{2,t}, X_{3,t})\) and future growth \((growth_{t+1}^q)\) across quantiles (superscript “\(q\)”).

- Typical application:
  - \(h = 1…12\) (quarters),
  - \(q = 0.1…0.9\) (quantiles)
  - \(X_{1,t}, X_{2,t}, X_{3,t}\): indices of financial conditions, vulnerabilities, and other macroeconomic factors, respectively.
Step 2: Quantile Regressions

The inverse relationship between FCIs and future growth

- ...is stronger for economic contractions (5th percentile) than for expansions.
Step 3: Fitting Conditional Growth Distributions

Use the predicted values across quantiles to fit a flexible distribution function

T-skew nests the Normal distribution

 Allows for (1) skewness and (2) fatter tails

Based on Adrian, Boyarchenko, and Giannone (2019)
Step 3: Fitting Conditional Growth Distributions

Financial conditions improve the ability to predict future economic downturns.
II: GaR: Applications in IMF Surveillance
**GaR Tool for Macrofinancial Surveillance: Overview**

- Excel-based GaR tool developed (Python with Excel interface)
- To support macrofinancial surveillance
- Usage to date includes:
  - **Article IVs**: Singapore, Panama, Portugal, Albania, Korea, Romania
  - **FSAPs**: Peru, Canada, Singapore, France, Italy
GaR Tool for Macrofinancial Surveillance: Main Elements

Flexibly Customizable

• Computes country-specific FCIs
• Allows for partitions of macrofinancial variables
• Ranks variables according to their informational content for future growth
• Estimates quantile regression coefficients
• Generates future growth distributions
• Growth distributions can be centered on WEO forecasts
• Facilitates scenario analysis
Step 1: Partitions

Three partitions were considered:

- **Price of Risk**: domestic and external asset prices (returns, spreads, volatility metrics)
- **Leverage**: selected measures of household- and corporate-sector leverage
- **External**: other relevant factors, e.g., main trading partner growth, commodity prices
Step 1: Loadings

Partition “loadings” quantify the relative importance of variables:

The most influential macrofinancial variables include:

- **Price of Risk**: short-term rates, interbank spreads
- **Leverage**: domestic credit measures
- **External**: Chinese growth, FX-related variables
Price of risk is negatively correlated with near-term future growth, especially for lower tail...
Step 2: Quantile regression Coefficients

In contrast, leverage is positively associated with growth 1 quarter ahead...

- ...but it is strongly negatively correlated 12 quarters out.
- A clear example of how loose financial conditions can stimulate growth in the near term...
- …but increase the likelihood of medium-term downside risks.
Accommodative financial conditions tend to dampen near-term risks…

…but also raise the odds of adverse medium-term growth outcomes.

Notice the relatively fatter left tail of the three-year-ahead growth distribution.
Step 3: Conditional Distributions

Distributions can be centered around the WEO baseline forecast…

- Notice the negative skew
Step 3: Conditional Distributions

Can track the probability of a recession over time…
Step 3: Scenario Analysis: Tighter Financial Conditions

Tool can be used to shock macrofinancial conditions to assess how tail risks change

- Can quantify the impact of a realization of a risk.
- Illustration of how tighter global financial conditions would increase the likelihood of a recession.
- Entire distribution is affected: changes in the average, degree of skewness, and shape of the tails.
### Step 3: Scenario Analysis: Risk Quantification

<table>
<thead>
<tr>
<th>Source of Risk</th>
<th>Relative Likelihood compared with the no-shock scenario</th>
<th>Simulated Shock (in standard deviations)</th>
<th>Estimated Impact on the Median vs. 10th percentile (in p.p. real growth)</th>
<th>No-shock and counterfactual probability of growth &lt;2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaker than expected growth in main trading partners</td>
<td>Medium</td>
<td>- 2 std in macroeconomic conditions of main trading partners</td>
<td>-1.6 p.p.; -1.7 p.p</td>
<td>3% ; 43%</td>
</tr>
<tr>
<td>Sharp tightening of financial conditions in the Euro Area</td>
<td>High</td>
<td>+ 2 std in EA FCI composite</td>
<td>-0.9 p.p.; -1 p.p</td>
<td>3% ; 20%</td>
</tr>
<tr>
<td>Financial turmoil in key partners country</td>
<td>Medium</td>
<td>+ 2 std in key partners bond rates</td>
<td>-1.1 p.p.; -1.8 p.p</td>
<td>3% ; 25%</td>
</tr>
<tr>
<td>Increase in leverage</td>
<td>Low</td>
<td>+ 2 std in leverage index</td>
<td>-0.4 p.p.; -2 p.p</td>
<td>3% ; 16%</td>
</tr>
</tbody>
</table>
GaR Tool Screenshots
GaR Tool: Screenshots
GaR Tool: Screenshots

Unsupervised data partitioning:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
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<tr>
<td>Before shock</td>
<td>After shock</td>
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<td></td>
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<td>Date of input</td>
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<td>Horizon forward</td>
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<tr>
<td>Conditional mode</td>
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<td>3.509576868</td>
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<tr>
<td>GaR%</td>
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<td>0.555576868</td>
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<tr>
<td>GaR1%</td>
<td>2.550576868</td>
<td>1.595576868</td>
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<td>Growth below 0 probability</td>
<td>0.0104</td>
<td>0.02</td>
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<td>Skewness</td>
<td>2.2549</td>
<td>2.282</td>
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<td>Scale</td>
<td>0.7733</td>
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</tbody>
</table>

Scenario test for 06/30/2018 growth rate forward 4
Looking forward:

Paper:

• Growth at Risk: Concept and Application in IMF Country Surveillance—IMF WP/19/36 (A. Prasad, S. Elekdag, P. Jeasakul, R. Lafarguette, A. Alter, A.X. Feng, C. Wang)

Tool:

• Available at Github: https://github.com/IMFGAR/GaR

Related and forthcoming work:

• The Term Structure of Growth-at-Risk—IMF WP/18/180 (T. Adrian, F. Grinberg, N. Liang, S. Malik)
• Downside Risks to House Prices—GFSR (April 2019)
• A Financial Stability Monitoring Framework for the GFSR—IMF SDN (forthcoming) (T. Adrian, D. He, N. Liang, F. Natalucci)
Thank you!

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