Expecting the unexpected: Economic growth under stress

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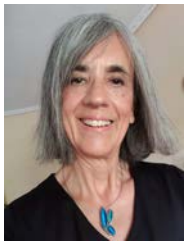

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Contribution

A new measure of economic growth vulnerability

Growth in Stress (GiS)

- Vulnerability refers to the exposure of the economy to stressful, rare, and catastrophic shocks, e.g., COVID-19
- Measuring vulnerability is important for the construction of resilience policies.
- Policy makers should be prepared in advance for **extreme shocks** and ready to implement corrective measures.

Definition of Growth-in-Stress (GiS)

$$GiS_{t+h} = \min q_\tau(y_{t+h|t})$$

$$\text{s.t. } g(F_t, \alpha) = 0$$

- Factor-augmented τ-quantile regression as a function of latent (unobservable) factors F_{it}:
  (typically τ= 5%)

$$q_\tau(y_{t+h|t}) = \mu_\tau^{(h)} + \phi_\tau^{(h)} y_t + \sum_{i=1}^{r} \beta_{\tau,i}^{(h)} F_{it} + v_{\tau,t+h}$$

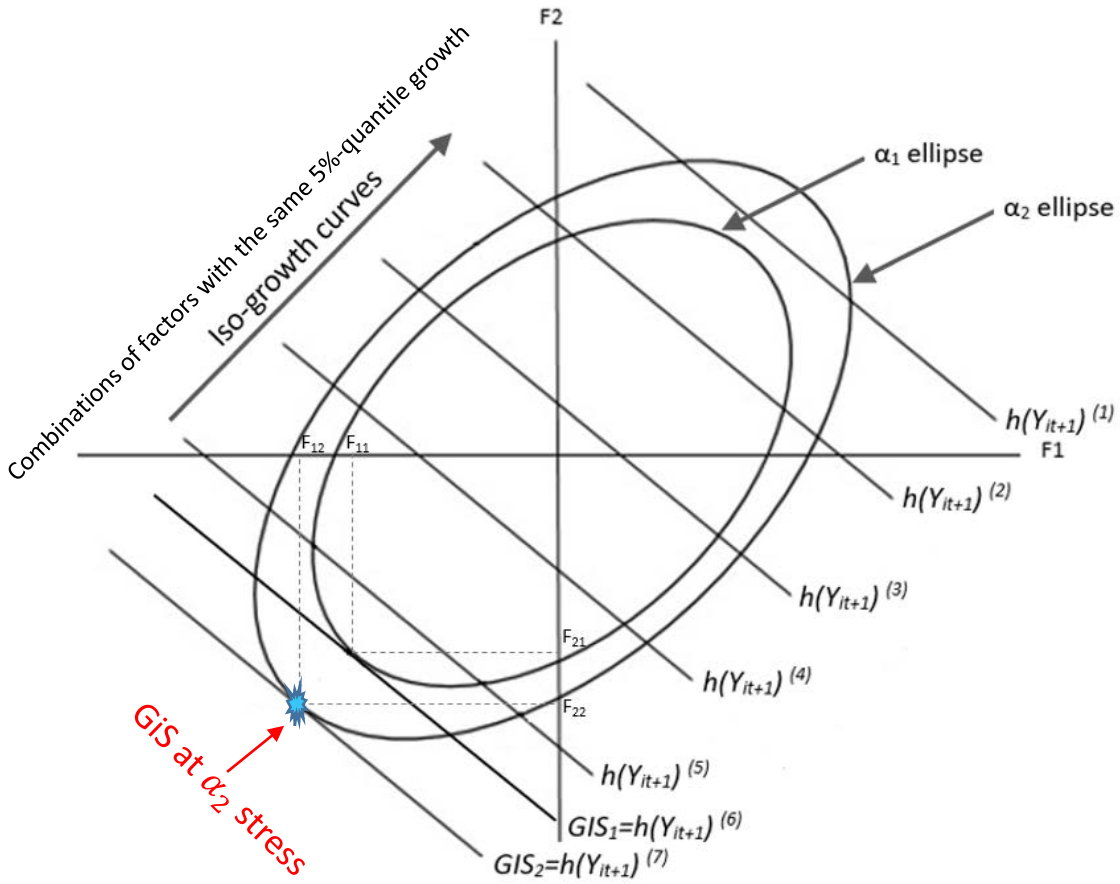
F_{it} extracted from a set of N variables, X_t.

- Multivariate probability density function of latent factors F_{it}:

$g(F_t, \alpha)$ is a the centered α-probability contour of F_{it},
(e.g., ellipsoid containing the true factor vector with probability α)

α selects the probabilistic stress scenarios (rare events)
(e.g. 95%-probability contour of F_{it})

Graphical Representation of Growth-in-Stress (GiS) – 2 factor case



US Growth-in-Stress (GiS)

- Extraction of Factors from the following data sets: (quarterly data from 2005Q1 to 2020Q2)

  $\boldsymbol{X_1}$: Local financial variables, $N_1 = 105$
  (same variables as those used to construct Chicago Fed's Financial Conditions Index, NFCI, as in Adrian, Boyarchenko and Giannone, 2019, *AER*)

  $\boldsymbol{X_2}$: Global financial variables, $N_2 = 208$ (Arregui et al.,2018, *WP*)

  $\boldsymbol{X_3}$: Local macroeconomic variables, $N_3 = 248$ (McCracken and Ng, 2016, *JBES*)

  $\boldsymbol{X_4}$: Global macroeconomic variables, $N_4 = 63$ (González-Rivera, Maldonado and Ruiz, 2019, *IJF*)

- Extraction of Factors based on **Multi-level Dynamic Factor Model** : 5 factor model selected

$$\begin{bmatrix} X_{2t} \\ X_{3t} \\ X_{4t} \end{bmatrix} = \begin{bmatrix} \lambda_{11} & \lambda_{12} & \lambda_{13} & 0 & 0 \\ \lambda_{21} & 0 & 0 & \lambda_{24} & 0 \\ \lambda_{31} & \lambda_{32} & 0 & 0 & \lambda_{35} \end{bmatrix} \begin{bmatrix} F_{1t} \\ F_{2t} \\ F_{3t} \\ F_{4t} \\ F_{5t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix}$$

F_{1t} is a pervasive factor that loads on all variables in the system
F_{2t} is a semi-pervasive factor that loads on world (global financial and macro) variables
F_{3t} (global financial), F_{4t} (local macro) and F_{5t} (global macro) are non-pervasive factors.

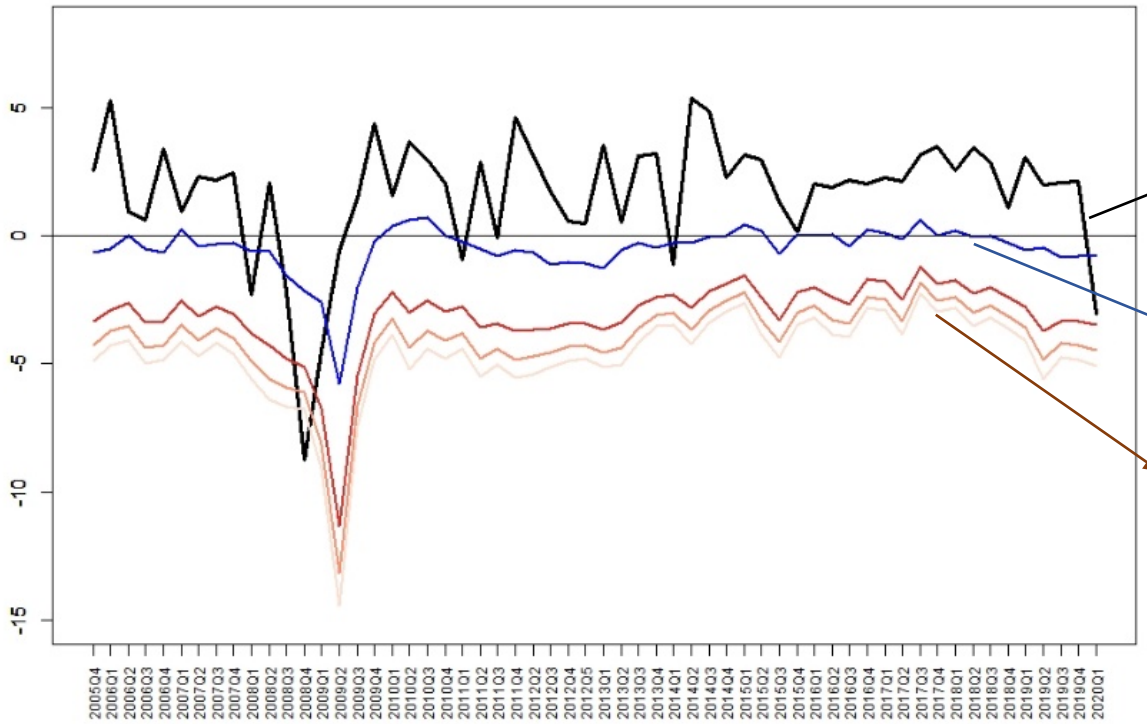
Note: The local financial factor extracted from $\boldsymbol{X_1}$, NFCI, is not relevant once all other variables are considered.

Factor-augmented Quantile Regression (one-step-ahead)

$$q_\tau(y_{t+1|t}) = \mu_\tau + \phi_\tau\, y_t + \sum_{i=1}^{5} \beta_{\tau,i} F_{it} + v_{\tau,t+1}$$

	$\tau = 0.05$	$\tau = 0.5$	$\tau = 0.95$
μ	**−2.62** (0.00)	**2.04** (0.00)	**4.33** (0.00)
ϕ	**0.15** (0.00)	−0.19 (0.37)	**−0.24** (0.01)
β_1	**0.68** (0.00)	0.45 (0.38)	**1.30** (0.00)
β_2	**2.19** (0.01)	−0.01 (0.99)	**0.62** (0.00)
β_3	**−1.20** (0.01)	**−0.87** (0.03)	**−1.06** (0.00)
β_4	**−1.21** (0.03)	0.48 (0.29)	0.23 (0.21)
β_5	**3.44** (0.00)	0.58 (0.19)	**−0.59** (0.00)
R^1	**0.49**	0.16	0.36

US Growth-in-Stress (GiS): Results



Observed quarterly growth

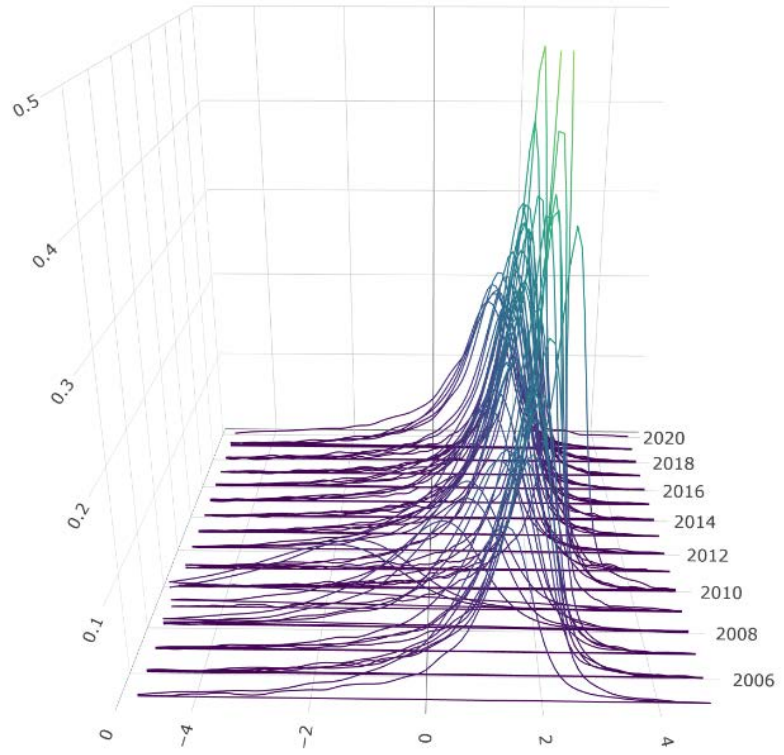
Growth-at-Risk (5%)

GiS (5%) with factors stressed at 70%, 95% and 99%

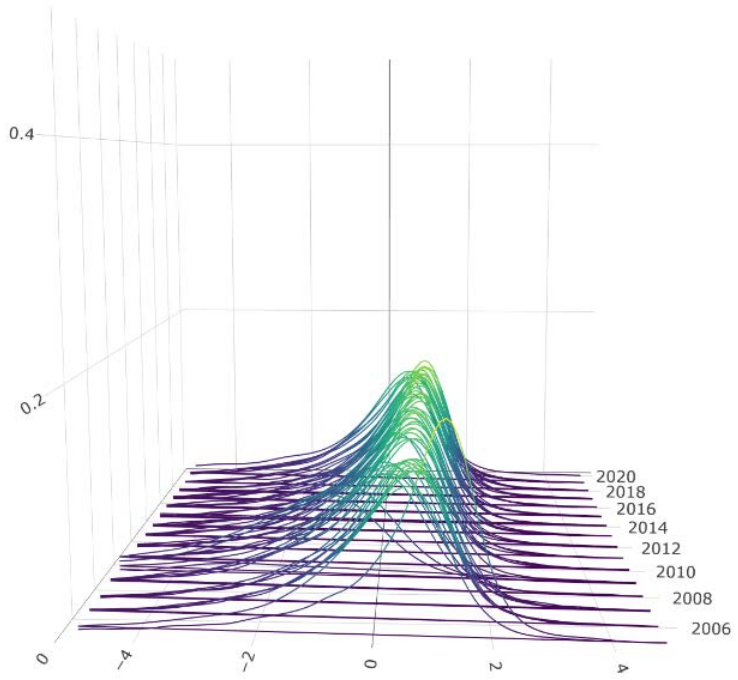
One-step-ahead GaR (5%) and GiS (5%) for 2020Q2 (-9.53%, IMF observed growth)	
GaR	-5.34
GiS 70%	-10.01
GiS 95%	-11.80
GiS 99%	-12.84

US Growth-in-Stress (GiS): Policy Tools

Growth densities (ML-DFM) with factors centered at their means



Growth densities (ML-DFM) with stressed factors at 95% level



By choosing different levels of stress, GiS helps policy makers to deal with the trade-off between building greater resilience in normal times and reducing downside risk in highly stressed periods.

Final Thought