Understanding Growth-at-Risk
A Markov-Switching Approach

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11th ECB Conference on Forecasting Techniques:
Macroeconomic Forecasting in Abnormal Times
June 15th, 2021

Motivation

- **Risk management** is an important consideration for policy decisions
  - Evans (2019): "a very important consideration in charting the course of monetary policy" in low r^* environment
  - Adrian *et al.* (2019): can reduce probability of a future financial crisis

- **Growth-at-Risk Modeling**:
  - Goal: Measure uncertainty and risks around forecast.
  - Key result: (Conditional) mean and volatility are negatively correlated.
    - High mean - Low volatility: Normal state
    - Low mean - High volatility: Large downside risks $\longrightarrow$ Growth-at-Risk!

Novelty of Approach

- **Standard approach** to measure risk: Quantile regressions (QR).
- **Our conjecture**: Markov-switching (MS) models should work well.
- **This paper**: Markov-Switching model of the entire distribution of future real GDP growth conditional on macroeconomic and financial indicators.
  - Transition probabilities depend on macroeconomic and financial conditions
  - Parsimonious model to capture features of "growth-at-risk"
- **Advantages of MS model**:
  - Explicit about GAR mechanism
  - Semi-structural interpretation $\rightarrow$ link to non-linear DSGE
  - Well-established parametric approach
  - Scenario analysis!

Novelty of Approach

A Markov-Switching Model of GAR

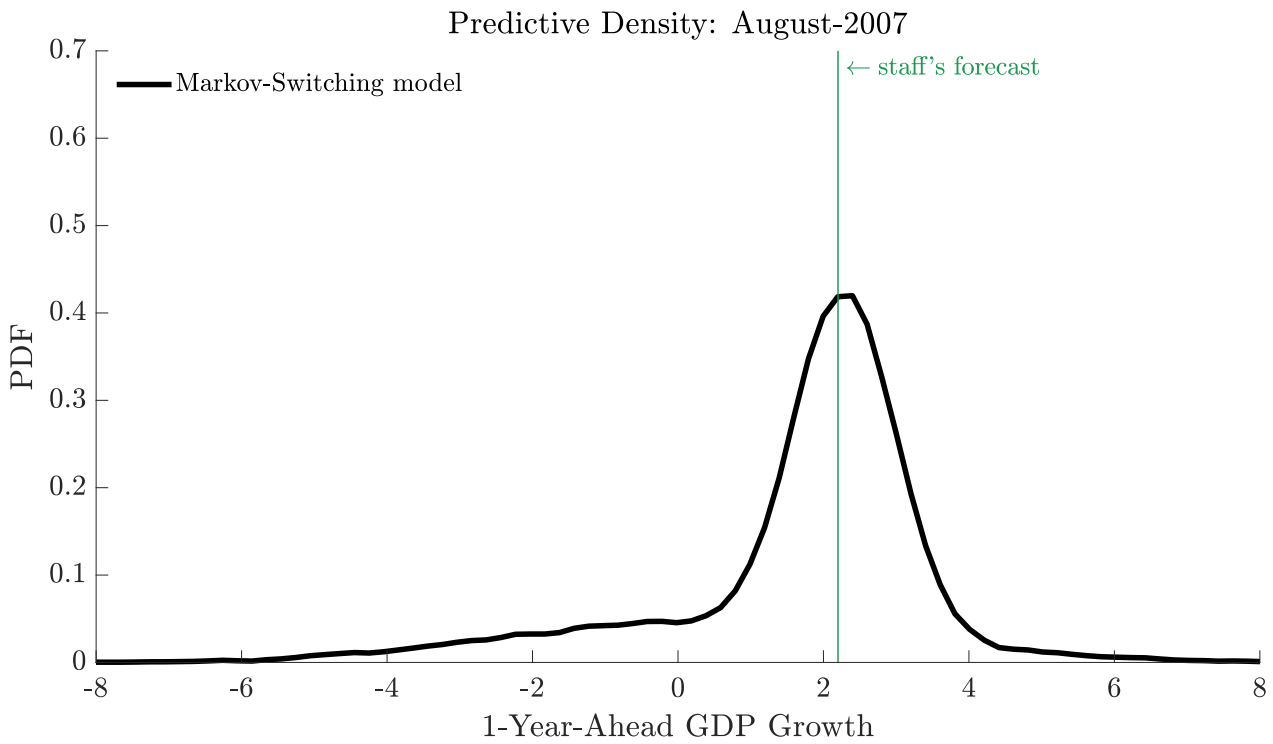
$$\underbrace{\bar{\Delta} y_{t+1,t+12}}_{\text{1-Year-Ahead Avg. Growth}} = \alpha_y(s_t) + \beta_y(s_t) f_t + \gamma_y(s_t) m_t + \sigma_y(s_t) \varepsilon_t^y$$

- f_t **and** m_t: financial and macroeconomic indicators from **DFM model**
- **Two regimes:** $s_t = 1$: Normal regime, $s_t = 2$: Bad regime
- **Three ingredients:**
  1. Regime specific mean and volatility
  2. Regime specific sensitivity to fundamentals
     - Akin to non-linear dynamics of DSGE models (Gertler *et al.*, 2019; Fernandez-Villaverde *et al.*, 2019; Aruoba *et al.*, 2020)
  3. Financial and macroeconomic conditions influence regime probabilities

An Illustration

"Financial market conditions have deteriorated, and tighter credit conditions and increased uncertainty have the potential to restrain economic growth going forward. In these circumstances, although recent data suggest that the economy has continued to expand at a moderate pace, the Federal Open Market Committee judges that the downside risks to growth have increased appreciably."

August 17, 2007 FOMC statement



- Optimistic forecast but concern about downside risk → MS model left tail

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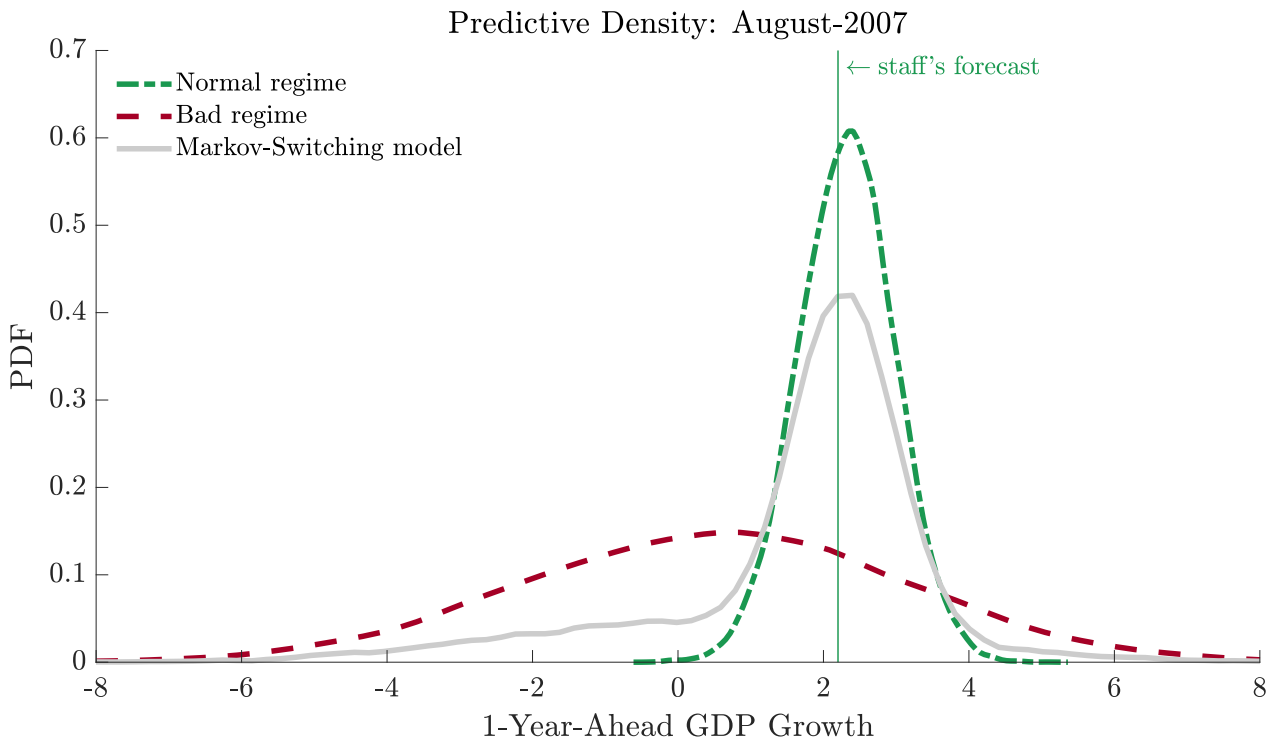


- MS model: endogenously weights on normal and bad regimes

First Key Result

Financial and Macro Conditions Both Affect Downside Risk

$$\bar{\Delta} y_{t+1,t+12} = \alpha_y(s_t) + \beta_y(s_t) f_t + \gamma_y(s_t) m_t + \sigma_y(s_t) \varepsilon_t^y$$

1. Negative correlation between mean and volatility

	Bad Regime		Normal Regime	
$\alpha_y(s_t)$	-0.94	[-1.26,-0.59]	0.60	[0.57, 0.63]
$\sigma_y(s_t)$	2.70	[2.48, 2.98]	0.66	[0.60, 0.72]

2. Asymmetry of sensitivity to fundamentals

	Bad Regime		Normal Regime	
$\beta_y(s_t)$	-0.27	[-0.47,-0.07]	-0.07	[-0.13,-0.01]
$\gamma_y(s_t)$	**0.65**	[0.36, 0.95]	**0.21**	[0.11, 0.31]

Note: Numbers in brackets represent 95% confidence intervals.

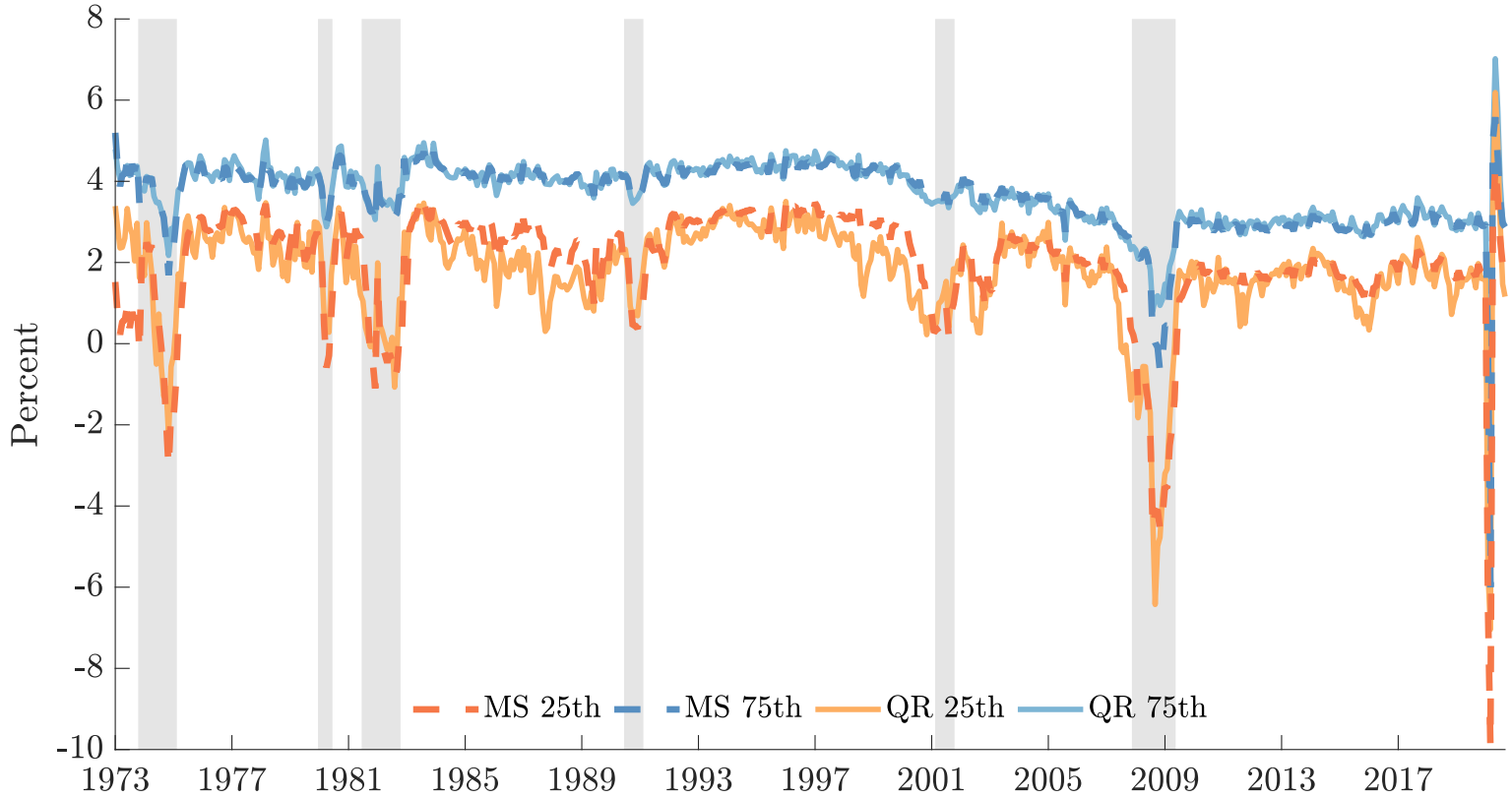
3. Asymmetry in regime transition probabilities

Second Key Result

MS and QR Both Capture Growth-at-Risk

- Follow QR framework of Adrian *et al.* (2019)

$$\widehat{\mathcal{Q}}_\tau(\bar{\Delta} y_{t+1,t+12}|x_t) \quad = \quad \hat{\alpha}_\tau + \hat{\beta}_\tau f_t + \hat{\gamma}_\tau m_t$$



- **MS and QR as complementary tools for risk assessment**

Thank You

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