Discussion of "Expecting the unexpected"

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Summary, focusing on methodology

Estimate G@R conditional on macro and financial factors

$$q_\alpha(y_{t+1}|\Omega_t) = \mu(\tau) + \phi(\tau)y_t + \beta_1(\tau)F_{1t} + \beta_2(\tau)F_{2t}$$

Question: How does G@R change when factors are under stress?

Answer: Use Growth in Stress (GiS)

$$\min q_\alpha(y_{t+1}|\Omega_t)$$
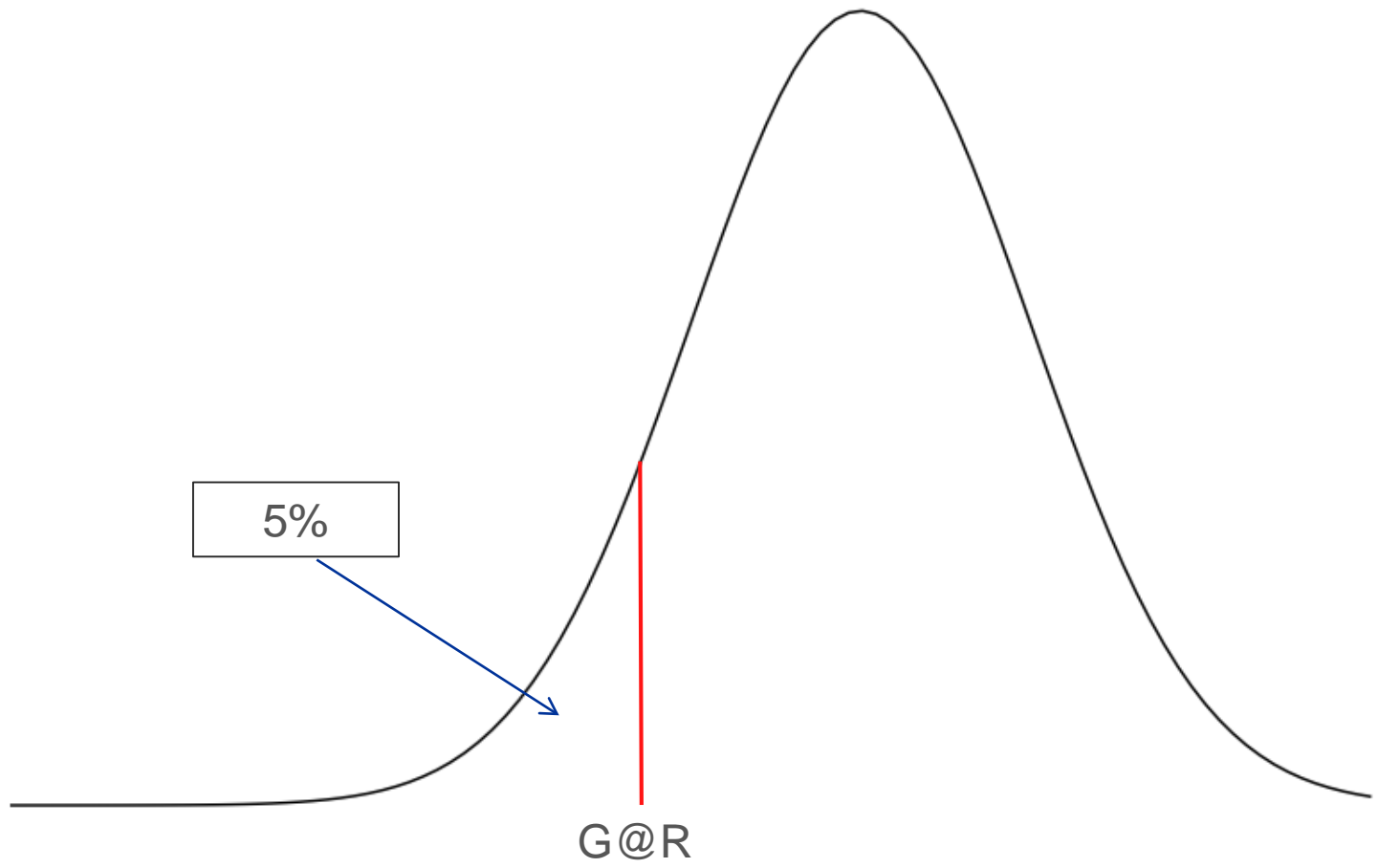$$g(F_{1t}, F_{2t}; \alpha) = 0$$

Methodological issues

1. Definition of multivariate quantile

2. Quantile factors

3. Identification

1. Definition of multivariate quantiles

Univariate definition

$$q_\tau(F_t) = \inf\{F_t : G(F_t) \geq \tau\} \qquad \tau \in (0,1)$$

The definition exploits the canonical ordering of the real line.

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G@R

1. Definition of multivariate quantiles

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The definition exploits the canonical ordering of the real line.

Multivariate definition

Problem: canonical ordering no longer exists for R^2 when $d \geq 2$

Figure 1: GaR and GiS.

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Multivariate definition

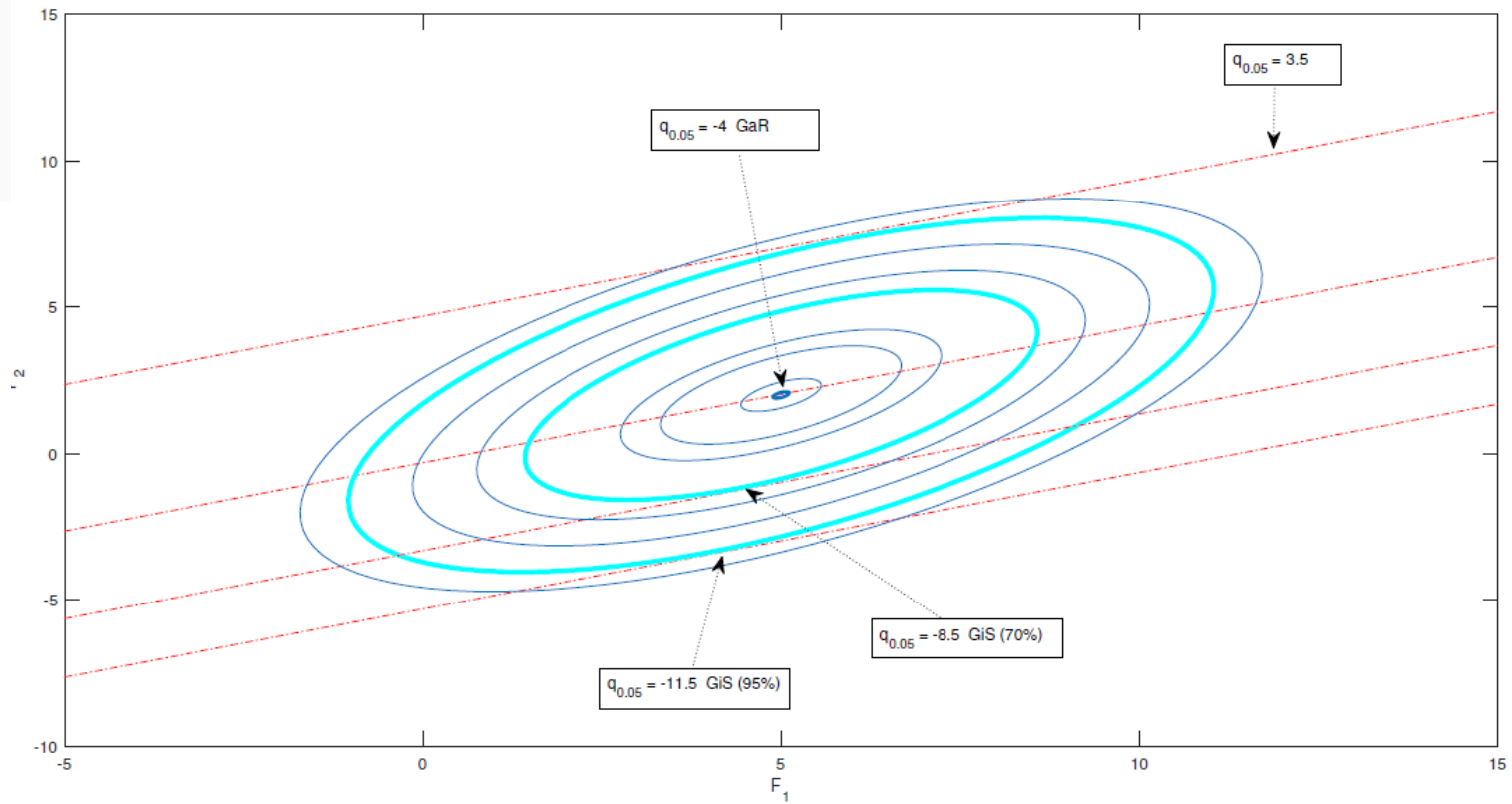Problem: canonical ordering no longer exists for R^2 when $d \geq 2$

-   Stratified quantile regression (Wei 2008)

-   Directional approaches (Hallin, Paindaveine and Siman 2010)

-   Optimal transport approach (Carlier, Chernozhukov, Galichon 2016)

See recent survey by Hallin and Siman in Handbook of Quantile Regression

2. Quantiles factor models

Chen, Dolado, Gonzalo (2021)

Suppose DGP is:

$$X_{it} = \beta_i F_{1t} + \eta_i F_{2t} \varepsilon_{it}$$

The α-quantile is:

$$q_\tau(X_{it}) = \beta_i F_{1t} + \eta_i F_{2t} q_\tau(\varepsilon_{it})$$

2. Quantiles factor models

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Principal component analysis would extract only location-shifting factor F_{1t}.

It cannot identify the scale factor F_{2t}.

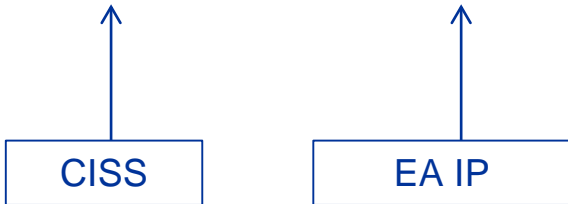**Financial factors are likely to affect both 1st and 2nd moments**

3. Quantile VAR

Chavleishvili and Manganelli (2019)

All variables are endogenous

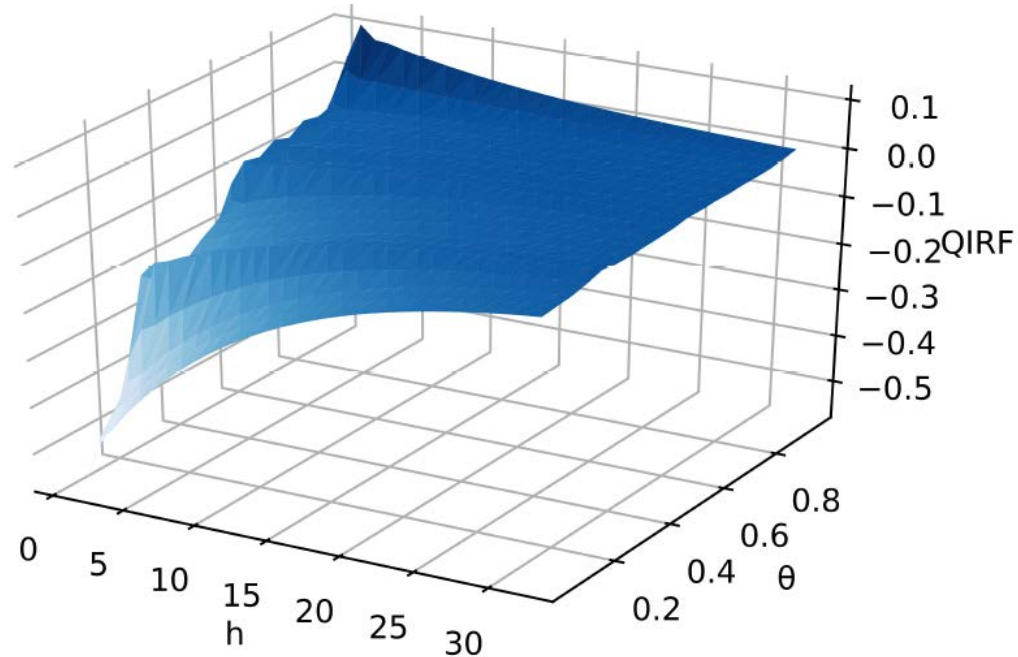To be able to shock the factors, you need identification assumptions

$$Y_{1,t+1} = \omega_1 \qquad\qquad\qquad + a_{11}Y_{1,t} + a_{12}Y_{2,t} + \varepsilon_{1,t+1}$$

$$Y_{2,t+1} = \omega_2 + a_0 Y_{1,t+1} + a_{21}Y_{1,t} + a_{22}Y_{2,t} + \varepsilon_{2,t+1}$$

CISS

EA IP

Quantile impulse response function for IP

Shock to CISS

Source: Chavleishvili and Manganelli (2019)

Conclusion

Punchline: G@R should be computed under situation of stress of the endogenous variables.

This represents a welcome contribution to the debate.

But:

- Mixing quantile and OLS techniques is not ideal.

- Combine recent quantile factor models with quantile VAR models.

References

G. Carlier, V. Chernozhukov, and A. Galichon. Vector quantile regression. Annals of Statistics, 44:1165-1192, 2016.

Chavleishvili and Manganelli (2019), "Forecasting and stress testing with quantile vector autoregression", Working Paper Series No 2330, European Central Bank.

Chavleishvili, Engle, Fahr, Kremer, Manganelli and Schwaab (2021), The risk management approach to macro-prudential policy, Working Paper Series No. 2565, European Central Bank.

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M. Hallin, D. Paindaveine, and M. Siman. Multivariate quantiles and multiple-output regression quantiles: From L1 optimization to halfspace depth (with discussion). Annals of Statistics, 38:635-669, 2010.

Y.Wei. An approach to multivariate covariate-dependent quantile contours with application to bivariate conditional growth charts. Journal of the American Statistical Association, 103:397-409, 2008.
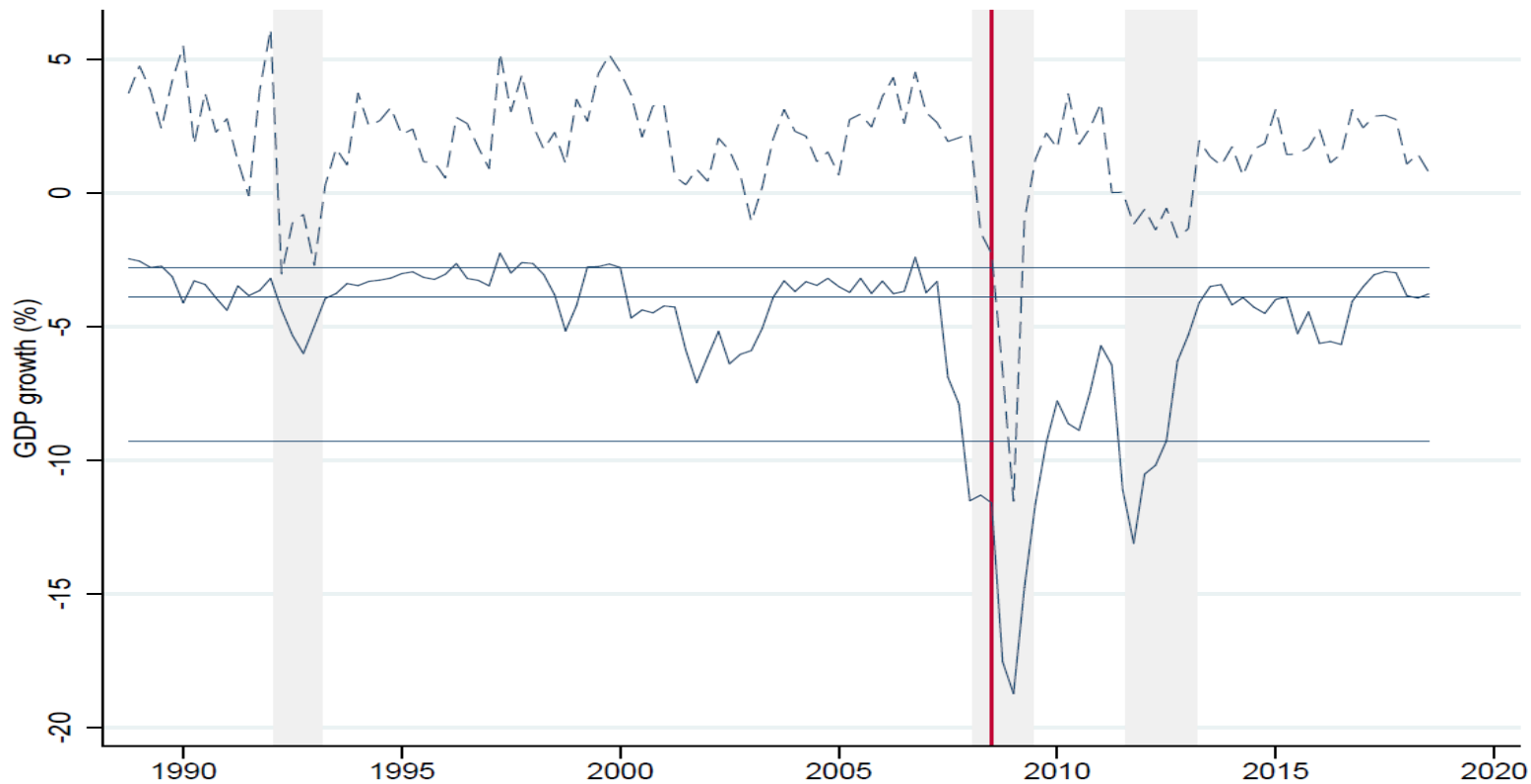
Annex

Stress testing with QVAR

$\tilde{Y}_{1,t+1}$ $\tilde{Y}_{2,t+1}$ $\tilde{Y}_{1,t+2}$ $\tilde{Y}_{2,t+2}$
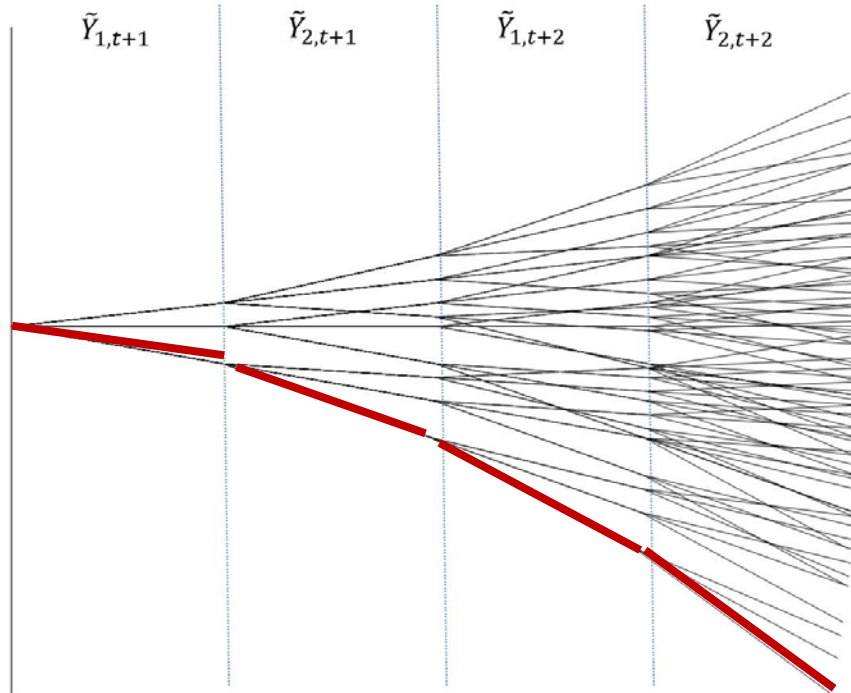
- Choose the quantile probabilities to match 2009 Q2 GDP contraction four quarters ahead
- Apply these quantile probabilities at each point in time

Vulnerability to GFC-sized shock

Source: Chavleishvili, Engle, Fahr, Kremer, Manganelli and Schwaab (2021)