BIS CCA-005-2010
May 2010

Discussant comments on
Macro stress testing of credit risk focused on the tails

Ricardo Schechtman and Wagner Piazza Gaglianone

Prepared for the BIS CCA Conference on

"Systemic risk, bank behaviour and regulation over the business cycle"

Buenos Aires, 18–19 March 2010

Discussant*: Simone Manganelli
Affiliation: European Central Bank
Email: simone.manganelli@ecb.europa.eu

* These comments reflect the views of the author and not necessarily those of the BIS or of central banks participating in the meeting.

Discussion of *“Macro stress testing of credit risk focused on the tails”* by Wagner Piazza Gaglianone and Ricardo Schechtman

Conference on “Systemic risk, bank behaviour and regulation over the business cycle”

18-19 March 2010, Buenos Aires

Simone Manganelli
DG-Research
European Central Bank

The paper

- Reduced form macro model (VAR):
  - GDP
  - Unemployment
  - Inflation
  - Interest rate
  - Credit volume
- Credit risk equation dependent on contemporaneous macro variables.
  - Credit risk proxied by non-performing loans (NPL).
- Stress testing based on bad macro scenario:
  - 1, 2, or 3 s.d. shocks to the macro forecasts of the VAR.
- Focus on quantiles of NPL:
  - Indirect: NPL is an additional equation of the VAR.
  - Direct: NPL is modelled via regression quantiles

The Model

$$\mathbf{y}_t = \boldsymbol{\mu} + \mathbf{A}_0 \mathbf{y}_t + \sum_{i=1}^{m} \mathbf{A}_i \mathbf{y}_{t-i} + \boldsymbol{\varepsilon}_t$$

$$\mathbf{y}_t \equiv \begin{bmatrix} \mathrm{NPL}_{\mathrm{t}} \\ \mathrm{GDP}_{\mathrm{t}} \end{bmatrix} \qquad \mathbf{A}_0 \equiv \begin{bmatrix} 0 & a \\ 0 & 0 \end{bmatrix}$$

$$\boldsymbol{\varepsilon}_t \sim \mathrm{N}(\mathbf{0}, \boldsymbol{\Sigma})$$

plus additional restrictions on $\mathbf{A}_i$, $i > 0$

Quantile estimation

Two strategies:

Indirect: Estimate previous model and obtain the quantiles from the parametric distribution of $\varepsilon_{1,t}$

Direct: Model first equation of previous model via regression quantile:

$$Q(NPL_t, \tau \mid \Omega_t, GDP_t) = \mu_1(\tau) + a(\tau)GDP_t + \\ + \sum_{i=1}^{m} [b_i(\tau)NPL_{t-i} + c_i(\tau)GDP_{t-i}]$$

Stress testing

- Assume bad realization for GDP at time T (1, 2, or 3 standard deviation shock).
- Look at the effect of this realization on the mean and quantile of NPL.
- Compare conditional (on bad realization of GDP at time T) and unconditional means and quantiles.

Comment 1: Structural VAR

$$\mathbf{y}_t = \boldsymbol{\mu} + \mathbf{A}_0 \mathbf{y}_t + \sum_{i=1}^{m} \mathbf{A}_i \mathbf{y}_{t-i} + \boldsymbol{\varepsilon}_t$$

Assume a diagonal variance-covariance matrix for $\boldsymbol{\varepsilon}_t$ and give a structural interpretation to the VAR:

Macro shocks contemporaneously affect the NPL but not vice versa.

$$\mathbf{y}_t = \Lambda \boldsymbol{\mu} + \Lambda \sum_{i=1}^{m} \mathbf{A}_i \mathbf{y}_{t-i} + \Lambda \boldsymbol{\varepsilon}_t$$

$\Lambda \equiv (\mathbf{I} - \mathbf{A}_0)^{-1}$ is upper triangular

Stress testing

$$1)\ E(y_{1,t} \mid \Omega_t, \varepsilon_{2,t}) - E(y_{1,t} \mid \Omega_t)$$

$$2)\ Q(y_{1,t}, \tau \mid \Omega_t, \varepsilon_{2,t}) - Q(y_{1,t}, \tau \mid \Omega_t)$$

$$3)\ \Pr[y_{1,t} < Q(y_{1,t}, \tau \mid \Omega_t) \mid \Omega_t, \varepsilon_{2,t}]$$

$$\hat{\tau} \quad \text{s.t.} \quad Q(y_{1,t}, \hat{\tau} \mid \Omega_t, \varepsilon_{2,t}) = Q(y_{1,t}, \tau \mid \Omega_t)$$

Comment 2: Quantile Simulation

$$y_{1,t} = Q(y_{1,t}, \tau \mid \Omega_t, \varepsilon_{2,t}) + \tilde{\varepsilon}_{1,t} \quad \text{where} \quad Q(\tilde{\varepsilon}_{1,t}, \tau \mid \Omega_t, \varepsilon_{2,t}) = 0$$

$$Q(y_{1,t}, \tau \mid \Omega_t, \varepsilon_{2,t}) = \alpha_0(\tau) + \sum_{i=0}^{p} \alpha_i(\tau) y_{t-i} + \sum_{j=1}^{m} \gamma_j(\tau) z_{t-j}$$

For instance you could assume:

$$\tilde{\varepsilon}_{1,t} \sim N(-k_\tau \sigma, \sigma) \quad \text{where } k_\tau \text{ is the } \tau\text{-quantile of the normal distribution}$$

$$\begin{aligned} \Pr(\tilde{\varepsilon}_{1,t} < 0) &= \Pr(\tilde{\varepsilon}_{1,t} + k_\tau \sigma < k_\tau \sigma) \\ &= \Pr[(\tilde{\varepsilon}_{1,t} + k_\tau \sigma)/\sigma < k_\tau] = \tau \end{aligned}$$

If you don't like the normality assumption, you could use the skewed Laplace distribution.

Comment 3: Uncertainty

- Careful about the impact on risk measurement of:
  - Model misspecification
    - After the summer 2007 turmoil Goldman Sachs admitted that its models suggested their portfolios were hit by a 25 standard deviation shock.
    - This is an event that occurs once every 10^{138} times…
    - What was the shock implied by GS models after September 2008?
  - Estimation error (DeMiguel et al., RFS 2009)
    - Show that no estimated mean-variance model can consistently outperform an equally weighted portfolio.
    - Exercise limited to 20 assets.
    - Typical portfolio of a bank includes many more assets.
    - Attempt to model joint macro and credit risks may suffer of similar problems.
- Rules of thumb may be not too bad after all.

Comment 4: The Decision Problem

- What is the assessment? Did banks have enough capital to face the worst case scenario?
- What is the decision variable? Given your macro stress test exercise, how much capital buffer would you recommend?
- To answer this question you need first to introduce into the model:
  - Decision variable
  - Objective function
- Impulse-responses with two instruments:
  - Interest rate
  - Macro-prudential tool
- Tightening the macro-prudential tool would reduce credit risk, but what about its impact on GDP? Need to define the optimal trade-off.
- The endogeneity of the decision variables adds complexity.