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Prudential regulation: is there a danger in reducing the volatility?

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Regulatory risk

- In the literature: multiple definitions
- 2014 research report of Risk Management sections of CAS, CIA and SOA:
  - Exposure to the financial loss arising from the probability that regulatory agencies will make changes in the current rules (or will impose new rules)
  - Inability to predict a regulatory outcome
- More generally, the notion of 'regulatory risk' refers to two main strands of thought:
  - Potential and actual challenges faced by insurers and regulators under a supervisory regime arising from changes of regulation
  - The **unintended results of regulations that put at risk** the ability of policyholders, shareholders or regulators to achieve their legal or fiduciary objective

Objective and methodology

- Aim of the paper
  - To explore, evidence and document the second meaning of regulatory risk: ‘unintended results’ (negative spillover of regulation)
- Terminology used in the paper
  - To isolate this specific risk and to distinguish it from the first, we use the term ‘regulation risk’
    - Possibility that prudential regulations may have the inverse effect of amplifying risk
- New approach of the paper
  - To use social sciences to highlight actuarial issues
    - Not ‘either… or’, but balanced

Outline

- Conventionalist approach of regulation risk
- Conventionalist cartoon model of regulation risk
- Empirical evidence and results

A conventionalist approach

- Main idea: two-sided approach
  - **Connection between quantification conventions and regulation frameworks** (Chiapello 2014, Desrosières 2003)
    - Actuarial issue: choice of models to quantify risk
    - Regulation issue: choice of rules to manage risk
- Quantification convention
  - A configuration of coherent set of operations **both cognitive and normative**
    - Selection of the items to take into account
    - Selection of relevant judgment criteria
    - Choice of mathematical schemas
- Comprehensive Actuarial Risk Evaluation (CARE) 2010 report
  - 'The use of mathematical models to quantify risk can be like looking for lost keys under the nearest lamp post'
  - The warning of CARE report revisited in the light of **conventionalist approach of models**
  - To go beyond the metaphor: lamp post as a quantification convention

Quantification convention: a closer look

- Three dimensions
- Epistemic (WHAT)
  - A set of assumptions regarding uncertainty
    - Selection of relevant predictive factors drawn from today's world used to construct a decision
    - Selection of **what is true**
- Pragmatic (HOW)
  - Makes certain actions possible
    - Trading, arbitraging, managing risk: **how it works**
- Political (WHO)
  - Authorizes specific actors
    - Not the same for each convention: **who is right**
    - Enables the growth of certain practices
    - Reconfiguration of certain professions

The epistemic issue

- Epistemic idea: the ‘financial reality’?
  - Financial ‘data’
    - Empirical basis obtained after choices
  - Representations of financial theory
    - Conceptual frameworks behind the actors
  - Conceptualizations of the regulator
    - Conceptual frameworks above the actors
  - Joint to co-construct a financial ‘reality’
- Epistemic consequence
  - Statistics must be conceived as simultaneously **conventional** and **real** (Desrosières 2009)

Two quantification conventions

- Two views of uncertainty in finance
  - One assumes the **principle of continuity**
  - The other does not
  - Two roots of a quantification convention
  - Two routes for a quantification convention
- The first view: quantification convention 1
  - Continuous diffusion processes
  - Example: Brownian motion
  - Origin in finance: Bachelier (1900)
- The second view : quantification convention 2
  - Discontinuous stochastic processes
  - Example: Lévy processes
  - Origin in finance: Mandelbrot (1963)

Risk metrology and QC1

- Quantification convention 1: continuity
  - **Principle of continuity: "*natura non facit saltus*"**
    - Leibniz, Newton: 'nature does not make jumps'
    - Change in nature is continuous rather discrete
    - Underpinned the works of Linnaeus and Darwin's theory of evolution (1859)
    - Critical assumption in:
      - Marshall's *Principles of economics* (1890)
      - Option theory and derivatives (Black, Scholes, Merton: 1973)
      - Arbitrage and asset pricing theory (Ross, Harrison, Kreps, Pliska: 1976-1981)
  - Single dimension of risk: volatility risk
    - Summarizes the risk in a Brownian universe
    - Provides all the relevant information to assess risk

The three aspects of QC1

- **Epistemic dimension**
  - Principle of continuity adopted in academic circles
  - Brownian representation in finance curricula
  - Most statistical descriptions of time series assume(d) continuity
- **Pragmatic dimension**
  - Principle of continuity adopted by professionals
  - Dominant view in the financial industry
  - Many popular financial techniques (e.g. portfolio insurance) assume(d) continuity
- **Political dimension**
  - Principle of continuity adopted in policymaking
  - Underlies prudential regulation
  - Square-root-of-time-rule: Bale III, Solvency II

Problems with QC1

- Large sudden variations
  - Well documented phenomenon
- QC1 response: isolation of large jumps
  - Focus on the most important variations
  - Splitting the market regimes
    - Discontinuities occurred only at large scales
    - Two market regimes: large scales small scales
  - First response of academics: EVT (large scales)
  - First response of regulators: internal models
- QC1 dead-end: discontinuities as ‘surprise’
  - Greenspan: “we will never be able to anticipate discontinuities in financial markets” (FT, March 16, 2008)
    - Two regimes: ‘smooth’ and ‘rough’
    - Behavioural conclusions: ‘rational’ and ‘irrational’ agents
    - Ethical flaws: the ‘good’ and the ‘bad’ behaviour (Walter 2009)

Risk metrology and QC2

- Quantification convention 2: discontinuity
  - Discontinuities remain at small scales
    - General property of stock paths
      - Not only a consequence of liquidity crises
    - Do not separate large and small variations
    - Do not split the market regimes
    - Do not cleave the agent behaviour
    - See small scales with micro-discontinuities (micro-crashes)
  - Financial large scale risk management
    - Analysing discontinuities at small scales (Le Courtois, Walter 2014)
      - Understanding the fragility of markets
    - Extrapolating from small discontinuities
  - Changes are due to two factors
    - Scale parameter of discontinuities : local volatility
    - Shape parameter of discontinuities : local intensity of jumps
    - Ignoring the shape parameter: the ‘nearest lamp post’ syndrome (CARE report)

A conventionalist cartoon model

- The regulator adopts quantification convention 1
  - Regulator's objective: decrease volatility
  - Regulator's constraint: VaR level
  - Risk metrology: VaR
- The market is driven by an infinite activity process (infinite number of discontinuities) relevant for QC2
  - Our aim: not to determine the most adequate model but to evidence the impact of the discontinuities
  - Simplest class of infinite activity 'pure jumps' processes: stable motion
    - Most jumps are small
    - Few jumps are large
    - Same mechanism for the two sizes
  - More complex models could be considered (e.g. CGMY, generalised hyperbolic etc.)

An infinite activity process with QC2: stable motion

Let us recall that a stable motion is an independent and stationary increments process whose increments follow an $\alpha-$stable law. Such a law has characteristic function:

$$\varphi(u) = \begin{cases} \exp\left\{i\mu u - \sigma^{\alpha}|u|^{\alpha}\left[1 - i\beta \text{sign}(u)\tan\left(\frac{\alpha\pi}{2}\right)\right]\right\} & \text{if } \alpha \neq 1 \\ \exp\left\{i\mu u - \sigma|u|\left[1 + i\beta \text{sign}(u)\frac{2}{\pi}\ln(u)\right]\right\} & \text{if } \alpha = 1 \end{cases}$$

The stable parameters in the QC2 view

A stable motion is defined by four parameters:

1. $\alpha \in (0, 2]$. When $\alpha < 2$, it quantifies the distribution of the size of jumps: during a given period, and for all integer j, the mean number of jumps with size of the order of 2^j is proportional to $2^{-j\alpha}$. As a consequence, a large α corresponds to a small jump intensity, and vice versa.
2. $\sigma > 0$ is a scale parameter: if the process is multiplied by $a > 0$, then σ turns to $a\sigma$. In the Gaussian case, *i.e.* $\alpha = 2$, the variance is equal to $2\sigma^2$. This means that σ governs volatility.
3. μ is a location parameter: if one adds a to the process, then μ becomes $\mu + a$.
4. β ranges in $[-1, 1]$ and is a symmetry parameter. When $\beta = 0$, the distribution of increments is symmetric around μ.

Empirical study of the S&P500 with QC2

We consider in our work the parameters α and σ, which respectively account for the jump intensity and the volatility.

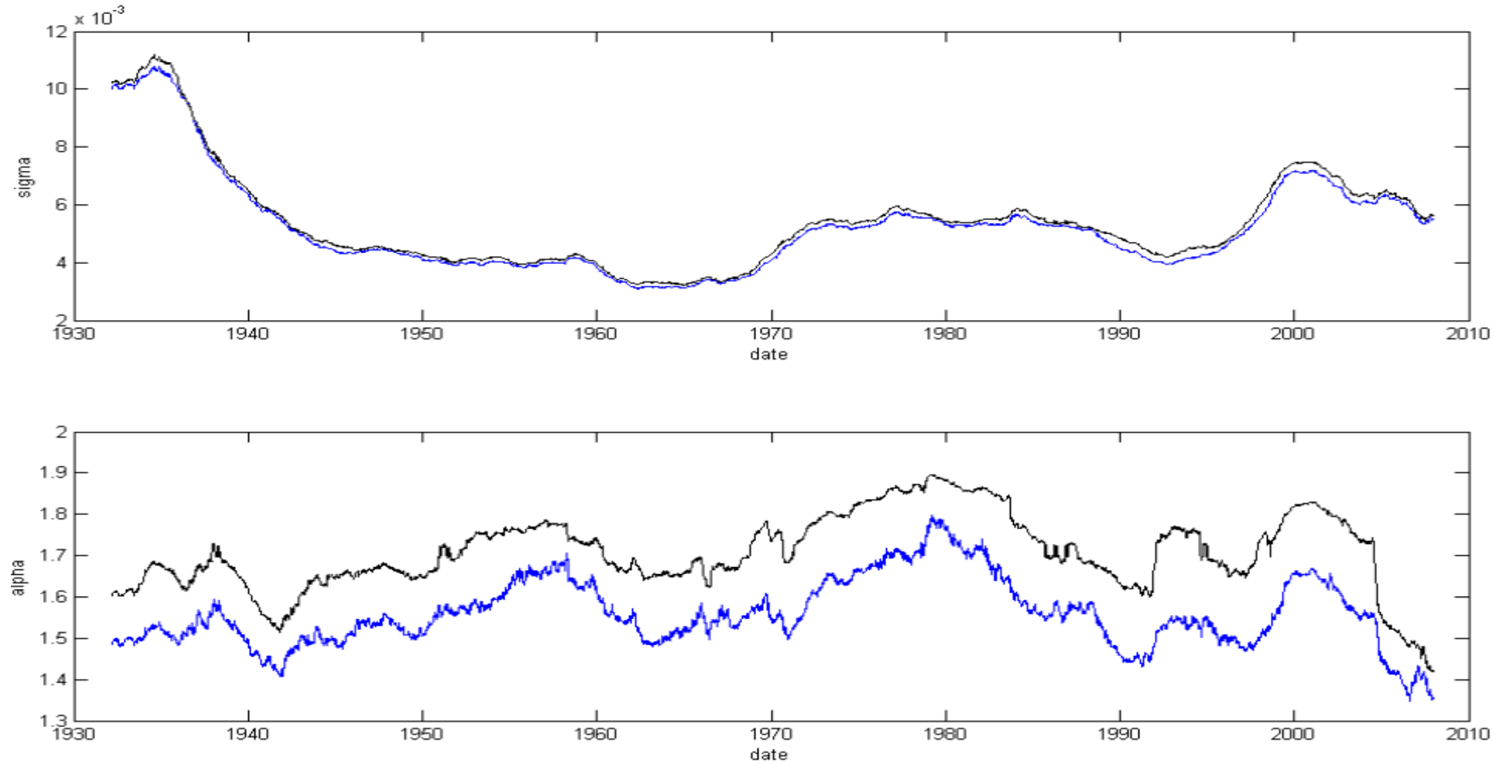
There is no reason to believe that they remain constant in time. We thus consider local versions $\alpha(t)$ et $\sigma(t)$.

We estimate α and σ on daily quotes of the S&P 500 between 01/03/1928 and 02/01/2012.

We used two classical estimation methods: the Kotrouvelis and Mc Culloch ones.

Each value of α and σ is estimated using a centred moving window containing 2000 points.

Empirical study of the S&P500 with QC2



Compared evolution of local volatilities (up) and local jump intensities (bottom), with Mac Culloch and Kotrouvelis methods on daily quotes of the S&P 500 between 01/03/1928 and 02/01/2012. Values estimated with a centred moving window of 2000 points.

Empirical study of the S&P500 with QC2

Both methods yield very similar results for σ. Estimations of α are a little bit more different. However, both estimations in this case give almost parallel curves: this is sufficient for us, as our aim is to compare the evolutions of σ and α.

Since 1960 or so, jump intensity and volatility evolve in an opposite way: when σ increases, the jump intensity decreases (since α increases) and vice versa: when the market is less "nervous", it is more prone to large jumps.

Evolution of recent years conforms that volatility has significantly decreased at the expanse of a notable increase of the local jump intensity.

Risk measures of the regulator with QC1

We consider two risk measures put forward by the regulator.

VaR (*Value at Risk*) at confidence level $1-p$ and horizon T, which is the quantity such that the probability that losses at horizon T are larger than VaR is p:

$$\mathbb{P}(X_T < -\text{VaR}) = 1 - p.$$

TCE (*Tail Conditional Expectation*) at confidence level $1-p$ and horizon T, which is defined as:

$$\text{TCE} = \mathbb{E}\left(X_T \mid X_T < -\text{VaR}\right).$$

Risk measures from QC1 in QC2 view

Under the assumption that prices follow a stable motion with $\beta = 0$, the asymptotic behaviour of VaR is given by:

$$\text{VaR} \simeq \sigma \left(\frac{C_\alpha}{2(1-p)} \right)^{\frac{1}{\alpha}}, \quad \text{where} \quad C_\alpha = \frac{1-\alpha}{\Gamma(2-\alpha)\cos(\pi\alpha/2)}.$$

This implies that VaR increases linearly with volatility. One can show that it also decreases when α increases. This does correspond to intuition : a larger jump intensity translates into a larger VaR, and thus a more risky market.

QC1 regulator constraint in QC2 world

As for TCE, and under the assumption $\alpha > 1$, the asymptotic behaviour is given by:

$$\mathrm{TCE} \simeq \frac{\alpha}{\alpha - 1}\mathrm{VaR}.$$

As a consequence, in a situation where σ decreases while the jump intensity increases (that is, α decreases), which is what we have observed empirically, then, under a constant VaR, TCE will increase.

For instance, if α moves from 1.75 to 1.4 (as measured on the S&P 500), then, if VaR remains constant, TCE is multiplied by 1.5. This means that a constraint on the VaR has a negative impact.

Negative spillover of QC1 regulation with QC2 market

We then see how model risk and regulation risk combine to create a market risk:

The model that is implicit in prudential regulation reduces variations to the sole volatility parameter, while a more adequate model should also consider the independent contribution of jumps.

Regulation risk consists in imposing a VaR constraint: because jumps are ignored, keeping VaR constant increases TCE, and thus market risk.

Results

- Regulation approach is challenged
  - Bad shaping of business practices can provoke negative spillover
  - Bad shaping comes from an dangerous representation of uncertainty
  - This representation is embedded in a quantification convention
  - Regulation risk is revealed with a conventionalist approach
- Model risk issue is revisited
  - Not only a discrepancy between the model and the 'financial reality'
  - The reflexive effect of model: co-construct the 'financial reality'
- Need to consider what should be done with this
  - We suggest that the effect evidenced here is a special case of class of regulation risks that remains to be explored

Conclusion

- Prudential regulation: is there a danger in reducing the volatility?
  - YES