Risk Appetite and Endogenous Risk

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Large Market Movements

1. Occasional extreme movements accompanied with big chunks of fresh information
2. Other seemingly unrelated or exaggerated movements, especially during *"crises episodes,"* are attributed by observers and the press to
   - the herd mentality of the financial market participants, or to
   - the fickleness and irrationality of speculators who seemingly switch between fear and overconfidence in a purely random fashion, and whose fear feeds on itself in a contagious fashion.


The Economist
NOVEMBER 1ST - 7TH 1997
CAMBODIA'S MISERY
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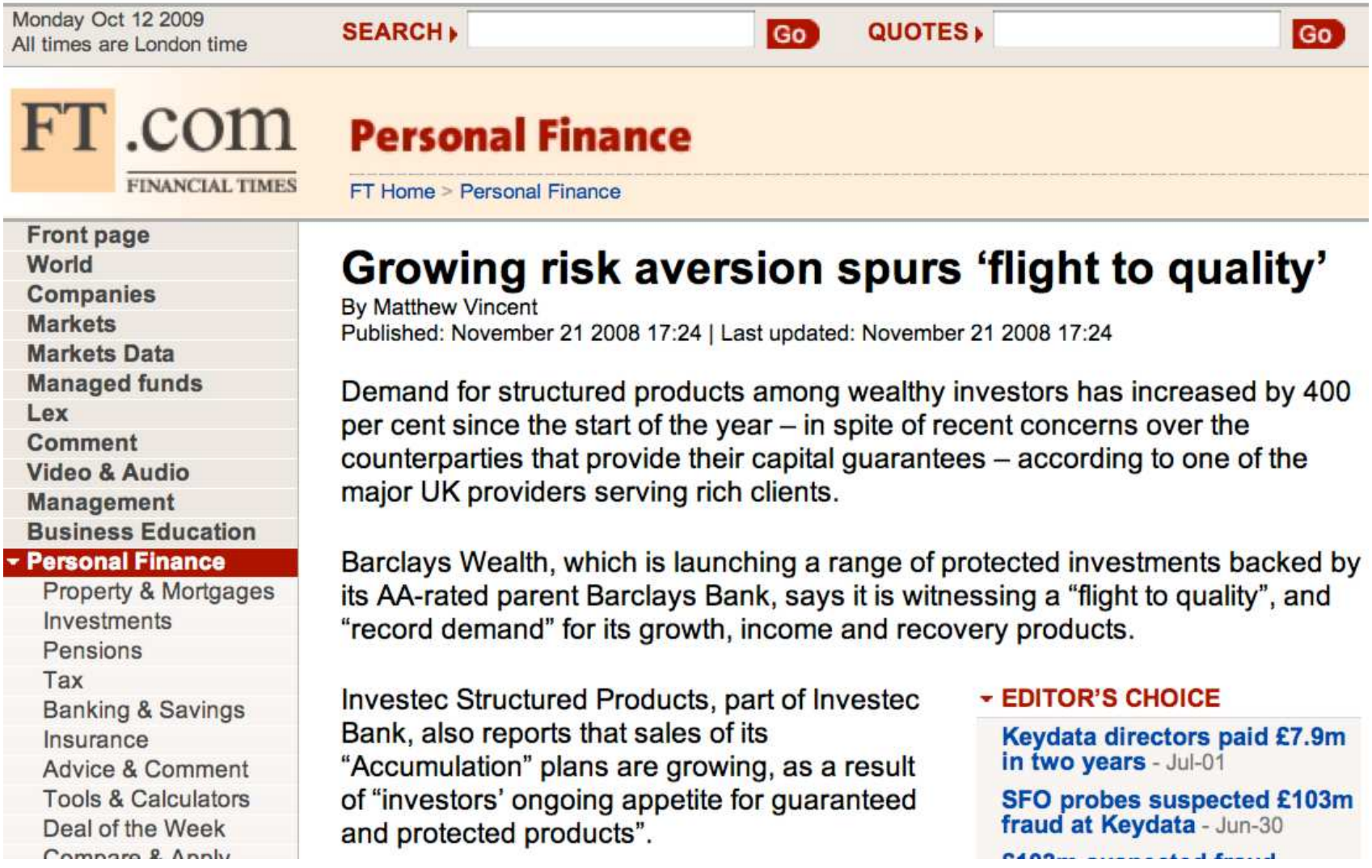
A week on the wild side
I'VE GOT A STOCK HERE THAT COULD REALLY EXCEL
REALLY EXCEL?
EXCEL?
SELL?
SELL?
SELL
SELL!
SELL!
SELL!
SELL!
SELL!
THIS IS MADNESS! I CAN'T TAKE ANYMORE
GOOD BYE!
GOOD BYE?
Bye?
Buy?
BUY!
Buy!
BUY!!
Buy!
Buy!
I'VE GOT A STOCK HERE..



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Growing risk aversion spurs 'flight to quality'

By Matthew Vincent
Published: November 21 2008 17:24 | Last updated: November 21 2008 17:24

Demand for structured products among wealthy investors has increased by 400 per cent since the start of the year – in spite of recent concerns over the counterparties that provide their capital guarantees – according to one of the major UK providers serving rich clients.

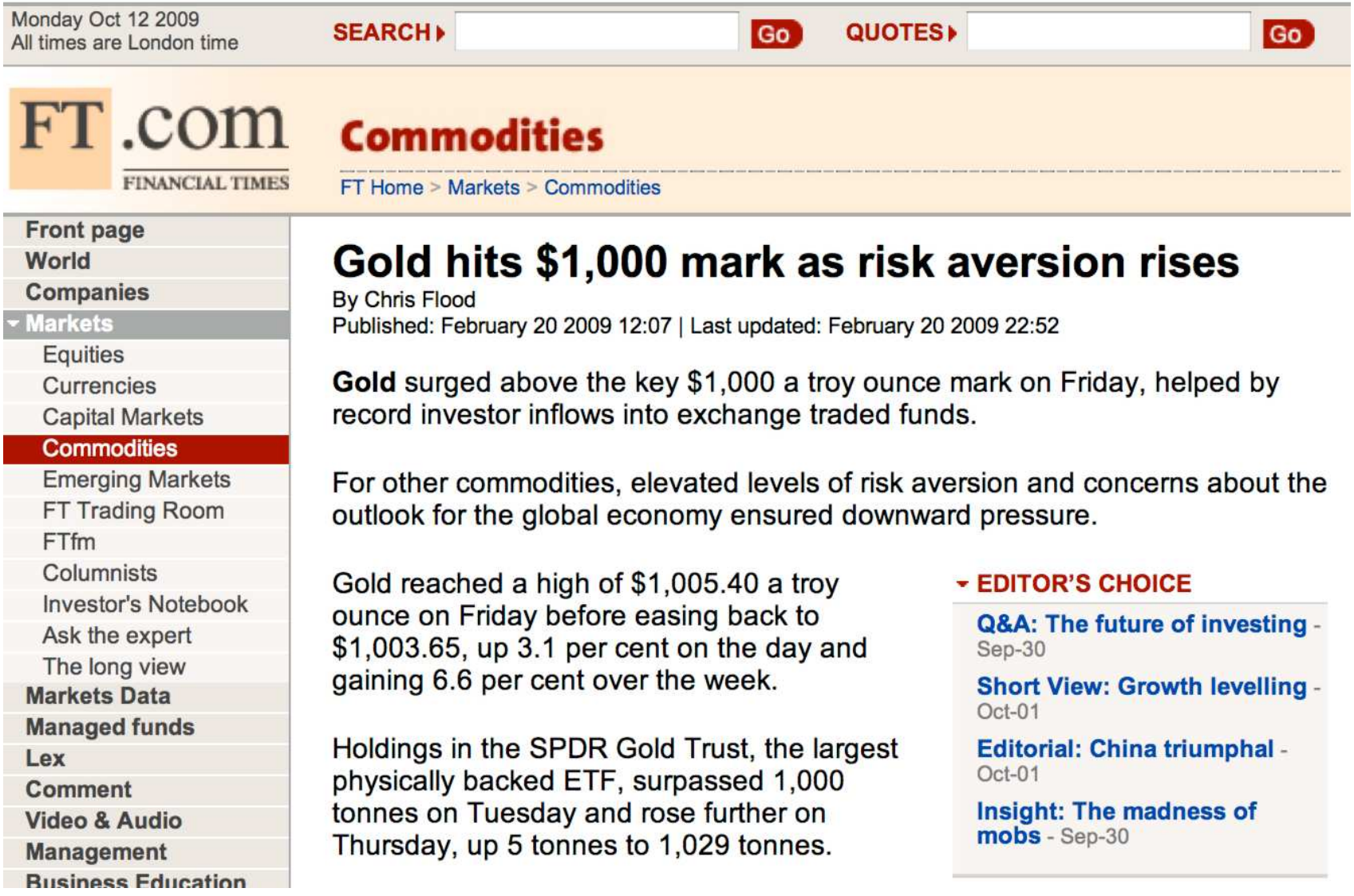
Barclays Wealth, which is launching a range of protected investments backed by its AA-rated parent Barclays Bank, says it is witnessing a "flight to quality", and "record demand" for its growth, income and recovery products.

Investec Structured Products, part of Investec Bank, also reports that sales of its "Accumulation" plans are growing, as a result of "investors' ongoing appetite for guaranteed and protected products".

EDITOR'S CHOICE

Keydata directors paid £7.9m in two years - Jul-01

SFO probes suspected £103m fraud at Keydata - Jun-30



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Gold hits $1,000 mark as risk aversion rises

By Chris Flood
Published: February 20 2009 12:07 | Last updated: February 20 2009 22:52

Gold surged above the key $1,000 a troy ounce mark on Friday, helped by record investor inflows into exchange traded funds.

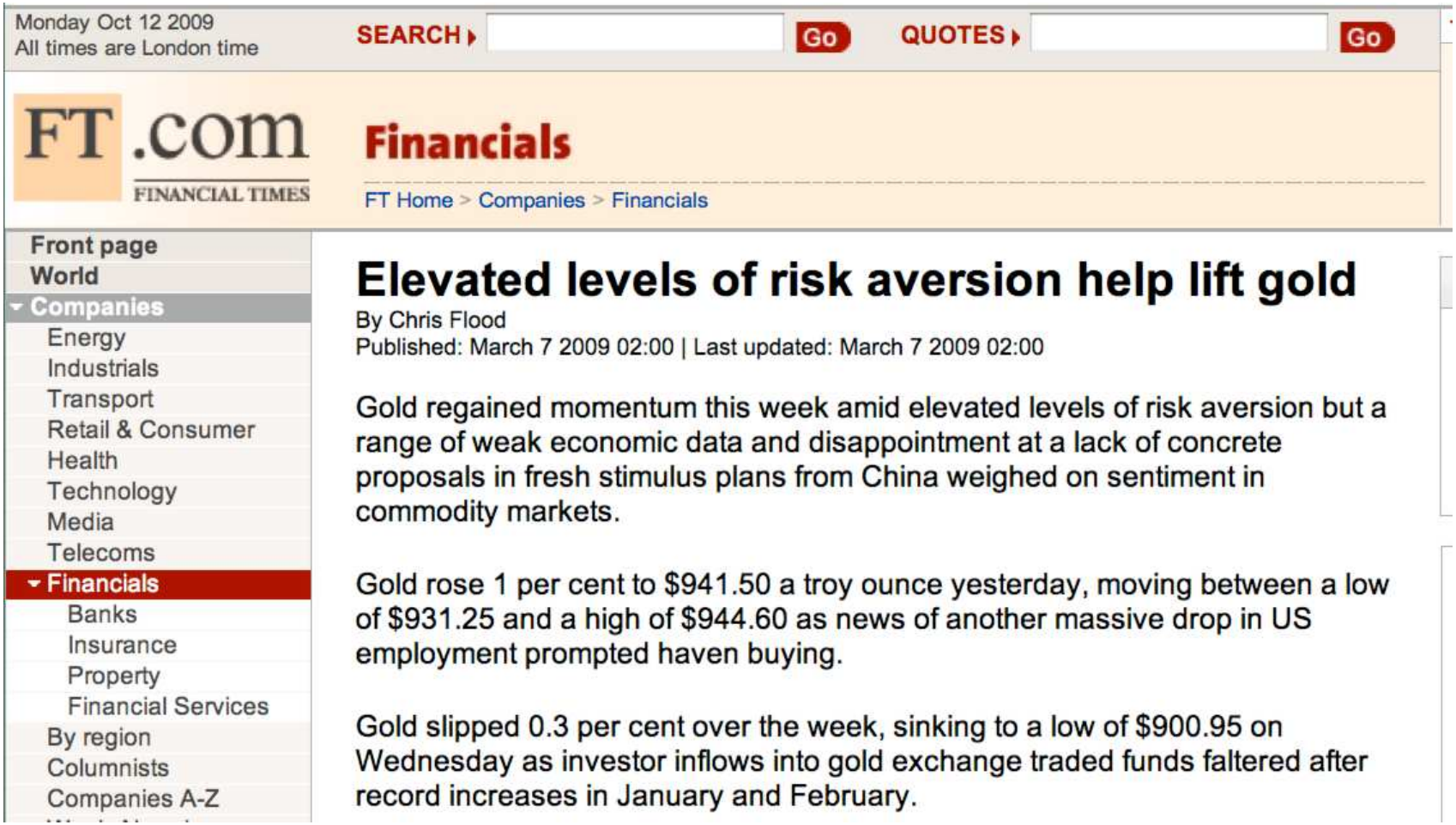
For other commodities, elevated levels of risk aversion and concerns about the outlook for the global economy ensured downward pressure.

Gold reached a high of $1,005.40 a troy ounce on Friday before easing back to $1,003.65, up 3.1 per cent on the day and gaining 6.6 per cent over the week.

Holdings in the SPDR Gold Trust, the largest physically backed ETF, surpassed 1,000 tonnes on Tuesday and rose further on Thursday, up 5 tonnes to 1,029 tonnes.

EDITOR'S CHOICE

- **Q&A: The future of investing** - Sep-30
- **Short View: Growth levelling** - Oct-01
- **Editorial: China triumphal** - Oct-01
- **Insight: The madness of mobs** - Sep-30



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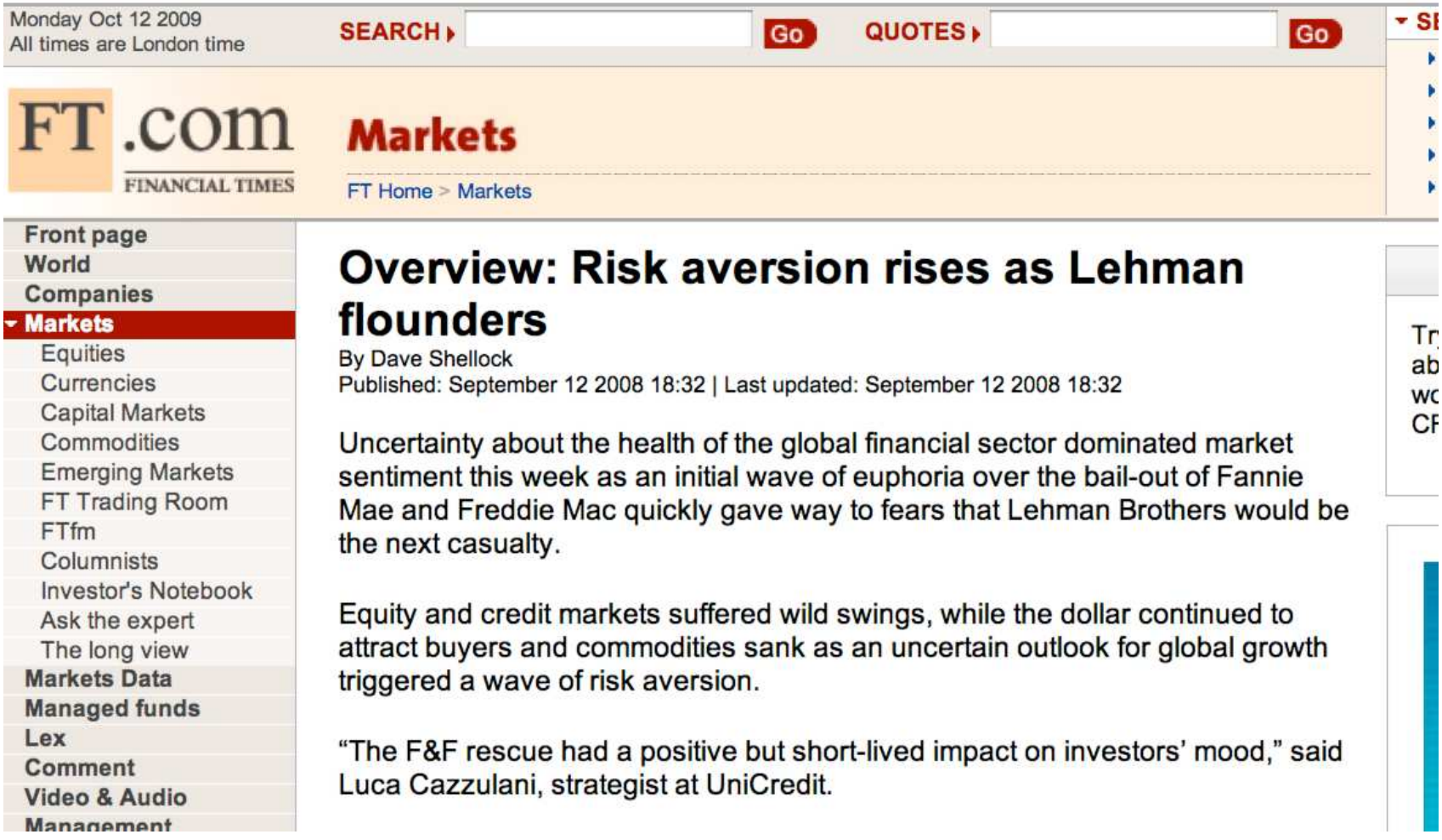
Elevated levels of risk aversion help lift gold

By Chris Flood
Published: March 7 2009 02:00 | Last updated: March 7 2009 02:00

Gold regained momentum this week amid elevated levels of risk aversion but a range of weak economic data and disappointment at a lack of concrete proposals in fresh stimulus plans from China weighed on sentiment in commodity markets.

Gold rose 1 per cent to $941.50 a troy ounce yesterday, moving between a low of $931.25 and a high of $944.60 as news of another massive drop in US employment prompted haven buying.

Gold slipped 0.3 per cent over the week, sinking to a low of $900.95 on Wednesday as investor inflows into gold exchange traded funds faltered after record increases in January and February.



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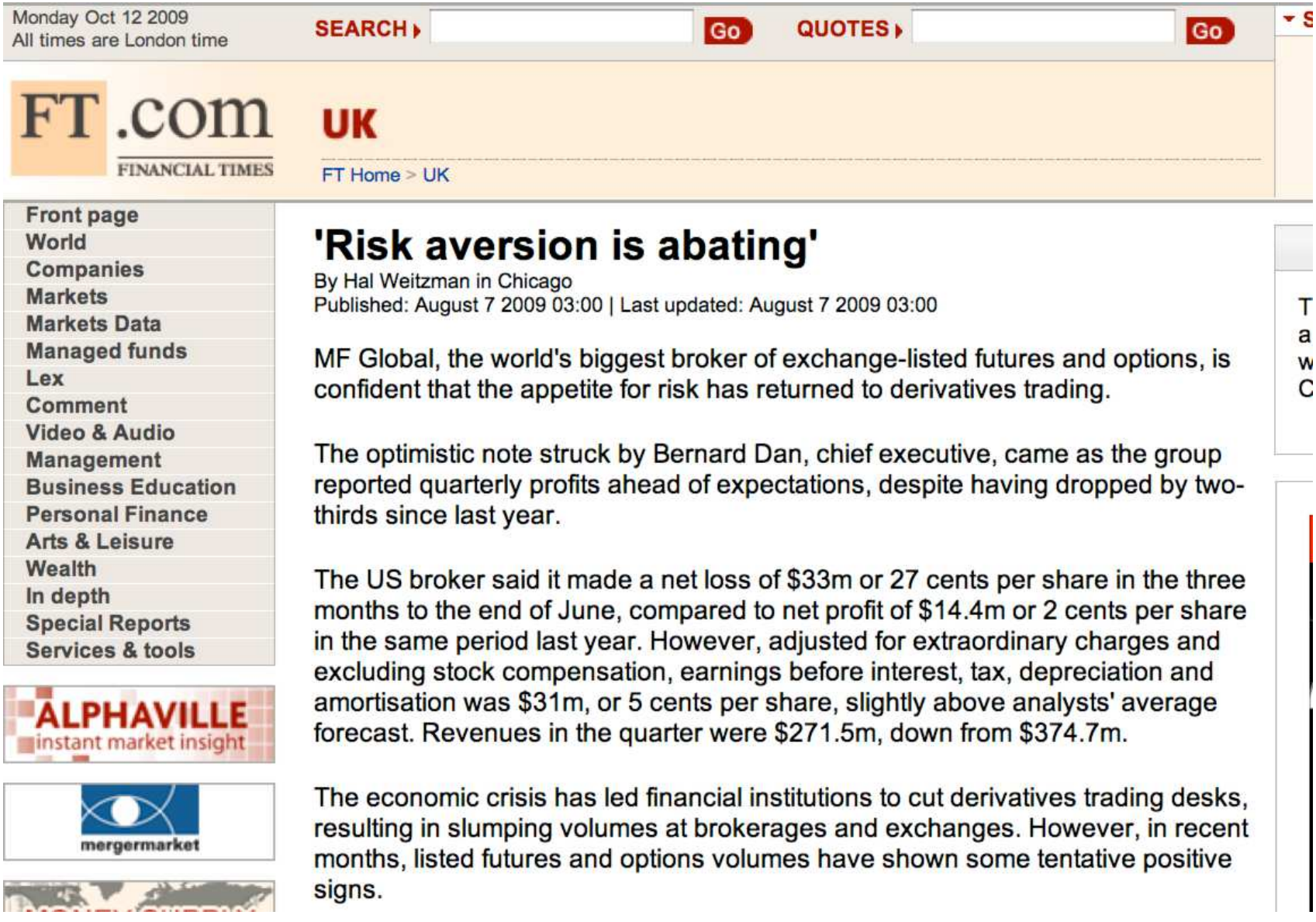
Overview: Risk aversion rises as Lehman flounders

By Dave Shellock
Published: September 12 2008 18:32 | Last updated: September 12 2008 18:32

Uncertainty about the health of the global financial sector dominated market sentiment this week as an initial wave of euphoria over the bail-out of Fannie Mae and Freddie Mac quickly gave way to fears that Lehman Brothers would be the next casualty.

Equity and credit markets suffered wild swings, while the dollar continued to attract buyers and commodities sank as an uncertain outlook for global growth triggered a wave of risk aversion.

"The F&F rescue had a positive but short-lived impact on investors' mood," said Luca Cazzulani, strategist at UniCredit.



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'Risk aversion is abating'

By Hal Weitzman in Chicago
Published: August 7 2009 03:00 | Last updated: August 7 2009 03:00

MF Global, the world's biggest broker of exchange-listed futures and options, is confident that the appetite for risk has returned to derivatives trading.

The optimistic note struck by Bernard Dan, chief executive, came as the group reported quarterly profits ahead of expectations, despite having dropped by two-thirds since last year.

The US broker said it made a net loss of $33m or 27 cents per share in the three months to the end of June, compared to net profit of $14.4m or 2 cents per share in the same period last year. However, adjusted for extraordinary charges and excluding stock compensation, earnings before interest, tax, depreciation and amortisation was $31m, or 5 cents per share, slightly above analysts' average forecast. Revenues in the quarter were $271.5m, down from $374.7m.

The economic crisis has led financial institutions to cut derivatives trading desks, resulting in slumping volumes at brokerages and exchanges. However, in recent months, listed futures and options volumes have shown some tentative positive signs.

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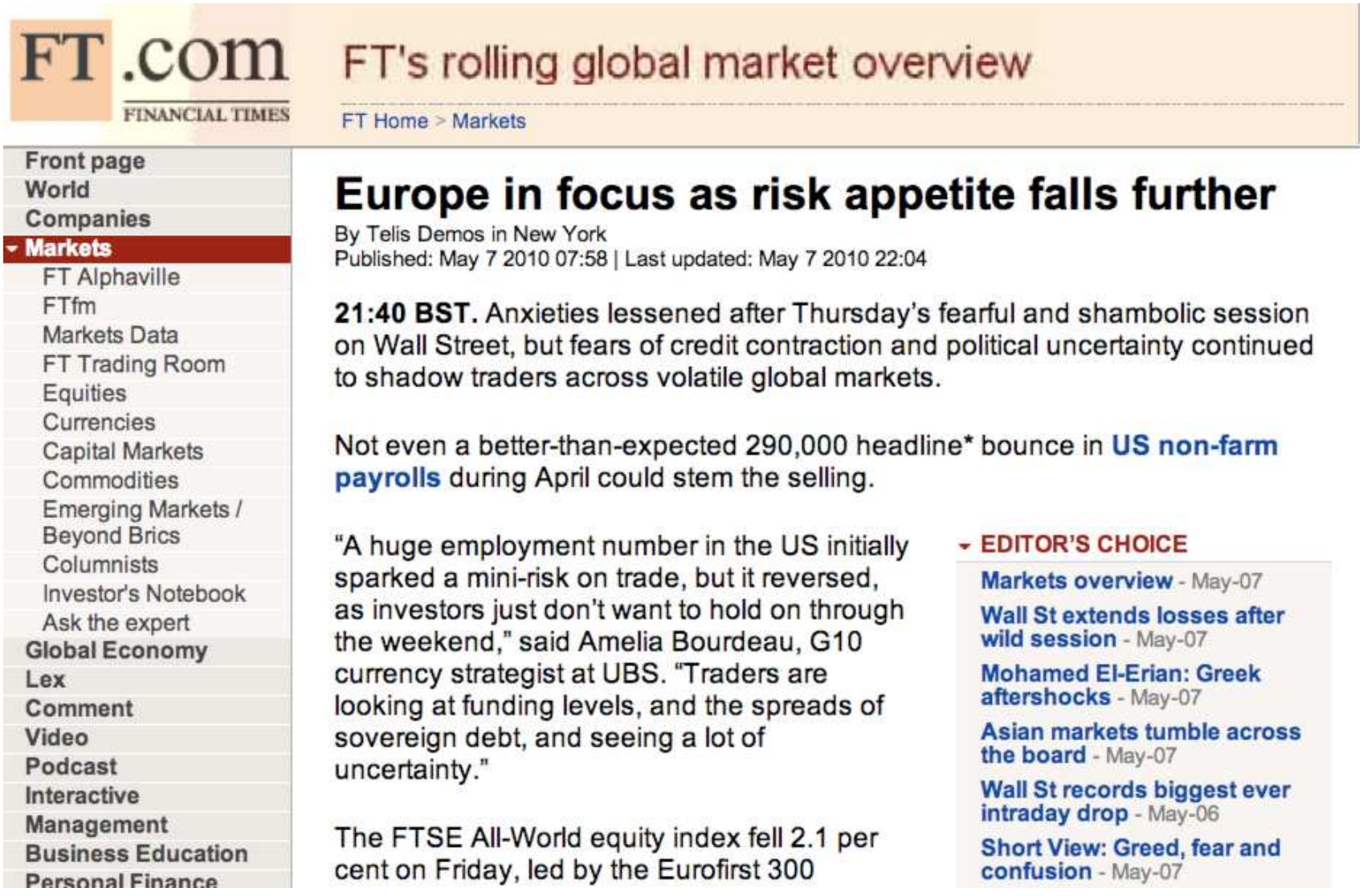
Investors' risk appetite takes hit

By Masa Serdarevic in New York
Published: May 1 2010 03:00 | Last updated: May 1 2010 03:00

Concerns over Greece's fiscal situation and the threat of contagion to other eurozone countries hit risk appetite, sending US stock prices sharply lower on the week.

"The continuing inability [of European leaders] to stem concerns over Greece is what we are focusing on," said Bruce McCain, chief investment strategist at Key Private Bank. "We are now reconfiguring our international exposure and looking into how it's going to affect companies with European operations."

He said he saw growing inflationary pressures on companies' input costs as a factor that could adversely affect the recovery.



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Europe in focus as risk appetite falls further

By Telis Demos in New York
Published: May 7 2010 07:58 | Last updated: May 7 2010 22:04

21:40 BST. Anxieties lessened after Thursday's fearful and shambolic session on Wall Street, but fears of credit contraction and political uncertainty continued to shadow traders across volatile global markets.

Not even a better-than-expected 290,000 headline* bounce in **US non-farm payrolls** during April could stem the selling.

"A huge employment number in the US initially sparked a mini-risk on trade, but it reversed, as investors just don't want to hold on through the weekend," said Amelia Bourdeau, G10 currency strategist at UBS. "Traders are looking at funding levels, and the spreads of sovereign debt, and seeing a lot of uncertainty."

The FTSE All-World equity index fell 2.1 per cent on Friday, led by the Eurofirst 300

EDITOR'S CHOICE

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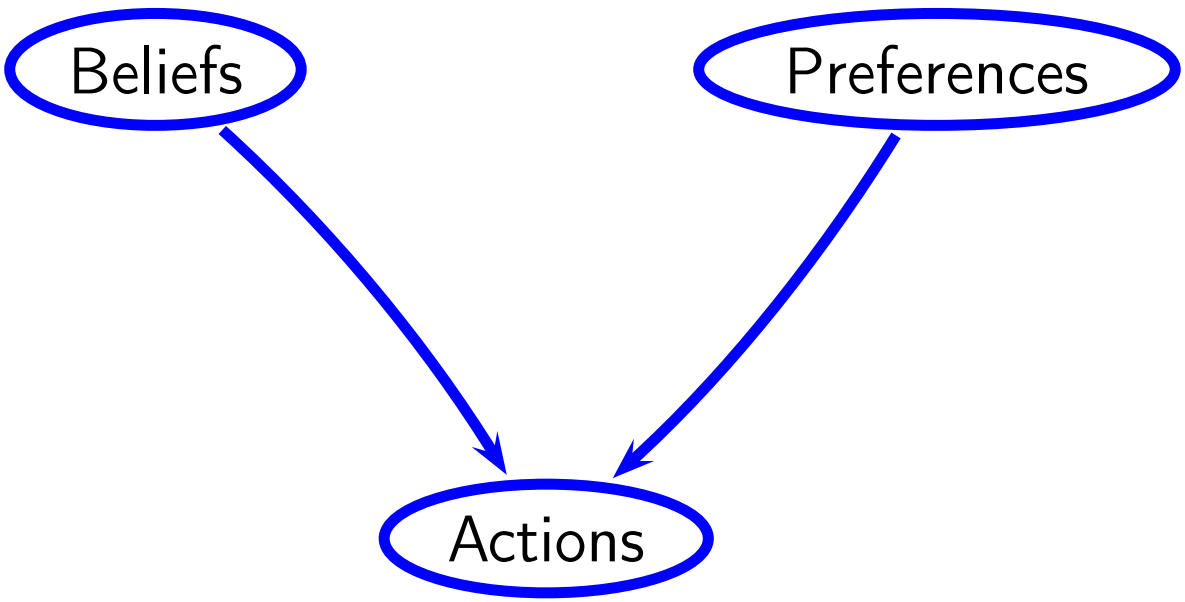
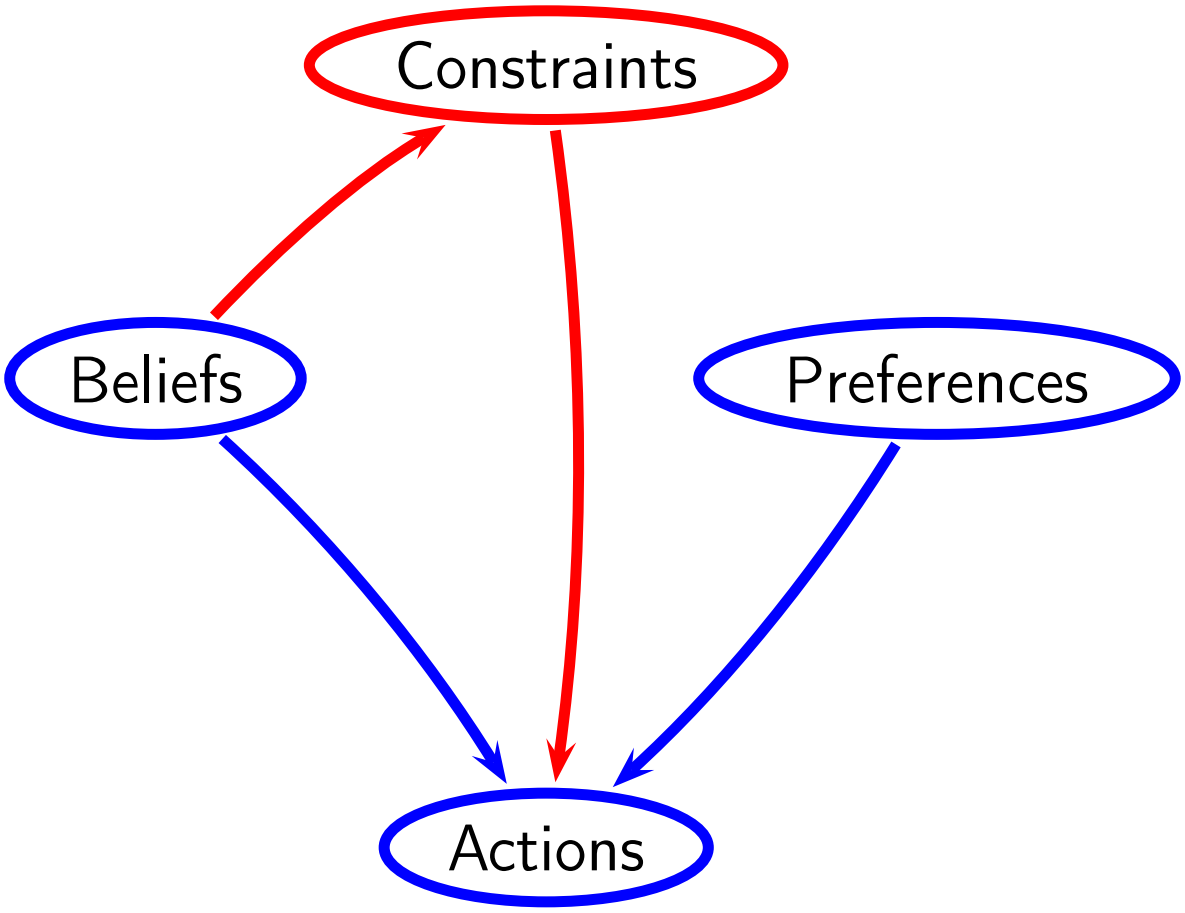
- **Wall St extends losses after wild session** - May-07
- **Mohamed El-Erian: Greek aftershocks** - May-07
- **Asian markets tumble across the board** - May-07
- **Wall St records biggest ever intraday drop** - May-06
- **Short View: Greed, fear and confusion** - May-07

- Close cousins of:
  - *confidence*,
  - *overreactiveness*,
  - *fear* and
  - *liquidity*
- But how can it be that human beings are risk averse one day, in a perfectly coordinated fashion, selling their risky holdings across the board and reinforcing the crisis, only to become contagiously risk loving not too long thereafter, pushing prices back to the pre-crisis levels?
- Surely they do not all together feel compelled to look right and left ten times before crossing the street one day while blindly crossing the next? But that's how it appears to an outside observer.

Beliefs and Preferences

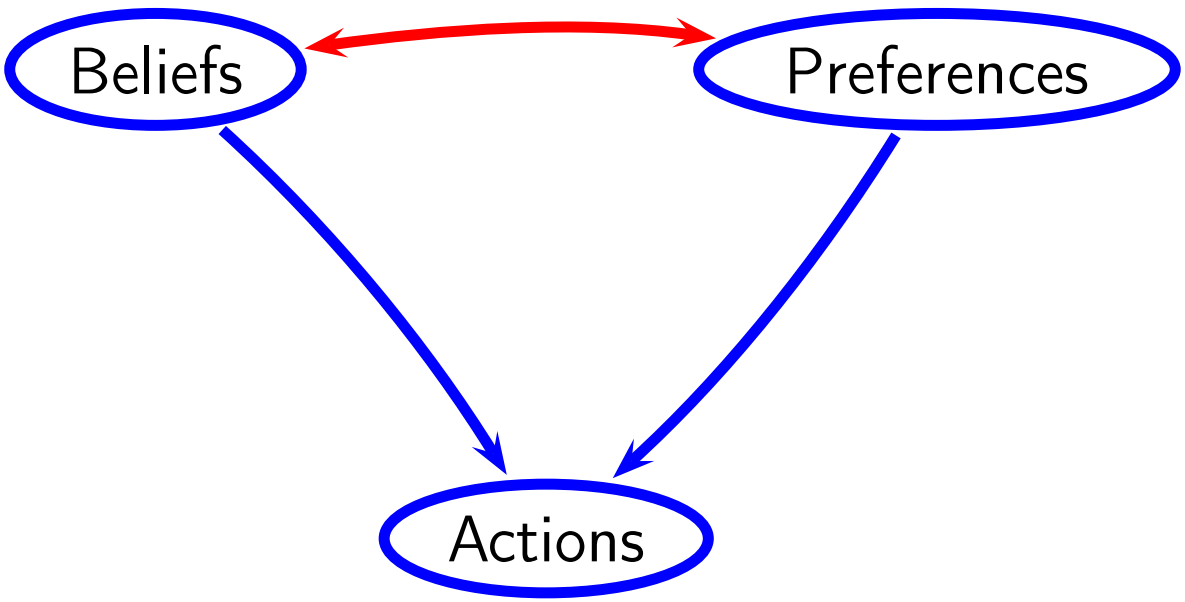


Beliefs and Preferences



Beliefs and Preferences

To outside observer,
beliefs and preferences
appear to be linked



- Sometimes markets gather momentum from the endogenous and coordinated responses of the market participants themselves, rather like a tropical storm or the Millenium Bridge.
- As financial conditions worsen, the willingness of market participants to bear risk seemingly evaporates in response to the deteriorating conditions. They curtail their risk-taking activities by cutting exposures and leverage. The prudent and conservative actions of one market participant entails negative spillover effects on others $\Rightarrow$ further declines in the prices of those assets etc.
- *Fallacy of Composition*.

- Endogenous risk is over and above the traditional domino model of contagious default, it captures the *price and leverage spirals* created by the anticipatory and reactive actions of the market participants and the *double-edged nature of prices* (prices as signals and as *imperative* to act)
- See Brunnermeier and Petersen (RFS, 2009), Danielsson and Zigrand (2008), Geanakoplos (NBER, 2009), Shin's "Risk and Liquidity" 2008 Clarendon Lectures in Finance, many others.
- Such spirals are *pro–cyclical* due to risk-sensitive constraints and regulations, time–varying vols, adverse selection and mark–to–market accounting $\Rightarrow$ as if market participants had lost their risk appetite *simultaneously* due to mtm accounting and similar risks and risk models.

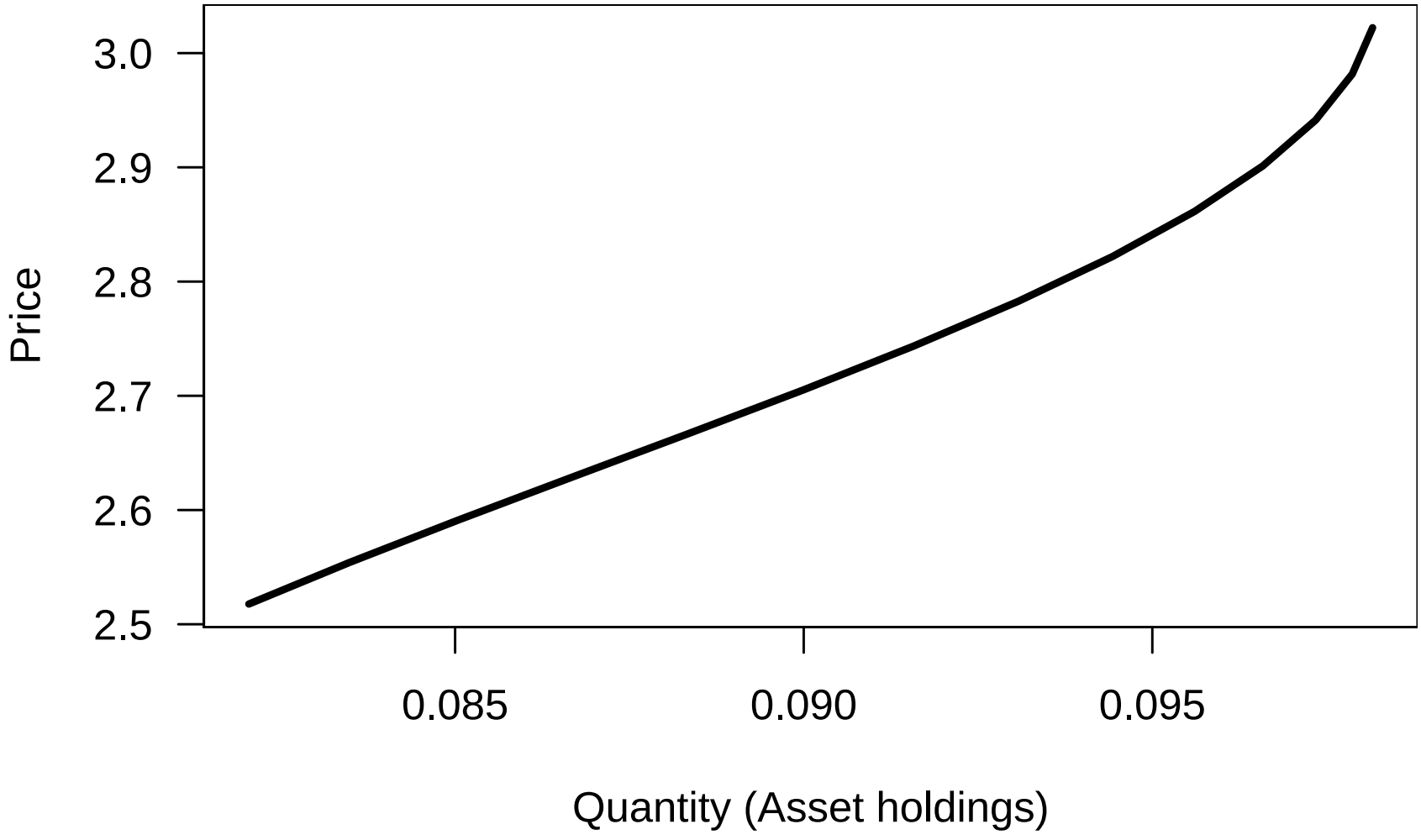
- Separate *risk aversion/tolerance* from *risk appetite*. coefficient of effective relative risk aversion

  $=$ coeff. of innate utility-based relative risk aversion

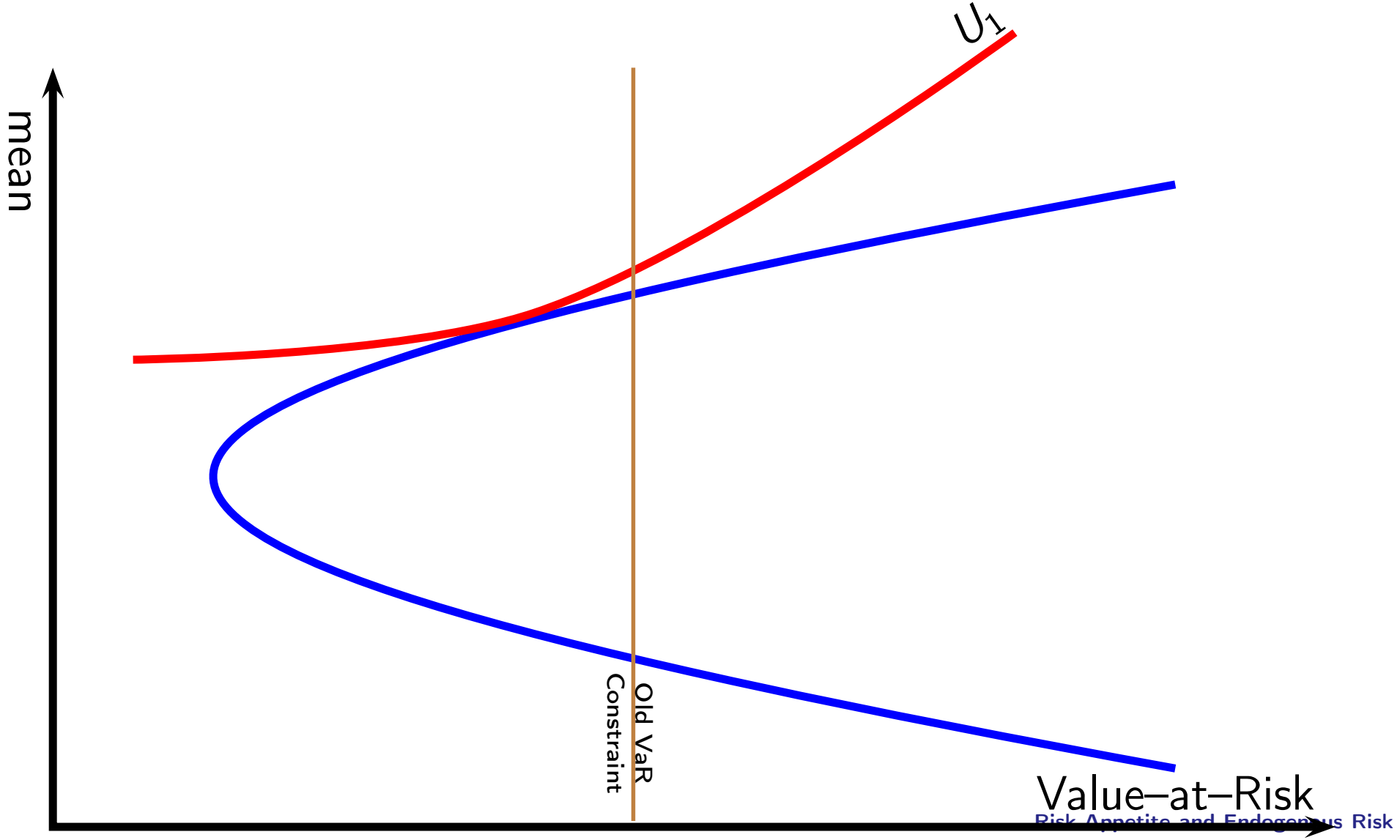
  $+$ Lagrange multiplier on the VaR constraint

- When the constraints bind tightly, the traders shed risky exposures, giving the outward appearance of a trader who has become more risk-averse, even though the underlying preferences may not have changed at all.
- Since by mtm and similar risk systems they do this together, it would appear as *contagious herding* or *ganging-up* $\Rightarrow$ *upward sloping demands*.

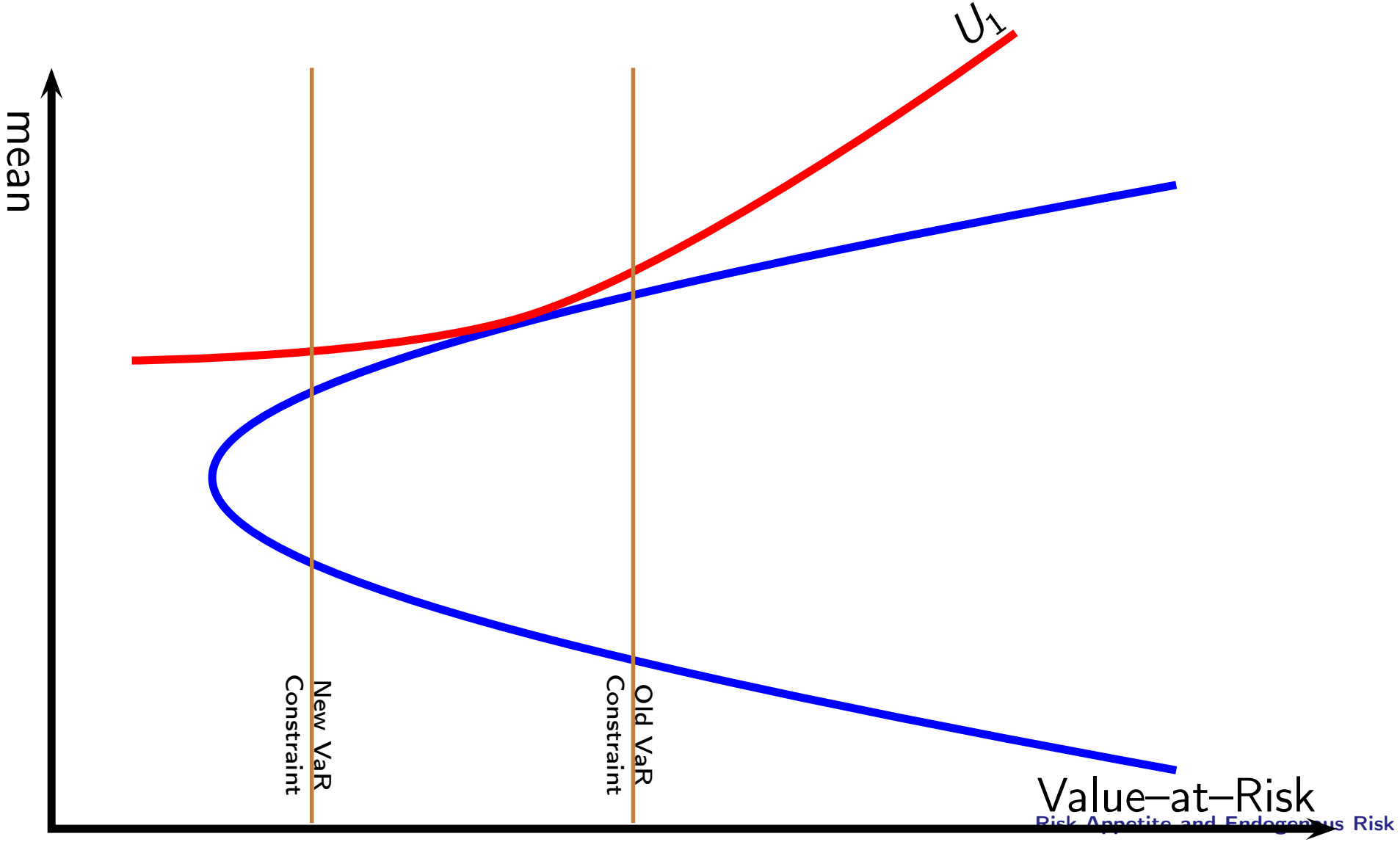
Demand Function from Model Simulation



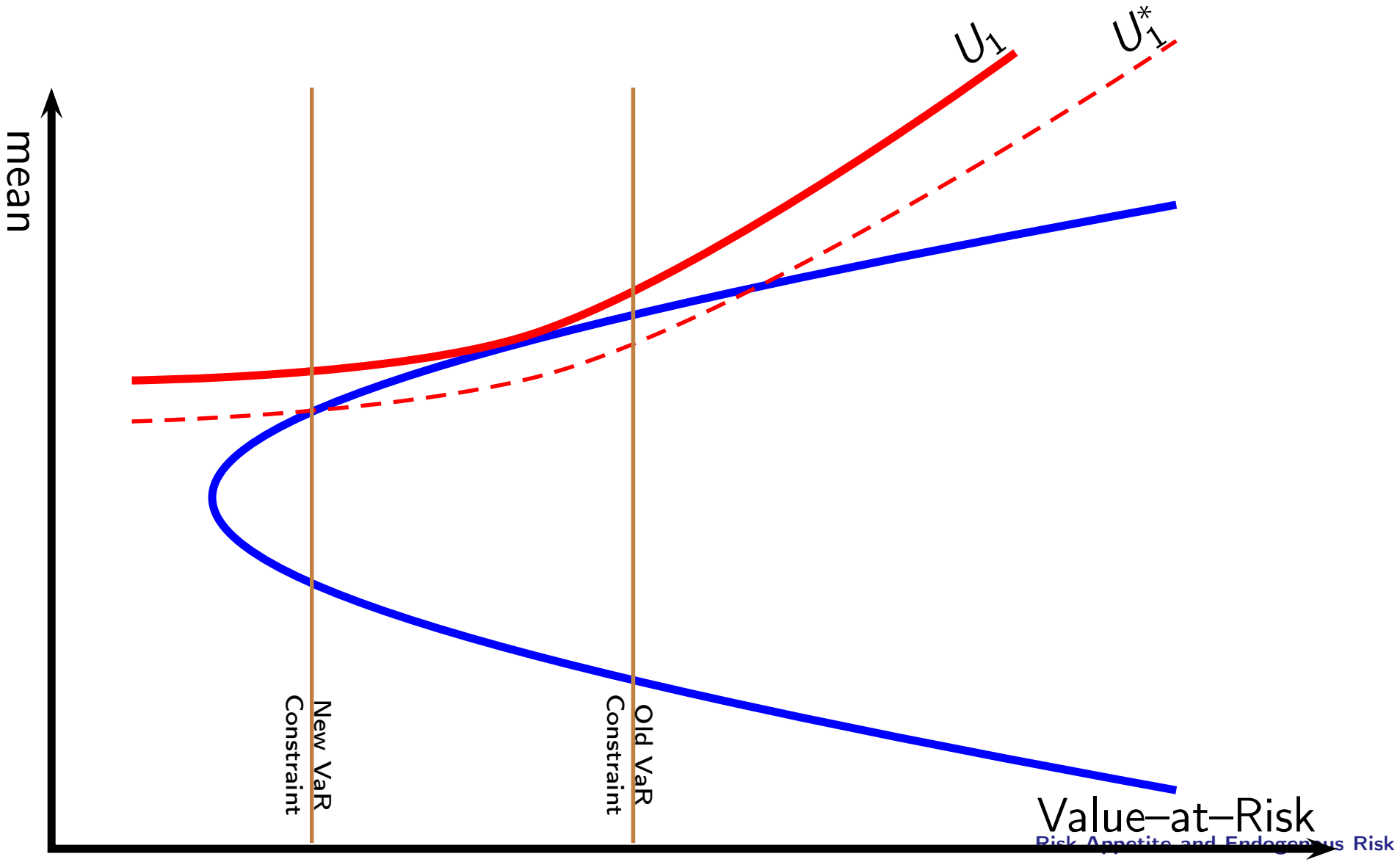
Mean–Variance with VaR constraints



Mean–Variance with VaR constraints



Mean–Variance with VaR constraints



Mean–Variance with VaR constraints

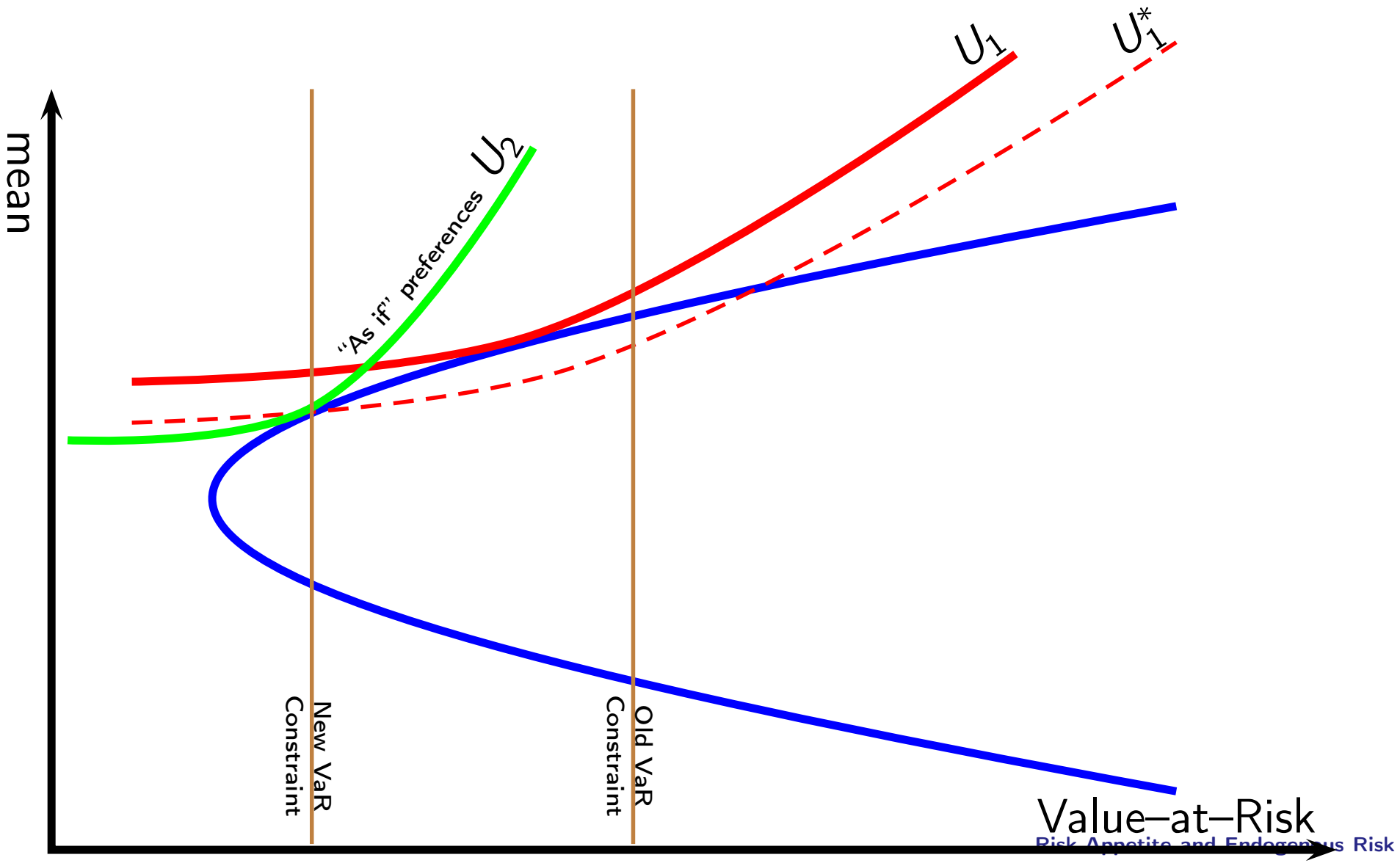


Exhibit 41: VIX Volatility Index
as of May 6, 2010

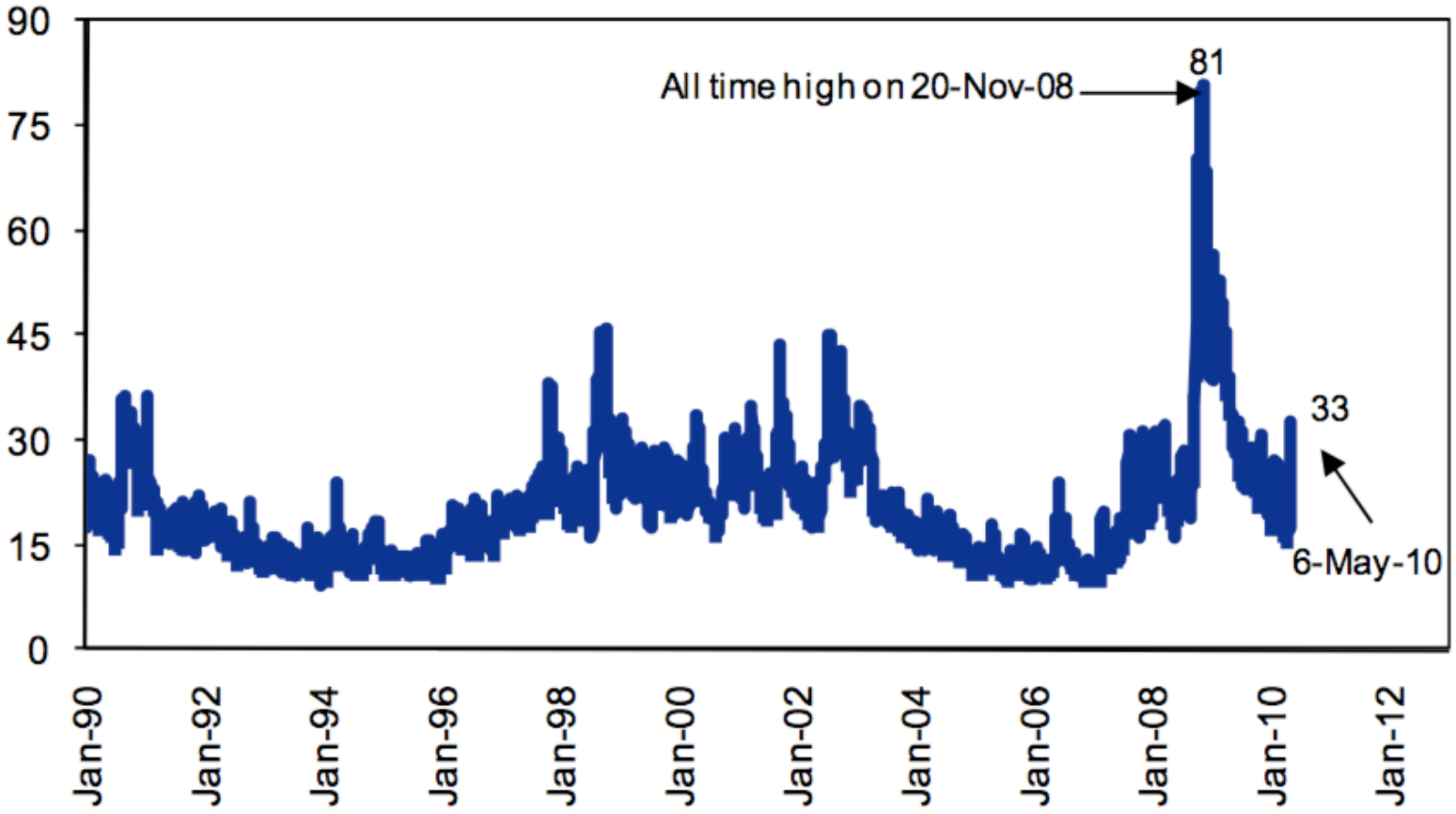
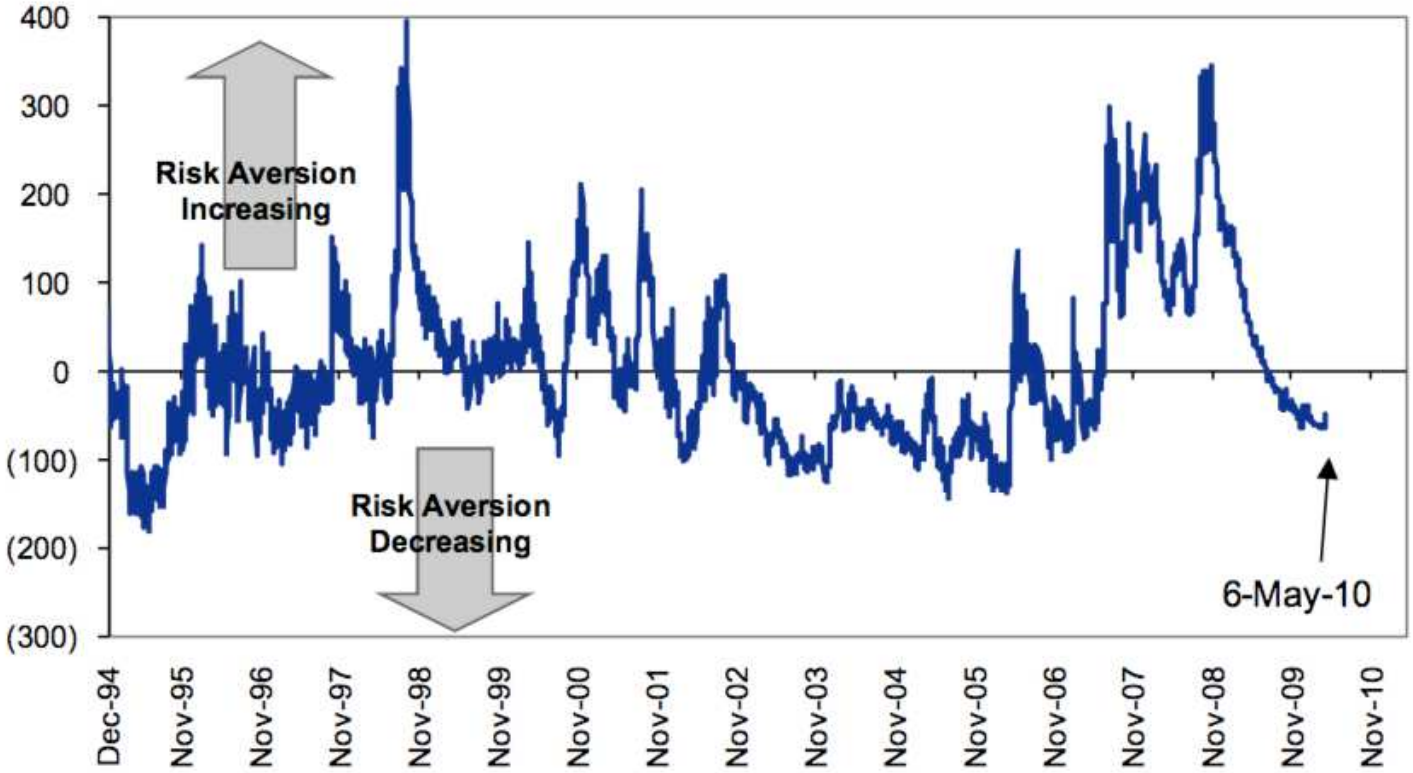


Exhibit 40: Goldman Sachs Risk Barometer

Index is number of standard deviations from the average * 100



Note: Metrics included are implied option volatility (S&P 500 and NASDAQ 100), normalized skew, high yield credit spreads, credit derivative swap spreads, mutual fund net flows, and cash levels.

- *Default* need not occur for these spirals to occur.
- In Hyun Shin's words (no pun intended, this quote predates the Greek Crisis):

  > *Rather like a Classical Greek tragedy, it is the actions taken by the actors who want to avoid a bad outcome that precipitates disaster.*

  So regulating with a view of reducing counterparty risk may be commendable and reduce feedbacks, but will not eliminate the crisis spirals.

Wish List

Construct a simple model (ideally one or two factors), that

- could be *calibrated and manipulated easily* for practical applications, that
- generates *procyclical risk appetite and leverage* that goes hand in hand with:
- *countercyclical stochastic volatility* (without having any such features in the driving processes),
- *countercyclical* (and largely convex) *risk premia* (Black's "mean reversion"), *Sharpe Ratios, vols of vols, and correlations* (despite no such relationships hard-wired), and
- *a countercyclical IV index* (such as VIX) and the *usual IV surface*.

Model

- Financial institutions (FIs) face VaR constraint: *cannot hold securities whose VaR is larger than the capital of the FI*
- Time indexed by $t \in [0, \infty)$.
- $N > 0$ non-dividend paying risky securities (date t price of ith risky security is P_t^i)
- One risk-free bond ($B_0 = 1$, $dB_t = rB_t dt$, with r constant)
- Two types of traders
  - *Active traders* (risk–neutral traders with VaR constraints)
  - *Passive traders* (residual demand/supply curves that close the model)

- Posit equilibrium of form:

$$\begin{bmatrix} dP_t^1/P_t^1 \\ \vdots \\ dP_t^N/P_t^N \end{bmatrix} = \begin{bmatrix} \mu_t^1 \\ \vdots \\ \mu_t^N \end{bmatrix} dt + \begin{bmatrix} - & \sigma_t^1 & - \\ & & \\ - & \sigma_t^N & - \end{bmatrix} \begin{bmatrix} dW_t^1 \\ \vdots \\ dW_t^N \end{bmatrix}$$

  - $\{W_t^i\}$ independent Brownian motions (fundamental shocks enter via passive traders' demands)
  - Scalars $\{\mu_t^i\}$ and $1 \times N$ vectors $\{\sigma_t^i\}$ are as yet undetermined coefficients to be solved in equilibrium
  - Solve for rational expectations equilibrium (REE) with respect to active traders' beliefs

- D_t^i is dollar holding of i^{th} security at t
  V_t is trader's capital (notice no superscript for trader, due to aggregation result, to follow)
- Balance sheet identity

$$b_t B_t = V_t - \sum_i D_t^i$$

- Evolution of capital

$$dV_t = \left[rV_t + D_t^\top (\mu_t - r) \right] dt + D_t^\top \sigma_t dW_t$$

$D^\top$ is transpose of D, σ_t is the $N \times N$ diffusion matrix, $r = (r, \ldots, r)^\top$.

- Expected capital gain:

$$E_t[dV_t] = [rV_t + D_t^\top(\mu_t - r)]dt \tag{1}$$

  Variance of capital:

$$\text{Var}_t(dV_t) = D_t^\top \sigma_t \sigma_t^\top D_t dt \tag{2}$$

- Short horizons. So no investment-opportunity-set hedging. Trader maximizes (1) subject to VaR constraint, where VaR is α times forward-looking standard deviation of return on equity.

- Assuming trader is solvent ($V_t > 0$) maximization problem is

$$\max_{D_t} \; rV_t + D_t^\top(\mu_t - r) \qquad \text{subject to} \qquad \alpha\sqrt{D_t^\top \sigma_t \sigma_t^\top D_t} \leq V_t$$

- First-order condition

$$\mu_t - r = \alpha(D_t^\top \Sigma_t D_t)^{-1/2}\gamma_t \Sigma_t D_t$$

where γ_t is Lagrange multiplier for VaR constraint, and

$\Sigma_t := \sigma_t \sigma_t^\top$.

$$D_t = \frac{1}{\alpha(D_t^\top \Sigma_t D_t)^{-1/2}\gamma_t}\Sigma_t^{-1}(\mu_t - r)$$

- Constraint binds due to risk-neutrality (provided $\mu_t \neq r$)

$$V_t = \alpha \sqrt{D_t^\top \Sigma_t D_t} \tag{3}$$

Therefore

$$D_t = \frac{V_t}{\alpha^2 \gamma_t} \Sigma_t^{-1} (\mu_t - r)$$

- *"As if" preferences.* Optimal portfolio is similar to mean-variance optimal portfolio where the Lagrange multiplier

$$\alpha^2 \gamma_t$$

appears like a relative risk-aversion coefficient.

Substitute into (3) to solve for Lagrange multiplier

$$\gamma_t = \frac{\sqrt{\xi_t}}{\alpha} \qquad ; \text{where} \quad \xi_t := (\mu_t - r)^\top \Sigma_t^{-1} (\mu_t - r)$$

Lagrange multiplier γ_t is

- proportional to generalized Sharpe ratio $\sqrt{\xi}$
- does not depend directly on equity V_t

CRRA is $\alpha^2 \gamma_t = \alpha \sqrt{\xi_t}$.
Interpretation. Additional unit of capital relaxes VaR constraint by multiple α of standard deviation, raising expected return by risk-premium on the portfolio per unit of standard deviation

- Finally, solve for optimal portfolio:

$$D_t = \frac{V_t}{\alpha\sqrt{\xi_t}}\Sigma_t^{-1}(\mu_t - r)$$

- Optimal portfolio is homogeneous of degree one in equity $V_t \Rightarrow$
  Aggregation result. Portfolio depends on V_t, total capital of active trading (dealer?) sector, not on profile of individual equity capital.

  $\Rightarrow$ Take aggregate capital, V_t, as state variable

Closing the Model

- A passive investment sector subject to positive demand or valuation shocks z_t^i, here assumed $dz_t = \sigma_z dW_t \in \mathbb{R}^N$.
- Passive traders in aggregate have the following vector-valued exogenous demand schedule for the risky assets, $y_t = (y_t^1, \ldots, y_t^N)$ with

$$y_t = \Sigma_t^{-1} \begin{bmatrix} \vdots \\ \delta^i \left(rt + \eta z_t^i - \ln P_t^i \right) \\ \vdots \end{bmatrix}$$

- Roughly standard optimal mean-variance demand, where investors expect the spread between their perceived "true" long term shadow price $P_t^{\text{shadow},i} := e^{rt+\eta z_t^i}$ (their NPV) and the actual price $\ln P_t^i$ to close over time. Like following a value-strategy.

Market Clearing

- Imposing the market-clearing condition $D_t + y_t = 0$,

$$P_t^i = \exp\left(\frac{V_t}{\alpha\delta^i\sqrt{\xi_t}}(\bar{\mu}_t - r) + rt + \eta z_t^i\right); \qquad i = 1, \ldots, N$$

- We solve the fixed point problem by solving for $(\bar{\mu}_t, \bar{\sigma}_t)$ in the equation:

$$\begin{bmatrix}\bar{\mu}_t \\ \bar{\sigma}_t\end{bmatrix} = \begin{bmatrix}\mu_t(\bar{\mu}_t, \bar{\sigma}_t) \\ \sigma_t(\bar{\mu}_t, \bar{\sigma}_t)\end{bmatrix}$$

- Get drift, and especially diffusion (can always solve by Sherman-Morrison, 2 fundamental theorems):

$$\sigma_t = V_t[\text{rank 1 matrix}]\bar{\sigma}_t - \eta\sigma_z$$

Single Risky Security, $N = 1$

- Equilibrium simplifies to $\ln P_t = rt + \eta z_t + \frac{\sigma_t V_t}{\alpha\delta}$.
- Solve for REE diffusion and drift, by Itô:

$$V_t^2 \frac{\partial \sigma}{\partial V_t} = \alpha^2 \delta(\sigma_t - \eta\sigma_z) - V_t \sigma_t$$

- The generic solution to this ODE is given by

$$\sigma(V_t) = \frac{1}{V_t} e^{-\frac{\alpha^2\delta}{V_t}} \left[-\alpha^2 \delta \eta \sigma_z \int_{-\frac{\alpha^2\delta}{V_t}}^{\infty} \frac{e^{-u}}{u} du \right]$$

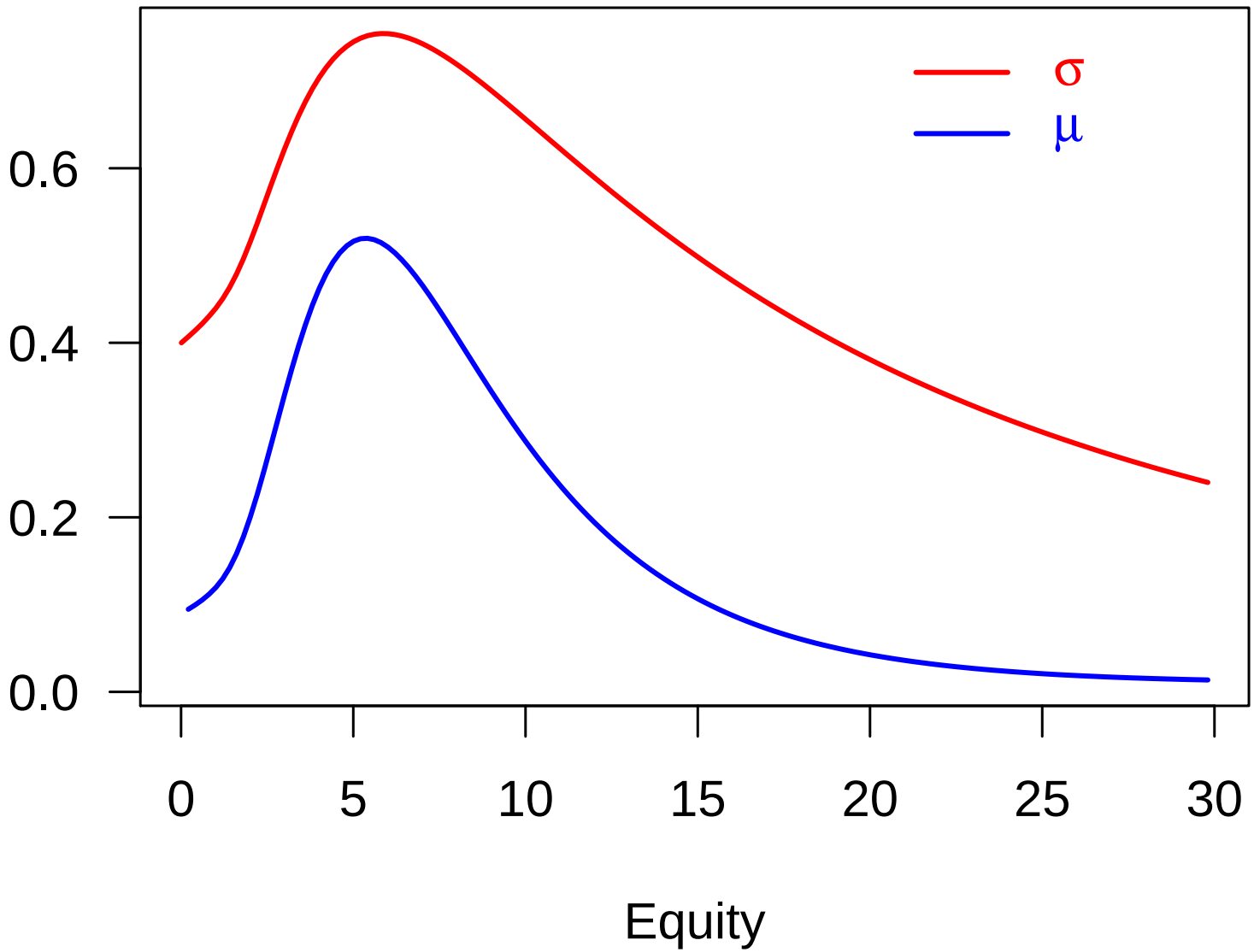
- Equilibrium drift μ_t

$$\mu_t = r + \frac{\sigma_t}{2\alpha\eta\sigma_z}\left\{\alpha\sigma_t^2 - \eta\sigma_z + (\sigma_t - \eta\sigma_z)\left[2\alpha^2 r + \frac{\alpha^2\delta}{V_t} - 2\right]\right\}$$

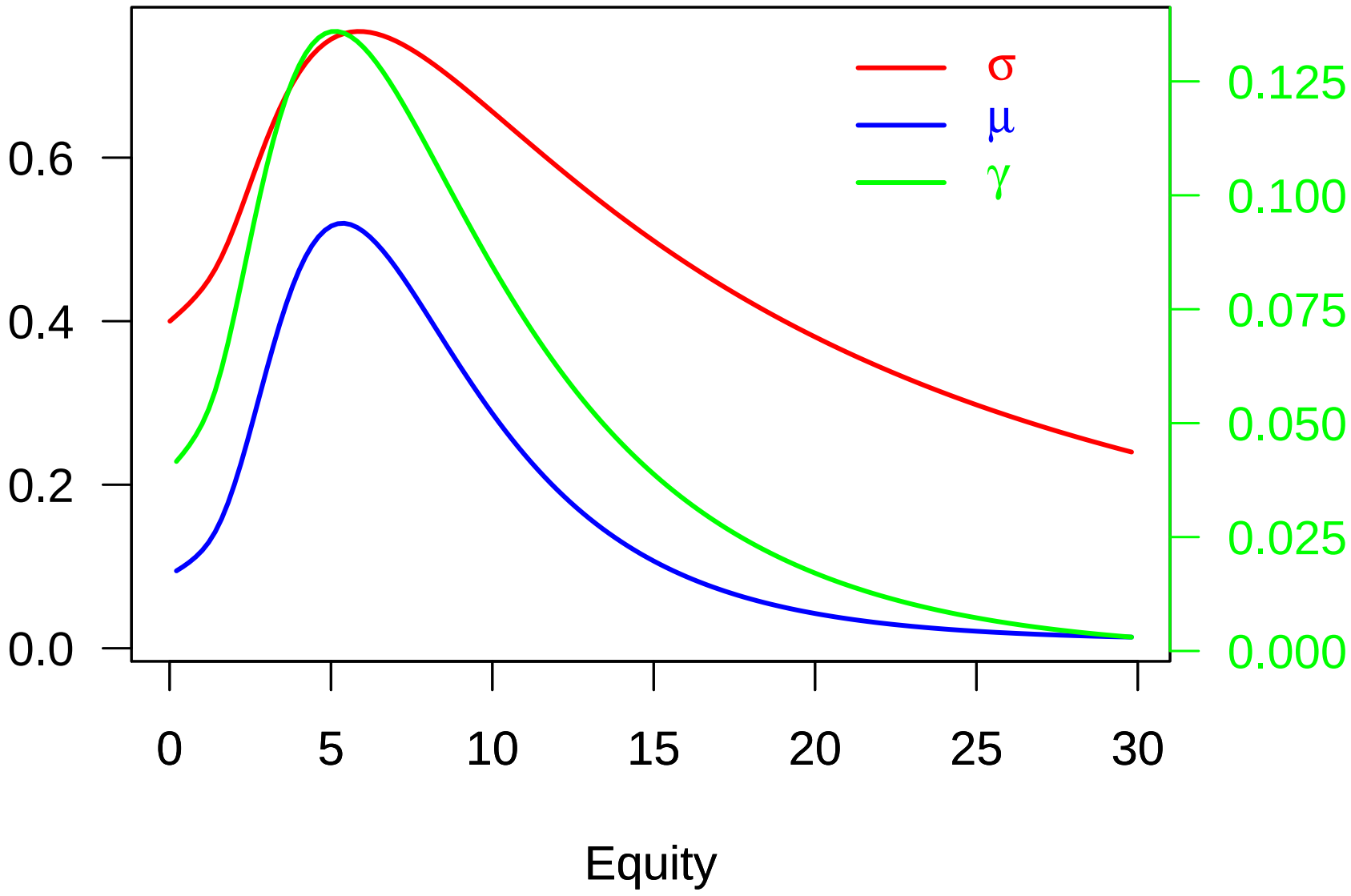
- Sharpe ratio:

$$\frac{\mu_t - r}{\sigma_t} = \frac{1}{2\alpha\eta\sigma_z}\left\{\alpha\sigma_t^2 - \eta\sigma_z + (\sigma_t - \eta\sigma_z)\left[2\alpha^2 r + \frac{\alpha^2\delta}{V_t} - 2\right]\right\}$$

Risk and Return



Risk and Return



Why this hump in vol for low capital basis?

- The mere presence of FIs increases volatility quite dramatically, endogenous risk.
- The reason for this lies in the interaction of REE and the wealth-VaR constraints of FIs. Recall that equilibrium is (setting $\alpha = \delta = 1$) $\ln P_t = rt + \eta z_t + \tilde{\sigma}_t V_t$. Itô's Lemma:

$$\sigma_t = \eta\sigma_z + \underbrace{\tilde{\sigma}_t \times (\text{diffusion of } V_t)}_{\text{vol due to FI's wealth-VaR effect}} + \underbrace{V_t \times (\text{diffusion of } \tilde{\sigma}_t)}_{\text{vol due to changing beliefs}}$$

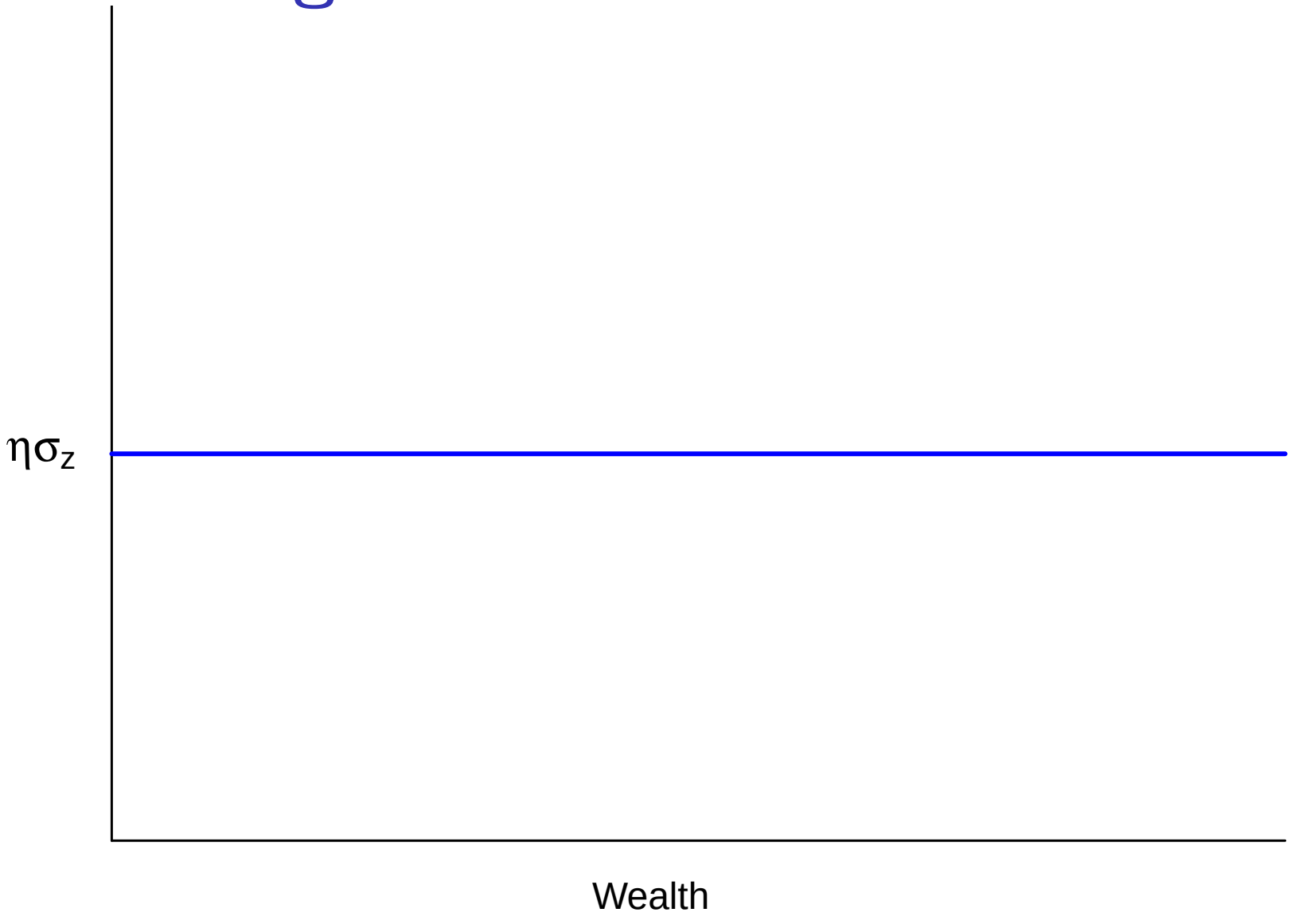
$$= \eta\sigma_z + V_t \left[\tilde{\sigma}_t + V_t \frac{\partial \tilde{\sigma}}{\partial V_t} \right]$$

since the actual diffusion term of wealth is V_t. Solving for $\sigma_t = \tilde{\sigma}_t$ is the REE ODE.

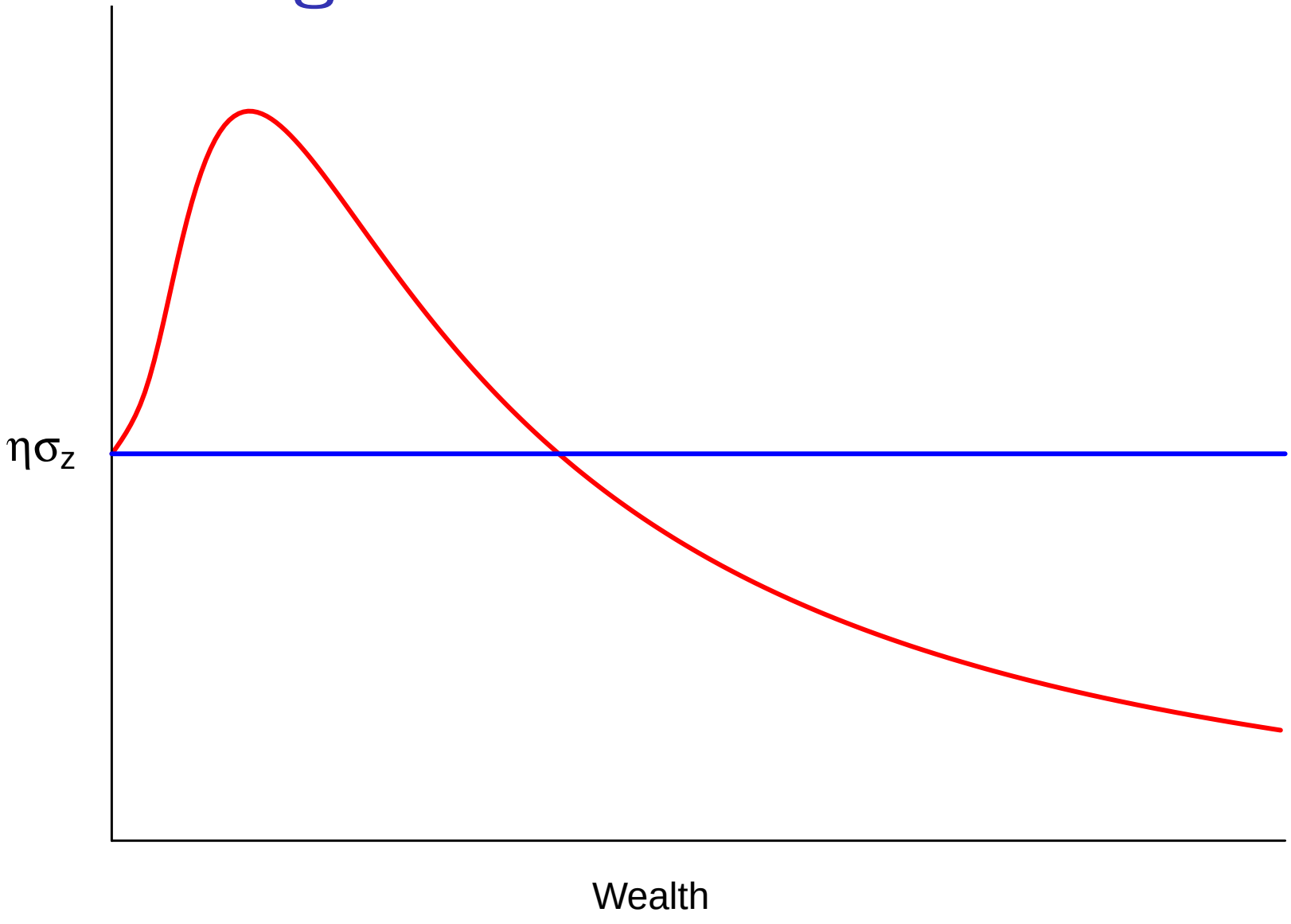
- So start at $V = 0$ and trace it out: a bit of equity means FIs enter the market, and the variability of their capital and of their beliefs feeds back into the one of prices at low levels.
- After some maximal vol, vol must come down with yet higher V, for else LHS=σ_t and
  RHS=$\eta\sigma_z + \underbrace{V_t}_{\text{large}}\Big[\tilde{\sigma}_t + \underbrace{V_t}_{\text{large}}\underbrace{\frac{\partial\tilde{\sigma}_t}{\partial V_t}}_{>0}\Big] \gg \tilde{\sigma}_t.$
- So FI beliefs cannot be confirmed unless FIs expect their influence on vol to be towards reducing it as their capital base increases and therefore their VaR constraints slackening.

- In reverse, if capital is lowered from a normal level, that means VaR constraints bind more, so FIs sell across the board, but that feeds back into lower and more volatile prices, which feeds back into a stricter VaR constraint and a lower level of risk tolerance, and here we go again.
- For high capital levels, the VaR constraints are binding less, and the risk-neutral nature of traders appears more and more.
- In paper we also formally characterize drift, ie risk premia, Sharpe Ratio etc. The shapes do not dependent on any particular parameter constellation, within reason.

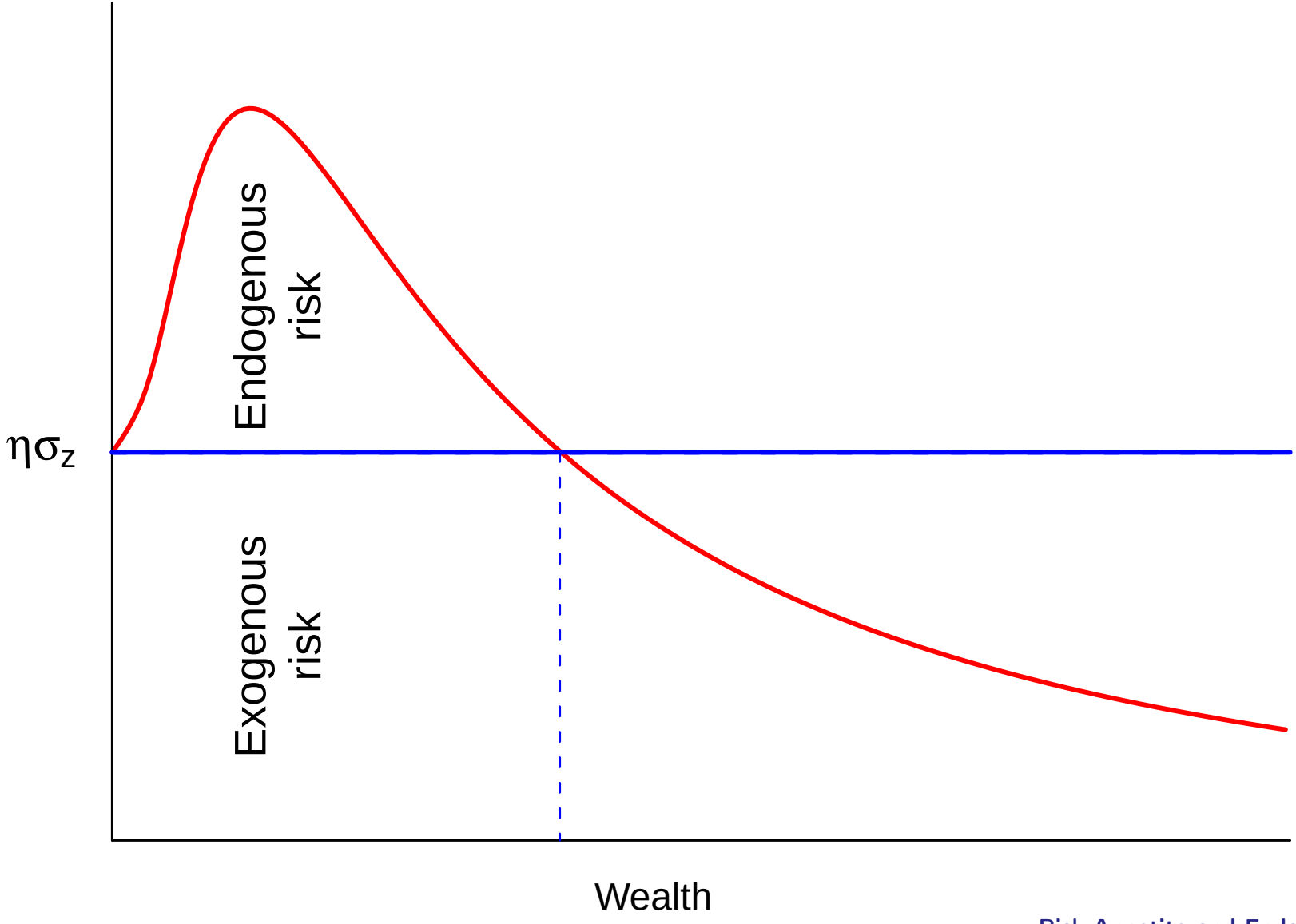
Endogenous Risk and Wealth



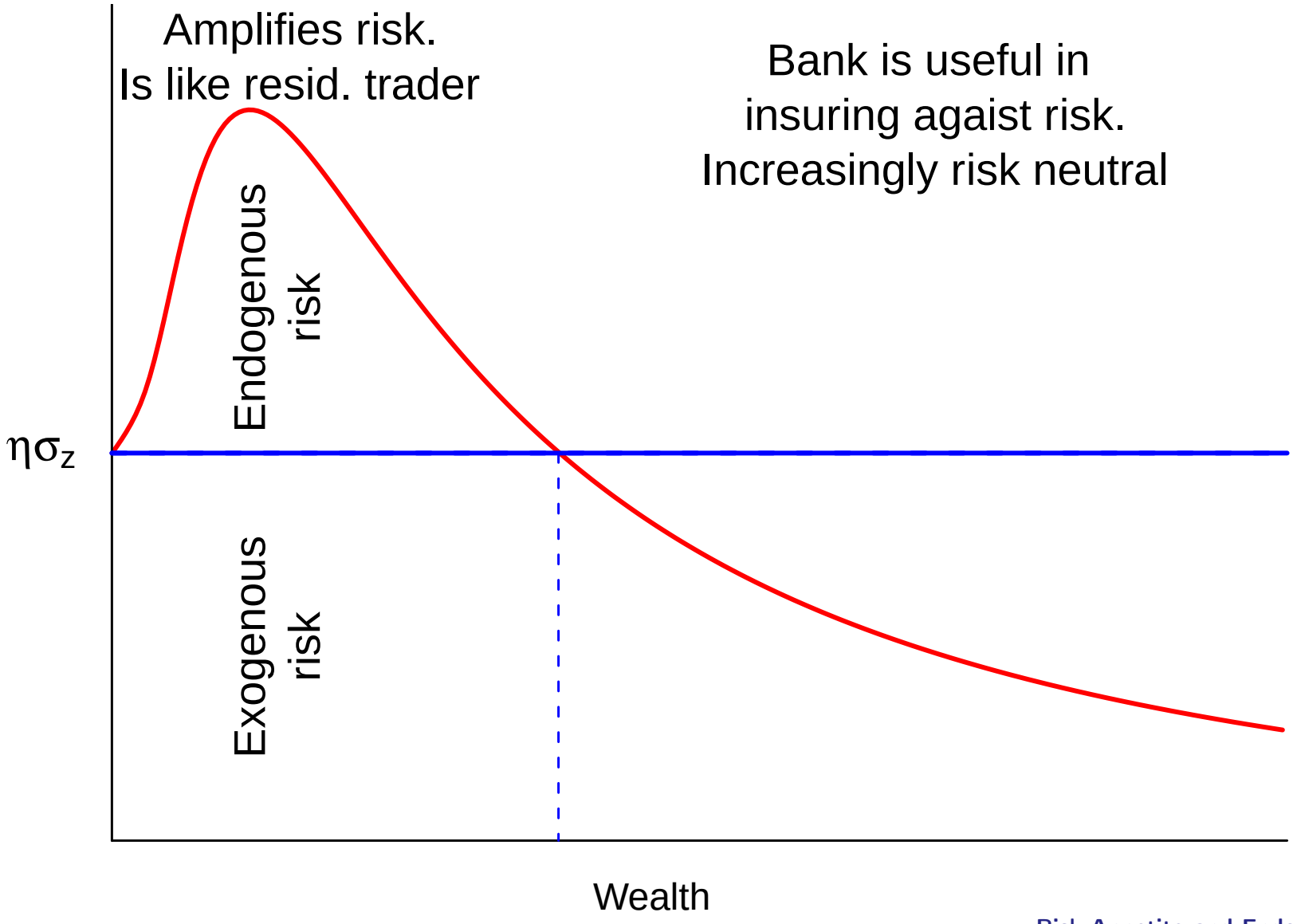
Endogenous Risk and Wealth



Endogenous Risk and Wealth



Endogenous Risk and Wealth

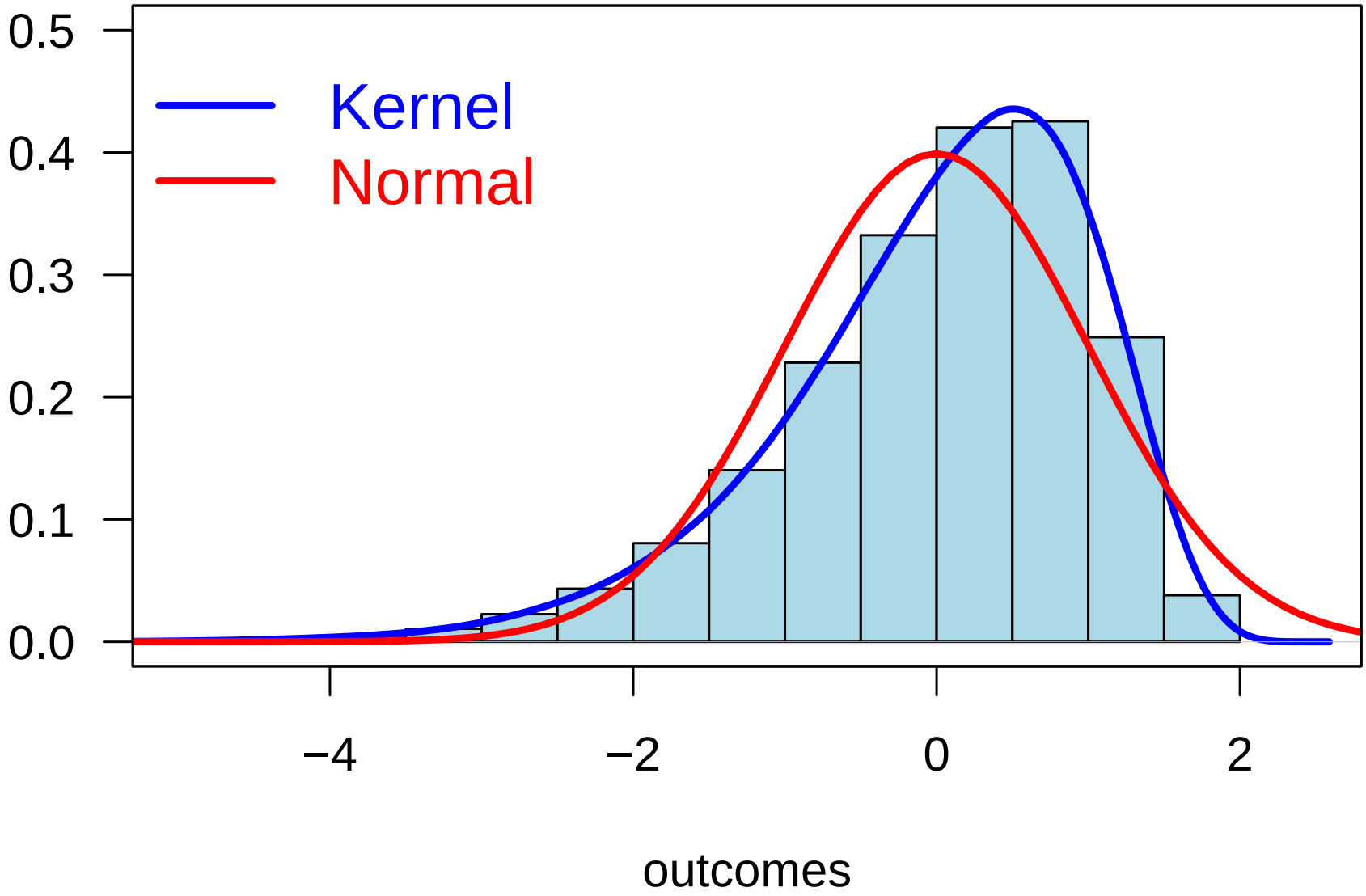


Lessons: Leverage and Capital

- Leverage is pro-cyclical. Capital matters.
- Leverage in the leading model is simply $\frac{\text{assets}}{\text{capital}} = \frac{D_t}{V_t} = \frac{1}{\text{VaR}_t}$ where $\text{VaR}_t = \alpha\sigma_t$.
- Leverage is procyclical and builds up in quiet booms where VaR is low and unwinds in violent busts, without requiring any exogenous increases in haircuts during crises.
- FIs have experienced increased haircuts in the recent crisis, reinforcing the feedback loops further through this second channel of forced delevering, see Adrian and Shin (2009) and Brunnermeier and Pedersen (2009).

- During sufficiently well capitalised episodes, FIs allow the absorption, diffusion and transformation of risk, resulting in calmer and more liquid markets than could otherwise be achieved.
- Financial crises and strong destabilising feedback effects naturally occur if and only if capital levels are too low.
- Once a crisis hits and risk-aversion and all the other factors peak, it will *take time for risk-aversion to come down*. This is borne out in the data as well (see Coudert et al (2008)). Financial sector capital needs to be replenished, and can be sped up by emergency capital injections and bail outs.

Risk Neutral Return Density



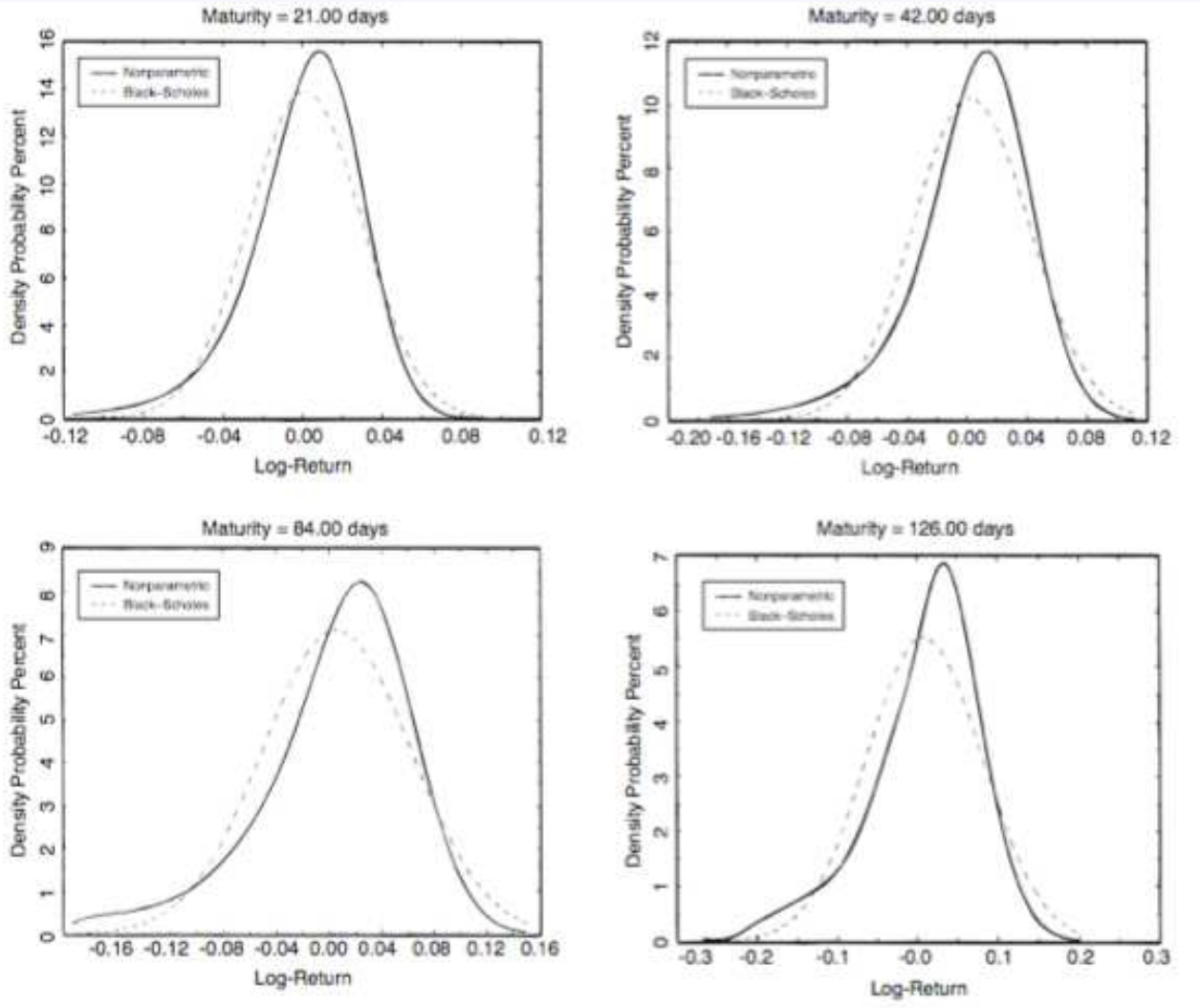
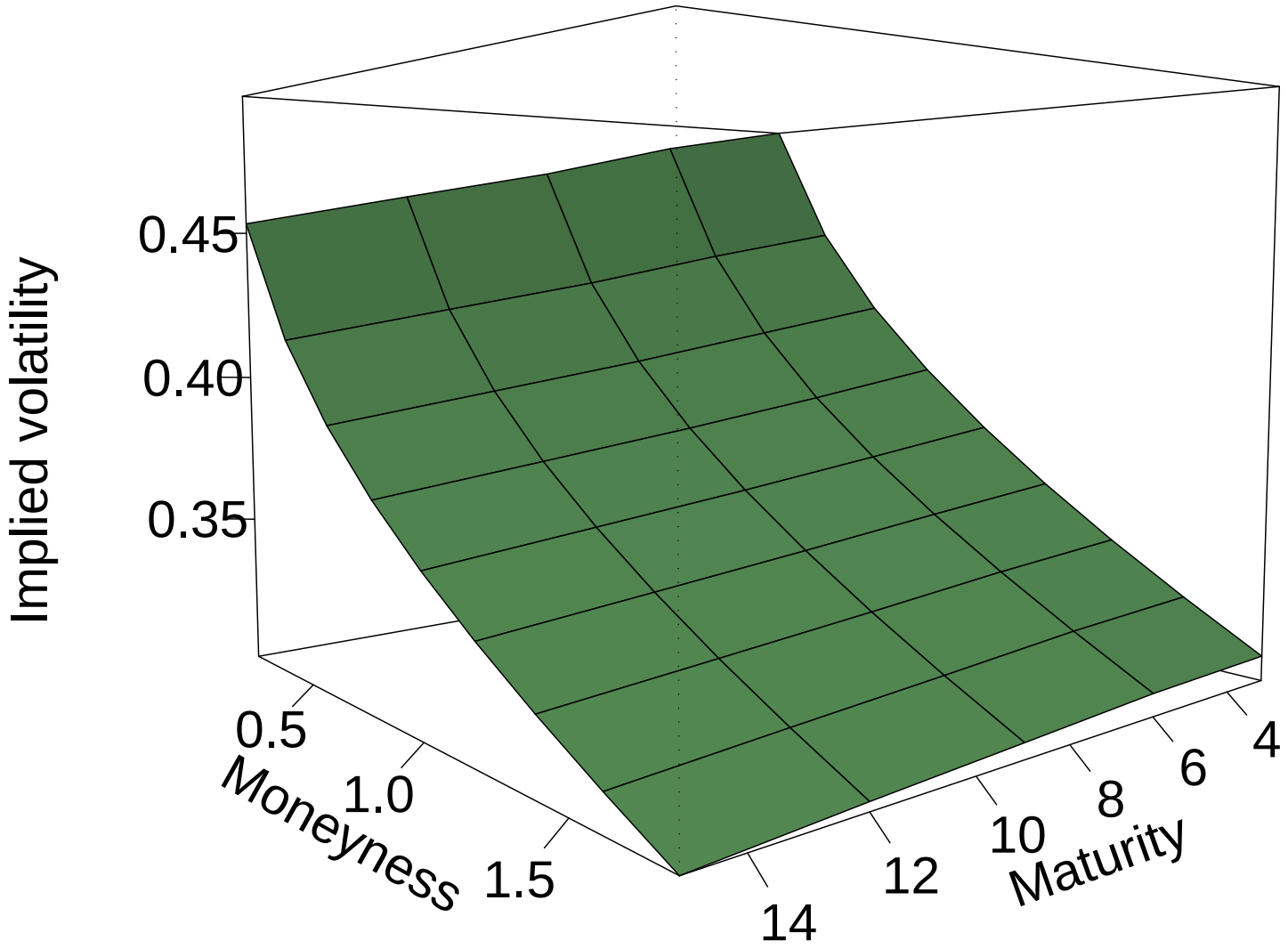


Figure 6. Nonparametric Estimate of SPD-Generated Densities for Continuously Compounded Returns. Estimated nonparametric density of the continuously compounded τ-period returns, $u_\tau = \ln(S_T/S_t)$, that is compatible with our nonparametric SPD estimator, for the same four maturities as in Figures 4 and 5. The corresponding Black–Scholes densities, evaluated at the average at-the-money implied volatility for each maturity, are overlaid.

Implied Volatility and Time Horizon



VIX

- In the model, ATM IVs (VIX) across various capital levels are counter-cyclical
- An economy with higher capital levels has a relatively lower VIX. This is a well-established empirical fact, so much so that the VIX is also referred to as the *"investor fear gauge."*

Many Risky Assets

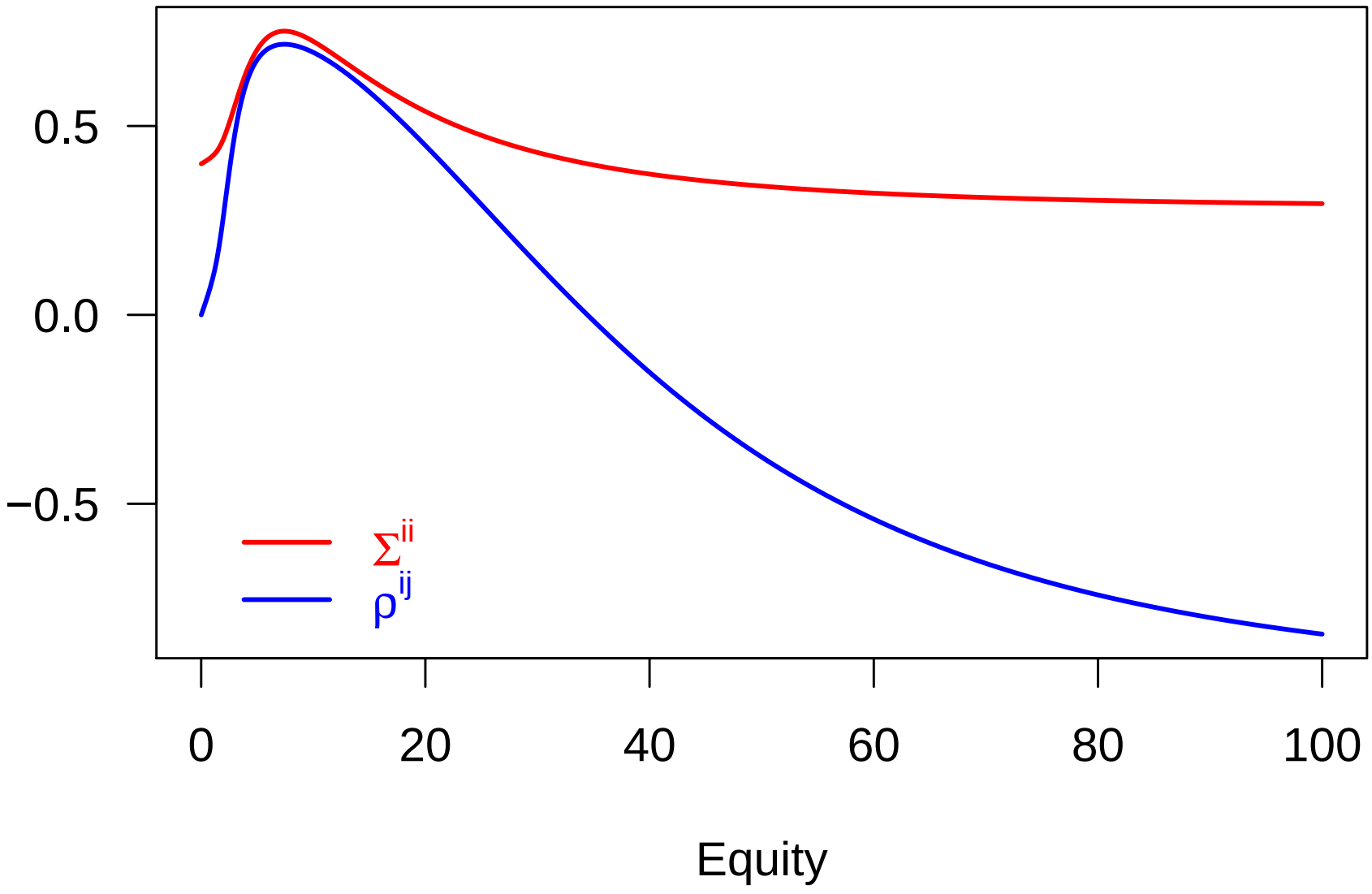
Special case of N risky securities case can be solved using ODE solution from the single risky asset case.

Assumption (Symmetry)

1. Diffusion matrix for z is $\tilde{\sigma}_z I_N$ where $\tilde{\sigma}_z > 0$ is a scalar and I_N is the $n \times n$ identity matrix.
2. $\delta^i = \delta$ for all i.

Let σ_t^{ij} be coefficient giving effect of change in demand shock of jth security on price of ith security.
From assumption of symmetry, we only need to solve for one diffusion variable, $\sigma_t^{ii} = \sigma_t^{11}$, since for $i \neq j$ the cross effects are tied down by $\sigma_t^{ij} = \sigma_t^{12} = \sigma_t^{11} - \eta\tilde{\sigma}_z$.
Define $x_t \equiv x(V_t)$ the solution to the ODE for single risky asset with η replaced by $\frac{\eta}{N}$.

Endogenous Correlation



Related Literature

- Two strands coming together
  - *Competitive equilibrium models of crashes:* Leland (1990), Genakoplos (1997) and Geanakoplos and Zame (2003)
  - *Corporate finance elements:* Shleifer and Vishny's (1997), Holmström and Tirole (2001), He and Krishnamurthy (2007)...
- *Portfolio constraints:* Basak and Croitoru (2000), Chabakauri (2008), Aiyagari and Gertler (1999), Gromb and Vayanos (2002), Brunnermeier and Pedersen (2007), Rytchkov (2008), Pavlova et al (2008)

- *Wealth effects:* Kyle and Xiong (2001). Xiong (2001) solves for fixed point numerically.
- *Lagrange multipliers associated with VaR constraints:* Danielsson, Shin and Zigrand (2004), Brunnermeier and Pedersen (2008), Danielsson and Zigrand (2008), Oehmke (2008).
- *Asset pricing taking account of balance sheet constraints:* Adrian, Etula and Shin (2009) [for exchange rates], Etula (2009) [commodities], Adrian, Moench and Shin (2009)

Discussion so far

- The single unifying mechanism why this one-factor construction works is the channel of endogenous risk-appetite (the *"risk-aversion gauge"*).
- In downturns the VaR constraints bind harder, inducing feedbacks as asset sales beget asset sales, delevering begets delevering, and forcing the FIs to become ever more risk-averse.
- Also, our model predicts: once a crisis hits and risk-aversion and all the other factors peak, it will take time for risk-aversion to come down as the capital basis of FIs replenishes to more normal levels.

There will always be strong procyclical forces

- FIs will still allocate capital to traders according to a VaR formula (moral hazard).
- Central clearing houses will impose daily settlement and contribute to procyclicality.
- Net derivative positions will still be at least partly delta hedged, implying reinforcing feedback effects (on top of the VaR induced feedback effects) if delta hedgers are net short gamma.
- Haircuts are naturally procyclical.

Implication for Capital — I

Dual role of capital

1. buffer against loss
2. constraint against excessive asset growth

"The received wisdom is that risk increases in recessions and falls in booms. In contrast, it may be more helpful to think of risk as increasing during upswings, as financial imbalances build up, and materialising in recessions."
Andrew Crockett in 2000:

Implication for Capital — II

The monster builds up quietly when we cannot see it

- Prepare for build–up a systemic build up
- Countercyclicality
- Capital requirements that depend on the rate of growth of various assets on a bank's balance sheet
- May be a short cut for systemic measures that look at the system on the whole
- Capital a function of the bank's growth of certain asset classes as well as a function of the overall banking industry's growth of those asset classes

Questions and Research Direction

- Contagion
  - From one asset to another (e.g. correlations)
  - From one institution to another
- Minsky moments — history–dependence
  - Long period of stability creates conditions for instability
  - Having V_t as sole state variable would helpas single state variable cannot take account of history-dependence (add mean-reverting factors to z?)
- Under what market conditions does speculative trading increase/decrease market stability
- Is harmonization (and higher quality) of risk management systems beneficial — competing risk systems
- Estimation