Fundamental Volatility and Financial Stability

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Motivation

- A long-standing debate about the sources of economic volatility
- Chicago-like view of volatility as driven by economic fundamentals and prices are reliable signals on values.
- Keynesian-like view emphasize belief-driven and excess volatility, Shiller (1981). Behavioral finance.
- We build a theoretical model where fundamental uncertainty may coexist non-fundamental sources of volatility.
- Beauty-contest where traders need to forecast aggregate investment to predict returns. Out-of-equilibrium beliefs of investors matter in case of failure, not otherwise.
- Conditions for success/failures are exploited to assess empirically the importance of fundamentals in actual volatility (use IBES data).

A simple setup

- A continuum of identical CARA financial investors (unit total mass), risk aversion a, choose a portfolio with two assets,
  - a safe asset with return $R > 0$,
  - a risky asset with (endogenous) return $\tilde{r}(k) = r(k) + \tilde{\varepsilon}$, $\tilde{\varepsilon} \sim \mathcal{N}(0, \sigma^2)$ when total investment in the asset is k, $r'(k) < 0$.
- Given CARA-Gaussian, investment of trader i when expecting k is

$$k_i = BR(k) = \frac{r(k) - R}{a\sigma^2}, \quad \text{with } k = \int_0^1 k_i \, \mathrm{d}i.$$

- Beauty-contest issue is solved in a Nash equilibrium, $k_i^* = BR(k^*)$ for every i, and so $k_i^* = k^* = BR(k^*)$.

Financial stability

Let us relax the a priori assumption that k^* is known:

1. Traders only know that $k \in I(0) = [k^{\inf}(0), k^{\sup}(0)]$, $k^* \in I(0)$.
2. $BR'(k) < 0 \Rightarrow k_i \in [BR(k^{\sup}(0)), BR(k^{\inf}(0))]$ for all i.
3. By summation, $k \in I(1) = \left[BR(k^{\sup}(0)), BR(k^{\inf}(0))\right] \cap I(0)$.

   $\vdots$

4. Traders know at step τ that $k \in I(\tau)$ where

$$I(\tau) = \left[BR(k^{\sup}(\tau - 1)), BR(k^{\inf}(\tau - 1))\right] \cap I(\tau - 1).$$

- Local convergence to k^* obtains iff $|BR'(k^*)| < 1$, i.e.,

$$\boxed{-r'(k^*) < a\sigma^2.}$$

- Intuition:
  $r'(k^*)$ close to 0 makes the return about fixed.
  $a\sigma^2$ large implies inertia in the investment decisions.

Linear-quadratic specification

- Given k, the (mean) profit of the monopolist in the good market when facing linear demand and quadratic cost is

$$\pi(k) = \max_q (A - Bq)\, q - \frac{Cq^2}{2k} = \frac{1}{2}\frac{A^2 k}{2Bk + C},$$

  and $\tilde{\pi}(k) = \pi(k) + \tilde{\varepsilon} k$.
- The return is decreasing and convex in k,

$$r(k) = \frac{\pi(k)}{k} - 1 = \frac{1}{2}\frac{A^2}{2Bk + C} - 1.$$

  Convexity: large risky firms (high k) favor financial stability.
- Local convergence iff

$$\frac{B}{C} < \frac{1}{2}\frac{a\sigma^2}{1+R}.$$

  New insight: a low price sensitivity B of demand, high monopoly price, large profits, and so a high investment k^*, which is stabilizing.

Competition in the good market

- Account for a multiplicity of risky assets (portfolio diversification).
- Mean return from firm j is $r(\mathbf{k}_j)$ with $\mathbf{k}_j = (k_j, \mathbf{k}_{-j})$.
- Only two different derivatives at $\mathbf{k}^*$,

$$r_1' = \frac{\partial r}{\partial k_j}(\mathbf{k}^*), \quad \text{and } r_2' = \frac{\partial r}{\partial k_z}(\mathbf{k}^*) \text{ for all } z \neq j.$$

- Two eigenvalues λ_1 and λ_2 drive convergence:
  $a\sigma^2\lambda_1 = (r_1' - r_2')$, same market size but broken symmetry.
  $a\sigma^2\lambda_2 = r_1' + (J-1)r_2'$, respect symmetry but higher market size.
- Convergence driven by λ_2 if $r_2' < 0$. It obtains iff

$$\boxed{-\left[r_1' + (J-1)r_2'\right] < a\sigma^2.}$$

Linear quadratic specification

- Linear demand and quadratic cost + Cournot competition.
- There exists a function $\bar{\beta}(J)$ decreasing in J and taking values between 0 and $1/(2J)$ such that stability obtains if and only if

$$\frac{B}{C} < \bar{\beta}(J)\frac{a\sigma^2}{1+R}.$$

In addition,

$$\frac{1+r(\mathbf{0})}{1+R} < 4(J-1)^2 \Rightarrow \bar{\beta}(J) = \frac{1}{2J}.$$

- Competition is destabilizing. Plays as a high B (low market power). For plausible values of the return, LHS $\simeq 1$, and thus $\bar{\beta}(J)$ is $1/(2J)$ for all $J > 1$.

Empirical illustration using IBES data

- Use net asset value (`nav`) to proxy k and the return on equity (`roe`) to proxy r (restrict to U.S. listed companies).
- Typical observation: The analyst 80474 reports on October 29, 2015 a prediction of 9.4 per cent for the 2015 `roe` (the forecast period end is December 31, 2015) of Talmer Bancorp (TLMR). The realized return was 10.14 per cent over this period.
- Predictions are collected from sell-side institutions (mostly brokers) while actual realizations are gathered from diverse sources, including press releases, company websites and public filings.
- Interpret the process iterated elimination of non best decisions as a short/medium run process and accordingly rely on analysts' forecasts formed within the same quarter as the forecast period end quarter.

Descriptive statistics

2-digit trbc sector	Number of companies	Number of markets[b]	Average nav[c]	Average roe[d,e]	Number of analysts[e]	Number of predictions[e]	Average roe prediction[d,e]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Energy (trbc 50)	284	27	84,430	14	166	7,872	23
Basic materials (trbc 51)	145	40	16,407	19	116	2,358	11
Industrials (trbc 52)	420	78	12,428	23	350	9,396	20
Consumer cyclicals (trbc 53)	406	117	10,104	23	273	9,644	16
Consumer non-cyclicals (trbc 54)	111	37	17,199	22	76	1,315	14
Financials (trbc 55)	933	55	77,962	11	696	103,119	10
Healthcare (trbc 56)	216	33	30,360	16	114	1,756	10
Technology (trbc 57)	526	50	39,458	20	354	12,887	17
Telecommunication services (trbc 58)	39	7	73,725	16	49	957	10
Utilities (trbc 59)	64	9	44,456	8	25	783	5

Notes:

b. 10-digit level of the Thomson Reuters Business Classification.
c. Net asset value expressed in millions USD. Mean of the sum of company nav per market and time period.
d. Expressed in per cent.
e. Data from the subsample of firm $\times$ time period with completed positive nav and roe.

Return sensitivity to capital

$$\texttt{roe}_{jmt} = \beta \log(\texttt{nav}_{mt}) + \texttt{time}_t + \texttt{market}_m + \varepsilon_{jmt}$$

- $\texttt{roe}_{jmt}$ = return of (`ticker`) firm j operating in market m at time t.
- $\texttt{nav}_{mt}$ = sum of net asset values of all firms j in market m subject to some prediction about the `roe` in period t.

	Return on equity $\texttt{roe}_{jmt}$			
	(1)	(2)	(3)	(4)
Net asset value $\log(\texttt{nav}_{mt})$	-1.437^{***}	-1.437^{***}	-1.372^{***}	-1.354^{**}
	(0.130)	(0.114)	(0.105)	(0.619)
Constant	31.283^{***}	31.283^{***}		
	(1.415)	(1.418)		
Observations	42,892	42,892	42,892	42,892
R^2	0.0028	0.0028	0.0075	0.0381
Standard error		Robust	Robust	Robust
Fixed effect			Time[a]	Time & Market[b]

Notes: *** (resp., ** and *) 1 (resp., 5 and 10) per cent level.
a. Forecast period end (`fpedats` IBES variable).
b. 10-digit `trbc` level.

- In the sequel, estimate 10-digit `trbc` sensitivities (β_m) to get

$$\hat{r}'_{mt} = \frac{J_m \hat{\beta}_m}{\texttt{nav}_{mt}}.$$

Return sensitivities and prediction errors

$$\log(e^{a\tau}_{jmt}) = \gamma \log(|\hat{r}'_{mt}|) + \delta \Delta^{a\tau}_{jmt} + \texttt{time}_t + \texttt{market}_m + \texttt{broker}^{a\tau}_{jmt} + \varepsilon^{a\tau}_{jmt},$$

- Prediction error made by analyst a at time τ is defined as

$$e^{a\tau}_{jmt} = \left| \frac{\mathbb{E}^{a\tau}\left[\texttt{roe}_{jmt}\right] - \texttt{roe}_{jmt}}{\texttt{roe}_{jmt}} \right|.$$

- $\Delta^{a\tau}_{jmt}$ = number of days between τ and the forecast end period t.

	Prediction error $\log(e^{a\tau}_{jmt})$		
	(1)	(2)	(3)
Return sensitivity (γ)	0.055***	0.040***	0.039***
	(0.021)	(0.019)	(0.019)
Time to realization (δ)			0.028***
			(0.008)
Observations	142,086	136,258	136,258
R^2	0.202	0.199	0.199
Standard error	Robust	Robust	Robust
Cluster	Broker	Broker	Broker
Fixed effects	Time & Market & Broker	Time & Market & Broker	Time & Market & Broker

Notes: *** (resp., ** and *) 1 (resp., 5 and 10) per cent level.

IBES economy-wide estimate of fundamental volatility

Estimate the two-regime model by OLS

$$e^{a\tau}_{jmt} = \zeta \texttt{stab}_{mt} + \delta \Delta^{a\tau}_{jmt} + \texttt{time}_t + \texttt{sector}_s + \texttt{broker}^{a\tau}_{jmt} + \varepsilon^{a\tau}_{jmt}$$

where $\texttt{stab}_{mt} = 0$ if $|\hat{r}'_{mt}| < \bar{r}$, and 1 otherwise.

- Scan for $\bar{r}$ over percentiles of the $|\hat{r}'_{mt}|$ distribution. Scan results
- The variant with the highest R-squared obtains for $\bar{r} = 1.519 \times 10^{-3}$.
- $\bar{r} = 1.519 \times 10^{-3}$ is the 88th percentile of the $|\hat{r}'_{mt}|$ distribution.
- $\hat{\zeta}$ is 0.021 (t-value 2.265)
  $\rightarrow$ Prediction errors are 2.1 percentage points higher in the high-sensitivity regime where $|\hat{r}'_{mt}| > 1.519 \times 10^{-3}$.

Quantifying fundamentals: Option 1

- Compute the (average) `roe` standard error in markets $\times$ quarter with $\texttt{stab}_{mt} = 0$.
- Volatility in the 'stable' regime $\sigma = 7.436$.
- The empirical `roe` standard error is 11.107 in the high-sensitivity regime. The contribution of non-fundamental factors to volatility would thus be $11.107 - 7.436 = 3.671$, i.e., one-third of the observed volatility in this regime.
- In the whole sample, the empirical `roe` standard error is 8.684. The difference $8.684 - 7.436 = 1.248$ still corresponds to 15 per cent of the observed volatility.

Quantifying fundamentals: Option 2

- $a\sigma^2 = 1.519 \times 10^{-3}$.
- Median estimate $a = 3.4 \times 10^{-5}$ in Cohen and Einav (2007) gives

$$\sigma^2 = \frac{1.519 \times 10^{-3}}{3.4 \times 10^{-5}} \Leftrightarrow \sigma = 6.684.$$

- Similar to the standard error of 7.436 in markets in the low-sensitivity regime. Suggests that both approaches are not inconsistent.

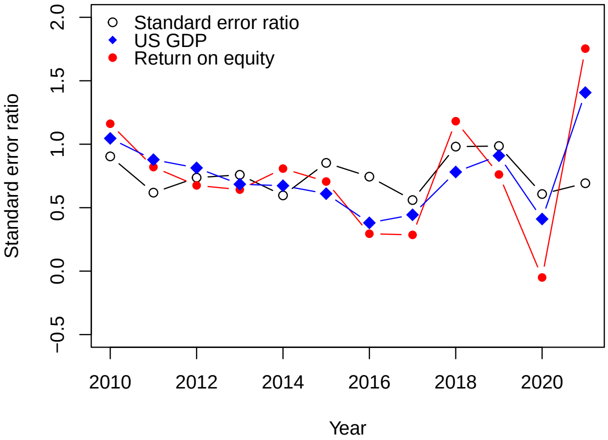
Sectoral estimates

2-digit trbc sector	roe standard error – stable markets only – (1)	roe standard error – all markets – (2)	σ_s (3)	a_s (4)
Energy (trbc 50)	6.71	8.65	2.26	3.87×10^{-6}
Basic materials (trbc 51)	5.87	6.00	26.92	7.14×10^{-4}
Industrials (trbc 52)	22.89	10.59	1.96	2.49×10^{-7}
Consumer cyclicals (trbc 53)	13.86	10.85	23.55	9.82×10^{-5}
Consumer non-cyclicals (trbc 54)	7.20	7.54	39.52	1.02×10^{-3}
Financials (trbc 55)	2.20	4.53	0.70	3.40×10^{-6}
Banking services (trbc 551010)	4.05	4.15	5.63	6.57×10^{-5}
Investment banking and services (trbc 551020)	2.95	4.98	0.26	2.62×10^{-7}
Insurance (trbc 553010)	0.94	3.65	1.72	1.14×10^{-4}
Real estate operations (trbc 554020)	11.72	11.89	25.43	1.59×10^{-4}
Residential and commercial REITs (trbc 554030)	2.78	3.20	2.52	2.79×10^{-5}
Collective investments (trbc 555010)	3.82	3.70	11.37	3.01×10^{-4}
Healthcare (trbc 56)	6.15	12.42	0.61	3.29×10^{-7}
Technology (trbc 57)	9.03	8.08	7.01	2.04×10^{-5}
Telecommunication services (trbc 58)	6.52	6.61	25.93	5.38×10^{-4}
Utilities (trbc 59)	3.99	4.78	2.15	9.82×10^{-6}

Note: Values of σ_s in Column (3) use the mean (economy-wide) estimate $a = 3.4 \times 10^{-5}$ in Table 5 in Cohen and Einav (2007). REIT (Real Estate Investment Trust).

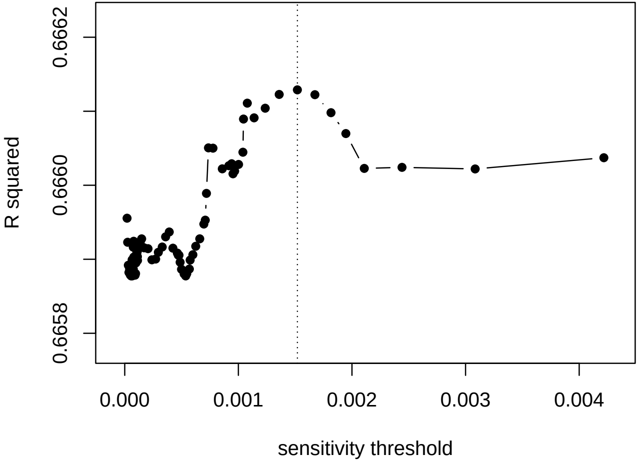
- Low risk aversion if non-fundamental volatility matters

Time decomposition



- Non-fundamental volatility when global macroeconomic downturns

Scanning for the best fit



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