# Leverage in Financial Markets

## An ACE model of Portfolio Choice and Trading

Klaus Reiner Schenk-Hoppé[1,2]
joint work with Terje Lensberg[2] and Dan Ladley[3]

[1]University of Leeds
[2]Norwegian School of Economics, Bergen
[3]University of Leicester

February 24, 2014
http://ssrn.com/abstract=2128599
ERC grant PIEF-GA-2010-274454 acknowledged

# Our goal

Forecast
&
quantify

impact of financial regulation

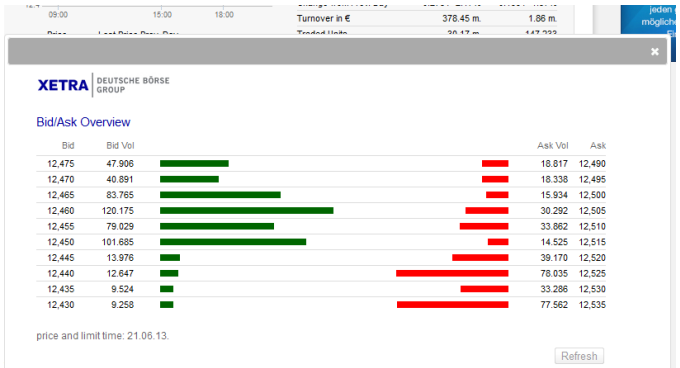
in order-driven markets

- Portfolio choice (incl. leverage, short-selling)
- Trading activity
- Market quality (incl. liquidity, spread)
- Price dynamics

# with the challenge to

create an ACE model that captures
the
interplay
of
portfolio choice & trading

BERNARD L. MADOFF
Investment Securities LLC



# Assets

**Stocks and bonds** issued by aggregate firm
EBIT-process

$$de_t/e_t = \eta^{s_t}\left(\mu^{s_t} - e_t\right)dt + \sigma\, dW_t$$

$s_t = 0, 1$ unobservable (boom, recession), $\mu^{s_t}$ earnings level, $\eta^{s_t}$ mean-reversion speed

- Interest to bondholders ($5\%$ pa), residual income to shareholders
- Bayesian estimate of regime gives share's risk-neutral value.

Goldstein, Ju, Leland ('01) + Pastor, Veronesi ('03), calibrate!

# Regulations

**Tax** 10bp on buyer (stocks and bonds)
**Short-selling ban**
**Leverage ban**

Short/leveraged positions subject to **margin requirement**

$$\textit{Equity} \geq M \times |\textit{value of stock position}|$$

and broker fee on margin loans (2.5% p.a.)

Initial/maintenance margin requirement $M = 50\% \ / \ 25\%$
violation leads to **margin call**.

# Agents

Fund managers pursuing

- **quantitative** strategies
- computer program (book, portfolio, fundamentals, news)

**Evolution** of trader population

$\rightsquigarrow$ **genetic programming** algorithm w. tournament selection

**Equilibrium** with heterogeneous population of 20,000 agents

---

It's better to breed  than to construct

# Factor analysis: Investment styles

| No. | Variable / Factor | Base case $F_1$ | Base case $F_2$ | Base case $F_3$ | No short $F_1$ | No short $F_2$ | No short $F_3$ | No leverage $F_1$ | No leverage $F_2$ | No leverage $F_3$ | Taxation $F_1$ | Taxation $F_2$ | Taxation $F_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $B_1$ | Size (log relative wealth) | | | | | | | | | | | | |
| $B_2$ | Relative trade volume | | | | | | | | | | | | |
| $B_3$ | Limit order | | | | | | | | | | | | |
| $B_4$ | Dist. from mkt portfolio | | | | | | | | | | | | |
| $I_1$ | Bid-ask spread | | | | | | | | | | | | |
| $I_2$ | Stock holdings | | | | | | | | | | | | |
| $I_3$ | Bond holdings | | | | | | | | | | | | |
| $I_4$ | Prices | | | | | | | | | | | | |
| $I_5$ | RNP | | | | | | | | | | | | |
| $I_6$ | Price change | | | | | | | | | | | | |
| $I_7$ | Change in RNP | | | | | | | | | | | | |
| $I_8$ | Margin account | | | | | | | | | | | | |
| | SS loadings | 2.20 | 1.50 | 1.49 | 2.84 | 1.45 | 1.38 | 2.07 | 1.76 | 1.24 | 2.44 | 1.13 | 1.41 |
| | Proportion Var. | 0.18 | 0.12 | 0.12 | 0.24 | 0.12 | 0.11 | 0.17 | 0.15 | 0.10 | 0.20 | 0.09 | 0.12 |
| | Cumulative Var. | 0.18 | 0.31 | 0.43 | 0.24 | 0.36 | 0.47 | 0.17 | 0.32 | 0.42 | 0.20 | 0.30 | 0.42 |

# Endogenous Heterogeneity

**Uninformed** traders

Market makers — carry traders

**Informed** traders

Value traders — news traders

**Size** effect

Market portfolio funds — gamblers

# Information usage

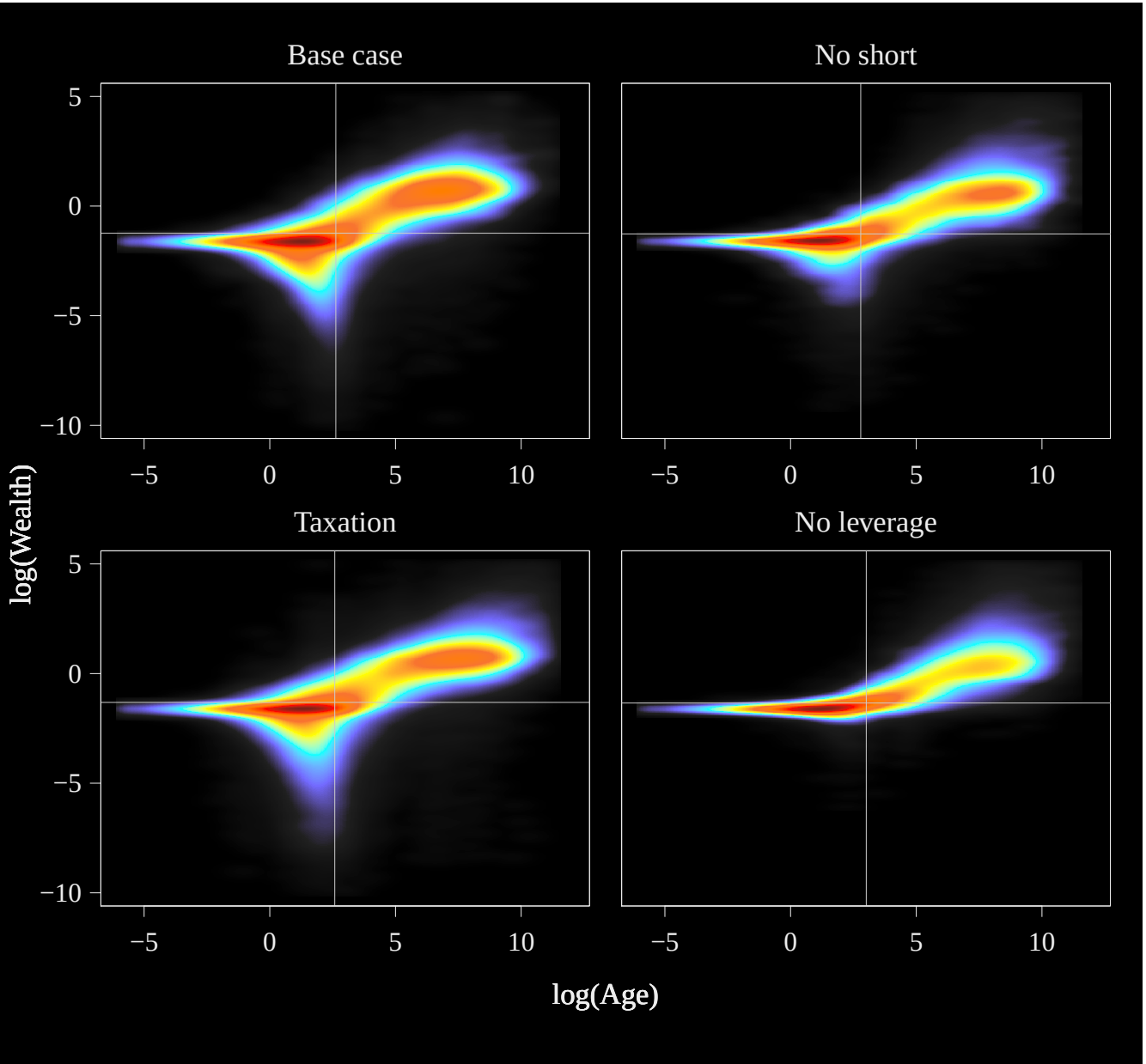
| Variable | Base case | No short | No leverage | Taxation |
|---|---|---|---|---|
| Liquidity suppliers | 18.7% | 17.1% | 16.8% | 19.0% |
| | (0.000) | (0.091) | (0.061) | (0.766) |
| Value traders | 24.6% | 21.9% | **32.4%** | **16.7%** |
| | (0.000) | (0.208) | **(0.001)** | **(0.000)** |
| News traders / arbs. | 41.9% | **49.6%** | **36.5%** | **47.3%** |
| | (0.000) | **(0.000)** | **(0.011)** | **(0.012)** |
| Informed traders | 83.3% | 85.2% | 82.0% | **78.2%** |
| | (0.000) | (0.100) | (0.296) | **(0.000)** |

- Lopsided speculation makes news trading attractive
- No margin trade, then better focus on value
- Tax puts focus on news, not value!

# Margin trading during extreme events

| | Base case | | No short | | Taxation | |
|---|---|---|---|---|---|---|
| | $\Delta p < 0$ | $\Delta p > 0$ | $\Delta p < 0$ | $\Delta p > 0$ | $\Delta p < 0$ | $\Delta p > 0$ |
| $\Delta$ *short interest* | | | | | | |
| Mean | **5.53** | **-10.69** | | | 5.62 | -12.78 |
| Median | 4.78 | -6.43 | | | 5.18 | -9.26 |
| $\Delta$ *long leverage* | | | | | | |
| Mean | **4.02** | **-2.62** | 4.97 | -3.62 | 6.05 | -4.56 |
| Median | 4.32 | -2.36 | 6.02 | -3.88 | 6.56 | -4.62 |
| *Net marg. trade* | | | | | | |
| Mean | **-2.44** | **8.76** | **4.97** | **-3.62** | -1.06 | 9.77 |
| Median | -1.68 | 3.24 | 6.02 | -3.88 | -0.79 | 5.20 |
| $\Delta$ *stock price* | | | | | | |
| Mean | -8.96 | 11.42 | -8.77 | 8.03 | -9.27 | 10.11 |
| Median | -8.58 | 9.83 | -8.30 | 7.84 | -8.57 | 8.85 |
| # obs. | 122 | 78 | 155 | 45 | 118 | 82 |

# Age vs wealth



# Summing up

ACE **equilibrium** model with

- institutional detail (microstructure etc)
- delegated fund management

to **quantify** equilibrium effects of regulation

**Endogenous heterogeneity**

- usage of information: Value vs news
- market making, gambling, ...
- short squeezes,...

# The End

**Portfolio choice.** Tax: market portf. ↑, leverage →.

| Position | Base case | No short | No leverage | Taxation |
|---|---|---|---|---|
| Short | **4.06** | | | **4.62** |
| | (0.000) | | | (0.000) |
| All bond | 2.49 | 6.35 | 10.47 | 1.12 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Overweight bond | 13.39 | 29.09 | 11.75 | 9.69 |
| | (0.000) | (0.000) | (0.028) | (0.000) |
| Market portfolio | **45.14** | 42.49 | 47.35 | **53.15** |
| | (0.000) | (0.074) | (0.115) | (0.000) |
| Overweight stock | 24.32 | 10.76 | 13.43 | 23.16 |
| | (0.000) | (0.000) | (0.000) | (0.261) |
| All stock | 5.46 | 3.83 | 17.00 | 3.90 |
| | (0.000) | (0.001) | (0.000) | (0.000) |
| Leveraged long | **5.10** | **7.48** | | **4.34** |
| | (0.000) | (0.000) | | (0.000) |

## Long swings

| | Base case | No short | No leverage | Taxation |
|---|---|---|---|---|
| Peak-to-trough | 43.1% | **39.6%** | **38.3%** | 42.4% |
| | (0.000) | **(0.000)** | **(0.000)** | (0.055) |
| High | 21.49 | 22.15 | 21.55 | 21.59 |
| | (0.000) | (0.100) | (0.872) | (0.781) |
| Low | 8.16 | **9.37** | **9.39** | 8.48 |
| | (0.000) | **(0.000)** | **(0.000)** | (0.004) |
| Average price | 15.37 | **16.45** | 16.10 | 15.47 |
| | (0.000) | **(0.000)** | (0.000) | (0.388) |
| Volatility (ann.) | 17.36% | **14.73%** | **14.29%** | 16.53% |
| | (0.000) | **(0.000)** | **(0.000)** | (0.010) |

- Tax no effect
- Bans dampen long swings by supporting prices in bad times
- Bans reduce volatility

**Trading activity.** Leveraged most active. Overall pattern stable.

| Position | Base case | No short | No leverage | Taxation |
|---|---|---|---|---|
| Short | **5.33** | | | 6.26 |
| | **(0.000)** | | | (0.000) |
| All bond | 6.63 | 3.75 | 2.25 | 12.78 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Overweight bond | 1.41 | 1.06 | 2.44 | 1.67 |
| | (0.000) | (0.000) | (0.000) | (0.005) |
| Market portfolio | **0.39** | **0.49** | **0.52** | **0.32** |
| | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Overweight stock | 0.48 | 1.29 | 1.60 | 0.46 |
| | (0.000) | (0.000) | (0.000) | (0.537) |
| All stock | 2.42 | 4.99 | 1.55 | 3.92 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Leveraged long | **5.24** | 3.96 | | 6.72 |
| | **(0.000)** | (0.000) | | (0.000) |

**Market quality.** Less trade. Tax ↑↑ trading costs

| | Base case | No short | No leverage | Taxation |
|---|---|---|---|---|
| Bid-ask spread (bp) | 10.18 | 9.60 | 10.93 | **20.64** |
| | (0.000) | (0.059) | (0.015) | **(0.000)** |
| Market impact (bp) | 1.07 | 0.91 | 1.96 | **5.26** |
| (endogenous) | (0.000) | (0.013) | (0.000) | **(0.000)** |
| Market impact (bp) | 3.11 | 5.00 | **13.14** | **12.34** |
| (50,000 shares) | (0.000) | (0.000) | **(0.000)** | **(0.000)** |
| Average order size | 6,067 | 3,330 | 2,012 | 1,980 |
| (number of shares) | (0.000) | (0.000) | (0.000) | (0.000) |
| Days between trades | 5.23 | 6.21 | **17.73** | **8.95** |
| | (0.000) | (0.000) | **(0.000)** | **(0.000)** |
| Turnover per day | 2.46% | **1.15%** | **0.24%** | **0.49%** |
| | (0.000) | **(0.000)** | **(0.000)** | **(0.000)** |