The Impact of Short-Selling Constraints on Financial Market Stability

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Definition

If a mean-variance investor, who demands

\[ A_{i,t}(p) = \frac{E_i[t+p_{t+1}+y_{t+1}] - (1+r_f)p}{a_i V_i[t+p_{t+1}+y_{t+1}]} , \]

expects positive return then \( A_{i,t} > 0 \), i.e. investor has “long” position

expects negative return then \( A_{i,t} < 0 \), i.e. investor has “short” position
Price Correction

\[ A_{i,t}(p) = \frac{E_{i,t}[p_{t+1} + y_{t+1}] - (1 + r_f)p}{a_i V_{i,t}[p_{t+1} + y_{t+1}]} \]

If price change is not expected

\[ A_{i,t} > 0 \quad \text{iff} \quad \bar{y} > pr_f, \text{ i.e., when asset is undervalued} \]

\[ A_{i,t} < 0 \quad \text{iff} \quad \bar{y} < pr_f, \text{ i.e., when asset is overvalued} \]

\[ A_{i,t} = 0 \quad \text{iff} \quad \bar{y} = pr_f, \text{ i.e., when price is on the fundamental value} \]

Notice that if price responds to the change in demand/supply, then strategy “buy low, sell high” is self-reinforcing and leads to price correction.
Mechanism

1. investor’s broker “locates” stocks
   - stock is borrowed
   - stock is actually not borrowed
2. security is sold and delivered to the buyer
3. investor closes (“covers”) his position, buying shares back
4. investor return the shares

*Note: The rebate may be credited in full or part to the short seller. Furthermore, any fee may be passed onto the short seller.*
Costs and risks of the short-selling strategy

- profit is limited, but loss are unlimited
- borrowing a stock might be difficult in an absence of a market for it
- a borrowed stock can be recalled at any moment by the lender
- legal restrictions
- hostility from society
Short Selling

- increases liquidity and informational efficiency, and eliminates mis-pricing


**Empirics:** Jones and Lamont (JFE, 2002), Lamont and Thaler (JPE, 2003), Diether, Lee and Werner (RFS, 2008)

- increases volatility and may lead to market crashes

  ▶ Lecce, Lepone and Segara (WP, 2006), Setzu and Marchesi (WP, 2008)
This Paper

- Take a model with heterogeneous agents (Brock and Hommes, JEDC, 1998)
- Introduce the short-selling constraints $\bar{A} > 0$:
  \[
  A_{i,t}(p) = \max \left( -\bar{A}, \frac{E_{i,t}[p_{t+1}] + \bar{y} - (1 + r_f)p}{a\sigma^2} \right)
  \]
- Analyse stability of the fundamental steady-state and amplitude of oscillations
Dynamical model of financial market

1. **two assets**
   - **riskless**: risk-free interest rate $r_f$
   - **risky**: price $p_t$ and i.i.d. dividend $y_t$ with mean $\bar{y}$
     
     supply per investor $\bar{S}$ fundamental price $p^f = (\bar{y} - a\sigma^2\bar{S})/r_f$

2. **mean-variance demand** for the risky asset
   
   $$z_{h,t} = E_{h,t} \left[ p_{t+1} + y_{t+1} - (1 + r_f) p_t \right] / a \sigma^2$$

3. **heterogeneous expectations** of agents
   - **fundamentalists**: $E_{f,t}[p_{t+1}] = p_f$
   - **trend-followers**: $E_{c,t}[p_{t+1}] = p_f + g (p_{t-1} - p_f), \quad g \geq 1$
Dynamical model of financial market

4. **market clears**, price $p_t$ is determined

\[ p_t - p^f = \frac{1}{1 + r_f} \sum_{h=1}^{H} n_{h,t} E_{h,t}[p_{t+1} - p^f] = \frac{g}{1 + r_f} n_{2,t}(p_{t-1} - p^f) \]

5. **performances** are computed

\[ A_{h,t-1} r_t = \left( \frac{E_{h,t-1}[x_t] - (1 + r_f)x_{t-1}}{a \sigma^2} + \bar{S} \right) \left( x_t - (1 + r_f)x_{t-1} + a\sigma^2\bar{S} \right) \]
Evolutionary updating of types

6. agents choose a new type for the next period
   
   ▶ past profits of two types
   
   \[ U_{f,t} = \pi_{f,t} - C \quad U_{c,t} = \pi_{c,t} \]
   
   ▶ fraction of type \( h \) is computed as
   
   \[ n_{h,t+1} = \frac{\exp[\beta U_{h,t}]}{Z_t}, \text{ with } Z_t = \sum_h \exp[\beta U_{h,t}] \]
   
   ▶ \( \beta \) is the intensity of choice
   
   ▶ \( \beta = 0: \) equal distribution \( n_{f,t+1} = n_{c,t+1} = 0.5 \)
   
   ▶ \( \beta = +\infty: \) all traders use the optimal strategy
Two regimes: stable and volatile

Zero Supply

Positive Supply
Two regimes: stable and volatile

- $\beta < \beta^*$: all agents have 0 assets
- $\beta^* < \beta < \beta^{**}$: “optimistic” type is long, “pessimistic” is short
- $\beta > \beta^{**}$: fluctuations
Two attractors: overvaluation and undervaluation
Short-Sell Constraints

Assume $\bar{A} > 0$ and impose a restriction:

$$A_i,t(p_t) = \max \left\{ -\bar{A}, \frac{E_{i,t}[p_{t+1}] + \bar{y} - (1 + r_f)p_t}{\alpha \sigma^2} \right\}.$$
Short-selling constraints: $\bar{A} = 1$

- primary bifurcation is not affected
- asymmetry between upper and lower attractors emerges
- the mispricing (amplitude of oscillations) increases
Adjusted demand and supply

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Effect of short-selling constraints on upper trend
Short-selling constraints vs. No constraints

When the short sell constraints are binding:

- Level of price becomes higher
- Smaller liquidity
- Level of return is higher (smaller in absolute value)
- Capital gain
- Fundamentalists’ performance worsens w.r. to chartists’
- \( (A_{f,t-1} - A_{c,t-1})r_t \)
- Fraction of fundamentalists is lower
Effect of short-selling constraints on crash

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The Impact of Short-Selling Constraints on Financial Market Stability
Short-sell constraints vs. No constraints

When the crash takes place under short-sell constraints:

- level of price is higher
- return is extremely low
- fractions of fundamentalists is much higher
Recall Lower Attractor vs. Upper Attractor

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Lower Attractor without and with Crash

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Summary

Under short-sell constraints

- primary bifurcation (of the fundamental steady-state) is not affected
  (local stability is a local property, and the restrictions at the fundamental steady-state are not binding)

- there is an asymmetry between upper and lower attractors
  (constrained investors are present there in different proportions)

- amplitude of oscillations on the upper attractor increases
  (investors who try to eliminate mis-pricing are short)
Dependence on $\bar{A}$ for zero and positive supply
Fundamentalists vs. Contrarians

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Conclusion

- Short-sell constraints affect the amplitude of cycle and drive price up
  - liquidity effect
  - “composition” of the ecology effect

- Short-sell constraints do not affect the local stability properties of the fundamental steady-state
Fundamentalists vs. Sophisticated Trend Followers

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