The Impact of Short-Selling Constraints on Financial Market Stability

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Definition

If a mean-variance investor, who demands

$$A_{i,t}(p) = \frac{\mathrm{E}_{i,t}[p_{t+1} + y_{t+1}] - (1 + r_f)p}{a_i \, \mathrm{V}_{i,t}[p_{t+1} + y_{t+1}]} \,,$$

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

$$A_{i,t}(p) = \frac{\mathrm{E}_{i,t}[p_{t+1} + y_{t+1}] - (1 + r_f)p}{a_i \, \mathrm{V}_{i,t}[p_{t+1} + y_{t+1}]},$$

If price change is not expected

$A_{i,t} > 0$ iff $\bar{y} > pr_f$, i.e., when asset is undervalued

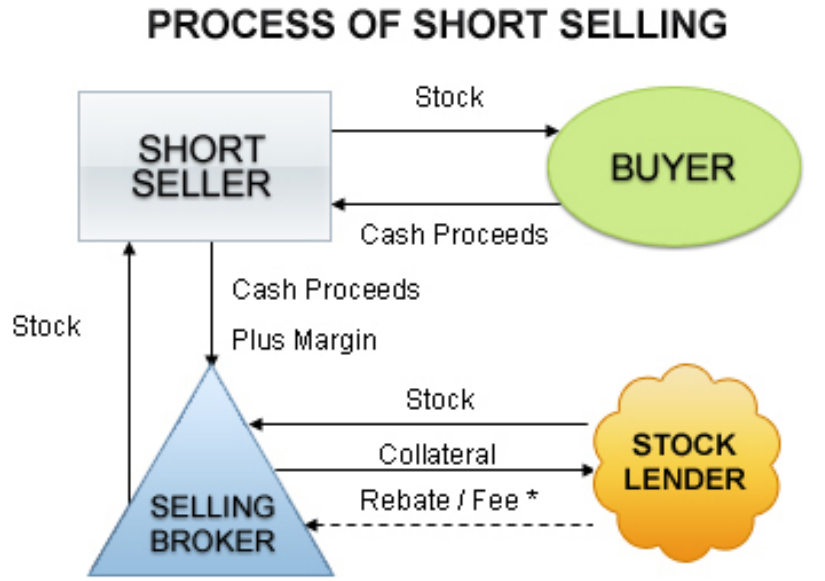
$A_{i,t} < 0$ iff $\bar{y} < pr_f$, i.e., when asset is overvalued

$A_{i,t} = 0$ iff $\bar{y} = pr_f$, 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



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

  Theory: Miller (JF, 1977), Harrison and Kreps (QJE, 1978), Diamond and Verrecchia (JFE, 1987), Gallmeyer and Hollifield (JF, 2008)

  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 $\bar{A} > 0$:

$$A_{i,t}(p) = \max\left(-\bar{A}, \frac{\mathrm{E}_{i,t}[p_{t+1}] + \bar{y} - (1 + r_f)p}{a\sigma^2}\right)$$

- 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

$$z_{h,t} = E_{h,t}\left[p_{t+1} + y_{t+1} - (1 + r_f)\, p_t\right] \Big/ a\,\sigma^2$$

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

Dynamical model of financial market

4. market clears, price p_t is determined

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

5. performances are computed

$$A_{h,t-1} r_t = \left(\frac{\mathrm{E}_{h,t-1}[x_t] - (1+r_f)x_{t-1}}{a\,\sigma^2} + \bar{S} \right) \left(x_t - (1+r_f)x_{t-1} + a\sigma^2 \bar{S} \right)$$

Evolutionary updating of types

6. agents choose a new type for the next period
   - past profits of two types

$$U_{f,t} = \pi_{f,t} - C \qquad U_{c,t} = \pi_{c,t}$$

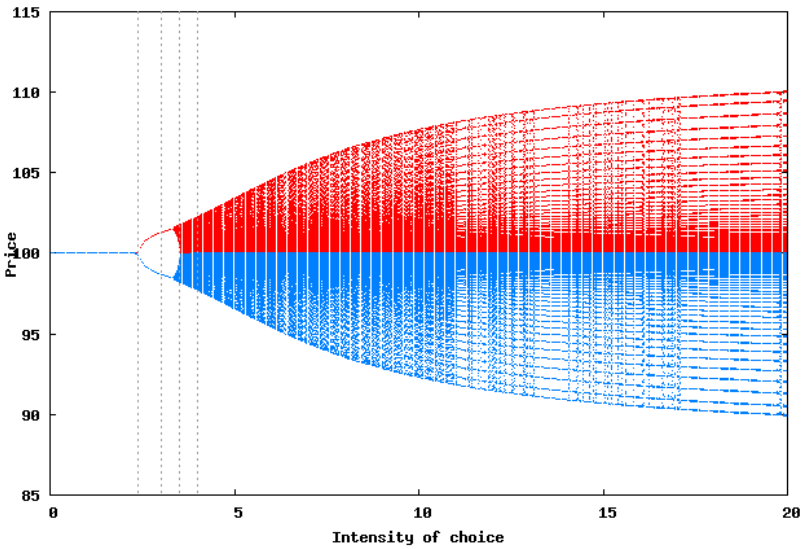
   - fraction of type h is computed as

$$n_{h,t+1} = \exp[\beta\, U_{h,t}] \Big/ Z_t, \text{ with } Z_t = \sum\nolimits_h \exp[\beta\, U_{h,t}]$$

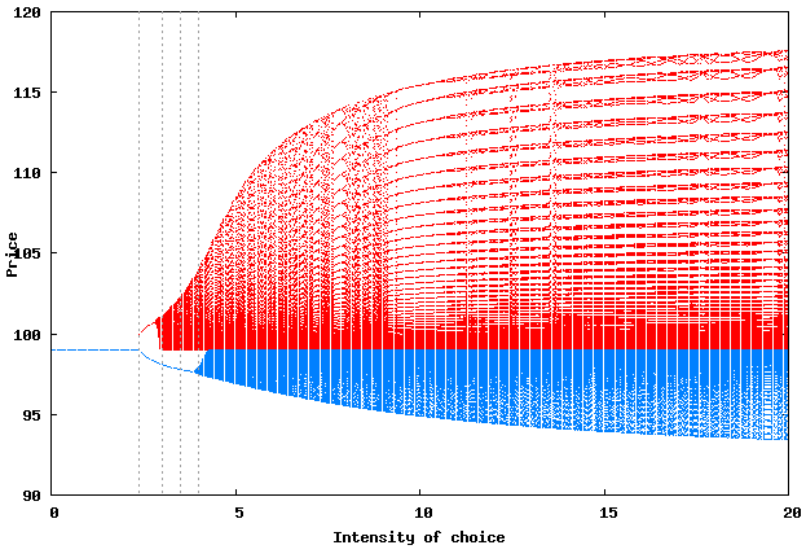
     - β is the intensity of choice
     - $\beta = 0$: equal distribution $n_{f,t+1} = n_{c,t+1} = 0.5$
     - $\beta = +\infty$: all traders use the optimal strategy

Two regimes: stable and volatile

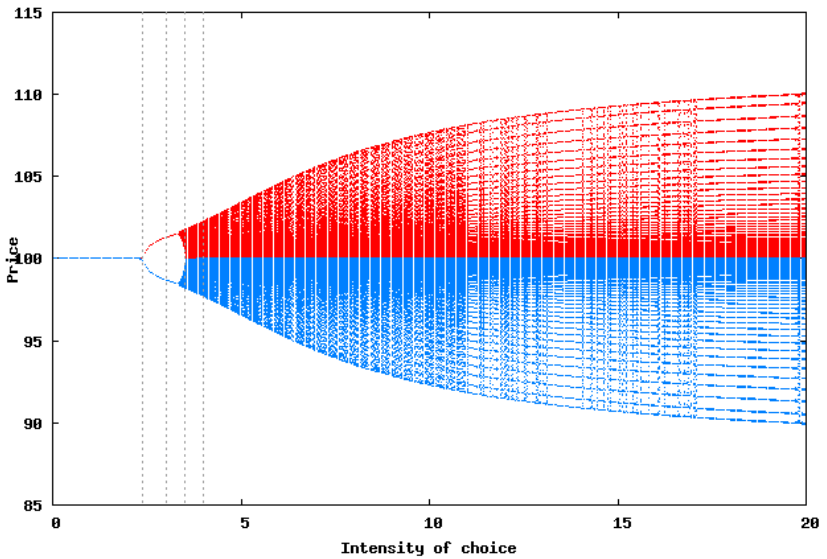
Zero Supply



Positive Supply

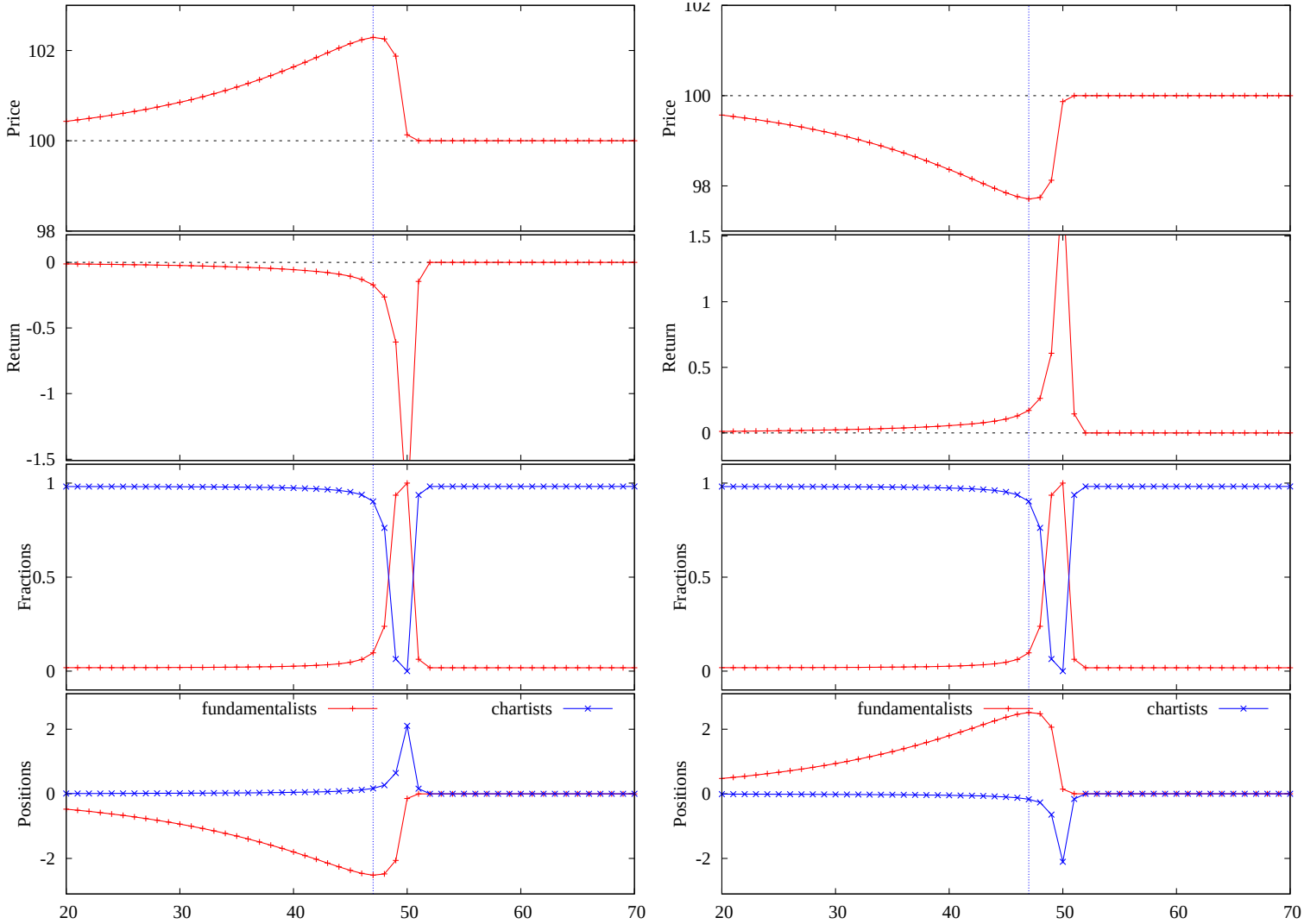


Two regimes: stable and volatile



- $\beta < \beta^*$:
  all agents have 0 assets
- $\beta^* < \beta < \beta^{**}$:
  "optimistic" type is long,
  "pessimistic" is short
- $\beta > \beta^{**}$:
  fluctuations

Two attractors: overvaluation and undervaluation

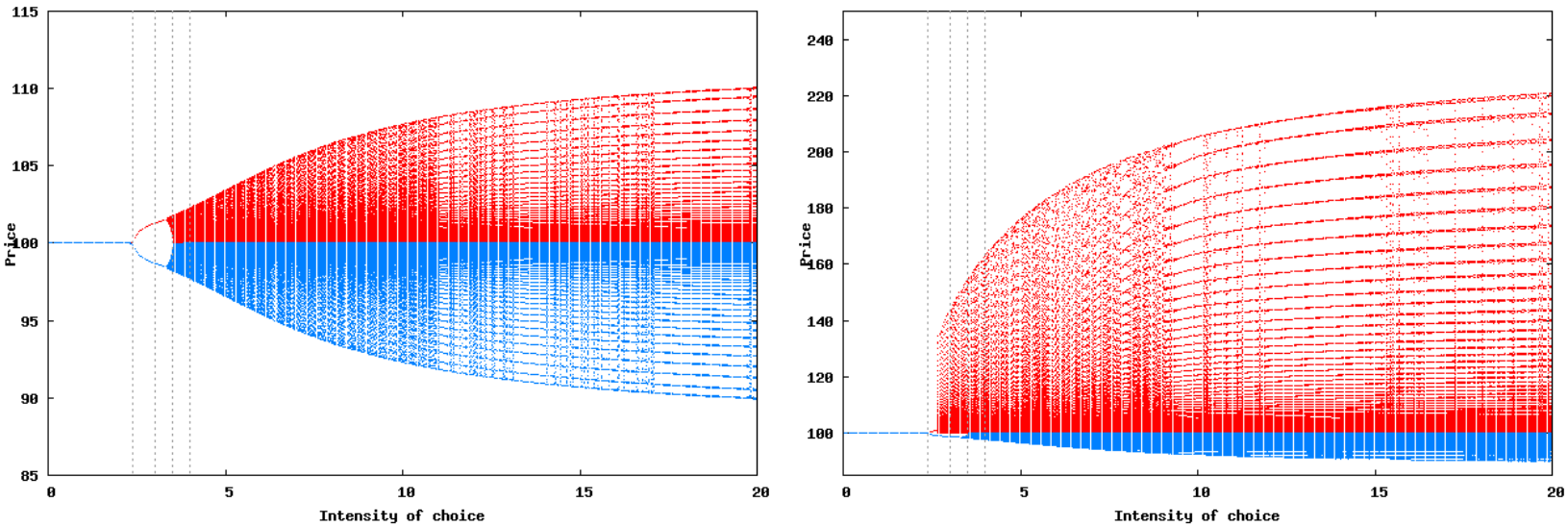


Short-Sell Constraints

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

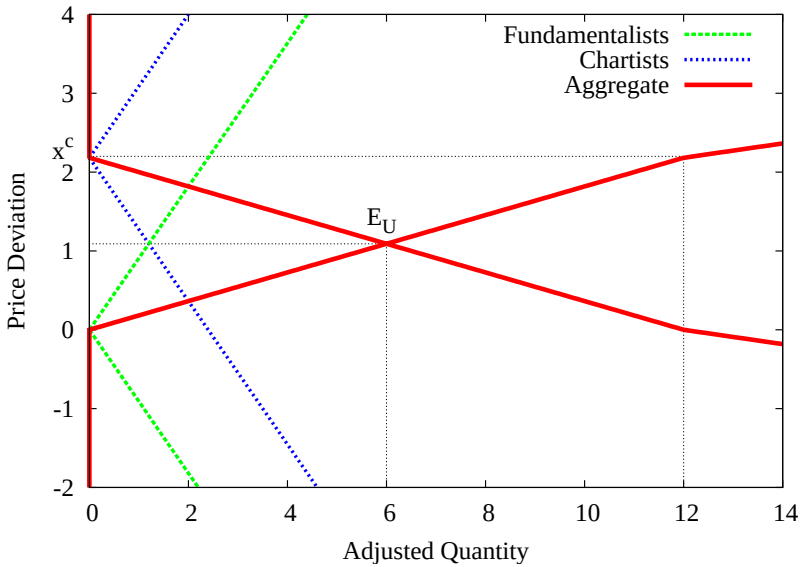
$$A_{i,t}(p_t) = \max\left\{ -\bar{A}, \frac{\mathrm{E}_{i,t}[p_{t+1}] + \bar{y} - (1 + r_f)p_t}{a\,\sigma^2} \right\}.$$

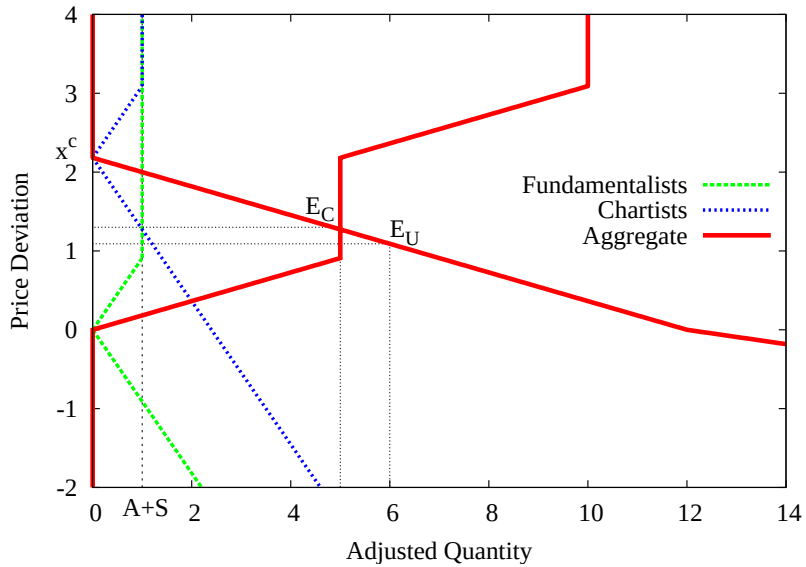
Short-selling constraints: $\bar{A} = 1$



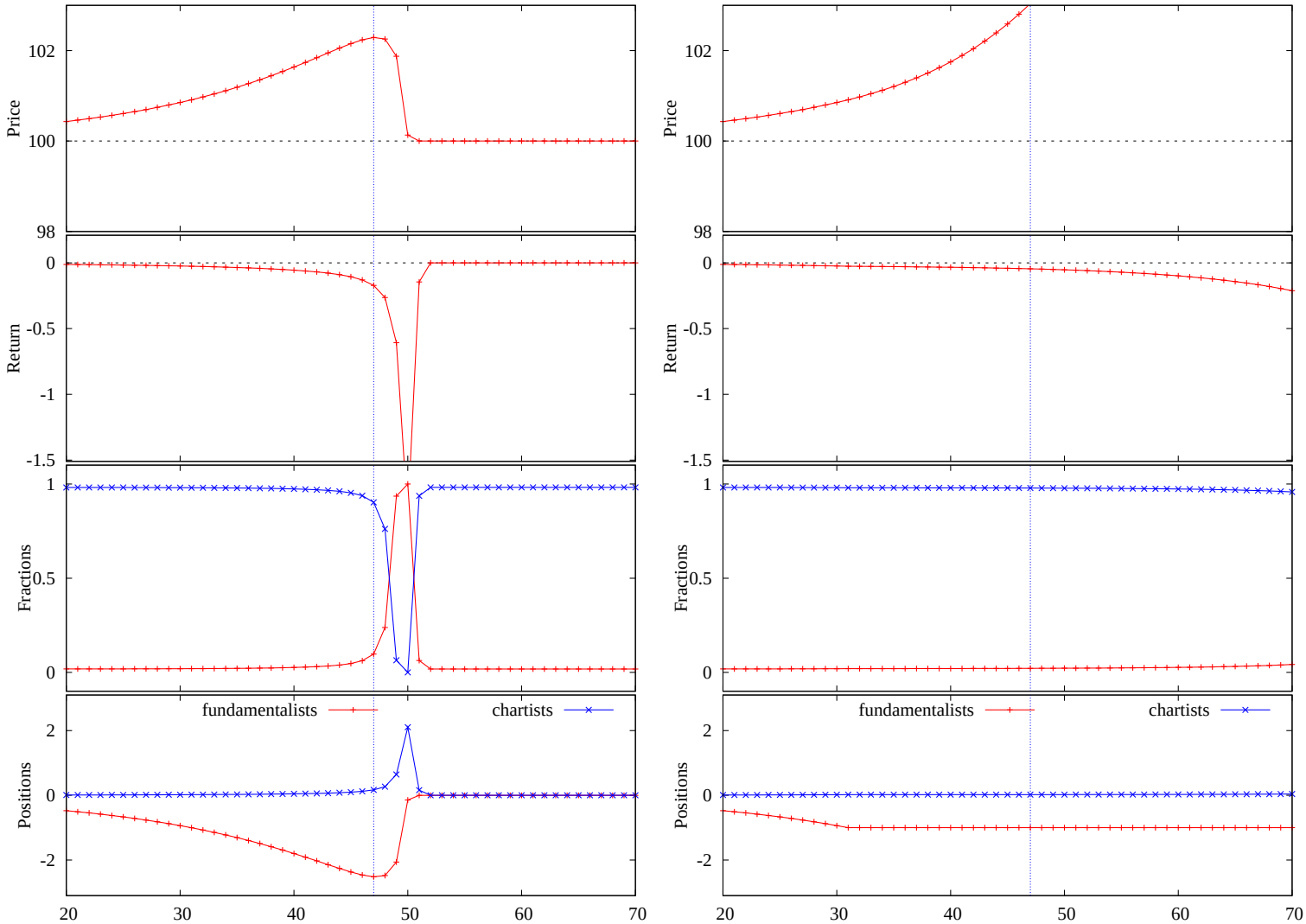
- primary bifurcation is not affected
- asymmetry between upper and lower attractors emerges
- the mispricing (amplitude of oscillations) increases

Adjusted demand and supply





Effect of short-selling constraints on upper trend

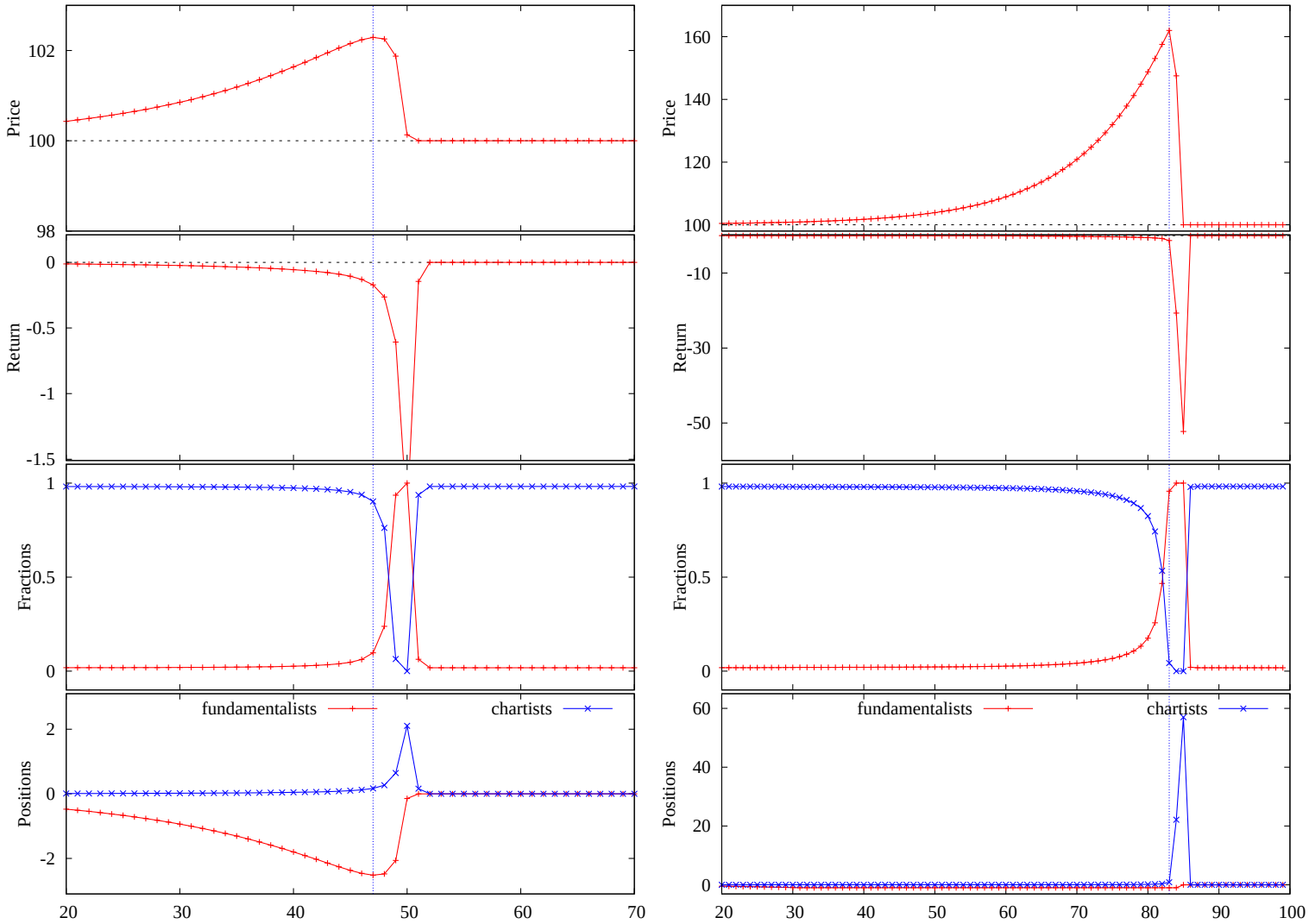


Short-selling constraints vs. No constraints

When the short sell constraints are binding:

- level of price becomes higher
  $\longleftarrow$ smaller liquidity
- level of return is higher (smaller in absolute value)
  $\longleftarrow$ capital gain
- fundamentalists' performance worsens w.r. to chartists'
  $\longleftarrow$ $(A_{f,t-1} - A_{c,t-1})r_t$
- fraction of fundamentalists is lower

Effect of short-selling constraints on crash

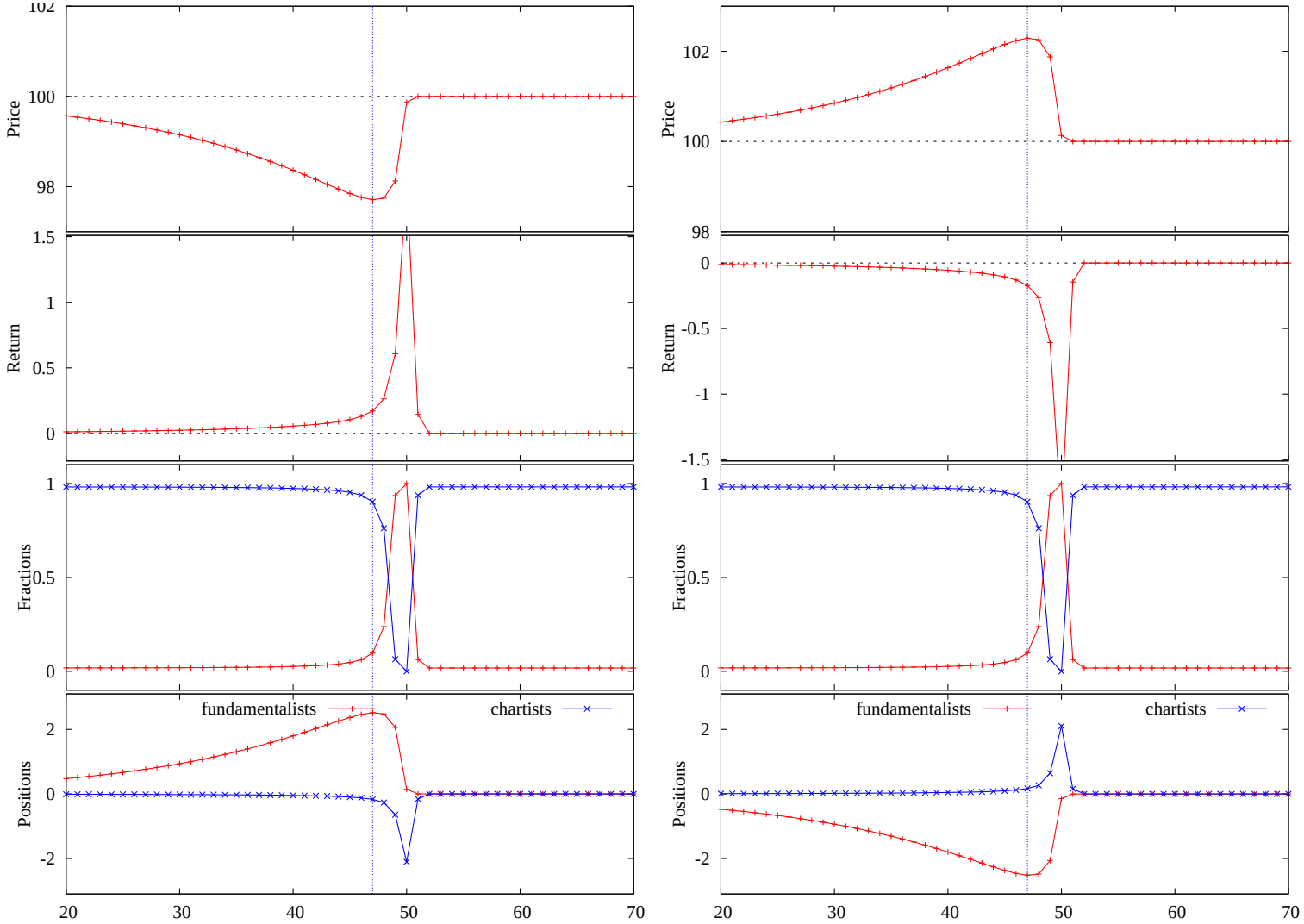


Short-selling constraints vs. No constraints

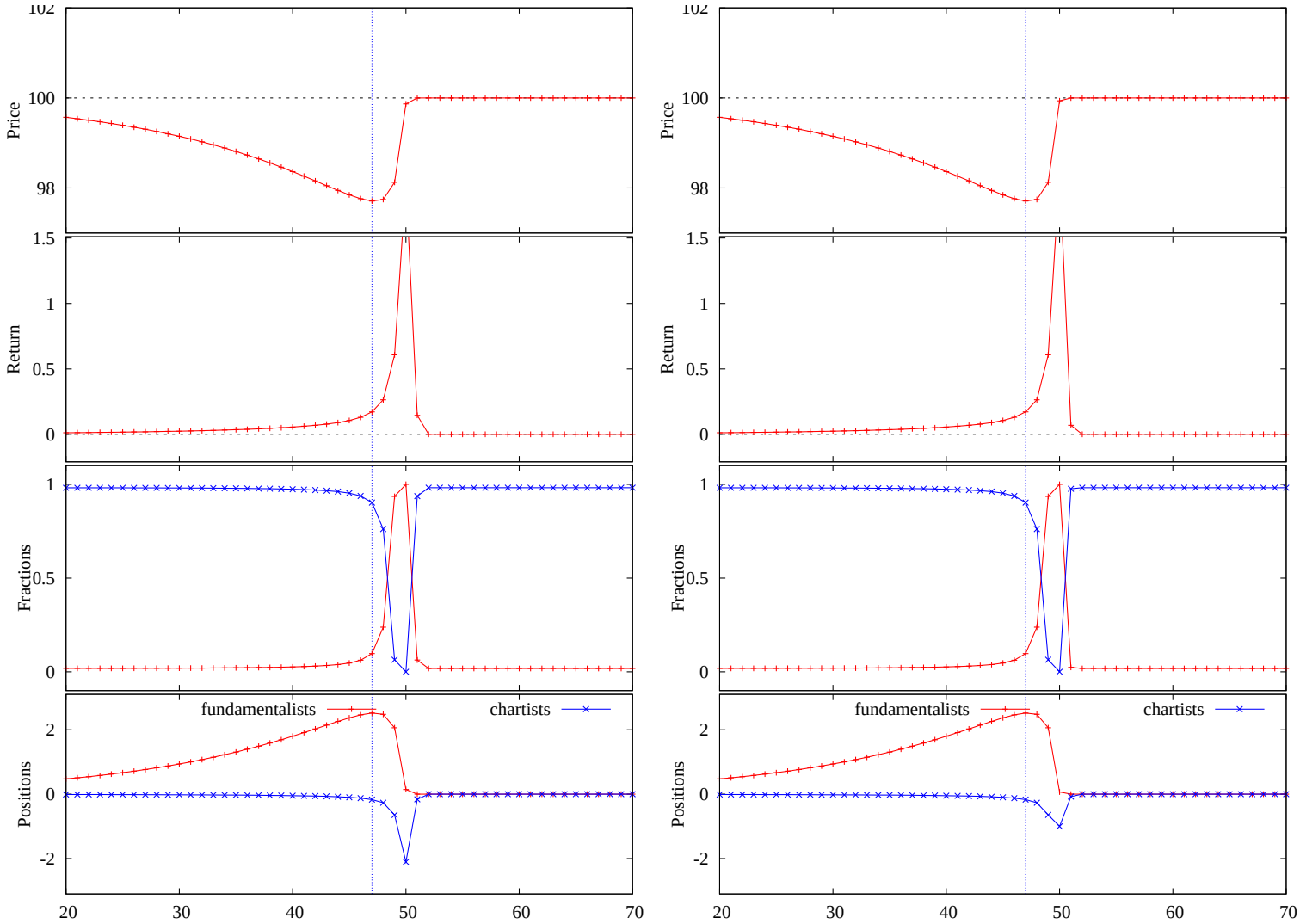
When the crash takes place under short-sell constraints:

- level of price is higher
- return is extremely low
- fractions of fundamentalists is much higher

Recall Lower Attractor vs. Upper Attractor



Lower Attractor without and with Crash

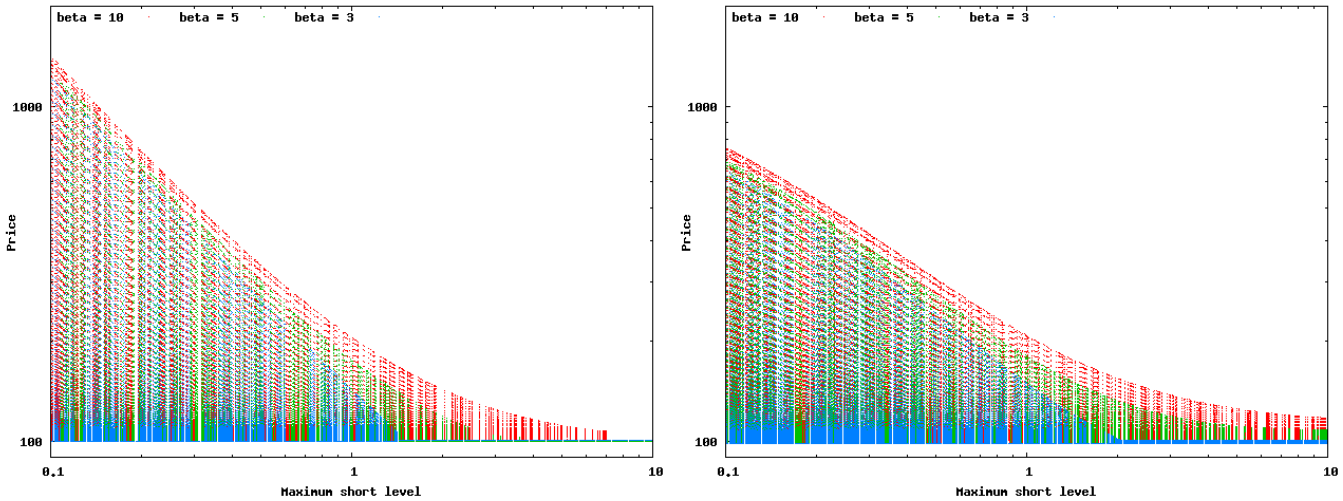


Summary

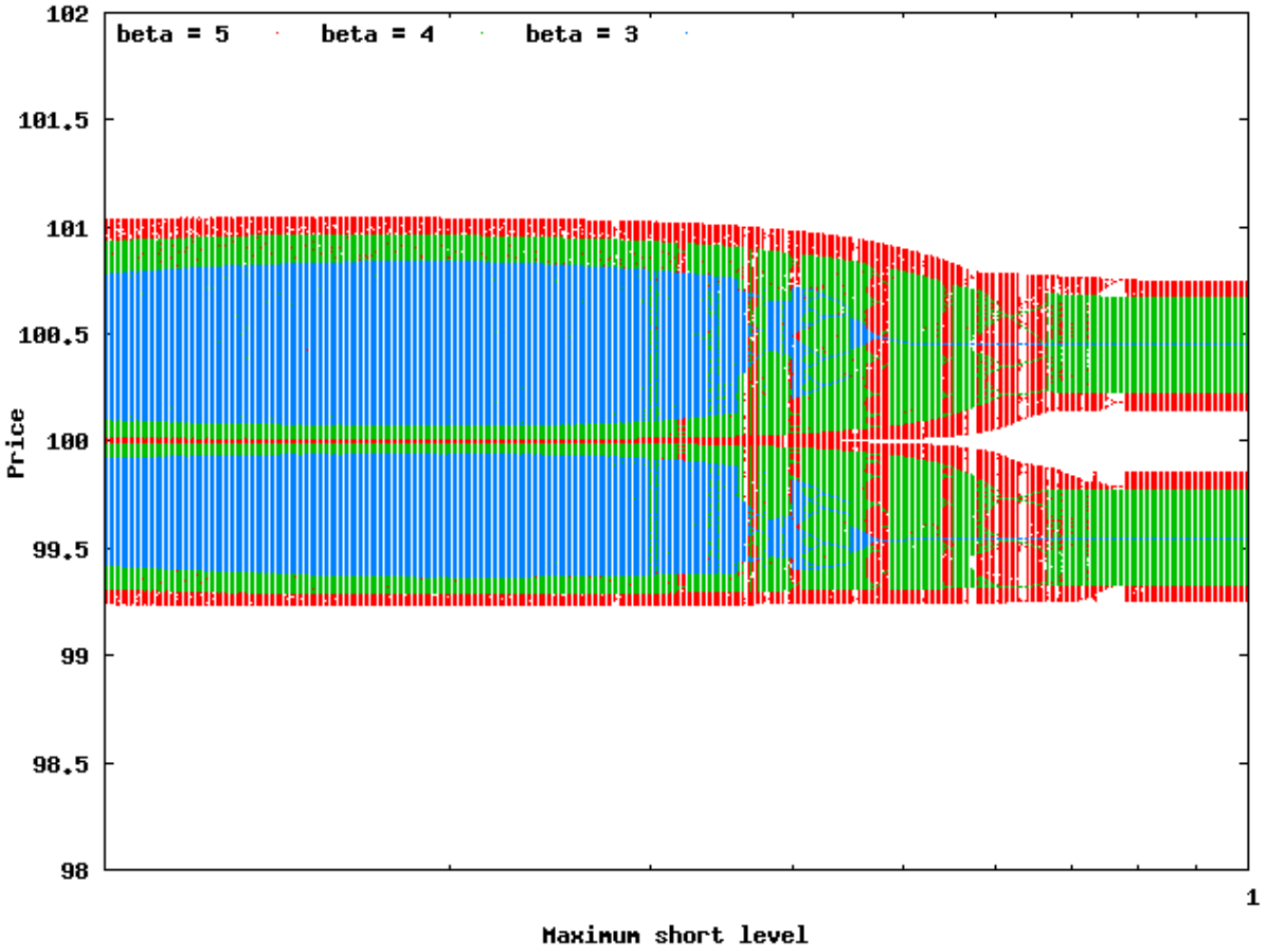
Under short-sell constraints

- 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)

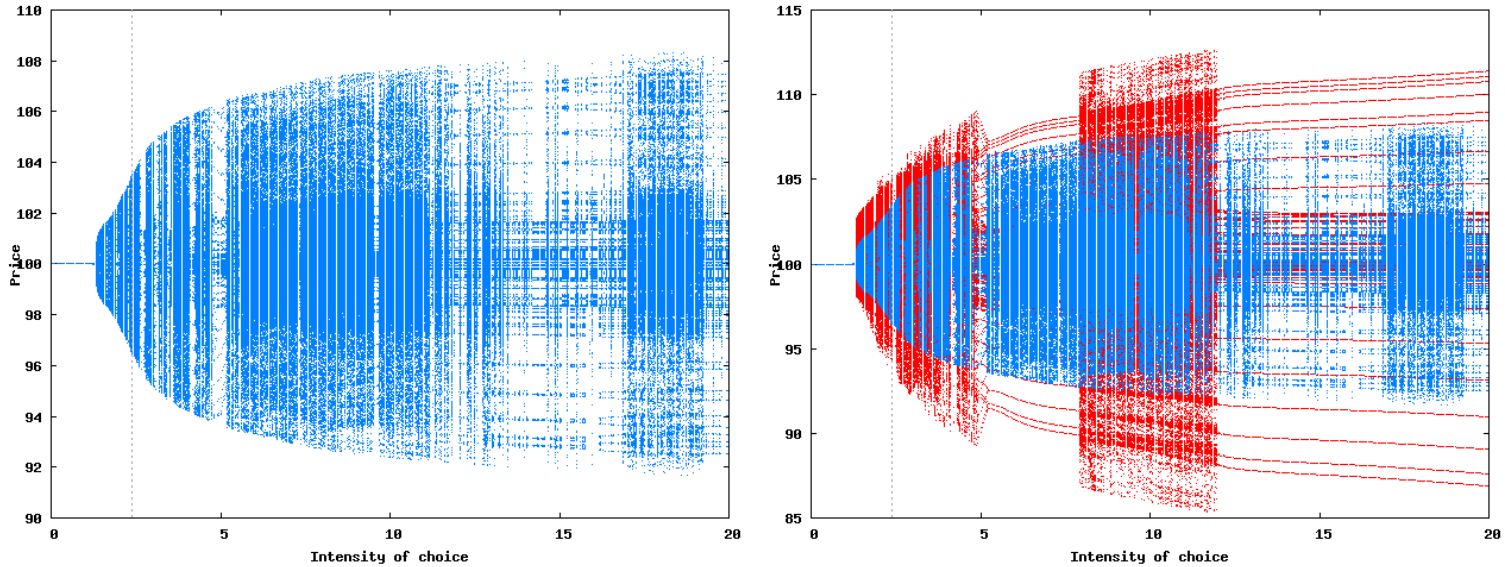
Dependence on $\bar{A}$ for zero and positive supply



Fundamentalists vs. Contrarians



Fundamentalists vs. Sophisticated Trend Followers



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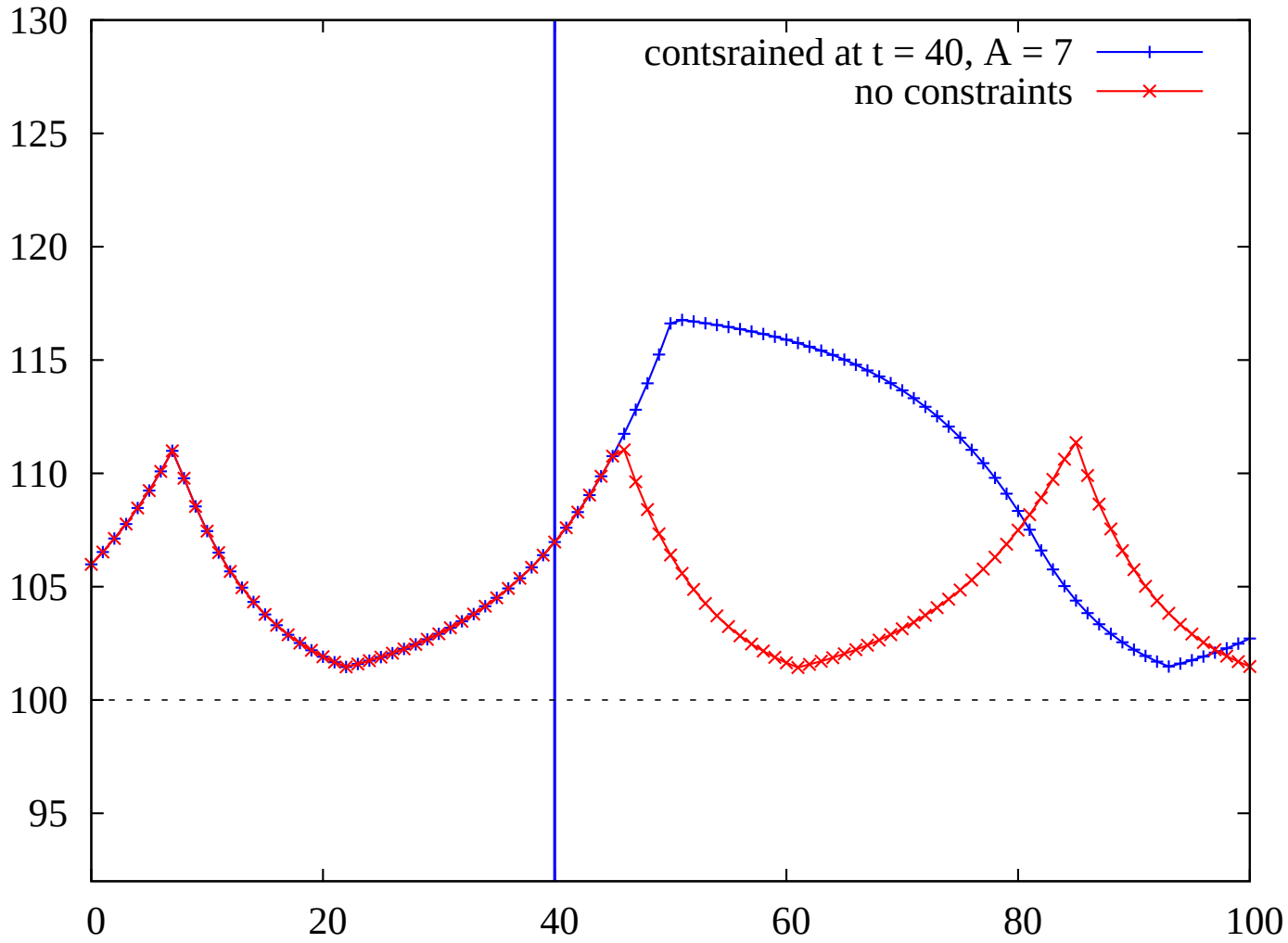

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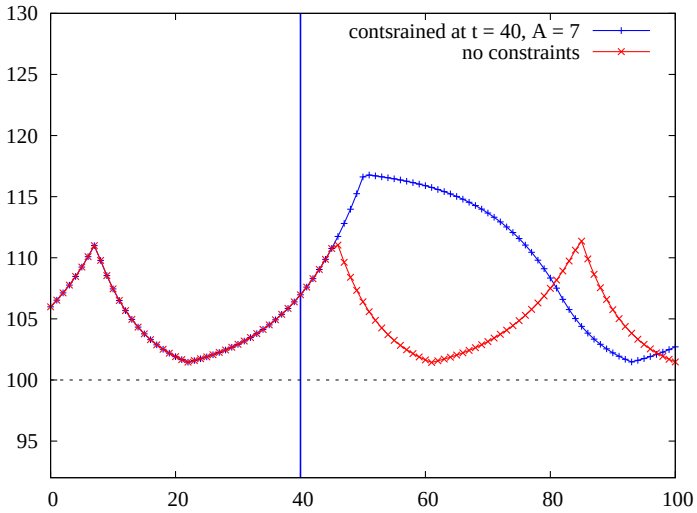
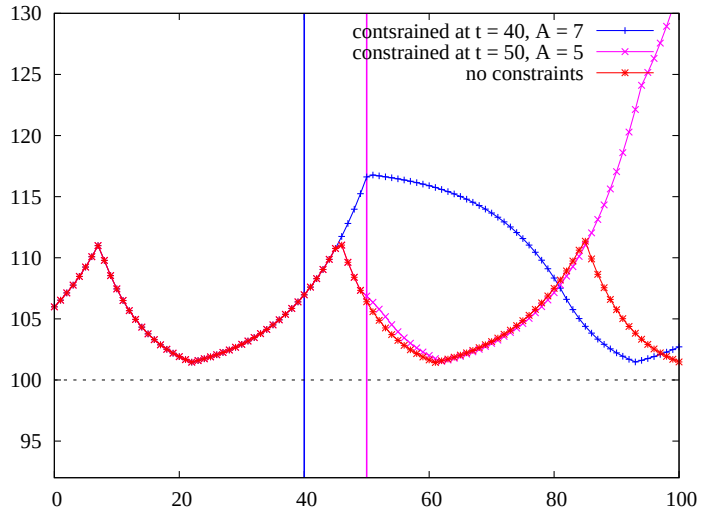
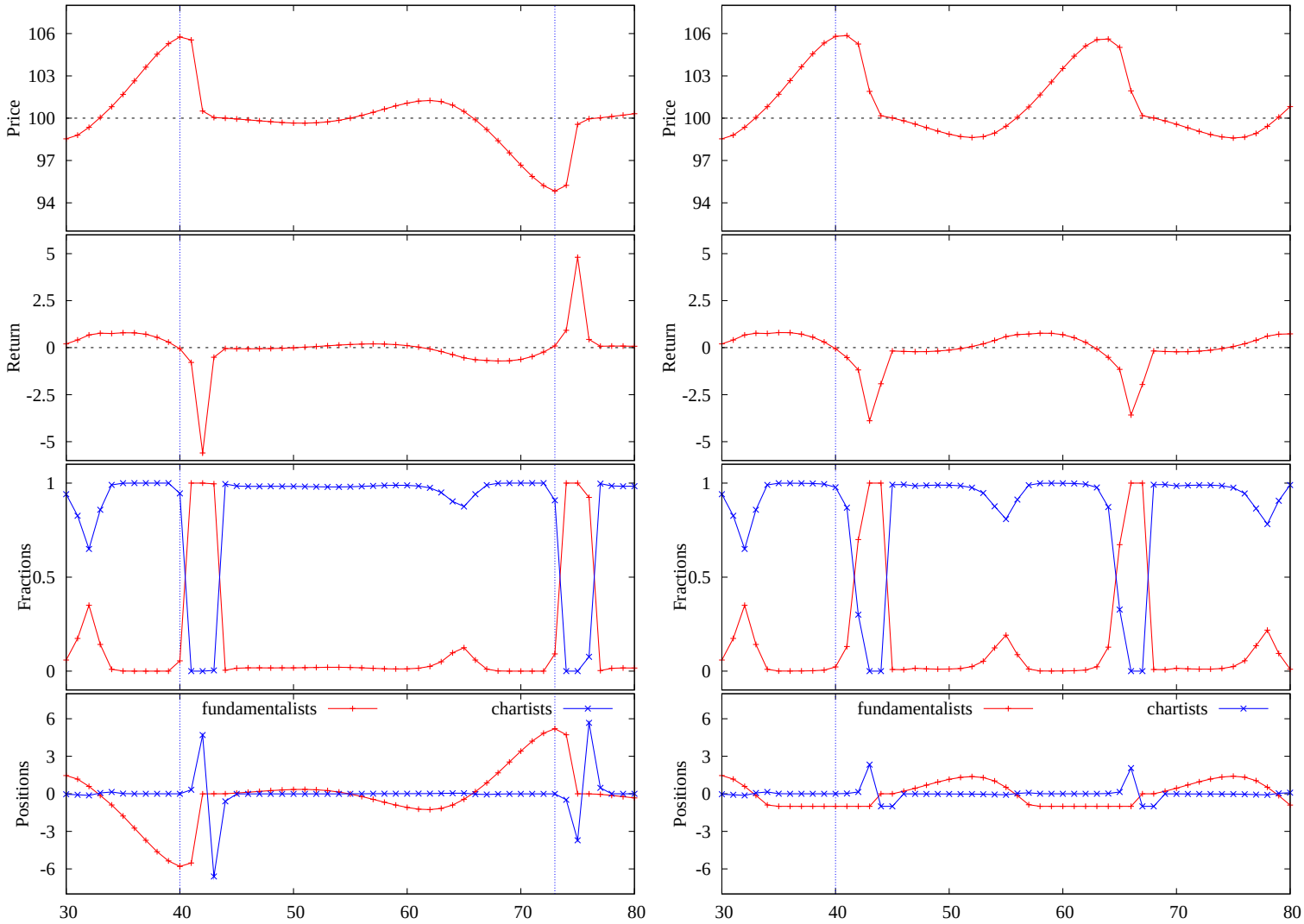




Conclusion

- 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



Fundamentalists vs. Contrarians