Price dynamics and financialization effects in corn futures markets with heterogeneous traders

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Index funds remove market entry barriers for new types of commodity traders

Trader types

| Speculators | Portfolio managers | Index fund | Commercial traders |

Futures market

(Source: CFTC)
Research question

How are price dynamics on corn futures markets affected by the availability of index funds?
Methodology

Few-type **heterogeneous agent model (HAM):**

- **Behavioral** price process

- **Structural** model of observable price levels and volatilities

1. Estimate parameters with simulated method of moments (SMM) using base period before 2006

2. Financialization scenario simulates market entry of portfolio managers trading via index funds
Prices emerge sequentially from supply/demand disequilibria

Volume trader type 1
Volume trader type 2
... Volume trader type N

Price (P)↑

Excess demand
Excess supply

P ↓
Trading volume of commodity market agents is determined by their behavioral functions

<table>
<thead>
<tr>
<th>Commodity traders</th>
<th>Stylized strategy</th>
<th>Behavioral model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercials</td>
<td>Fundamentalist</td>
<td>$\gamma_{CO}$</td>
</tr>
<tr>
<td>Speculators</td>
<td>Chartist</td>
<td>$\gamma_{S}$</td>
</tr>
<tr>
<td>Portfolio managers</td>
<td>Weighted combination (via index funds)</td>
<td>$\gamma_{PM}$</td>
</tr>
</tbody>
</table>

- **Fundamentalist**
  - Reaction function: $(\bar{P}_F - P_t)$
  - Reaction coefficients: $\gamma_{CO}$
  - Independent stochastic effects: $\epsilon_{t}^{CO}$

- **Chartist**
  - Reaction function: $(P_t - P_{t-1})$
  - Reaction coefficients: $\gamma_{S}$
  - Independent stochastic effects: $\epsilon_{t}^{S}$

- **Weighted combination (via index funds)**
  - Reaction function: $\omega_F (\bar{P}_F - P_t) + \omega_C (P_t - P_{t-1})$
  - Reaction coefficients: $\gamma_{PM}$
  - Independent stochastic effects: $\epsilon_{t}^{PM}$

**Short-selling constraint**

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The short-selling constraint is a result of the index fund’s replication model.
Market weights of trader types depend on relative attractiveness of their stylized strategies

Determinants of attractiveness

Herding
Pre-disposition
Price misalignment

Relative strategy attractiveness

Fundamentalist
Chartist

Traders’ response

Commercials
Speculators

Portfolio managers
Fundamentalist
Chartist
The market prices emerge from the interaction of fundamentalist and chartist volumes.

Trading volume (period t)

Demand

Supply

Price impact (period t+1)

Excess demand

Market maker reduces excess demand

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Price, volatility and volume development

(Source: Bloomberg)
Table 1: Empirical moments

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corn</td>
<td>Soy</td>
<td>S&amp;P 500</td>
<td>Corn</td>
<td>Soy</td>
<td>S&amp;P 500</td>
</tr>
<tr>
<td>$\bar{A}_t$</td>
<td>0.0102</td>
<td>0.0114</td>
<td>0.0077</td>
<td>0.0112</td>
<td>0.0116</td>
<td>0.0080</td>
</tr>
<tr>
<td>$\rho^r_1$</td>
<td>0.0503</td>
<td>0.0568</td>
<td>-0.0381</td>
<td>0.0431</td>
<td>0.0515</td>
<td>-0.0580</td>
</tr>
<tr>
<td>tail</td>
<td>2.5209</td>
<td>2.8034</td>
<td>2.7516</td>
<td>2.6944</td>
<td>2.9013</td>
<td>2.5272</td>
</tr>
<tr>
<td>$\rho^{ac}_1$</td>
<td>0.2239</td>
<td>0.2933</td>
<td>0.1807</td>
<td>0.2248</td>
<td>0.2660</td>
<td>0.2545</td>
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<tr>
<td>$\rho^{ac}_5$</td>
<td>0.2168</td>
<td>0.2755</td>
<td>0.1969</td>
<td>0.2150</td>
<td>0.2506</td>
<td>0.2705</td>
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<tr>
<td>$\rho^{ac}_{10}$</td>
<td>0.1995</td>
<td>0.2512</td>
<td>0.1685</td>
<td>0.1978</td>
<td>0.2309</td>
<td>0.2424</td>
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<tr>
<td>$\rho^{ac}_{25}$</td>
<td>0.1421</td>
<td>0.2163</td>
<td>0.1342</td>
<td>0.1585</td>
<td>0.1948</td>
<td>0.1770</td>
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<tr>
<td>$\rho^{ac}_{50}$</td>
<td>0.0834</td>
<td>0.1495</td>
<td>0.1338</td>
<td>0.1091</td>
<td>0.1365</td>
<td>0.1417</td>
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<tr>
<td>$\rho^{ac}_{100}$</td>
<td>0.0356</td>
<td>0.0846</td>
<td>0.0835</td>
<td>0.0617</td>
<td>0.0790</td>
<td>0.0979</td>
</tr>
</tbody>
</table>

Notes: Soybean prices are available from 05/20/1970 and S&P 500 prices from 04/21/1981.
Parameter estimation

\[ J = (m^{sim}(\theta) - m^{emp})' W (m^{sim}(\theta) - m^{emp}) \]

- Reaction coefficients, parameters determining strategy attractiveness (predisposition, reaction to herding, reaction to price misalignment), variances of stochastic volume components

- Weight matrix uses estimated covariance matrix of moments
Model validation

Generally compares empirical sampling distribution of moments with distribution generated by the model

Percentage coverage of distributions ("p-values")

Relative entropy
Base results overview
Base results
volatility effects
Financialization scenarios

<table>
<thead>
<tr>
<th>Parameter</th>
<th>(1) “High impact”</th>
<th>(2) “Low impact”</th>
<th>(3) “Fast reaction”</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_{PM}$</td>
<td>5</td>
<td>0.5</td>
<td>10</td>
</tr>
<tr>
<td>$\sigma_{PM}^2$</td>
<td>50</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>$\chi$</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Here, only scenario (1) results are presented
Position holdings (scenario 1)
Price level effects (scenario 1)
Volatility effects (scenario 1)

Squared returns

30-day volatility

90-day volatility
Conclusions

- Base period: higher reaction coefficients decrease persistence of price deviations from fundamental value

- Financialisation scenario: price levels are not inflated, fluctuation even more closely around fundamental value

- Volatility increased as the new stochastic volume of portfolio managers transports new information from other markets

- Effect of short-selling constraint minimal, certainly not in the direction of increasing
Further research plans

Development and analysis of policy scenarios, e.g.

- position limits
- transaction taxes
- price limits/bands

Model extensions to physical market
Reference

For more details and full references see discussion paper under

http://www.ilr.uni-bonn.de/agpo/publ/dispap/download/dispap14_05.pdf