Analyzing concentration patterns in experimental asset markets.

Thomas Stöckl[#] Nicole Palan[*] Stefan Palan[+]

[#]Department Business & Management, MCI | The Entrepreneurial School

[*]Graz Schumpeter Centre, University of Graz

[+]Institute of Banking and Finance, University of Graz

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Motivation

- Experimental asset markets generate rich data sets particularly suitable for analyses that are difficult or impossible to do with real-world data.
- In this paper, we develop a toolbox for analyzing concentration patterns in subsets of experimental asset market data by systematically discussing, contrasting, and applying different approaches.
- Quantifying and studying potential patterns will contribute to the understanding of market dynamics and phenomena. Thereby, we extend the work of Caginalp et al. (2000), Caginalp and Ilieva (2008), and Lugovskyy et al. (2014) who provide first evidence on a link between concentration in asset holdings and mispricing.

Properties of experimental asset market data

Any meaningful measure has to consider the characteristics of the data.

Set 1: Endowment data (assets and experimental currency units)

- Usually, traders' endowments ≥ 0 but values < 0 are possible (short positions or by design).
- Homogeneous or heterogeneous initial distributions.

Set 2: Trading activity data (offers, trades, other (sub)sets)

- Data records are zero at the start and for inactive traders.
- Single (e.g., offers) vs. double count data (e.g., trades).

Measuring concentration

Concentration ratios ($\mathrm{CR_n}$)

- $\mathrm{CR_n}$ (Lugovskyy et al., 2014) is the share of the top n traders in a specific category.
- Uses only parts of the data.
- With increasing n, $\mathrm{CR_n}$ takes higher values.

$$\mathrm{CR_n} = \frac{\sum_{i=1}^{n} x_i}{\sum_{j=1}^{N} x_j}$$

Hirschman-Herfindahl Index (HHI)

- Widely used in economics.
- All traders' records considered.

$$\mathrm{HHI} = \sum_{i=1}^{N} a_i^2$$

where

$$a_i = \frac{x_i}{\sum_{j=1}^{N} x_j}$$

x_i is trader i's realization of a specific characteristic; a_i is trader i's "market share" in that characteristic; N is the total number of subjects (traders); n is a subset of N.

Measuring concentration – Short positions

Concentration ratios ($\mathrm{CR_n}$)

- Traders with (large) negative x_i rank below traders with (small) positive x_i.
- Use $|x_i|$ to calculate rank and share of the top n traders.

$$\mathrm{CR_n} = \frac{\sum_{i=1}^{n} |x_i|}{\sum_{j=1}^{N} x_j}$$

Hirschman-Herfindahl Index (HHI)

- A traders with a negative x_i has a negative a_i.
- When calculating HHI this value gets squared.
- No adaptation necessary.

These procedures imply that HHI and $\mathrm{CR_n}$ may take values > 1.

Example: a trader holds all assets plus some assets that were sold short.

Values > 1 correctly reflect this pattern of extreme concentration.

Measuring concentration – Normalization

$\mathrm{CR_n}$ and HHI have ill-defined lower bounds ($\mathrm{CR_n}$ is $\in \left[\frac{n}{N}, 1\right]$; HHI is $\in \left[\frac{1}{N}, 1\right]$) indicating equal distributions. This reduces comparability.

Normalization $\mathrm{CR_n}$

$$\mathrm{CR_n'} = \left(\mathrm{CR_n} - \frac{n}{N}\right) \cdot \left(1 - \frac{n}{N}\right)^{-1}$$

Normalization HHI

$$\mathrm{HHI'} = \left(\mathrm{HHI} - \frac{1}{N}\right) \cdot \left(1 - \frac{1}{N}\right)^{-1}$$

This procedure ensures that $\mathrm{CR_n'}$ and $\mathrm{HHI'}$ are $\in [0, 1]$ (except for short positions).

Measuring concentration – Transaction data

As trades are recorded twice, the normalization procedures need to be adapted.

Normalization (trades) CR_1

Max. value for CR_1 equals 0.5.

$$\mathrm{CR}'_{1(\mathrm{TR})} = \left(\mathrm{CR}_1 - \frac{n}{N}\right) \cdot \left(\frac{1}{2} - \frac{n}{N}\right)^{-1}$$

For $n \geq 2$ the regular normalization applies.

Normalization (trades) HHI

Max. value for HHI equals 0.5.

$$\mathrm{HHI}'_{\mathrm{TR}} = \left(\mathrm{HHI} - \frac{1}{N}\right) \cdot \left(\frac{1}{2} - \frac{1}{N}\right)^{-1}$$

This procedure ensures that $\mathrm{CR}'_{1(\mathrm{TR})}$, $\mathrm{CR}'_{n(\mathrm{TR})}$, and $\mathrm{HHI}'_{\mathrm{TR}}$ are $\in [0, 1]$.

Measuring concentration – Decomposition

Additional insights about concentration patterns can be gained by modifying HHI such that it measures diversity instead of concentration.

$$\mathrm{DT} = 1 - \mathrm{HHI}$$

Acar and Sankaran (1999) show that DT can be decomposed without residual, so we can study within group diversity (DR) and between group diversity (DU).

$$\mathrm{DT} = \mathrm{DR} + \mathrm{DU}$$

This decomposition (with some modifications) can be used to study concentration patterns among different subgroups, e.g., traders with different initial endowments, incentive schemes, or information.

Application: Asset concentration

We use market data from five experimental studies that investigate mispricing in similar market environments (Smith et al., 1988) to analyze

1. how the concentration in asset holdings evolves over time.
2. whether asset concentration and mispricing correlate.

E1: Cheung and Palan (2012), Two heads are less bubbly than one: Team decision-making in an experimental asset market.

E2: Kirchler et al. (2012), Thar she bursts – Reducing confusion reduces bubbles.

E3: Cheung et al. (2014), To see is to believe – Common expectations in experimental asset markets.

E4: Stöckl et al. (2015), Multi-period experimental asset markets with distinct fundamental value regimes.

E5: Lugovskyy et al. (2014), Asset holdings caps and bubbles in experimental asset markets.

Application: Asset concentration

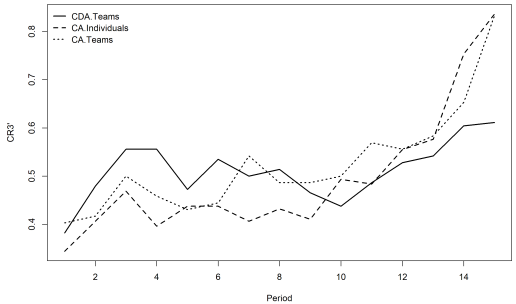
Summary statistics for CR'_3 and HHI' for E1 and E2 (period values).

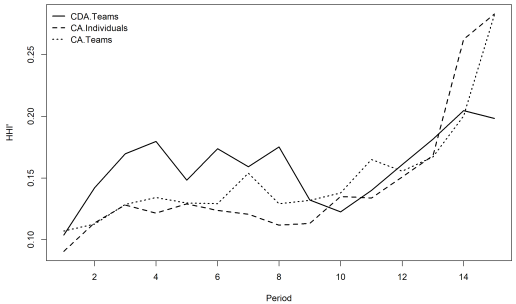
	treatments (code)	CR'_3 initial	CR'_3 mean	CR'_3 min	CR'_3 max	HHI' initial	HHI' mean	HHI' min	HHI' max
Cheung and Palan (2012)	1 E1[T/DAM]	0.25	0.51	0.25	0.88	0.02	0.16	0.07	0.43
E1	2 E1[I/CAM]	0.25	0.50	0.29	1.00	0.02	0.15	0.08	0.38
	3 E1[T/CAM]	0.25	0.52	0.29	0.96	0.02	0.15	0.09	0.34
Kirchler et al. (2012)	1 E2[\+]	0.21	0.42	0.19	0.85	0.03	0.08	0.02	0.31
E2	2 E2[\ =]	0.21	0.32	0.19	0.59	0.03	0.05	0.02	0.10
	3 E2[—+]	0.21	0.45	0.18	0.88	0.03	0.10	0.01	0.50
	4 E2[— =]	0.21	0.33	0.20	0.44	0.03	0.05	0.02	0.08

Similar numbers in all treatments of E1; treatment effects in E2.
Comparable patterns in both measures.

Application: Asset concentration – Time development

Time development of asset concentration in E1 (Cheung and Palan, 2012).

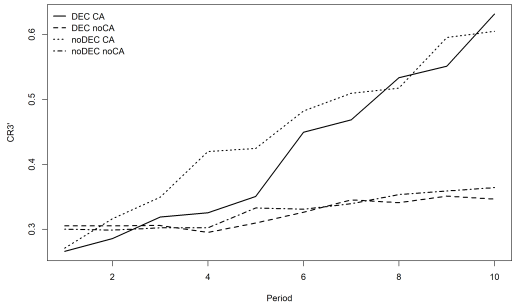


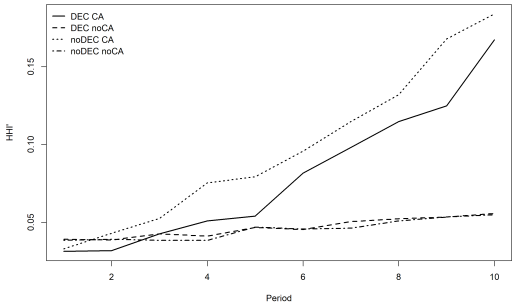


Concentration increases in the beginning and toward the end of the experiment.
Similar patterns for both measures and in studies E3 and E5 (not shown).

Application: Asset concentration – Time development

Time development of asset concentration in E2 (Kirchler et al., 2012).





In treatments with high C/A-ratios, concentration increases linearly over time.
The FV-process (dec./con.) does not seem to have an impact (as compared to mispricing).

Application: Asset concentration & mispricing

Pearson correlation between RAD/RD and asset concentration (CR_3' and HHI').

	treatments (code)	CR_3' RAD	CR_3' RD	HHI' RAD	HHI' RD
Cheung and Palan (2012)	1 E1[T/DAM]	−0.268	0.146	−0.226	0.165
E1	2 E1[I/CAM]	0.804***	0.847***	0.730***	0.783***
	3 E1[T/CAM]	−0.292	0.134	−0.324	0.109
Kirchler et al. (2012)	1 E2[\+]	0.912***	0.939***	0.896***	0.913***
E2	2 E2[\ =]	0.949***	−0.707**	0.896***	−0.566*
	3 E2[—+]	−0.979***	0.966***	−0.966***	0.979***
	4 E2[— =]	0.537	−0.573*	0.477	−0.521

Notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

No clear pattern identifiable. Results difficult to rationalize with treatment effects. Additional analyses necessary to better understand the link between mispricing and asset concentration.

Conclusion

We discuss and contrast two approaches of analyzing concentration patterns among traders in experimental asset markets.

- HHI' and $\mathrm{CR}'_{\mathrm{n}}$ ensure comparability across treatments. For short positions, the measures may take values > 1.
- $\mathrm{HHI}'_{\mathrm{TR}}$ and $\mathrm{CR}'_{1(\mathrm{TR})}$ consider double counts.
- We outline a procedure of analyzing diversity for subgroups of traders.

Applying the measures to asset endowment data, we find that

- concentration increases steadily over time with cash fueling the development.
- no clear correlation patterns emerge between mispricing and concentration.

Thank you for your attention!

Questions?

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