Investor Networks[1]

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[1] Based on “Trading, Profits and Volatility in a Dynamic Information Network Model," and “Investor Networks in the Stock Market", with Han Ozsoylev, Deniz Yavuz, and Recep Bildik

Background

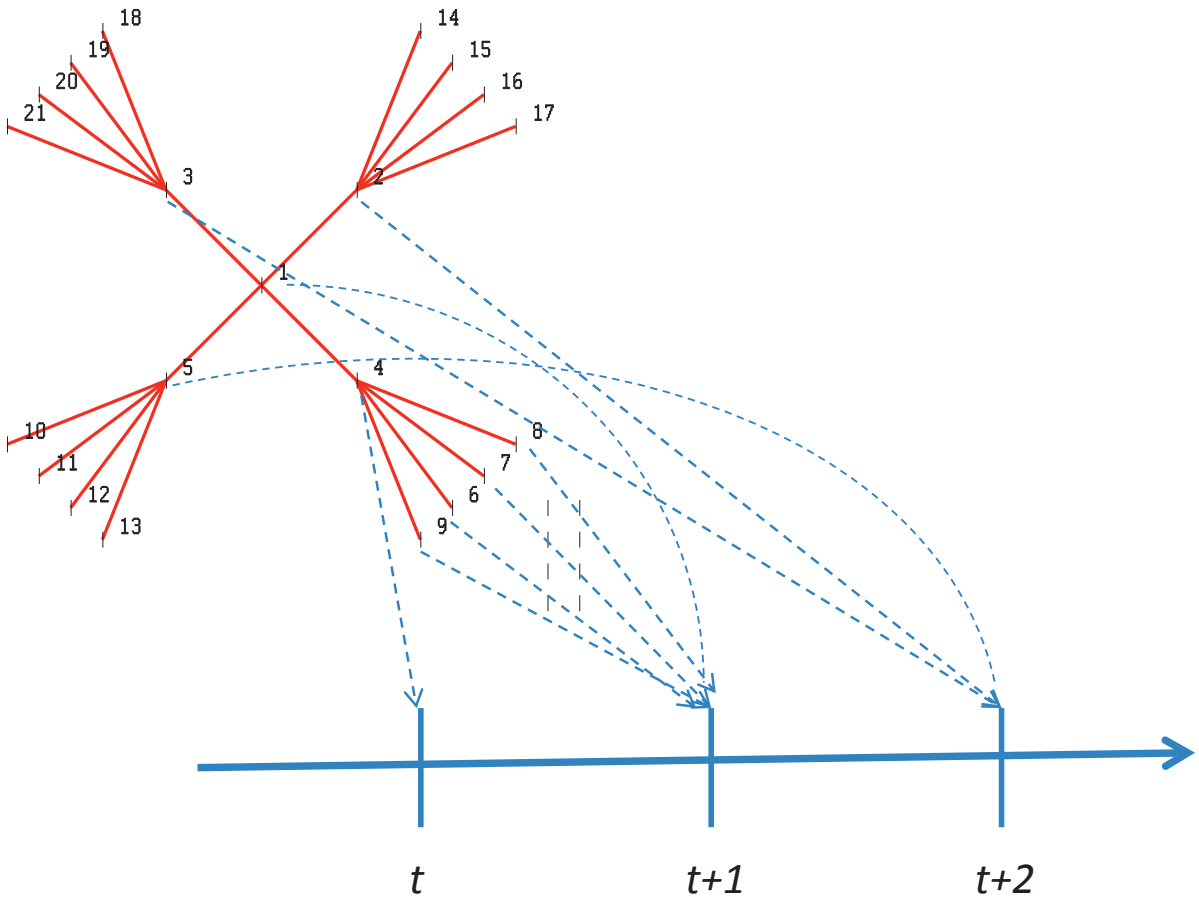
- Several studies suggest that decentralized, heterogeneous, diffusion of information important for investors' trading behavior (e.g., Shiller and Pound 1989; Hong, Kubic, and Stein 2004; Ivkovic and Weisbenner 2007; Heimer and Simon 2012)
- Relates to fundamental stylized stock market facts:
  - May help explain heterogeneity in investors' performance
  - May provide micro-foundation for aggregate market behavior, e.g., high, time varying, volatilities of returns and trading volume
  - May help understanding of price movements without public news events
- Recent strand of literature uses information networks. Important questions:
  - Macro: How is network structure related to price volatility and trading volume?
  - Micro: Are investors' trades and performance consistent with information diffusion in networks?

Related Literature

- Hellwig (1980)
- Shiller and Pound (1989)
- Hong, Kubic and Stein (2004)
- Feng and Seasholes (2004)
- Das and Sisk (2005)
- Cohen, Frazzini and Malloy (2007)
- Ivkovic and Weisbenner (2007)
- Pareek (2009)
- Fracassi (2009)
- Duffie, Malamud and Manso (2009)
- Colla and Mele (2010)
- Shive (2010)
- Ozsoylev and Walden (2011)
- Han and Yang (2011)
- Tetlock (2007,2011)

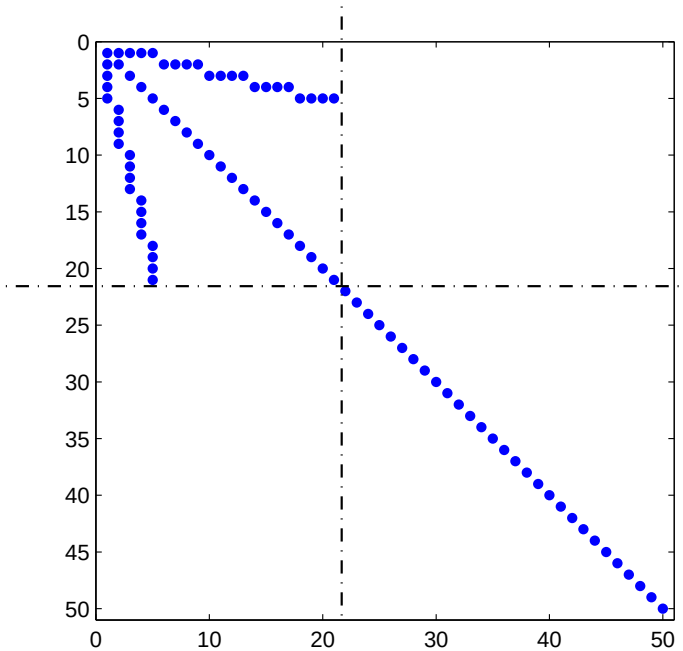
An information network model of trading

- Agent 4 receives signal at t.



Representation by adjacency matrix

- Example: $N_I = 21$, $N_U = 29$, $N = 50$



- Degree Centrality, D: Number of neighbors.
- Eigenvector Centrality: $C_i = \frac{1}{\lambda} \sum_j \mathcal{E}_{ij} C_j$

Eigenvector centrality captures agent profitability

Agent	C	D	P
1	0.5	5	2
$2-5$	0.354	6	1.41
$6-21$	0.125	2	1.04
$22-100$	0	1	-0.31

Theorem

For large random networks, the expected cross sectional correlations between centrality measures and profitability satisfy the following inequalities:

$$E\left[\rho_{K^\alpha}(N)\right] > E\left[\rho_D(N)\right] > \max\left(E\left[\rho_{\hat{C}}(N)\right], E\left[\rho_B(N)\right]\right).$$

Rich dynamics of volatility

Theorem

For $t = 1, \cdots, T$, the volatility of prices between $t-1$ and t, is

$$\sigma^2_{p,t} = \frac{y_t}{(\tau_v + Y_t)(\tau_v + Y_{t-1})},$$

where we use the convention that $Y_0 = 0$, and between T and $T+1$, it is

$$\sigma^2_{p,T+1} = \frac{1}{\tau_v + Y_T}.$$

Moreover, given coefficients, $k_1, \ldots, k_{T+1}$, such that $k_t > 0$, and $\sum_{t=1}^{T+1} k_t = 1$ and an arbitrarily small $\epsilon > 0$, there is a preference symmetric economy, such that

$$\left| \sigma^2_{p,t} - \frac{k_t}{\tau_v} \right| \leq \epsilon, \qquad t = 1, \ldots, T+1.$$

Rich dynamics of trading volume

Theorem

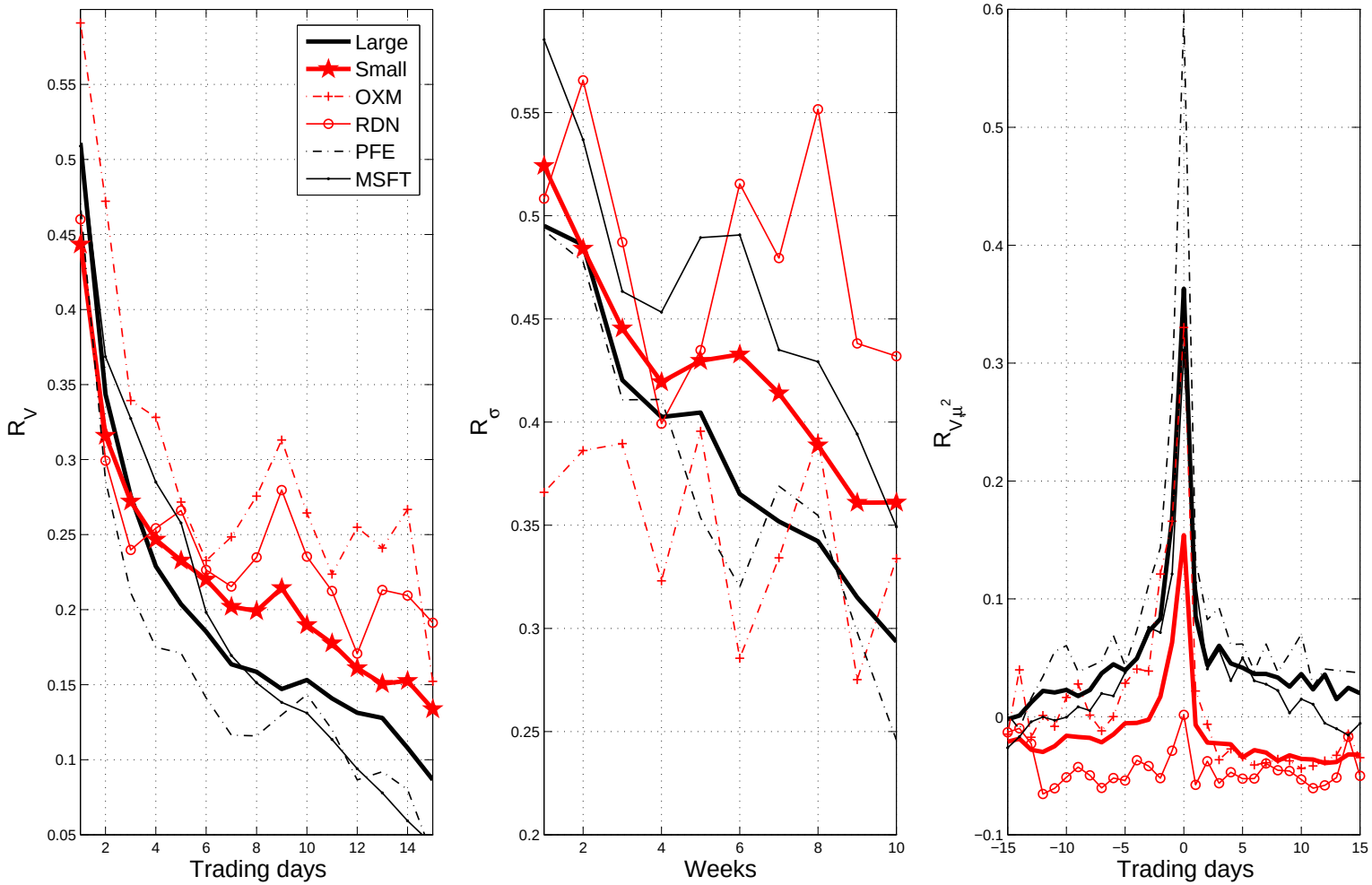
The time-t expected trading volume is

$$X_t = \frac{\tau}{N}\sum_{a=1}^{N}\frac{1}{\gamma_a}\sqrt{\frac{2}{\pi}\left(\frac{V_{a,t-1}^2}{\tau_v + Y_{t-1}} - \frac{V_{a,t}^2}{\tau_v + Y_t} + \frac{\Delta V_{a,t}^2}{\tau_v + Y_t} + \frac{\Delta V_{a,t}}{\tau}\right)}.$$

Moreover, given positive coefficients, $c_1, c_2, \ldots, c_{T+1}$, and any $\epsilon > 0$, there is an economy such that

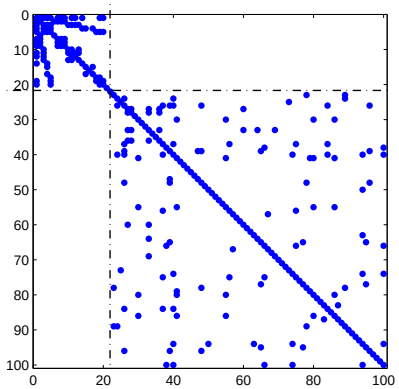
$$|X_t - c_t| \leq \epsilon, \qquad t = 1, \ldots, T+1.$$

Dynamics of small stocks consistent with information diffusion



The Empirical Investor Network (EIN)

- Associate investors as neighbors if they take on similar positions within $[t, t + \Delta T]$ at least $M \geq 1$ times.



- EIN captures centrality of agents ($Corr(C, C_{EIN}) = 0.64$).
- EIN stable across simulations (average $\|\mathcal{E}^1 - \mathcal{E}^2\|_F^2 / N^2 = 0.03$).
- Central agents trade before neighbors ($corr(C, f) = 0.97$)
- Central agents earn higher profits ($Corr(C, P) = 0.76$, $Corr(C_{EIN}, P) = 0.51$, $Corr(C_{EIN}/D_{EIN}, P) = 0.55$, $Corr(D_{EIN}, P) = 0.19$)

Data

- All trades on Istanbul Stock Exchange in 2005, identified by account number
- 19th largest stock exchange in the world
- 303 stocks
- Order-driven, multiple-price, continuous auction market without dedicated market makers or specialists
- 580,142 traders, of which 492 are classified as institutional
- On average 200,000 trades per day
- All tests are truncated so that top and bottom 2% of traders are excluded

Summary statistics — EIN

Window length ΔT (mainly work with 30 minutes), threshold for number of overlaps $M = 1$, profits calculated using ΔT_P= 30 days.

ΔT	1 min	5 min	15 min	30 min
# links	0.51B	1.01B	1.66B	2.25B
Average #links	876	1,736	2,860	3,881
Fraction of links	0.15%	0.3%	0.5%	0.7%
# investors with one link	18,927	1,939	192	32
maximum # links	153,923	204,635	249,064	312,807

Central investors make higher profits (1/2)

μ	$c-d$	n	v	μ^e	$c-d$	n	v
β_{OLS}	0.0126	0.0059	-0.0019	β^e_{OLS}	0.0109	0.0013	-0.0007
t_{OLS}	> 20	> 20	< -20	t^e_{OLS}	> 20	15.3	-10.6
$\Delta\mu_{OLS}$	0.27%	1.1%	-0.53%	$\Delta\mu^e_{OLS}$	0.23%	0.27%	-0.19%
$\beta_{t-error}$	0.0160	0.0039	-0.0014	$\beta^e_{t-error}$	0.0128	0.0006	-0.0006
$t_{t-error}$	14.9	18.0	-9.7	$t^e_{t-error}$	13.6	3.1	-5.1
$\Delta\mu_{t-error}$	0.36%	0.73%	-0.39%	$\Delta\mu^e_{t-error}$	0.27%	0.11%	-0.18%
β_{Ramsey}	0.0135	0.0058	-0.0019	β^e_{Ramsey}	0.00116	0.0013	-0.0007
t_{Ramsey}	> 20	> 20	< -20	t^e_{Ramsey}	> 20	14.2	-10.8
$\Delta\mu_{Ramsey}$	0.28%	1.1%	-0.53%	$\Delta\mu^e_{Ramsey}$	0.24%	0.25%	-0.19%

Table: Normalized profits, μ, and excess profits, μ^e, regressed on log-rescaled centrality, $c-d$, n and v.

Central investors make higher profits (2/2)

μ	c	d	n	v
β_{OLS}	0.0116	-0.0144	0.0080	-0.0017
t_{OLS}	> 20	< -20	> 20	< -20
$\Delta\mu_{OLS}$	2.2%	-2.6%	1.5%	-0.47%
$\beta_{t-error}$	0.0148	-0.0182	0.0066	-0.0012
$t_{t-error}$	13.7	-16.7	> 20	-8.4
$\Delta\mu_{t-error}$	2.8%	-3.4%	1.2%	-0.34%
β_{Ramsey}	0.0124	-0.0153	0.0080	-0.0017
t_{Ramsey}	> 20	< -20	> 20	< -20
$\Delta\mu_{Ramsey}$	2.3%	-2.9%	1.5%	-0.47%

Central investors trade earlier on information

Ticker	*Name*	*Main operation area*	*Movement date*	*Sign and magnitude*
BJKAS	Besiktas Futbol Yatirimlari	Soccer	7/26/2005	+19.4%
			12/26/2005	-33.5%
DEVA	Deva Holding	Pharmaceuticals	7/12/2005	+15.8%
DYOBY	DYO Boya	Paint and chemicals	7/14/2005	+12.25%
EREGL	Eregli Demir ve Celik Fabrikalari	Steel manufacturing	9/12/2005	+10.56%
SAHOL	Haci Omer Sabanci Holding	Multibusiness enterprise	10/4/2005	+6.99%
SEKFK	Seker Finansal Kiralama	Financial leasing	7/8/2005	-21.27%
SISE	Turkiye Sise ve Cam Fabrikalari	Glass manufacturing	7/29/2005	+7.08%
SKBNK	Sekerbank	Banking	7/12/2005	+14.55%
TEKST	Tekstilbank	Banking	8/16/2005	+12.27%
TNSAS	Tansas	Retail	8/19/2005	+12.12%

$c - d$

	T	n	v
β_{OLS}	-0.000007	-0.00006	-0.00001
t_{OLS}	< -20	< -20	-14
$t_{t-error}$	-11	< -20	< -7.6
t_{Ramsey}	< -20	< -20	< -14.0

Results robust to several extensions and variations

- Out-of-sample tests: Create degree, centrality, number of trades, and trading volume, using first half of year, and profit measures using second half
- Use a higher threshold for connections, $M = 10$
- Condition regression on degrees instead of using rescaled centrality
- Use longer time window, ΔT (up to a day)
- Vary the profit window, ΔT_P, between a week and three months
- Do not allow for neighbors in the same brokerage house

Concluding remarks

- Results support view that information diffusion important determinant of trading behavior.
  - EIN stable over time
  - Central investors systematically trade before others
  - Central investors make higher profits
  - Central investors trade earlier on information
- May help us better understand
  - Link between micro-foundational information motives for trading and aggregate behavior of stock markets
  - Time varying return volatilities and trading volume
  - Large movements without news
- Future work
  - Improve measures of centrality
  - Understand channels of information diffusion