Partial information, market efficiency, and anomalous continuous phase transition

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Introduction

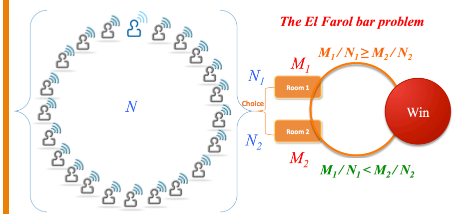
- ✧ *Everyday* we have to compete with each other for limited resources.
- ✧ *Everyone* wants to get complete information before making decisions.

Efficient-market hypothesis:

✓*Weak-form:* prices adjust to the technical information rapidly. Hence, no one can give a correct prediction by analyzing the past prices.
✓*Semi-strong-form:* prices adjust to the publicly available new information rapidly. Hence, no excess returns can be earned by trading on that information.
✓*Strong-form:* prices reflect all the public and private information and no one can earn excess returns.

Is complete information really good for both individuals and markets?

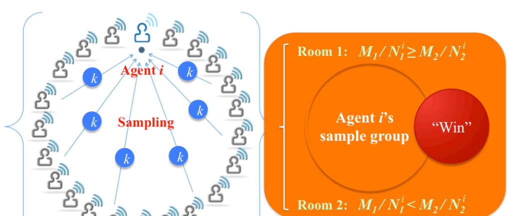
✧ *Resource Allocation System:*



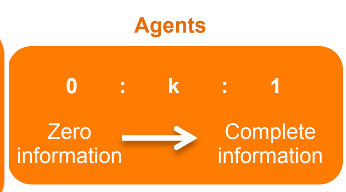
The most efficient state

Optimal state $M_1/N_1 = M_2/N_2$ and with lowest fluctuation level

The System



The sample group is fixed during each game.



Model

Table 1. A particular strategy.

Exogenous situation	Choice
1	0
2	1
3	1
.	.
.	.
.	.
$P-1$	0
P	1

✓ *Strategies:*
- ❖ *P* possible situations.
- ❖ Choice 1 for Room 1; 0 for Room 2.
- ❖ Each agent creates *S* strategies: with probability of *L*/*P* to fill 1 in the choice column, where *L* is randomly drawn from [0, *P*].

✓ *Process:*
- ❖ A situation is drawn randomly from [1, *P*] at every time step.
- ❖ Each agent uses his/her best-scored strategy to make decisions under the current situation.
- ❖ Every strategy will be evaluated based on the "winning" room unveiled.

Experiment

To validate the model design:

- ❖ We recruit 25 students from the Department of Physics at Fudan University.
- ❖ Each set of parameters (*k* and M_1/M) is conducted for one round with 15 time steps.

Results

Fig. 1

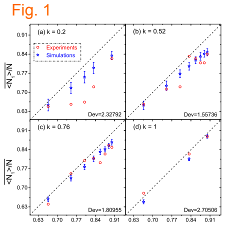


Fig. 4

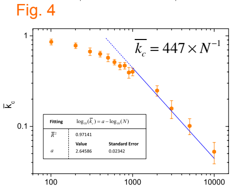


Fig. 2

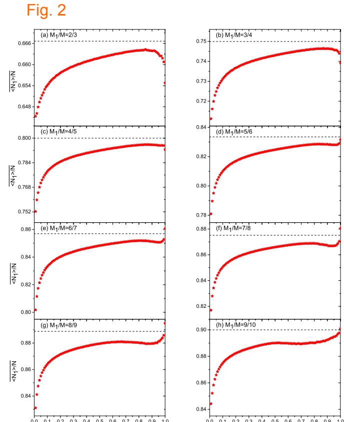


Fig. 3

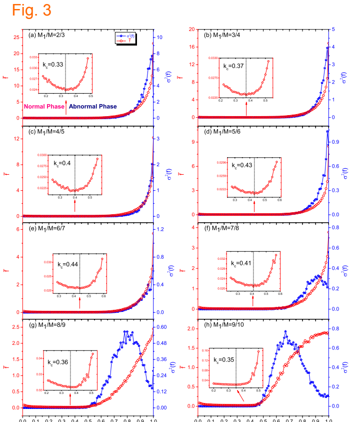


Fig. 1: Well fitness between the values of $\langle N_1 \rangle / N$ from experiments and simulations.
Fig. 2: Even for *k=0.2*, the system can almost reach the optimal state $M_1/N_1 = M_2/N_2$.
Fig. 3: *Anomalous continuous phase transition.* $f = (1/N)\left\langle \left(N_1 - \langle N_1 \rangle\right)^2 \right\rangle,\ \sigma^2(f) = \overline{f^2} - \left(\overline{f}\right)^2$
Fig. 4: For system with infinite number of agents.

Conclusions

- ✓ Even for a very low level of partial information, the system can still almost reach the optimal state.
- ✓ Ensemble average of the simulated system's fluctuation level undergoes a continuous phase transition, showing that in the abnormal phase more information can hurt the system's stability instead (*complete information is not good for the system's efficiency*).
- ✓ At the critical point, ensemble fluctuations of fluctuation level remain at a low value which is in contrast to the textbook knowledge about continuous phase transitions.
- ✓ When the number of agents becomes infinite, there still exists this anomalous fluctuation transition phenomenon.