Market dynamics and agents behaviors

A computational approach

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- some theories explain these phenomenoms but with too strong hypotheses (rational expectation)
- our approach :
  - bottom-up approach to relax these hypotheses (bounded rationality)
  - multi-agents simulations (Santa-Fe Artificial Stock Market)

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- new result in finance !

Market architecture

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  - do nothing
- agents' cash money is invested in a risk free asset with a fixed interest rate r

Price and dividend calculation

- p_t is updated according to the number of buyers and sellers :

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$$p_t = p_{t-1} + \beta(B_t - O_t)$$

- d_t follows a random walk :

$$d_{t+1} = d_t + \epsilon_t$$

A special value : the fundamental value

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- gives the price the stock would have on an ideal market
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- here :

$$\mathrm{fv}_t = \frac{d_t}{r}$$

Generalities

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- knowledges : past values of p_t, d_t and fv_t
- no knowledge on the generation process of these values
- challenge : maximize the amount of money owned at the end of the simulation

Market perception

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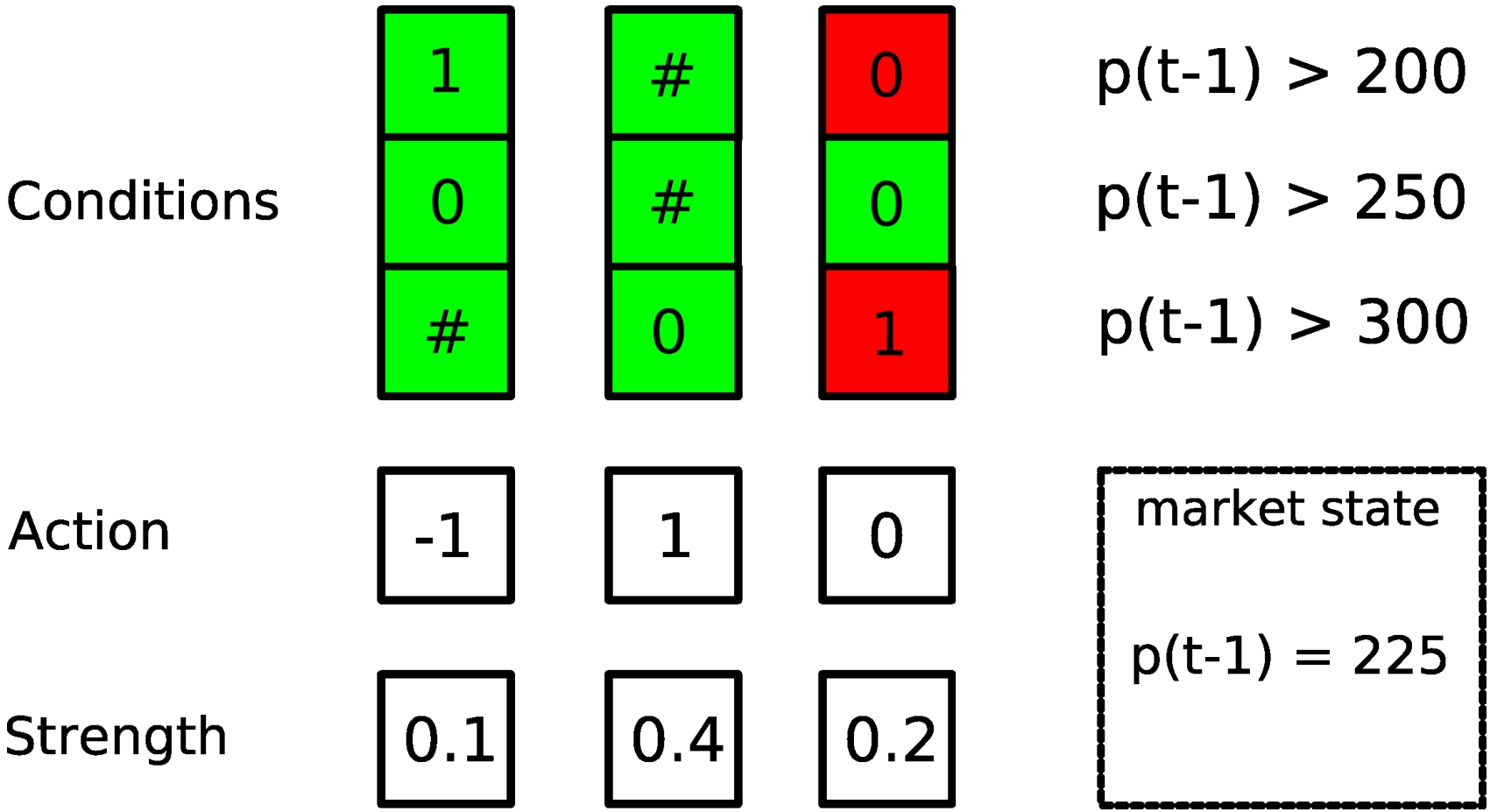
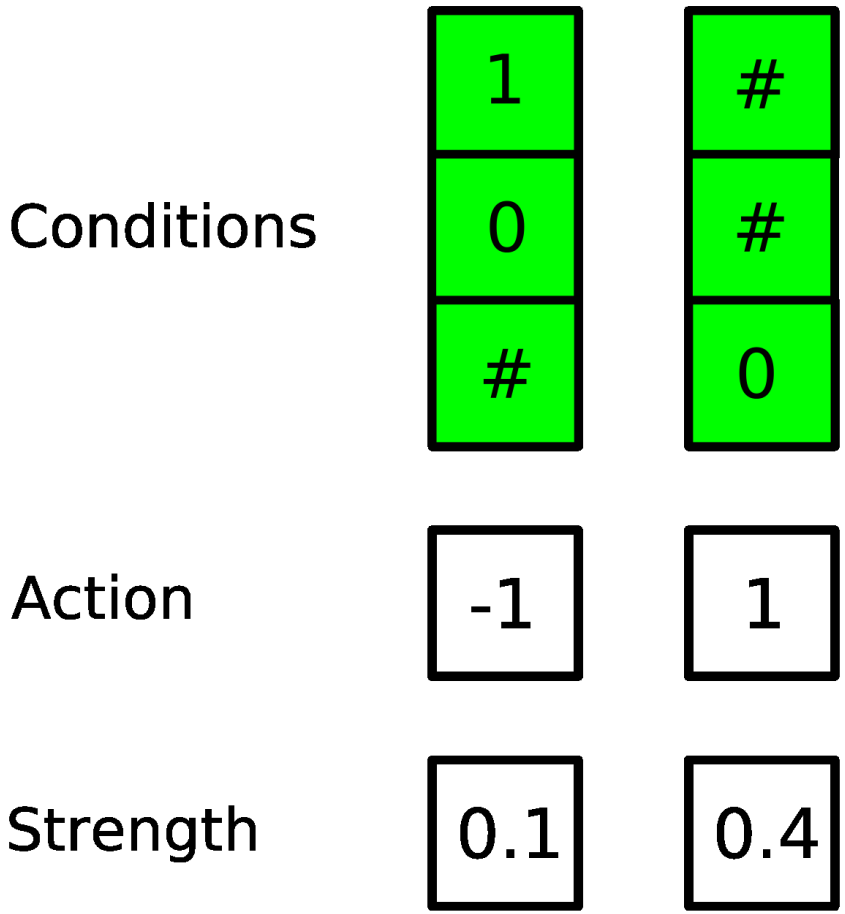
- The *condition* part is composed of indicators which can be: `true`, `false` or `non-significative`.

Indicators

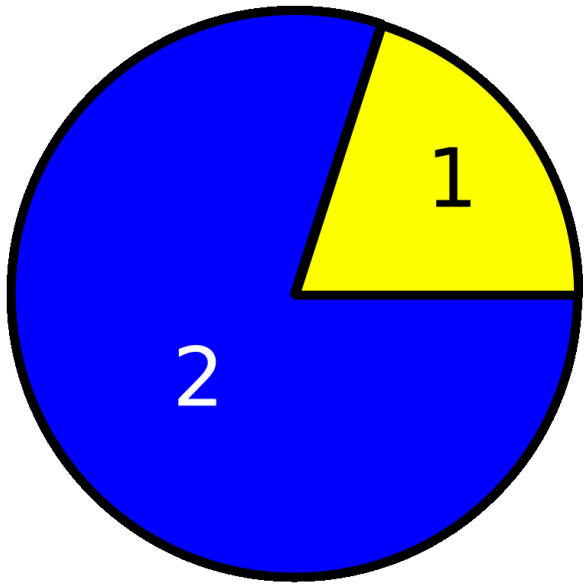
Conditions	1	#	0	p(t-1) > 200
	0	#	0	p(t-1) > 250
	#	0	1	p(t-1) > 300
Action	-1	1	0	
Strength	0.1	0.4	0.2	

Indicators


Conditions
1
0
#
#
#
0
0
0
1
p(t-1) > 200
p(t-1) > 250
p(t-1) > 300
Action
-1
1
0
Strength
0.1
0.4
0.2
market state
p(t-1) = 225


Conditions
1
0
#
#
#
0
Action
-1
1
Strength
0.1
0.4

Number	1	2
Conditions	1 0 #	# # 0
Action	-1	1
Strength	0.1	0.4



Model limitations

Several limitations in the original model:

- agents observe the market with indicators coming from classical theory and speculation theory

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- agents may not take rational economic decisions

Two types of agents

To improve the original model, we create two new types of agents:

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  $\Rightarrow$ herd behavior

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- Fundamentalists agents : market observation through indicators which use classical economic theory
  $\Rightarrow$ arbitration of deviations between the price and the fundamental value
- Speculator agents : market observation through technical indicators (trends)
  $\Rightarrow$ herd behavior
  - till a certain point...

Speculation limit

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- speculation activity must be bounded
- lack of liquidity make speculators fear and revert their positions (A. Orlean)
- leads to critical events (crashes)

Rationalization

- for fundamentalists:
  - if the stock is over evaluated, sell
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  - if information is too vague, do nothing

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- for fundamentalists:
  - if the stock is over evaluated, sell
  - if the stock is under evaluated, buy
  - if information is too vague, do nothing
- for speculators:
  - if the market is globally *bull*, buy
  - if the market is globally *bear*, sell
  - if the market is *stationnary*, do nothing

Methods

- experiments running during 10000 iterations with 100 agents

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- most of model parameters are fixed but the proportion of speculator agents

First experiment: baseline

- experiment without speculator agents

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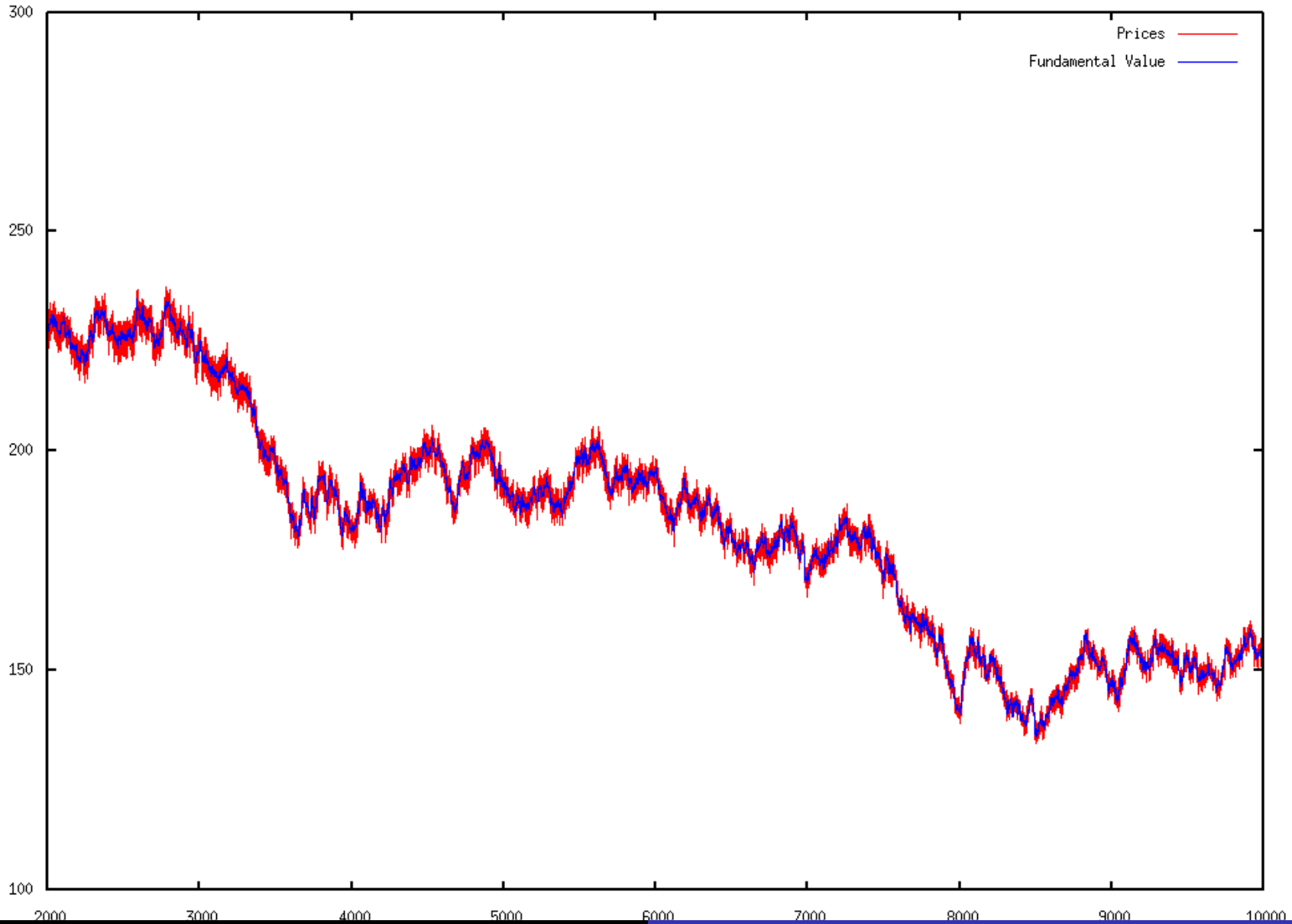
- experiment without speculator agents
- is used as a reference to compare with other simulations


Prices
Fundamental Value
300
250
200
150
100
2000
3000
4000
5000
6000
7000
8000
9000
10000

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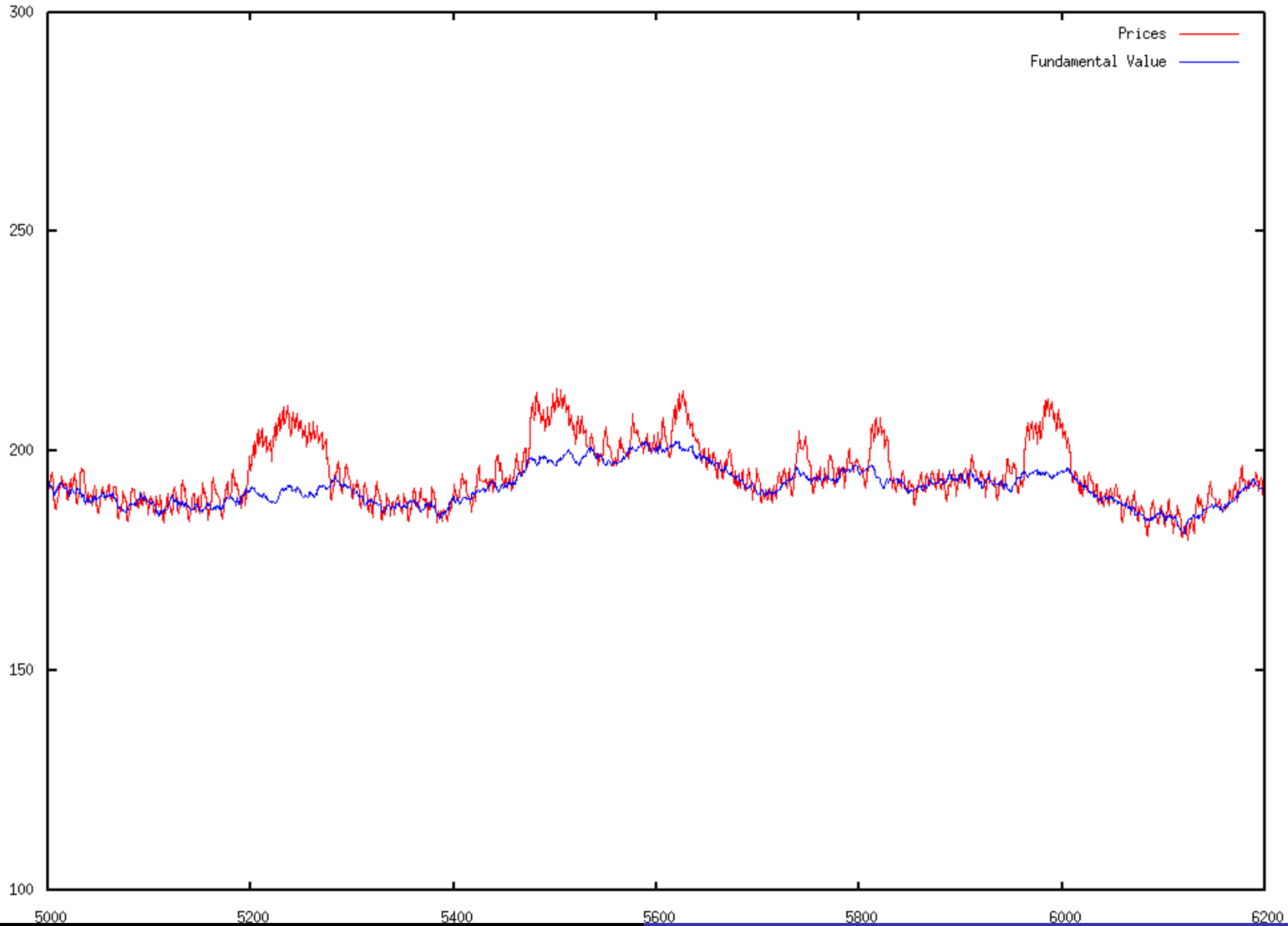
- several experiments run until a critical state is found in the fundamentalists/speculators proportion
- highly volatile market until a new kind of regim is reached : bubbles & crashes
- after this critical state: market becomes chaotic


Prices
Fundamental Value
300
250
200
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100
5000
5200
5400
5600
5800
6000
6200

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- market dynamics are close to the ones which can be observed on real markets (statistic proof) with rational agents

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- bubbles can appear even if the price dynamics is efficient
- illustration that speculative behaviors described by Keynes or Orlean can exist on markets

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- create a new agent to prevent bubbles and crashes (by smoothing liquidity for example)