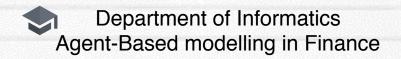
Simulation and Study on Trading Strategies in Stock Market

Liyun Chang Qi Ding Jialu Shi Ming Wu Yuchen Ye





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O1 Strategy Background

02 Artificial Stock Market Simulation

03 Simulation Result Analysis

04 Conclusion





Strategy Background



1 Investment strategies

Buy stocks that have had high returns. ■ Momentum Strategy Sell stocks that have had poor returns. Buy stocks that have had poor returns Contrarian Strategy Sell stocks that have had high returns. Buy or sell stocks on the basis of "noise" instead of fundamental ■ Noise Strategy information. Buy a stock if the intrinsic value is greater than the price. Rational Strategy Sell a stock if the intrinsic value is less than the price.



Artificial Stock Market Simulation



2.1 Steps to construct artificial stock market



Build conceptual model on the basis of behavioural finance.



Program on the Netlogo platform to implement the artificial stock market.



2 <

Design and establish the artificial stock market.

4 <

Run simulations and use resulting data to detect and analyse the model.



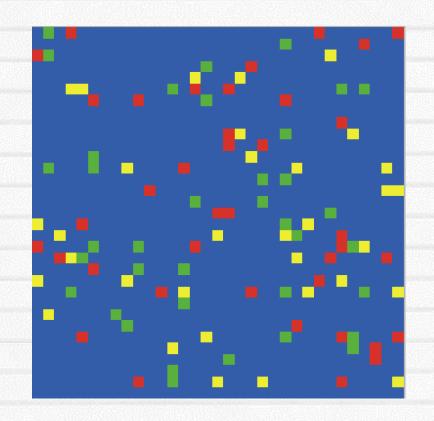
2.2 Four kinds of traders in the market

■ Momentum Traders → Green Patches

□ Contrarian Traders → Yellow Patches

■ Noise Traders → Red Patches

□ Rational Traders → Blue Patches





2.3 Stock price and wealth calculation

price change =
$$\frac{buy\ volume\ -sell\ volume}{buy\ volume\ +sell\ volume}$$

Wealth of traders

wealth = cash + price-one * stock-hold-one + price-two * stock-hold-two

If wealth < 0, the trader has an investment loss and would change his trading strategy randomly.

If wealth > 0, the trader continue to use the same strategy.



2.4 Graphic attribute list

Graphic Space Name	Graph Name	Graphic Space Name	Graph Name
Total	number-of-ContrarianTraders	intrinsic-value-one	intrinsic-value-one
	number-of-MomentumTraders	price-one	price-one
	number-of-NoiseTraders	intrinsic-value-two	intrinsic-value-two
stock-trade-one	trade-of-contrariantraders	price-two	price-two
	trade-of-momentumtraders	return	return-one
	trade-of-noisetraders		return-two
stock-trade-two	trade-of-contrariantraders	volatility	indicator-volatility-one
	trade-of-momentumtraders		indicator-volatility-two
	trade-of-noisetraders	wealth-of-contrariantraders	wealth-of-contrariantraders
stock-hold-one	hold-of-contrariantraders		wealth-of-rationaltraders
	hold-of-cmomentumtraders	wealth-of-momentumtraders	wealth-of-momentumtraders
	hold-of-noisetraders		wealth-of-rationaltraders
stock-hold-two	hold-of-contrariantraders	wealth-of-noisetraders	wealth-of-noisetraders
	hold-of-cmomentumtraders		wealth-of-rationaltraders
	hold-of-noisetraders		

^{*} Here we set rational traders as a standard and compare the wealth of rational traders with the other three kinds of traders respectively.

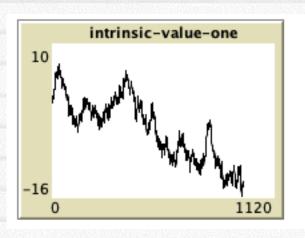


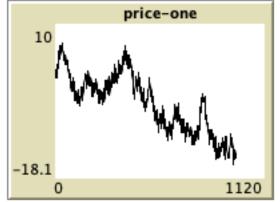
Simulation Result Analysis





☐ The causal relationship between stock price and value





The change in the market price and value of stock 1

Granger test results for stock 1

Pairwise Granger Causality Tests Date: 03/18/19 Time: 20:48

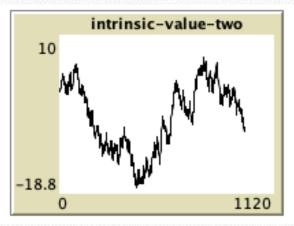
Sample: 1907

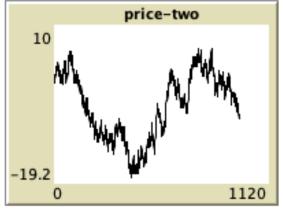
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
PRICE_ONE does not Granger Cause INTRINSIC_VALUE_ONE INTRINSIC_VALUE_ONE does not Granger Cause PRICE_ONE	905	1.23829 117.978	0.2904 3.E-46



☐ The causal relationship between stock price and value





The change in the market price and value of stock 2

Granger test results for stock 2

Pairwise Granger Causality Tests Date: 03/18/19 Time: 20:54

Sample: 1 907

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
PRICE_TWO does not Granger Cause INTRINSIC_VALUE_TWO INTRINSIC_VALUE_TWO does not Granger Cause PRICE_TWO	905	0.22916 129.240	0.7952 5.E-50



☐ Stability test of price series (stock1)

Augmented Dickey-Fuller Unit Root Test on PRICE_ONE

Null Hypothesis: PRICE_ONE has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=0)

		t-Statistic	Prob.*
Augmented Dickey-Ful	ler test statistic	-1.035719	0.2709
Test critical values:	1% level	-2.567517	
	5% level	-1.941173	
	10% level	-1.616464	

^{*}MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation Dependent Variable: D(PRICE_ONE)

Method: Least Squares Date: 03/18/19 Time: 21:20 Sample (adjusted): 2 907

Included observations: 906 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PRICE_ONE(-1)	-0.002456	0.002371	-1.035719	0.3006
R-squared Adjusted R-squared S.E. of regression Sum squared resid Log likelihood - Durbin-Watson stat	0.001157 0.001157 0.925821 775.7155 -1215.228 2.609998	Mean depend S.D. depende Akaike info cr Schwarz crite Hannan-Quin	ent var iterion rion	0.004829 0.926357 2.684831 2.690139 2.686858

Augmented Dickey-Fuller Unit Root Test on D(PRICE_ONE)

Null Hypothesis: D(PRICE_ONE) has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=0)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic Test critical values: 1% level 5% level 10% level	-41.33701 -2.567520 -1.941173 -1.616464	0.0000

^{*}MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation Dependent Variable: D(PRICE_ONE,2)

Method: Least Squares Date: 03/18/19 Time: 21:21 Sample (adjusted): 3 907

Included observations: 905 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PRICE_ONE(-1))	-1.308069	0.031644	-41.33701	0.0000
R-squared Adjusted R-squared S.E. of regression Sum squared resid Log likelihood Durbin-Watson stat	0.654004 0.654004 0.881365 702.2315 -1169.353 2.091519	Mean depend S.D. depende Akaike info cri Schwarz crite Hannan-Quin	nt var iterion rion	-5.68E-05 1.498375 2.586415 2.591728 2.588444



☐ Stability test of price series (stock2)

Augmented Dickey-Fuller Unit Root Test on PRICE_TWO

Null Hypothesis: PRICE_TWO has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=0)

		t-Statistic	Prob.*
Augmented Dickey-Ful Test critical values:	ler test statistic 1% level 5% level 10% level	-0.033024 -2.567517 -1.941173 -1.616464	0.6716

^{*}MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation Dependent Variable: D(PRICE_TWO)

Method: Least Squares Date: 03/18/19 Time: 21:16 Sample (adjusted): 2 907

Included observations: 906 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PRICE_TWO(-1)	-5.66E-05	0.001714	-0.033024	0.9737
R-squared Adjusted R-squared S.E. of regression Sum squared resid Log likelihood Durbin-Watson stat	-0.000983 -0.000983 0.923970 772.6163 -1213.415 2.626687	Mean depend S.D. depende Akaike info cr Schwarz crite Hannan-Quin	ent var iterion rion	-0.028959 0.923516 2.680828 2.686136 2.682855

Augmented Dickey-Fuller Unit Root Test on D(PRICE_TWO)

Null Hypothesis: D(PRICE_TWO) has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=0)

	t-Statistic Pro	b.*
Augmented Dickey-Fuller test statistic	-41.64781 0.00	00
Test critical values: 1% level	-2.567520	
5% level	-1.941173	
10% level	-1.616464	

^{*}MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation Dependent Variable: D(PRICE_TWO,2)

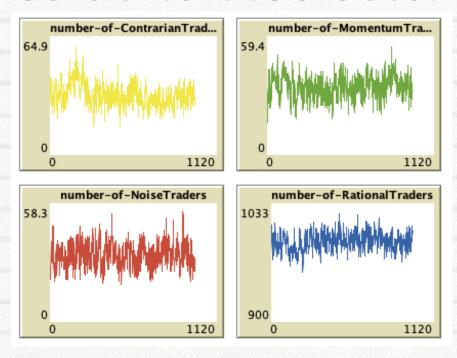
Method: Least Squares Date: 03/18/19 Time: 21:18 Sample (adjusted): 3 907

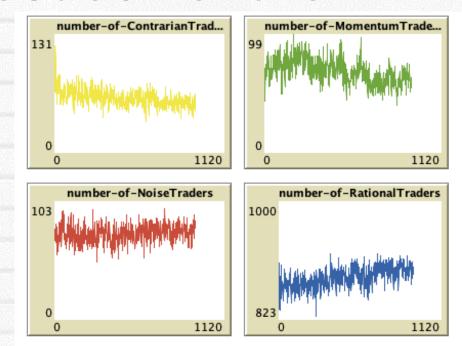
Included observations: 905 after adjustments

911					
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
- -	D(PRICE_TWO(-1))	-1.314831	0.031570	-41.64781	0.0000
	R-squared Adjusted R-squared S.E. of regression Sum squared resid Log likelihood Durbin-Watson stat	0.657386 0.657386 0.877034 695.3469 -1164.895 2.076859	Mean depende S.D. depende Akaike info cr Schwarz crite Hannan-Quin	ent var iterion rion	5.48E-05 1.498353 2.576563 2.581876 2.578592



General conclusions about the state of the market





basic parameters: scale-of-fundamentalists=32

correct-rate1=correct-rate2=0.5

affect-rate=0.27

limitation-of-short-selling=150

base-term-Contrarian=1

base-term-Momentum=1

basic parameters: scale-of-fundamentalists=15

correct-rate1=correct-rate2=0.5

affect-rate=0.27

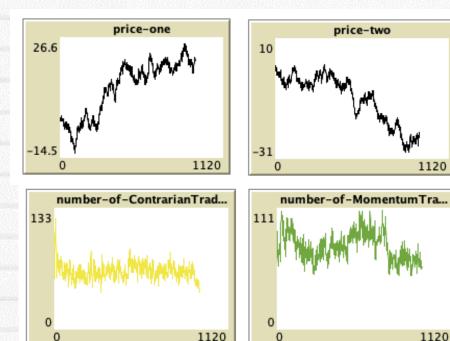
limitation-of-short-selling=150

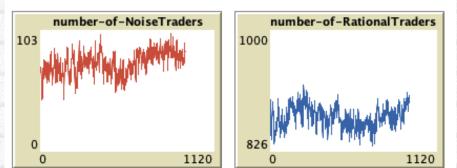
base-term-Contrarian=1

base-term-Momentum=1



General conclusions about the state of the market



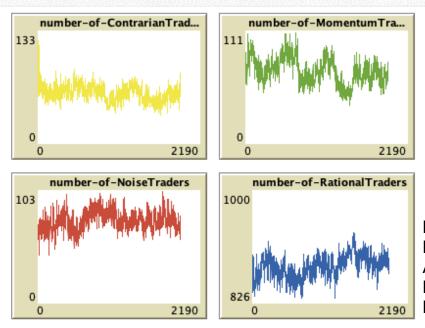


We assume that there are two types of financial assets in the market, so that the execution of a trader's strategy depends not only on the change of one stock, but also on the performance of multiple assets, closer to the real market.

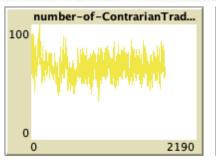
In extreme cases, one stock price rises sharply and the other falls sharply. The experimental results we obtained are as shown in the figure. The trend of volatility of contrarian traders and momentum traders is opposite in extreme cases.

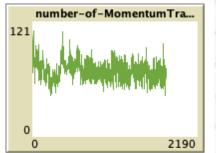


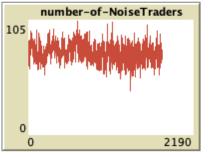
■ The influence of the choice of base period on the trading state

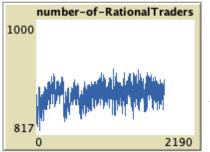


base-term-Contrarian=1
base-term-Momentum=1
After 1000 rounds
base-term-Contrarian=15
base-term-Momentum=1









base-term-Contrarian=1 base-term-Momentum=1 After 1000 rounds base-term-Contrarian=1 base-term-Momentum=15

Contrarian traders and momentum traders have the largest fluctuations and have a clear trend in the opposite direction.

Similarly, when base-term Contrarian remains unchanged while base-term Momentum is adjusted, the same result can be obtained, that is, the choice of observing base period has no influence on the strategic choice and learning of investors.



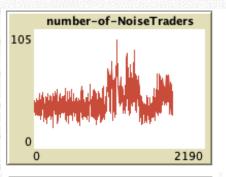
■ The influence of noise affect-rate on transaction status

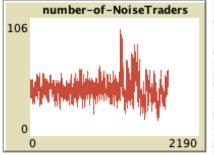
Affect -rate refers to the proportion of noise traders' investment decision execution affected by individual factors and herd factors.

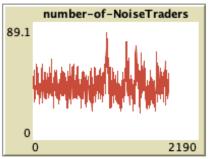
At the beginning, select affect-rate = 0.8

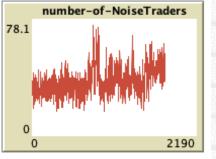
After 1000 transactions, we adjusted the affect-rate value to 0.2, and the herd effect was dominant.

After several tests, it was found that noise traders' quantity volatility increased significantly (see figure below). This phenomenon indicates that herding is the main reason for the fluctuation of noise population.









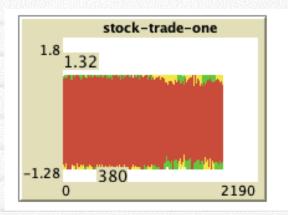


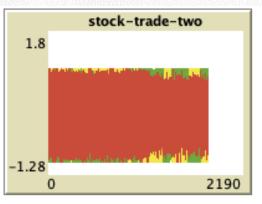
■ The influence of noise affect-rate on transaction status

When the affect-rate changes, the trading volume of the two stocks also changes greatly.

Similarly, the above experiment was used. Adjust the affectrate to 0.8 and conduct 1000 transactions, then adjust the affect-rate to 0.2, and then conduct 1000 transactions to observe the change in trading volume.

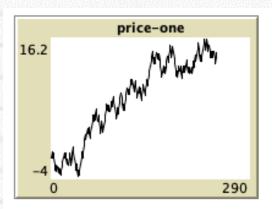
Many tests show that when the affect-rate is 0.8, the trading volume of two stocks fluctuates between positive and negative 0.8, while when the affect-rate is 0.2, the trading volume decreases rapidly and the fluctuation range is between positive and negative 0.6, which is also the result of the herd effect.

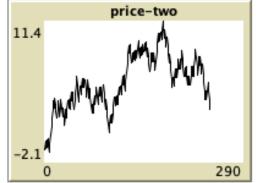






■ Trader benefit analysis





According to the different trend of two kinds of stocks, the income of various investors is analyzed.

Two stocks generally move higher when four types of investors gain.

Contrarian trader	average income	10.98
	standard deviation	22.73
	biggest gains	139.82
	minimum income	-62.32
	kurtosis	6.62
	skewness	2.32
Momentum trader	average income	2042.43
	standard deviation	2422.67
	biggest gains	9124.25
	minimum income	-19.72
	kurtosis	-0.65
	skewness	0.94
Noise trader	average income	125.82
	standard deviation	88.73
	biggest gains	346.72
	minimum income	-0.76
	kurtosis	-1.73
	skewness	0.63
Rational trader	average income	27.73
	standard deviation	42.84
	biggest gains	209.73
	minimum income	-4.92
	kurtosis	3.64
	skewness	2.17



■ Trader benefit analysis





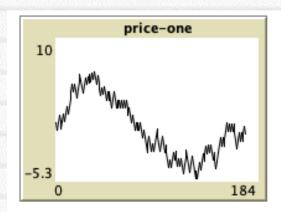
According to the different trend of two kinds of stocks, the income of various investors is analyzed.

One stock goes up and one stock goes down, four types of investor gains.

Contrarian trader	average income	128.46
	standard deviation	189.63
	biggest gains	1102.98
	minimum income	-203.47
	kurtosis	4.18
	skewness	1.84
Momentum trader	average income	9.73
	standard deviation	20.87
	biggest gains	143.25
	minimum income	-32.53
	kurtosis	8.23
	skewness	2.61
Noise trader	average income	61.98
	standard deviation	34.85
	biggest gains	139.92
	minimum income	0.26
	kurtosis	-0.72
	skewness	-0.38
Rational trader	average income	16.82
	standard deviation	21.98
	biggest gains	96.63
	minimum income	-4.82
	kurtosis	2.54
	skewness	1.52



■ Trader benefit analysis





For momentum trading strategies and contrarian trading strategies, the higher the yield, the higher the volatility.

Noise traders with stable excess returns and low volatility are a good choice of investment strategies.

The rational trader represents the general strategy of the market, and less return is the best choice for the conservative investment risk aversion.

Contrarian trader	average income	134.53
	standard deviation	190.72
	biggest gains	1104.82
	minimum income	-211.98
	kurtosis	4.92
	skewness	1.89
Momentum trader	average income	8.42
	standard deviation	21.37
	biggest gains	142.65
	minimum income	-32.15
	kurtosis	8.1
	skewness	2.74
Noise trader	average income	63.72
	standard deviation	34.17
	biggest gains	140.82
	minimum income	0.01
	kurtosis	-0.83
	skewness	-0.41
Rational trader	average income	19.73
	standard deviation	20.71
	biggest gains	95.02
	minimum income	-3.91
	kurtosis	2.43
	skewness	1.45



Conclusion

PART 04



4 Conclusion

1 The trend in the number of momentum traders is the opposite of the trend in the number of contrarian traders, especially in small markets where one side of the momentum trader and the other side of the contrarian trader is completely out of the market when the trade has been going on long enough.

2 Herding behavior has a significant effect on the number of noise traders. At the same time, herd behavior also has a significant impact on stock trading. The greater the herd effect is, the less the stock trading volume will be.

3 Trader's gain. One of the contrarian and momentum traders can earn significant excess returns. Noise traders always have higher returns than rational traders, and volatility is not significant. Therefore, noise traders' strategies are relatively good investment choices. It also confirms that noise traders are not driven out of the market.



THANK YOU!

