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Investor behavior heterogeneity in the French stock market

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Abstract

We estimate in this paper a non probabilistic Markovien model of stock prices with an evolutionary selection of heterogeneous strategies. It is a model proposed by Brock and Hommes (1997, 1998) and improved later by Boswijk and al. (2007). Indeed, the latter propose one of the few estimations considering stock markets data, characterized by an evolutionary selection procedure of heterogeneous strategies. They estimate the model to annual US stock price data from 1871 to 2003. In this paper, we chose to proceed by estimation concerning 27 companies from the CAC 40 and the composite index corresponding to these 27 companies to avoid the risk of an average effect on adding these stocks. In addition, the strategy adopted by an investor can depend on his investment horizon and to verify this assumption we chose daily, monthly and quarterly data.

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1. Introduction

Estimating heterogeneous models began in 1984 with Shiller who presented a model with heterogeneous agents: rational and ordinary. He estimates a proportion of rational investors between 1900 and 1983 and finds that this proportion considerably fluctuates between 0% and 50%. More recently, Westerhoff and Reitz (2003) estimate heterogeneous agent model with fundamentalists and chartists using exchange rate data and find significant fluctuations of fundamentalist impact. Brock and Hommes (1997, 1998) propose a heterogeneous agent model improved later by Boswijk et al. (2007). Indeed, the latter propose one of the few estimations considering stock markets data, characterized by an evolutionary selection procedure of heterogeneous strategies. They estimate the model to annual US stock price data from 1871 to 2003. The estimation results support, on the first hand, the existence of two expectation regimes, fundamentalists and trend following; and on the other hand, offer an explanation for stock prices run-up. Then we use the considered nonlinear model with the purpose of studying investor behaviour heterogeneity in the French stock market. We consider two investment strategies and accordingly two extreme regimes: chartist and fundamentalist. This choice is justified by many papers which show that they are the most observed behaviours in the markets. This is a dynamic model which considers an evolutionary selection of investment strategies and a transition between the two regimes which depends on the last profits generated by each decision rule.

In the following we will present the results of the estimations. The originality of our estimation lies in empirical applications founded on the use of individual assets and daily, monthly and quarterly data. Indeed, we think intuitively that the use of price index could skew our results and this is because of the possible compensation effects between stocks in the same index. The use of individual stocks will also allow a clearer vision of speculative movements undergone by different companies. On the other hand, considering daily, monthly and quarterly data, will allow us to conclude on a possible link between adopted strategy and investment horizons.

2. A heterogeneous agent model

This model presented by Boswijk et al. (2007), is a reformulation in terms of price to cash-flow ratio of heterogeneous agent model introduced by Brock and Hommes (1997, 1998). It considers two assets: a risky asset and a riskless one. The risky asset pays an uncertain cash-flow D_t in each period. We note P_t risky asset price and r the discount rate.

We suppose that the agents choose between two beliefs or investment strategies; chartist or fundamentalist. We suppose that each agent has a myopic mean/variance demand function and that investors have the same risk aversion coefficient and the same variance anticipation. The only source of heterogeneity selected relates to the anticipated future return of the risky asset. All the agents anticipate the same cash-flows:

$$E_t[D_{t+1}] = (1+g)D_t \tag{1}$$

With g the constant dividend growth rate

Bounded rational agents are thus able to anticipate future dividends.

The choice by agents of forecasting strategies depends on the recent past profits. At the beginning of the t period, profits realized by each kind of strategy at the end of $(t-1)$ are available for all agents.

The dynamic asset pricing equation is written as follows:

$$R^* x_t = n_t \phi_1 x_{t-1} + (1-n_t)\phi_2 x_{t-1} + \varepsilon_t \tag{2}$$

With $R^* = \frac{1+r}{1+g}$, r the discount rate

x_t represents the deviation of the observed price/cash-flow ratio from the fundamental ratio, ϕ_1 and ϕ_2 parameters characterizing beliefs of the two types agents, n_t fraction of type 1 investors. When $0\langle\phi_h\langle 1$, investors anticipate a decrease of the deviation from the fundamental value in the future: they would be thus fundamentalists. The closer ϕ_h is to 1, the more persistent deviation is expected. If $\phi_h \rangle 1$, it implies that investors expect an increase in the deviation of the stock price through time at a constant speed: these agents would be thus chartists or trend followers.
The fraction of type 1 investor is:

$$n_t = 1/1+\exp\left\{-\beta^*\left[(\phi_1-\phi_2)x_{t-3}\left(x_{t-1}-R^* x_{t-2}\right)\right]\right\} \qquad (3)$$
$$\text{With } \beta^* = \beta(1+g)^2/a\eta^2 \text{ and } \eta^2 = (1+m)^2(1+g)^2 V_{t-2}[\varepsilon_{t-1}]$$

β: the transition parameter or the transition speed between strategies
m: the "fundamental" price/dividend ratio
Subsequently, this model will be used in order to characterize agent behaviour on the French stock market. As we have already announced, the originality of our study is to consider individual assets and to distinguish several frequencies in data.

3. Estimation

3.1 Data description
We use observations relating to twenty seven companies which are among those belonging to CAC40 for a longer period than others, from January 1989 to October 2007.
We think that the use of individual assets is justified by the fact that not only agents are unable to follow the same strategies for companies constituting the same index, but they are not also the same investors who hold various assets. Investor behaviour would probably depend on the characteristics of each company and those of its industry branch. The index study, in this case, would be skewed and would mask situations and movements specific to diverse companies. It would be on the other hand interesting to compare results which we find for different companies to the situation on the stock market. For this, we initially built an index gathering the 27 selected companies[1]. We studied investor behaviour for this index and we showed thereafter that the results found for this index are not the same ones for all companies and thus the agent behaviour is indeed heterogeneous and varies through companies.
In this study, we propose empirical application founded on daily, monthly and quarterly data in order to explore the assumption according to which the strategy adopted by an investor can depend on his investment horizon. We can think that an investor acting in shorter term would be more chartist than fundamentalist.

3.2 Estimation method

We estimate in this section the parameters (ϕ_2 ϕ_1 β^*) in model (2) and (3) by nonlinear least squares method and more precisely by simplex method. As we stated before, we use daily,

[1] To calculate this index and its dividend we balanced stock prices (respectively dividends) of each company by stock market capitalization.

then monthly and finally quarterly observations of 27 companies from the CAC 40 and their composite index that we built and called P27.

3.3 Estimation results

We retained for the various frequencies of data, Student statistics as well as Akaike selection criterion value (AIC) of equation (2) and Akaike value (AICAR $_{(1)}$) of the linear model AR(1).We also estimated the coefficient $\phi_{AR(1)}$ of this same model. The linear model corresponds in fact to the case of agent homogeneity i.e. $\phi_1 = \phi_2 = \phi_{AR(1)}$. Using Wald statistics, we compared nonlinear heterogeneous model and linear homogeneous agent model. We suppose that the null assumption corresponds to $\phi_1 = \phi_2$.

According to the Wald test, the nonlinear model is not always significantly better than the linear model. Table I represents, for the three used frequencies, assets proportions for which, the nonlinear model is significantly better than the linear model. We thus note that using the nonlinear model is better justified for high frequency data. Indeed, the nonlinear model is more significant than the linear model for 52% assets and daily data. For monthly frequencies, the nonlinear model is superior to the linear model for 44% of assets. And finally, for quarterly data the nonlinear model is superior for only 26% assets.

We now observe with table II the evolution of agent behaviours according to investment horizon. $0\langle\phi_h\langle 1$ corresponds to a fundamentalist strategy coefficient. $\phi_h\rangle 1$ is a chartist strategy coefficient. When ϕ_h is not significantly different from 1, there is no adjustment with the fundamental value. According to table III, that corresponds to the case of 1.85% assets when data are daily, 7.40% assets when data are monthly and 0.00% when data are quarterly. It is noted that in the shorter term, even fundamentalist agents who exist in the market believe in a slow mean return and in a sort of persistence of the deviation. Indeed, coefficients $\phi_h < 1$ are very close to 1 and in particular for daily data. For monthly observations, fundamentalist agents believe in a faster return to fundamental values. We pass, indeed, to coefficients ϕ_h closer to zero.

The non adjustment to fundamental value, i.e. when $\phi_h = 1$ or ϕ_h is not significantly different from 1, can be explained by the existence of arbitrage limits or implicit risk or by the existence of transaction costs. It also justifies the nonlinear price dynamics. Indeed, Shleifer and Summers (1990) explain why the existence in the markets of "noise traders" can lead to deviation of price from fundamental value which are not reduced by the arbitragists because of the uncertainty characterizing these deviations. As indicated above, transposed in evolutionary selection strategies model, we can advance the assumption that expected fundamental value is the same for all agents, but that this value in fact is supplied with a margin of uncertainty ascribable to perception errors, which seems a more realistic assumption than an exact knowledge of this value. This implies that it can be risky for rational arbitragists to make decisions on the basis of these perceived deviations which can be different from truth deviations which are still unknown. Arbitrage gains can be in this case insufficient to compensate the risk run by the arbitragists. As a result, price deviation from fundamental value persists. The arbitrage risk is treated in an implicit way.

The existence of transaction cost can also explain the non adjustment to fundamental value when these costs are higher than expected profits. We must underline previous analyses, using nonlinear adjustment models, like Bohl and Siklos (2004), Psaradakis, Sola and Spagnolo (2004) and Coakley and Fuertes (2006), which show that return to fundamental value becomes higher when deviation from this value is significant, and becomes weak or non-existent when deviation is weak. These results confirm the existence of a no-arbitrage

zone on the stock market which can be allotted to the fact that arbitrage risk prime and transaction costs are in total more significant than expected profits. Therefore, there are not any more forces allowing prices to adjust to benchmark value.

We also see the interest of analyzing individual asset price dynamics. Indeed, if we considered for example the portfolio formed by these 27 assets we could not realize that there are assets for which fundamentalist strategy is applied in the short term. And, if we refer only to P27 index, the market would be governed only by chartists for daily and monthly observations. For long term observations, i.e. quarterly data, we find exclusively fundamentalists. This implies agent behaviour heterogeneity varies from an investment horizon to another, whereas agents having the same investment horizon would adopt homogeneous behaviours. Investors would adopt the chartist strategy for daily and monthly investment horizons and the fundamentalist strategy for quarterly investment horizon. However, individual asset study disproves this result obtained for a composite index cannot thus be generalized for all the assets which constitute it.

We will now study the evolution of chartist and fundamentalist proportions for each investment horizon and for different companies.

Table III enables us to confirm one of our starting intuitions: Chartist strategy is the dominant one in shorter term, while fundamentalist strategy dominates investor behaviour in longer-term. A thesis which is besides defended also by traditional finance which recommends that fundamental value is established in the long run.

In the appendices below, we deferred the chartist fraction evolution figures for various investment horizons and for some companies. We can observe for the diverse companies a presence of large fluctuations for some periods which could correspond to bubbles. We notice in particular, for most intense and the most known stock market crisis for our study's period. It is also called the technological bubble because it affected mainly technological assets, i.e. those of sectors related to informatics and telecommunications. It concerns in priority Alcatel, Bouygues or Vivendi. Crisis concerns also sectors dependent on or in relation with technological sectors. It comes out from our study, except for some companies, a kind of confusion of investors for crisis period. Indeed, for middle term investment horizon, where we generally notice the existence of two types of strategies, we distinguish a kind of stability of chartist fraction and fundamentalist one turning around 50%. During crisis period (during the bubble and at its bursting), agents switch brutally between the two strategies. During these periods, there exist strategy imitation phenomena probably because of the lack of information. These phenomena can also be explained by the great uncertainty which reigns. Indeed, investors do not rely on their beliefs any more. In a state of total uncertainty, imitation is imposed as the rational behaviour: copying other strategies becomes a strategy. In this case, if the other does not have more information than me, my position remains unchanged and if they know something, I improve my situation. Even companies which are not concerned a priori by the crisis were touched under panic effect of market and investors. The bubble which was initially technological is extended to the majority of companies. Let us notice that some companies such as Suez, Shneider, Perno Ricard or Air France were not affected by the crisis and kept stable chartists proportions in the middle term always around 50%.

4. Conclusion

Boswijk et al (2007) estimate the evolutionary selection model using annual observations of the S&P500 index. But agents do not adopt inevitably the same strategies for companies constituting the same index. Indeed, investor behaviour depends on the characteristics of each company and on its industry branch. The study of index, in this case, would be skewed and would mask situations and movements specific to the diverse companies. In addition, the

strategy adopted by an investor can depend on his investment horizon. It is thus interesting to treat different horizons. We chose then to estimate this model with individual assets and not only with the composite index, to avoid the risk of an average effect on all the assets hiding heterogeneous behaviours subjacent with individual price dynamics. From a systematic comparison of results obtained according to data frequencies, we also tried to explore the assumption implying that agent adopted behaviours would depend on the investment horizon. Our study shows that if one referred only to the composite index, market would be governed only by chartists for daily and monthly observations. For long term observations, i.e. quarterly, we find only fundamentalist. Agents would be thus homogeneous for the same investment horizon and heterogeneous for different investment horizons. However, the analysis of individual asset often shows agent heterogeneity even for the same investment horizon. These results are different from those provided by Boswijk et al. (2007). Indeed, with the used data, the latter distinguish heterogeneous agents over all period of study. However we noted situations of homogeneity by treating individual stocks and also by considering various investment horizons.

The last remark relates to the period of Internet bubble. The result was also awaited: the confusion of investors during the crisis period with a brutal switch between two strategies. This was often the case for the majority of investors. We concluded for this period that there are imitation phenomena probably related to the lack of information and the climate of uncertainty. This result agrees with what we generally observe on the market during the formation and bursting of bubble, when investors do not rely on their beliefs any more. The rational behaviour is then imitation because by copying strategies of the others, we think of improving our information.

APPENDICES
Tables

Table I: Comparing nonlinear and linear model:

Frequencies	Superiority of nonlinear model
Daily	52% assets
Monthly	44% assets
Quarterly	26% assets

Each percentage represents proportion of assets for which nonlinear model is significantly better than linear model, with a significance threshold at 10%. For example, for daily data, the linear model is better for 14 among 27 assets, i.e. for 52% assets.

Table II: Compared results according to data frequencies:

Assets	Daily data		Monthly data		Quarterly data	
	ϕ_1	ϕ_2	ϕ_1	ϕ_2	ϕ_1	ϕ_2
Accor	1.01	1.02	0.88	1.004	0.62	0.98
AirFrance	1.05	1.07	0.97	1.05	0.68	1.14
Air Liquide	1	1.02	0.93	0.96	0.87	0.9
Alcatel	1.011	1.024	0.86	1.03	0.52	1.22
Axa	1.01	1.03	0.86	0.94	0.68	0.69
Bouygues	0.96	1.08	0.99	1.15	0.69	1.24
CapGémini	0.87	1.15	0.5	1.4	0.73	0.76
Carrefour	1.011	1.017	0.96	1.018	0.69	1.36
Danone	1.0108	1.011	0.77	1.11	0.52	1.25
Essilor	0.99	1.02	0.95	0.97	0.86	0.98
La farge	1.01	1.02	0.89	0.95	0.87	0.94
LaGardère	0.88	1.12	0.8	1.02	0.85	0.95
L'oréal	0.99	1.01	0.91	1.03	0.74	1.21
LVMH	1.002	1.018	0.5	1.17	0.68	0.78
Michelin	1.01	1.02	0.94	1.06	0.43	1.11
Pernod Ricard	1.001	1.008	0.6	1.02	0.63	0.95
Peugeot	1.007	1.03	0.57	1.44	0.69	1.26
PPR	0.98	1.05	0.88	1.1	0.68	1.21
Publicis	0.98	1.03	0.91	1.03	0.79	0.99
Sanofi Aventis	1.011	1.019	0.94	1.04	0.93	1.04
Schneider	1.008	1.04	0.03	1.12	0.74	0.9
Ste générale	0.79	1.025	0.65	1.08	0.58	0.99
St gobain	1.022	1.024	0.89	0.99	0.76	0.8
Suez	1.024	1.025	0.55	1.42	0.88	0.95
Total	0.88	1.15	0.89	1.08	0.76	1.13
Unibail	1.04	1.05	0.84	1.15	0.67	1.15
Vivendi	1.007	1.053	0.9	1.03	0.71	0.97
P_{27}	1.013	1.03	1.005	1.019	0.69	0.98

This table enables us to compare for each company the evolution of strategies adopted by the investors according to their horizons of investment. ϕ_h superior to 1 indicates chartist strategy and ϕ_h lower than 1 indicates fundamentalist strategy.

Table III: Chartist and fundamentalist fraction with a 10% significant level:

Data	Companies fraction for which ϕ_h >1 with a 10% significant level ***Chartists***	Companies fraction for which ϕ_h <1 with a 10% significant level ***Fundamentalists***	Companies fraction for which ϕ_h is not significativly different from 1 with a 10% significant level
Daily	81.48%	16.67%	1.85%
Monthly	40.74%	51.85%	7.40%
Quarterly	22.22%	77.78%	0%

To calculate each agent type fraction for various investment horizons, we proceed as following. For example to calculate chartists fraction to 10% significant level (using Student statistic) and for daily data, we have 44 ϕ_h significantly higher than 1 among 54, we says that 81.48% of investors on the market adopt chartist strategies.

Figures

Chartist fraction evolution figure for some companies and different frequencies

Figure 1: Chartist fraction of Bouygues and for daily, monthly and quarterly investment horizon

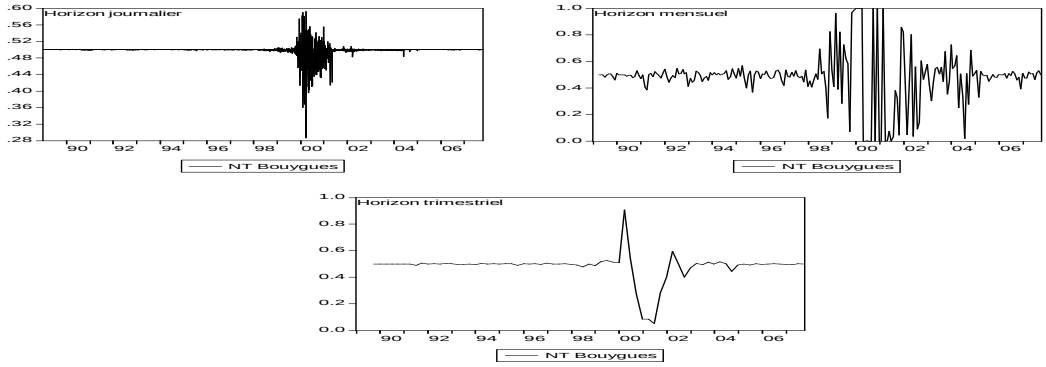


Figure 3: Chartist fraction of Cap Gémini and for daily and monthly investment horizon

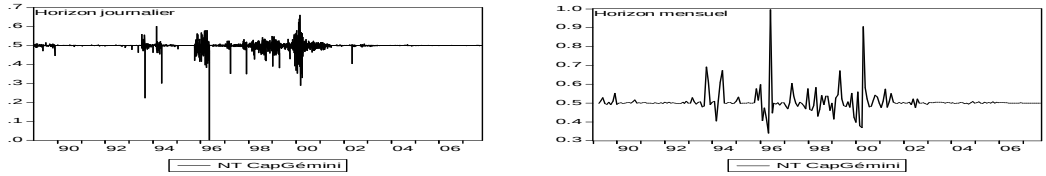


Figure 4: Chartist fraction of L'Oréal and for daily, monthly and quarterly investment horizon

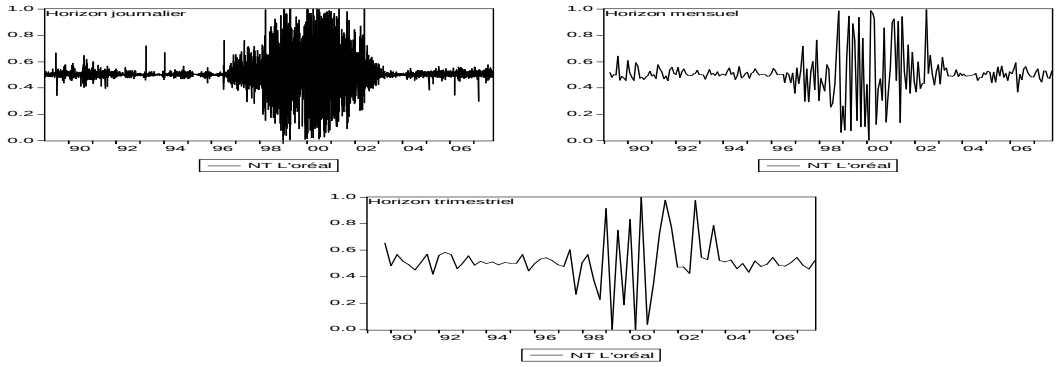


Figure 5: Chartist fraction of PPR and for daily, monthly and quarterly investment horizon

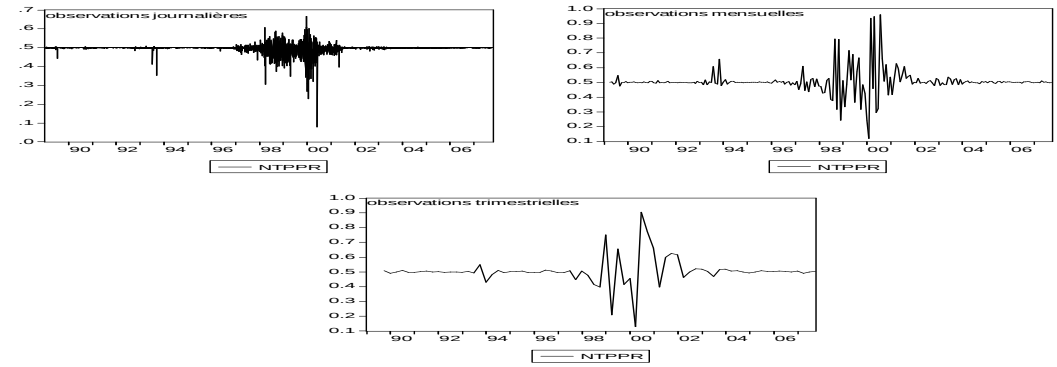
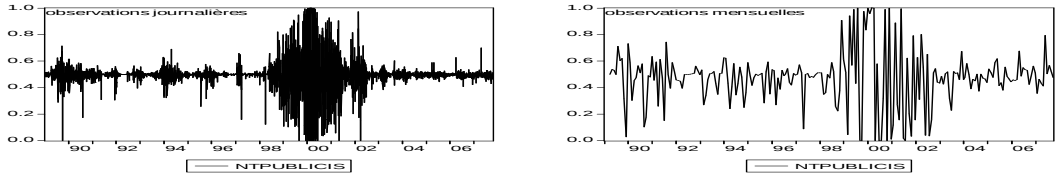


Figure 6: Chartist fraction of Publicis and for daily and monthly investment horizons



References

Bohl, M.T. and Siklos, T. (2004) "Empirical Evidence on Feedback Trading in Mature and Emerging Stock Markets" Research Paper Series 137, Quantitative Finance Research Centre, University of Technology, Sydney

Boswijk, H.P., Hommes, C.H. and Manzan, S. (2007) "Behavioral heterogeneity in stock prices" Journal of Economic Dynamics and control, Volume 31, Issue 6, June 2007, Pages 1938-1970.

Brock,W.A., and Hommes, C.H. (1997) "A rational route to randomness" Econometrica 65, pp. 1059-1095.

Brock, W.A., and Hommes, C.H. (1998) "Heterogeneous beliefs and routes to chaos in a simple asset pricing model" Journal of Economic Dynamics and Control 22, pp. 1235-1274.

Coakley, J. and Fuertes, A.M. (2006) "Valuation ratios and price deviations from fundamentals" Journal of Banking & Finance Volume 30, Issue 8, August 2006, Pages 2325-2346

Psaradakis, Sola and Spagnolo (2004) "On Markov Error-Correction Models, with an Application to Stock Prices and Dividends" Journal of Applied Econometrics Vol. 19, No. 1 (Jan. - Feb., 2004), pp. 69-88

Shiller, R.J. (1981) "Do stock prices move too much to be justified by subsequent changes in dividends?" American Economic Review 71, pp. 421-436.

Shiller, R.J. (1984) "Stock prices and social dynamics" Brookings Papers in Economic Activity 2, pp. 457-510.

Shleifer, A. and Summers, L.H. (1990) "The noise trader approach to finance" Journal of Economic Perspectives 4 (2), 19-33.

Westerhoff, F.H. and Reitz, S. (2003) "Nonlinearities and cyclical behaviour: the role of chartists and fundamentalists" Studies in Nonlinear Dynamics & Econometrics Vol. 7, Issue 4, article 3.