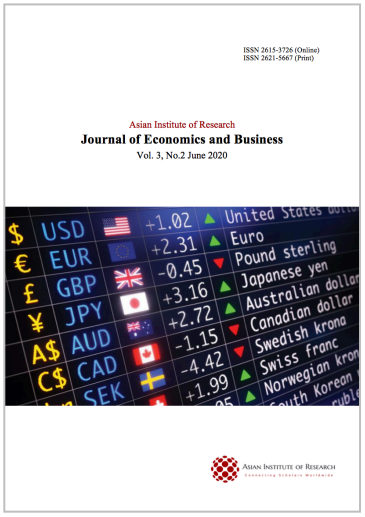

Journal of Economics and Business

Boutouria, Nahla, Ben Hamad, Salah, and Medhioub, Imed. (2020), Investor Behaviour Heterogeneity in the Options Market: Chartists vs. Fundamentalists in the French Market. In: *Journal of Economics and Business*, Vol.3, No.2, 917-923.

ISSN 2615-3726

DOI: 10.31014/aior.1992.03.02.248

The online version of this article can be found at:
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The Asian Institute of Research
Journal of Economics and Business
Vol.3, No.2, 2020: 917-923
ISSN 2615-3726

DOI: 10.31014/aior.1992.03.02.248

Investor Behaviour Heterogeneity in the Options Market: Chartists vs. Fundamentalists in the French Market

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Abstract
Behavioural finance confirmed the existence of two types of agents, fundamentalists and chartists, in the financial market. Fundamentalists follow the traditional efficiency market theory based on adaptive learning rule, whereas chartists follow the price tendency and past price movements. This paper examines the heterogeneity between fundamentalists and chartists. To this aim, we propose to introduce a sentiment variable in the classic model of Black and Scholes (1973) and to extract in a novel way the implied volatility variable. After that, we estimate the Markov switching model on this variable to test heterogeneity in the French market. The estimated daily data from 2009 to 2018 for 30 companies daily of CAC40 in a sectoral analysis confirm the evidence of heterogeneity between chartists and fundamentalists.

Keywords: Behavioural Heterogeneity, Behavioural Finance, Fundamentalists and Chartists, Options Market, Black and Scholes, Implied Volatility, Two-State Markov Switching Model

1. Introduction

Because of anomalies observed in the market, many works have criticised the traditional literature of finance based on the efficiency of financial markets and the rationality of investors. These criticisms gave rise to the development of the behavioural finance theory. The behavioural finance approach attempts to explain inefficiencies detected in financial markets according to the cognitive processes and the importance of investors' psychology in making decisions in the financial markets. However, due to the limits of the traditional approach, many works criticised investor homogeneity hypothesis and developed models based on the concept of investor behaviour heterogeneity. According to the literature, markets are divided into two types of investors with different behaviours (fundamentalists and chartists), and heterogeneity was confirmed in many works. Shiller (1984) proposed the estimation of a heterogeneous model. He presented a model with heterogeneous agents: rational and irrational. He estimated a proportion of rational investors between 1900 and 1983 and found that this proportion fluctuated

considerably between 0% and 50%. Westerhoff and Reitz (2003) estimated a heterogeneous agent model with fundamentalists and chartists using exchange rate data and found significant fluctuations in the case of fundamentalists. Brock and Hommes (1997, 1998) proposed a heterogeneous agent model, which was subsequently improved by Boswijk et al. (2007) and estimated the model with annual data ranging from 1871 to 2003 for the American stock price. They confirmed the evidence of two different types of behaviours and then they accepted the heterogeneity among investors: fundamentalists and chartists. Guirat (2011) studied investor behaviour heterogeneity in the French stock market. She considered 27 firms operating in the French market during the period January 1989–October 2007 for daily, monthly and quarterly data. Results found by this author are different than the above-mentioned studies, where she highlighted that heterogeneity among investors varies from one investment horizon to another where investors with the same horizon of investment would adopt homogeneous strategies. She concluded that the chartist strategy was adopted in the case of daily and monthly investment horizons whereas fundamentalist strategy was adopted for the quarterly investment horizon.

In this paper, we are interested to study the same subject area evoked by Guirat (2011) but with a different methodology. Our objective in this research is to detect anomalies in the market caused by investor behaviour heterogeneity in the stock market. Our point of view starts with the famous model of Black and Scholes (1973) which was applied to the valuation of European options contracts according to this model. This model seems to be inefficient when incorporating the sentiment variable as a measure of implied volatility. For this reason, and in order to overcome the limits and criticisms regarding the performance of the Black and Scholes model, we consider the Markov switching model to estimate the implied volatility with an evolutionary selection of heterogeneous strategies. For doing this, we follow the strategy adopted by an investor that may depend on the degree of volatility in order to identify the heterogeneity of investor sentiment: chartists and fundamentalists. By applying the two-state Markov switching model to 30 companies operating in the French stock market for daily data options ranging from 18/06/2009 to 05/09/2018, we conclude that both types of investors govern the French market, chartists and fundamentalists and that Markov switching estimations improve heterogeneity of the investors.

The present paper is organised as follows. Section 2 presents the literature review of behavioural finance and the heterogeneity existing between fundamentalists and chartists. Section 3 describes the empirical methodology, data and empirical results. Finally, section 4 concludes the paper.

2. Behavioural finance and heterogeneity among fundamentalists and chartists

In a seminar work, Bondt and Thaler (1985) published a paper entitled “Does the stock market overreact” where they criticised the efficiency market hypothesis. From that date and even before it with reference to Kahneman and Tversky (1979), new literature developed for analysing the functioning of stock markets known as behavioural finance.

Due to the progress of neuroscience finance, a logical understanding of the main mechanisms conducting the decision of investors was presented. The originality of novel approaches is based on human psychological behaviour coming from their transdisciplinary nature. Finance is considered then a discipline that has been analysed using sociological, genetic, neurological, physical, psychoanalysis or even psychological concepts, often called behavioural finance (Kahneman and Tversky, 1979).

Many works and researchers highlighted that emotions and other subjective elements played an important role in making investment decisions. The interest accorded to the behaviour of the investors gave rise to the discipline of behavioural finance. Behavioural finance is a field that is of interest to the introduction of psychology to finance. In this research field, we focus mainly on the behaviour of investors when making decisions.

Phenomena found in this theory are purely psychological and relate behavioural finance to behavioural economics in general. It was largely used in periods of crises and it is interested in the imbalances caused by investor behaviour. Contrary to the classical financial theory based on the rationality of economic agents, behavioural finance seems to be an anecdotal approach as it offers a more pragmatic vision of the behaviour of investors, notably based on psychology.

Many critics have been given to the hypothesis of market efficiency. One of the answers to the violation of this hypothesis gives rise to the development of behavioural finance (Kahneman and Tversky, 1979; Barberis et al., 1998). Behavioural finance criticises the notion of rationality and introduces elements of social psychology to economic decision making. Divergence from the rationality hypothesis implies the introduction of the notion of heterogeneity into the behaviour of investors, i.e. there are endless ways to behave irrationally in the market. In general, literature provides three essential reasons for heterogeneous behaviour.

Indeed, the heterogeneity of expectations may exist due to the existence of different types of agents with different behaviours. De Long et al. (1990), for example, proposed a model that illustrates the coexistence of different types of investors and that rational investors looked for opportunities. Frankel and Froot (1986, 1990) developed the idea that two types of participants in the market dominate the foreign exchange market: fundamentalists and chartists. They differ in the manner of using information. For the fundamentalists, they considered the exchange rate as an economic model, while chartists used historical data corresponding to the exchange rate to form their expectations.

Several studies examined the impact of heterogeneous beliefs on option prices. In a theoretical framework, Shefrin (2001) showed that the heterogeneity of beliefs influences option prices (i.e. which leads to prices different than those of Black and Scholes), and can explain the fluctuations observed in implied volatilities. Through an example of two investors, they showed how these investors have different beliefs and can obtain different option prices. Meanwhile, the option price equilibrium is a weighted average of the two option prices. Several documents focusing on heterogeneity highlighted that traders having more pessimistic (optimistic) opinions may be attracted by call options (e.g. Benninga and Mayshar, 2000; Buraschi and Jiltsov, 2006).

More precisely, studies that focus on heterogeneity among options traders have insisted on the heterogeneous beliefs that they hold regarding the fundamentals for determining the price of the option. For example, Benninga and Mayshar (2000) showed that heterogeneity in risk aversion can observed smile volatility observed could explain the fluctuations observed in the implied volatility. Several agent heterogeneity models make distinctions between fundamentalist and chartist agents.

Fundamentalists base their expectations of future prices and their investment strategies on market fundamentals and on economic factors such as dividends, profits, GDP growth, unemployment, etc. They have the tendency to invest in assets characterised by an undervaluation and whose prices are below the fundamental reference value and sell the overvalued assets, whose prices exceed the fundamental market value. On the contrary, chartists or technical analysts ignore market fundamentals and base their expectations of future asset prices and their arbitrage strategies based on the historical data price.

In reality, chartists are considered naive investors or those who are forced to sell when asset prices fall. In this regard, De Grauwe and Dewachter (1993) showed that periods of high volatility are associated with the predominance of fundamentalists while periods of low volatility are associated with the predominance of chartists. Agents can change strategies over time where chartists can become fundamentalists and vice versa.

3. Empirical analysis

3.1 Description of the data

In this paper, we aim to study fundamentalists and chartists in the French stock market. We collected the following data from 30 companies operating in the CAC40 stock index: the price of the underlying asset (S), the strike price of the option (K), the current date, time to expiration, the price of the call option (Price), the transaction volume, the implied volatility at 3 months and the interest rate (R). Further, our database is made up of a series of continuous options of the companies considered here using Thomson Reuters calculations for the entire period of our study. The use of the stock option is based on the fact that individuals cannot follow the same behaviour according to the

companies constituting the same index and also that the behaviour of investors would probably depend on characteristics linked to the psychology of the latter.

In order to determine heterogeneity in the French market and testing the sentiment of investors, we use a proxy variable. This variable allows us to evaluate the importance of investors' behaviour on European price options and to deduce the behavioural typology that characterises the strategies of fundamentalists and chartists. This variable is calculated using the Black Scholes (1973) model. First, we explain how we extract this variable, and after that, we apply the Markov switching model to analyse the heterogeneity among fundamentalists and chartists in the French market. We use a modified version of the Black and Scholes model by introducing a sentiment variable[1]. According to the traditional hypothesis of Black and Scholes (1973)[2], from which we assume the market is efficient, investors are assumed to be risk-neutral and the sentiment was not included in the model. As investors are irrational and markets are inefficient, sentiments can modify the impact of price option volatility on the market. For this reason, we propose the introduction of investors' sentiment in the Black and Scholes (1973) model. We use the Newton algorithm to calculate implied volatility and then the option price, taking into account this implied volatility.[3]

We use the following variables to calculate implied volatility:
C = price of a call option
P = price of a put option
S = price of the underlying asset
X = strike price of the option
r = interest rate
t = time to expiration
s = volatility of the underlying asset
Companies and sectors selected in our study are summarised in Table 1.

Table1. Sample of the study

Sector	Company
Financial	BNP PARIBAS, Crédit Agricole, Société Générale, Axa.
Automotive	Renault, Peugeot, Valeo.
Commercial	Danone, Carrefour, L'Oréal, LVMH, Pernod, Unibail.
IT services	CAP Gemini, Atos
Advertising	Publicis, Vivendi.
Construction	Lafarge, Saint Gobin, Vinci.
Oil and gas	Total, Air liquid.
Electric and equipment	Schneider, Micro-electronics company.
Water	Suez, Veolia.
Medical	Essilor, Sanofi.
Aerospace	Airbus.
Pneumatic	Michelin.

3.2 Descriptive statistics

[1] We assume that the implied volatility is decomposed into rational and irrational implied volatility in presence of market sentiment in the Black and Scholes model.
[2] Black-Scholes model (1973) is a pricing model used to determine the fair price for a call option or a put option based on the following variables: type of option, strike price, underlying stock price, volatility, time, strike price and risk-free rate. This model was employed to the case of European call option.
[3] The introduction of the sentiment variable in the option valuation formula, led to theoretical prices closer to the market price.

Table 2 presents the descriptive statistics for the variables considered in the Black and Scholes model and defined in the previous section. We are considering in this table the mean statistics for the 30 companies based on the sectorial statistics. According to these statistics, it was noticed that the mean, median, minimum and maximum in the financial sector are the larger in the sample.

Table 2: Descriptive statistics

	K	LIFE_DAYS	R	PRICE	S	SIGMA
Mean	47.112	79.719	1.995	0.416	46.821	0.285
Median	46.751	73.667	1.808	0.321	45.500	0.272
Maximum	77.731	430.000	7.238	1.856	77.500	0.650
Minimum	23.461	14.917	0.189	-0.284	23.533	0.140
Std. Dev.	12.773	43.634	1.035	0.571	12.781	0.073
Skewness	0.173	2.767	1.666	0.700	0.218	0.973
Kurtosis	2.511	69.274	11.633	2.588	2.531	4.559
Jarque-Bera	156.547	2145565.186	56912.052	262.890	167.599	1062.808
Probability	1.75E-6	0.000	0.000	0.000	5.11E-5	0.000

As shown in Table 2, the mean value of the price is equal to .416 and ranges between a maximum value of 1.856 and a minimum value of -.284. The more important conclusion for these statistics is the Jarque-Bera statistic, indicating that all of the series deviate from the normal distribution. Most of the variables follow a leptokurtic distribution and tails are fatter.

According to the descriptive statistics, we can see that, in the French market, options vary considerably in price, in terms of maturity and volatility for the period 18/06/2009 to 05/09/2018.

3.3 Empirical results

The aim of this paper was to study the heterogeneity behavioural concept that may exist in the French stock market. We assumed that fundamentalists and chartists do not have the same behaviour. For doing this empirically, we find that it is legitimate to use the Markov Switching model[4]. We apply this model to study whether there are different beliefs between fundamentalists and chartists in the French market. The variable that can give a good answer to this hypothesis is the implied volatility of the call option. This variable detects the behaviour of investors among the sentiment of chartists and fundamentalists.

Therefore, we considered an autoregressive two-regime Markov switching model of order p, noted MS(2)-AR(p), which is presented as follows:

$$X_t - \mu(S_t) = \varphi_1[X_{t-1} - \mu(S_{t-1})] + \varphi_2[X_{t-2} - \mu(S_{t-2})] + \cdots + \varphi_p[X_{t-p} - \mu(S_{t-p})] + \varepsilon_t$$

Where, $\varepsilon_t \rightsquigarrow i.i.d(0, \sigma_{S_t}^2)$ and $\mu(S_t) = \begin{cases} \mu_1 & for\ fundamentalist \\ \mu_2 & for\ chartist \end{cases}$

The transition from one state to another is governed by a first-order Markov chain with transition probabilities, expressed as follows: $p_{ij} = P(S_t = j \backslash S_{t-1} = i)$, i, j = 1, 2

Where p_{ij} is the probability of moving from State i at time t-1 to State j at time t.

[4] Markov switching models have experienced strong development in empirical literature since the discovery of these models by Hamilton (1989). These models allow greater flexibility to accommodate for different behaviors in the time series data. We consider in this paper the two states Markov switching models as we have divided investors in two types: fundamentals and chartists.

For the Markov switching model, we specify an MSIH(2)-AR(0)[5] process for which we assume the same variance for each regime and no autoregressive lags to avoid the deterioration of the reproduction of the stylised facts of the cycles[6]. Table 3 gives an estimate of the Markov switching models for the companies.

Table3: Markov switching estimation results

	μ_1	μ_2	σ_1	σ_2	p_{11}	p_{22}	Duration State1	Duration State2	Linearity test
Financial	.272 [a]	.721 [a]	.348	.872	.99	.974	106	39	134.45[a]
Automotive	2.945 [a]	5.534 [a]	.801	1.57	.99	.98	103	50	86.79[a]
Commercial	1.584 [a]	2.848 [a]	.459	.603	.966	.966	29	29	79.57[a]
IT services	2.472 [a]	8.16 [a]	.813	5.37	.99	.978	102	45	102.45[a]
Advertising	1.076 [a]	2.143 [a]	.302	.763	.981	.976	53	42	91.14[a]
Construction	1.424 [a]	2.471 [a]	.386	.587	.988	.954	83	22	101.34[a]
Oil and gas	2.538 [a]	5.339 [a]	.983	1.71	.98	.976	50	42	89.7[a]
Electric and equipment	2.864 [a]	6.786 [a]	.974	2.25	.994	.983	167	59	112.88[a]
Water	.522 [a]	1.188 [a]	.175	.662	.991	.972	112	36	125.94[a]
Medical	1.829 [a]	3.596 [a]	.603	.801	.986	.98	71	50	97.17[a]
Aerospace	1.51 [a]	3.95 [a]	.557	1.41	.99	.987	98	77	102.68[a]
Pneumatic	.02 [a]	.801 [a]	.11	.597	.967	.92	31	13	71.25[a]

[a] denotes the null hypothesis is rejected at five percent significance level.

From this table, we can note, first, that the linear model null hypothesis is rejected in favour of the state Markov switching model. This non-linearity is caused by the existence of asymmetries characterising time series. These asymmetries reflect the differences in the market between fundamentalists and chartists, as each type has its own strategy. Second, estimated coefficients of intercepts, probabilities and standard errors show significant differences between chartists and fundamentalists, and the results are in line with the expected signs. The estimated coefficients are positives and significant. In general, for all sectors, persistence is greater for fundamentalists than chartists, except for the commercial sector. On average, the duration in State 1 (fundamentalists) is larger than the duration in State 2 (chartists) and Regime 2 is more volatile than Regime 1 for all sectors. We can notice the evidence of significant heterogeneity between chartists and fundamentalists. The results show a large difference in duration in State 1 and State 2 in the banking and insurance sectors, where we observed a high persistence in Regime 1. In fact, during a crisis, investors in the financial sector suddenly switch between strategies, which is also the case for major vital sectors. We can observe in the market a phenomenon of strategy imitation, probably due to a lack of information. In conclusion, the results of the Markov switching model show heterogeneity of behaviour and subsequently we reject the null hypothesis of the homogeneity of beliefs.

Conclusion

The present paper aimed at studying investor behaviour heterogeneity in the French market. We proposed a modified European options model for evaluation. We introduced to the B-S model (1973) a sentiment investor variable and we extract implied volatility to test the heterogeneity between fundamentalists and chartists in the market. We considered the implied volatility as a good proxy measure to the sentiment behaviour of investors. For the empirical analysis, we employ the two-state Markov switching intercept heteroscedasticity model to evaluate the French market of options and then verify heterogeneity between fundamentalist and chartist investors about the sentiment behaviour. Through the daily data from 30 companies listed in the CAC 40, ranging from 18/06/2009 to 05/09/2018, we found a few differences among sectors.

Our results show that both types of investors govern the French market: chartists and fundamentalists. Estimations by employing Markov-switching estimations demonstrated the heterogeneity of the investors. Therefore, we reject the null hypothesis of the homogeneity of beliefs.

[5] Markow switching two-step intercept heteroscedasticity model.

[6] See Ferrara, L. (2003).

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