Traders' Behavior in Financial Markets: Paris Option Market Case

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Abstract
Purpose: This paper develops a model of heterogeneous agents on an options market. On Paris Option Market, negotiators have different beliefs about future-at the volatility of the underlying.
Design/Methodology/Approach: We assume in advance two groups; fundamentalists who believe in mean reversion and Chartists that incorporate exogenous shocks in their expectations. Both agents are able to migrate between groups, under the constraint of the logic switching rule, given the forecast error.
Findings: Our model is simplified to a model of GJR-GARCH-M (1.1) with coefficients varying over time. Our results showed that all the negotiators involved in the volatility process.

Keyword: Traders behavior, Paris Option Market, Chartist, Fundamentalist, GJR-GARCH-M
JEL classification: C14, C15, G1
Paper type: Research Paper

Introduction

The volatility prediction is essential to understand the functioning of financial markets, so that agents are able to develop their strategies. This hypothesis seems somewhat flimsy in the presence of market option. Indeed, some agents neglect the volatility's variables when it comes to trading activity on the options market. They buy when they forecast calls bullish on the underlying value and in the opposite case, they buy puts. Thus, investors spend overly high costs for the purchase and sale of option contracts even if their expectations about the underlying trends are not biased.

It is now recognized that the implied volatility is a good estimator of realized volatility. These aspects of option contracts have been ignored in theoretical models; however the prices of options can be proxies to understand the interactions between agents explained by the phenomenon of switching and what distinguishes optional markets compared to another markets.

Our study is based on the assumption that Paris Option Market precedes spot market in terms of transmission and dissemination of information. So this is privileged active agents that form heterogeneous expectations on volatility. When a large fraction of agents speculating on changes in volatility, market makers require additional transaction costs to cover their positions, so that investors wishing to invest on future price trends can pivot between the two markets.

Global Business & Management Research: An International Journal

Vol. 5, No. 1, 2013
pp. 1-12

However, an agent may have interest in trading the option market even his anticipation is different to that market. The speculative activity in options market appears to be a standard, and so can the predictive performances of option contracts on the underlying.
Various research works such as those of De Grauwe and Grimaldi (2005), Lux (2009), Chiarella and al (2009), and LeBaron (2006), tried to get clarification on agents behavioral in financial market. However, this literature that aimed to describe the evolution of stock prices completely ignored the alternative hypothesis of homogeneity of behavior. Considering the heterogeneity of behavior, their classifications and their potential strategies, we could probably evaluate the desires of its traders and the impact of their price negotiations and on the volatility process.
Until now, most researches are based on experimental studies and through determinist's techniques and stochastic simulation to detect the presence of agents that can explain some stylized facts of returns on financial markets.
And relevant questions arise about this topic: How heterogeneous market expectations affect option prices? Are proportions of the agents in the Paris Options Markets fixed or variable? And if it's variable, what is the cause? Is this variability rather persistent or fixed? What is the cause of switching between operating?

Heterogeneous Speculative Rule

Divergence from the assumption of rationality implies that one can introduce heterogeneity in anticipations as well; it's only a way of being rational, while there are many ways to be irrational. There are three explanations for being heterogeneous that we can discern from the literature. The first one is the existence of asymmetric information. Different market participants are assumed to hold different sets of information, where the information is common for all participants and a part is private. The concept of asymmetric information was first introduced in the new classical theory of the macro economy, where negotiators were assumed to be unable to obtain information that is public in other parts of the economy, and where negotiators are rational in the Muth (1961) sense in that they use the information that is accessible to them in the finest possible way to form their expectations of a particular variable. Second is the claim that negotiators might differ in the way (symmetric) information is interpreted. To argue why the difference in interpretation occurs we can follow the rational belief theory due to Kurz (1994), which assumes that heterogeneity of beliefs is caused by the fact that economic negotiators do not know the structural relations of the economy. Negotiators have only 'information' or 'empirical knowledge', which is readily observable from the economy. Third and final ground for heterogeneity in expectations is the existence of fundamentally different types of negotiators. Frankel and Froot (1990) interpret the assumption that the foreign exchange market is controlled by two forms of market participants that differ in which information they use for forming their expectations.
The literature on heterogeneous agent's models continues on the line of thought that there can be essentially different types of negotiators[1]. The literature on heterogeneous negotiators applied to financial markets aims to describe the evolution of stock price by relaxing the assumption of homogeneity among investors. By allowing for heterogeneity among investors, different agents can be allocate along with their strategies, and one can evaluate how possible it is that these traders are active in a market and what the effect of their trading is for the price and volatility process. Normally, negotiators are classified in two categories: Fundamentalists, who trade on

[1] Hommes (2006) and LeBaron (2006).

the basis value and chartists, who trade on historical prices or exogenous chocks. In the models described by Hommes (2007), negotiators do not only differ, but they are able to migrate between groups. This switching leads to a non-linear model that mixes different regimes, based on economic foundations. To date the majority of studies on HAM's have been showed in experimental settings. Using either deterministic or stochastic simulation techniques, the presence of different traders in financial markets clarifies some schematic facts of returns from financial markets[1]. The switching between negotiators makes heavy tails, volatility clustering, slow mean reversion and volatility excess. To our best knowledge, there are only a handful of papers that directly attempt to estimate a HAM with full-fledged switching mechanism. Boswijk et al. (2007) study the SP500, Westerhoff and Reitz (2005, 2007) look at commodity markets; De Jong et al. (2009) focus on EMS exchange rates. All studies, though, find significant evidence of heterogeneity among traders, and switching between strategies.

Methodological Analyses

The combined strategies of operative agents' chartists and fundamentalists, in the financial markets in general and optional in particular, determine the process of the conditional volatility that comes from a strategic synthesis. They are limited to a model with asymmetric GARCH factor varying over time.

Assuming that S_t is the value of the underlying at time *t* and r_t is the underlying performance in a discreet fashion Gaussian. The logarithmic return the underlying asset is then defined by

$$r_t = \ln\left(\frac{S_t}{S_{t-1}}\right)_t + d_t = \mu + \sqrt{h_t \varepsilon_t}. \quad (1)$$

Where:

$\varepsilon_t / \Omega_{t-1} \approx N(0,1)$

Under probability, P, μ the mean of r_t, h_t the conditional volatility of assets, ε_t is the standard normal random and finally Ω_{t-1} is the information setup to time *t-1*.

In this empirical validation, we will target to trends in conditional volatility. Knowing that all traders operating on the options market account for speculative purposes, these agents can be classified into two groups and their expectations are heterogeneous regarding the future level of volatility h_t. The first group is composed of fundamentalists who speculate the following rule: The price of the underlying varies, but they eventually return to their averages, that is to say their basic values if they trade and on the rule of mean reversion. Second group is the Chartists who trade on exogenous shocks. All agents are active traders, they can enter and exit the market at any time in accordance with laws, but that counts was that these agents are limited to two groups.

In our study we propose the following notations

$$E_t^F(h_{t+1}) = h_t - (1-\alpha)(h_t - \overline{h_t}). \quad (2)$$

Where:

$E_t^F(h_{t+1})$: The expected volatility for the fundamentalist, $\overline{h_t}$: The long-run of unconditional volatility α : measure the sopped with which the fundamentalist expect mean reversion process .

[1] De Grauwe and Grimaldi (2005, 2006) and Lux (1998).

For the relationship (2) is a forecast steady , alpha must range between -1 and 1 .Nevertheless it is anticipated that this coefficient will fluctuate around the unit, seems the conditional volatility revert uniformly to the unconditional volatility. In cases where the speed at which the fundamentalists anticipate the return prices to their fundamental values tend to zero, the processes become more persistent so little mean reversion take place. In the other case ($\alpha \mapsto 0$), the reverting process of unconditional volatility is instantaneous.

Equation (2) shows that fundamentalist agent expectations are limited to a GARCH (0, 1) model, so they don't care about any exogenous shocks. Moreover, the volatility is the only variable unknown to those operative in determining the option price, in a context where speculators anticipate the mean revert process. Indeed, fundamentalist are requesters of options through the followed trend of volatility. Thus, when they anticipate an increase in volatility, they step up their requests for options and vice versa, so there is a positive correlation between the variations in the volatility process and demand options.

The Chartists vision is different from the fundamentalists on the anticipation of the conditional volatility, they are unaware of the standard of mean reversion, so chartists speculate according to laws, in which there is an integration of observed vision shocks, that is to say, exogenous shocks and we know that bad news and good differentially affect the level of conditional volatility. Therefore, agent Chartist reflects the asymmetry of volatility mainly explained by the effect of feedback-and leverage. They believe that the positive and negative signals are treated differently in the determination of the conditional volatility. Asymmetric GARCH models are the best examples to explain the impact of heterogeneous signal on volatility.

Chartist predicting volatility process is as follows:

$$E_t^c(h_{t+1}) = h_t + \beta_0(\sqrt{h_t}\varepsilon_t^+)^2 + \beta_1(\sqrt{h_t}\varepsilon_t^-)^2 \quad (3)$$

Where:

$E_t^c(h_{t+1})$: The Chartist volatility prediction ε_t^+ : Pasts positives shocks ε_t^-: Pasts negatives shocks, β_0 : Measure the capacity in which chartists agents incorporate positive shocks in their expectations β_1 : Measure the capacity in which chartists agents incorporate negative shocks in their expectations.

Since we have already assumed that the market consists of two groups and speculate based volatility expectation, Chartist agents will follow the same reasoning as well as fundamentalists ie, their request for options is based on expectations. Thus, the observed volatility h_{t+1} is therefore correlated with forecasts of chartists and fundamentalists agents. Therefore $h_{t+1} = f((prediction^{f,C}) + f(prediction^{f,F}))$. The two strategies, do not release information and special abilities. Thus, agents may at any moment switch from one strategy to another without incurring transaction costs.

Let's propose the fraction of fundamentalist present in the market is denoted by w_t , it is defined as the profit related to the fundamentalists chartists. Thus, when agents' fundamentalists anticipate an increase in volatility, they adopt a clear strategy. In this case, it is most beneficial, agents chartists will face pressure to follow, leading to their proportions in the market decreases. In the opposite case, that is to say that the strategies of fundamentalists are losing, they will imitate the behavior of chartists' agents, and here we are with the concepts of switching, defined as a migration between groups seeking the maximization of their utilities. The choice of w_t , is based primarily

on a rule that consider the pricing forecast errors when adopting a fundamentalist strategy. It stills defined as a logical choice of switching. Migration between groups depends mainly on the absolute forecast error of fundamentalist versus the Chartists agents. Thus, the switching rule is given by:

$$W_t = (1+e^{\gamma(\left|\ln(E_{t-1}^{F}(h_t))-\ln(h_t))/\ln(h_t)\right|-\left|(\ln(E_{t-1}^{c}(h_t))-\ln(h_t))/\ln(h_t)\ \right|)})-1 \quad (4)$$

Where:

γ : The measurement of sensitivity of fundamentalists and chartists agents due to their bias's percentages in the prediction of volatility and expected that its value is between 0 and ∞.

The sensitivity parameter is interpreted as the error in the status of agents being the two groups or aversion operative to give up what they really are. It also measures the speed of the reaction of agents to take advantage of switching. In the case where the parameter tends to 0, fundamentalists and chartists are distributed evenly between the two groups. However, when it tends to ∞, both types of agents will perform switching, to take advantage of their strategies; in such cases will be near 0 and 1.

The special thing in the switching rule is that most strategies are trustworthy and reliable in previous periods; this attracts more agents in subsequent periods. Thus, if expectations of fundamentalists are more accurate than those of the Chartists in the period *t*, then the weight w_{t+1} increases. Nevertheless, better forecasting of chartists that leads to decreased in value. The switching rule does not imply that each agent can change its group at any time. Indeed, fundamentalists and chartists have the opportunity to do so frequently, but really it is not the case. Moreover, the updating of the strategies depends essentially on the extent of γ and as already mentioned earlier, the agent may enter and exit the market at any time and this affects the population and not the distribution between the groups with the weight and the different strategies of speculation.

We can now develop the process for conditional volatility resulting from the purchase and sale of options, so certainly the request of the options is a function of expectations of volatility and it may simply be considered as the average weight of anticipated volatility of both agents' chartists and fundamentalists. The mechanism is as follows: An excess demand for both groups increases the demand for market as a whole, leading to what the market maker will transform this excess demand for a change in volatility level[1] .such us:

$$h_{t+1} = W_t E_t^F(h_{t+1}) + (1-W_t)E_t^C(h_{t+1}) \quad (5)$$

The equation 5 presents the conditional volatility process and shows that this is an average forecast of chartists and fundamentalist agents which is weighted by the proportion of market participants, after the fixation of their strategies.

When we integrate (2) and (3) in equation (5) we obtain:

$$h_{t+1} = -W_t\alpha\overline{h_t} + (1+W_t\alpha)h_t + (1-W_t)(\beta_0(\sqrt{h_t}\varepsilon_t^{+})^2 + \beta_1(\sqrt{h_t}\varepsilon_t^{-})^2) \quad (6)$$

Or else:

$$h_{t+1} = \overline{h}_t + \alpha_t h_t + \beta_{0,t}(\sqrt{h_t}\varepsilon_t^{+})^2 + \beta_{1,t}(\sqrt{h_t}\varepsilon_t^{-})^2 \quad (7)$$

Where:

[1] Chiarella et He (2002).

$\overline{h_t} = -W_t \alpha \bar{h}$, $\alpha_t = (1 + W_t \alpha)$, $\beta_{0,t} = (1 - W_t)\beta_0$, $\beta_{1,t} = (1 - W_t)\beta_1$

Equation (7) shows that our model is reduced to a GJR-GARCH-M (1.1), volatility model with timing-varying coefficients and this variation is driven by profitability caused by chartist or fundamentalist strategy. In addition, this model clearly shows that the conditional volatility mean reversion is caused by the presence of fundamentalist agents. Nevertheless, the Chartists disrupt the market and cause persistence in the volatility process. Indeed, when the number of chartists is very low, the mean revert is almost instantaneous and in case there are several chartist agents, the persistence of conditional volatility is sustainable. The impact of shocks on volatility is generally incorporated by chartists and when one integrates fundamentalists therefore we can explain ARCH and GARCH effects.

The second interesting feature of the model concerns the stability of the equation (7). Indeed, in ideal circumstances, a financial market without exogenous shocks, the fundamentalists are developing strategies that ensure the conditional volatility that remains bounded in upward and downward. However in case the two types of agents are present in the market with a number that varies in short time, the volatility process outlined in equation (6) becomes unstable in the short term while ensuring stability long-term in the process of volatility. The stability of equation (7) depends on the parameters α , β_0 and β_1, and this is explored in detail in the econometric part.

The third aspect of this model is the new explication of the variation in volatility process causes. This trend is not driven only by variation in the unconditional volatility of the underlying, but also due by the fractions of fundamentalists and chartists. Fundamentalists who believe in mean reversion and chartists are unaware of this hypothesis. Thus, when the market completely dominated by them, then there will be no unconditional volatility.

Data and Results

We use daily CAC40 index option for the shortest maturity. Our work situated under financial crisis; study period was from 05/2005 until 04/2009. The raw data set is directly obtained from Euronext, Paris Option Market. The market for CAC40 index options is the most active index options market in Europe. Since options expire at the Friday immediately preceding the third Saturday of each month for our index option. The sample option will have 4, 9, 14, 19 or 24 trading day to expiration.

Panel 1: Parameter estimates in static mode

	α	β_1	β_0	h_0	γ
Mean	0.8735	0.1073	0.0431	0.2685	-
Min	0.8407	3.7166e-007	1.4919e-007	0.1137	-
Max	0.9935	0.5006	0.2009	0.8382	-
2^e quartile	0.8522	0.0377	0.0151	0.2320	-

Panel 2: Parameter estimates in switching mode

	α	β_1	β_0	h_0	γ
Mean	0.8935	0.1273	0.0631	0.3197	105.9942
Min	0.8607	0.0200	0.0200	0.2018	76.1441
Max	1.0135	0.5206	0.2209	1.0628	135.4146
2^e quartile	0.8722	0.0577	0.0351	0.2827	105.8999

Panel 1 and 2 present the Mean parameters estimates, Min, Max, 2^e quartile of the daily estimations of the model during the period march 2005 until April 2009. h_0 represents the estimated local volatility, or starting value of the volatility process. Additionally, panel 1 shows the results without switching i.e γ = 0, and panel 2 with switching such that γ is estimated contemporaneously.

Focusing on the first panel with static mode, $W_t = W = 0.5$ we find that mean reversion parameter is below one for all sample 0.8735 indicate that mean reversion take place, but very slow. The absolute magnitudes of the estimate mean of indicate on average is more than 12 % of the excess volatility to disappear in the next period. The values of mean reversion are always between 0 and 1, which is reassuring as it would reject the stability of conditions. The values of is dependable with finding on GARCH models that are applied to financial time series data. The parameters of shocks β_0 and β_1 have the same sign, which explains the unstable movement of chartists. Results to explain the asymmetry of volatility are clear, the presence of leverage. And we note that there is a variation of these two coefficients in the entire sample.

The result for dynamic mode, reported in panel 2. The parameters of estimation have almost the same magnitude to those presented in static model .the average mean revision parameter tend to be slightly higher than static mode indicating more mean revision on average and this may be a consequence of the minimum values of this parameter throughout our sample. The advantage of this model compared with that in static mode, is that it can discern those fundamentalists and chartists strategies, which are detected by the sensitivity parameters γ.

Noting that this parameter is positive and is high amplitude throughout our sample, this implies that the switching mechanism follows a positive feedback mechanism. In other words, when the sensitivity coefficient is positive, this indicates that agents have an incentive to switch making the groups in which there is little forecast error. The intensity of x is therefore conditioned by the functional form of profit groups, in other words, from a sensitivity coefficient; we can interpret the evolution of agents' behavior over time. However, it is not possible to make instant statements referring to the profit generated during the migration between groups.

For the whole sample, we observe that the values of sensitivity coefficients are mostly positive and having a high intensity that leads us to conclude that the two types of agents' fundamentalists and chartists are active in the market. Their impact on the variance is as expected, chartists destabilize the market and fundamentalists tend to stabilize the volatility process. There is also a major test of the rule of switching between the two strategies. Therefore it is even more interesting to examine the stability of the coefficients in the estimation process and through monitoring of trends in parameters of our model.

Fig.1 presents the evolution of estimated local volatility, the coefficients values of two expectations formation function, chartists and fundamentalists and their intensities to choose the sensitivity parameter.

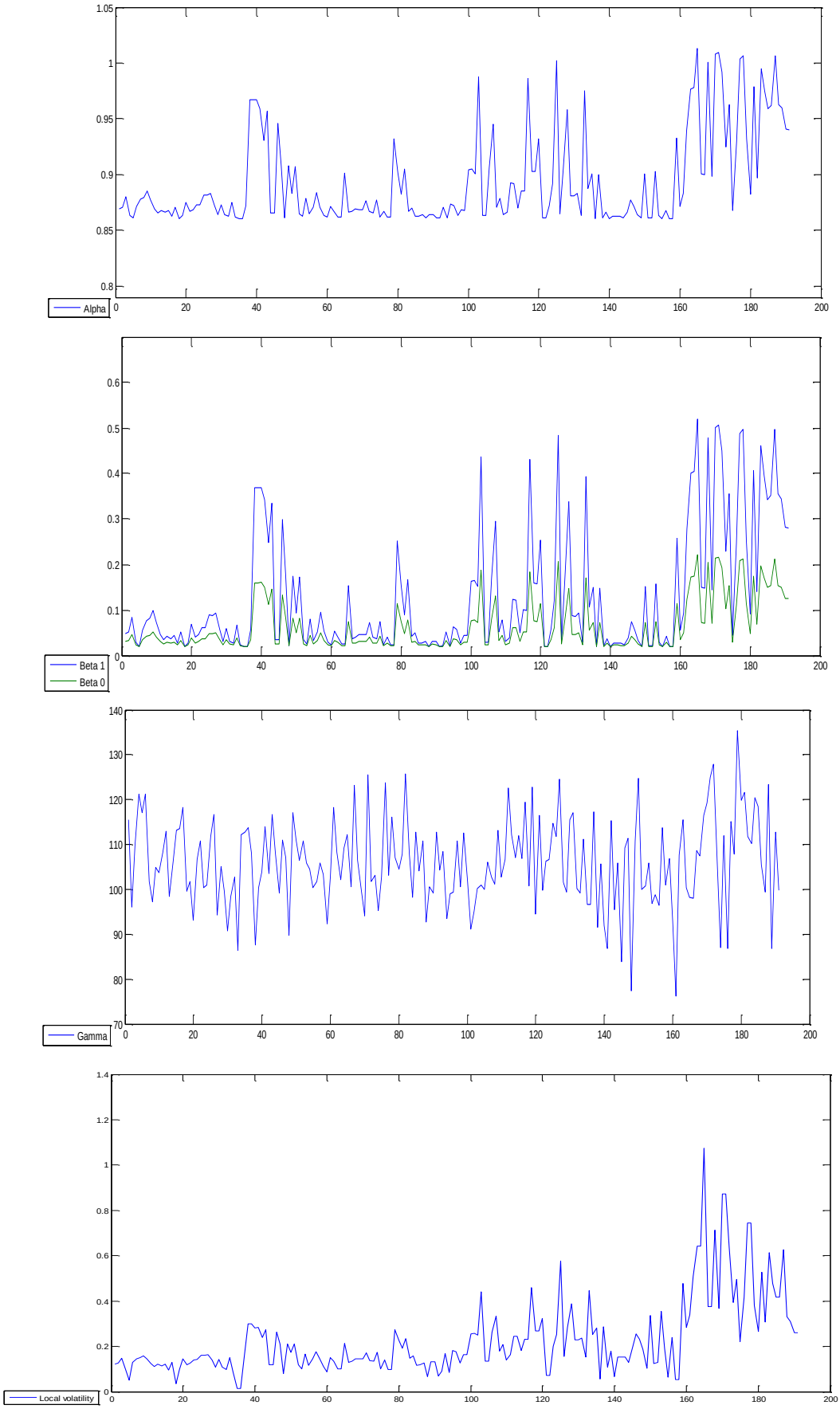

Figure 1: Parameters estimated during the study period

In the entire sample, we note that the estimated coefficients are generally α , β_0 and β_1 stable. Thus they operate in a relatively small band, this result was already expected. Noting that about two-thirds of the sample, that is to say, the observation that more 162 and 181 β_0 and β_1 tend to zero, more coefficient α tends to unity. However, the coefficient γ becomes volatile. This change sudden in the parameters can be directly explained by the double logic of the underlying heterogeneous agents' model .the volatility of CAC40 is relatively constant in this period. This can be seen in the graph that illustrates the volatility. Thus, when both operative form their expectations based on trends in local volatility with the inclusion of an error term, we expect that volatility will be stable and actually this is not the case, since the minimization of this term explained by α , β_0 and β_1 trends, and are followed by a disruption of volatility, this is certainly explained by exogenous shocks affecting Paris Option Market[1]. Thus, agents such expect large differences in the volatility process, the difference of the bias of estimates in these two types of agents will be relatively large. So it's profitable to change strategy given the magnitude of the forecast error. As well as the graph shows, the sharp fluctuation of the parameter γ , explains what's really happening in the market. Indeed, when gamma goes to infinity, the two types of agents will make switching to take advantage of their strategies W_t will be close to 0.5 and that's really the case with a coefficient W_{switch} = 0.5287.

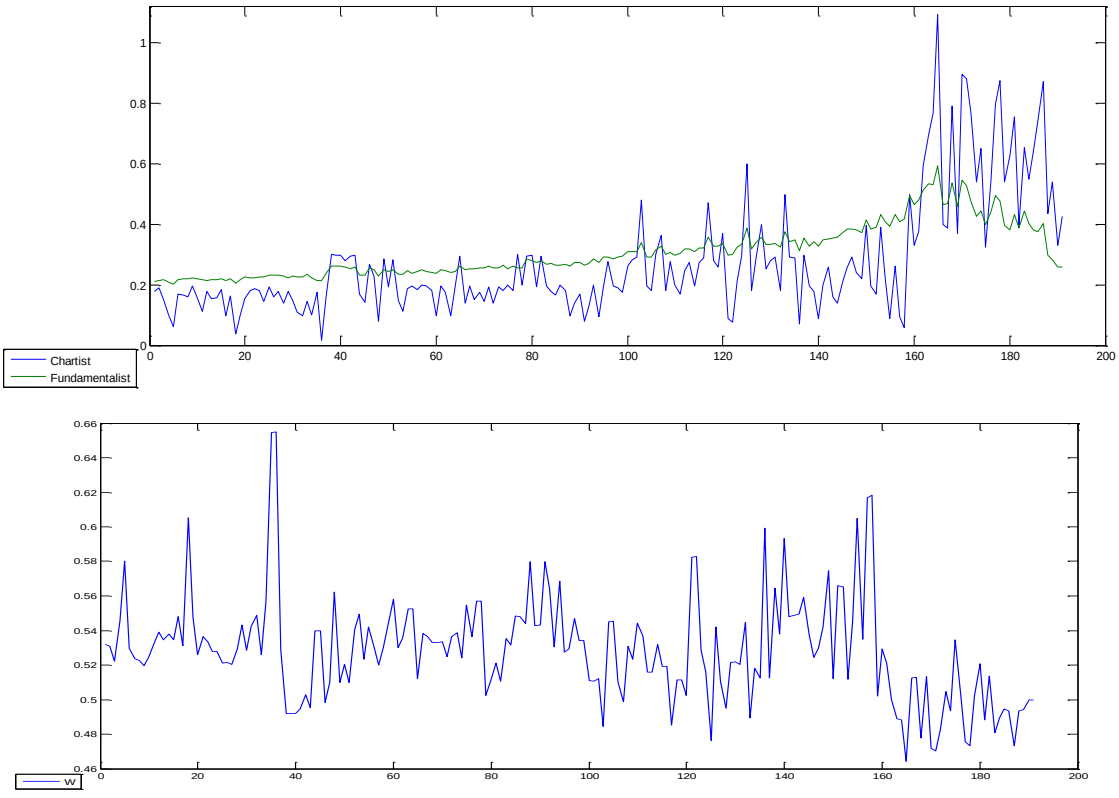

Figure 2: The evolution of the switching rule[2]

[1] The transmission of shocks between the financial markets is ignored in this paper.

[2] Coefficient values are: α = 0.1592, β_0 = 0.5220, β_1 = 0.2095 and γ = 0.2370. They are obtained directly from the estimation of GJR-GARCH-M (1.1) model.

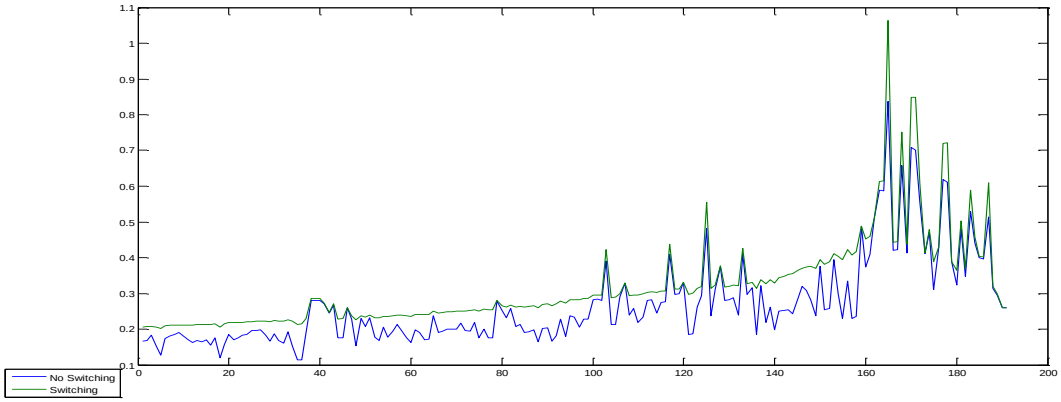

Figure 3: The volatility evolution in a static and dynamic mode

The results concerning the nature of the model are as expected. Thus, while exploring the Fig.2, we can deduce the nature of the expectations of chartists and fundamentalists. As well as the graph, the local volatility follows the same pattern of expectations chartists and fundamentalists $E_t^F(h_{t+1})$ and $E_t^c(h_{t+1})$.

The variation between h_t, $E_t^F(h_{t+1})$ and $E_t^c(h_{t+1})$ are explained by the weight of W_t and fluctuates constantly goshawks of 0.5 with a minimum around zero, with an average of 0.5287. The Fluctuations of W_t, are generally unstable implying that the two agents tend to change their strategies based on daily observations, although they are able to keep their positions. We note that on average, more than three quarters of traders make switch, only 25% of active agents keep their positions and do not change strategies ($xcorr_{W_t}$ = 26.7635).

The nature of the two groups is clearly illustrated in Fig.3. It is easy to discern the behavior of both agents and as shown in Fig.2, the expected volatility of the fundamentalists is more stable. There is also a negative relationship between the weights of fundamentalists and trend of the local volatility. The peaks of volatility (Fig.1) coincide with decreases in W_t and vice versa (Fig.2), this is explained by the dominance of chartists who lead that follows the volatility of the upward trend. That is clear from observations around 100 and 160, in the curves that describe the movements W_t and h_t .So chartists have a disruptive intervention on trends in volatility, and however, fundamentalists tend to stabilize the operation of markets through the volatility process. Figure 3 illustrates the evolution of volatility in a static mode and dynamic as the graph rises, with the switching model is more relevant to the capture of the jumps in the volatility process. Indeed, the high volatility and high amplitude is explained by the Chartists strategies in Paris Option Market.

Conclusion

Studies of behavior negotiators in financial market are frequent, but to our knowledge, very few studies have addressed this issue in context of an option market. Our results are consistent with previous work, such as those of Boswijk and al (2007), who found, from a study in the U.S. market, significant evidence of the existence of two operative

chartists and fundamentalists. De Jong and al. (2009a, b) found a significant relationship between the switching mechanism of the chartists and fundamentalist groups and by exploring the British market exchange. The switching mechanism is based mainly on the estimation of parameter sensitivity. But what happens, really, in the options market is different than the stock market and exchange. Indeed, agents can change their strategies at any time given the errors in forecasting prices and not only on the profits of their own strategies.

In an option pricing model, volatility is the only unobservable variable. It plays a major role in determining the value of an option contract. In Paris Option Market, there are two types of agents who have heterogeneous expectations on volatility process and consequences affect market liquidity. Fundamentalists who speculate under the constraint of mean reversion, the Chartists complete their transactions under the base of informational signal, so their expectations of volatility increase (decrease), if they receive an information signal negative (positive). By integrating the strategies most beneficial, both types of agents can switch between groups on the basis of a logical strategy.

It has been deduced expectations of both agents in a model GJR-GARCH-M(1.1), with coefficients that vary over time, the contribution is that variations of the parameters are caused by the trader behavior . By applying our model for CAC40 index option, it has been clear that traders are involved in the volatility process. Both chartists and fundamentalists are active in the market over throughout our study both groups are consistent. Thus, option prices are the result of heterogeneous expectations of future volatility. In this paper we presented the simplest form that reveals strategies chartists and fundamentalists. However, there are various possible extensions for the two groups that we develop in our future researchers. In addition, when modeling the expectations of chartists, we can integrate other micro-structural variables, such as trading volume and transactions number.

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To cite this article:

Souissi, N., & Boujelbene, Y. (2013). Traders' Behavior in Financial Markets: Paris Option Market Case. *Global Business and Management Research: An International Journal*, 5(1), 1-12.