Heterogeneous beliefs, regret, and uncertainty: The role of speculation in energy price dynamics*

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Abstract

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1 Overview & methodology

The recent and unprecedented surge observed in energy prices, and especially in crude oil price, from 2003 to 2008 has given rise to hot public and academic debates about the true nature of these shocks. Due to the potential impact of these huge movements on most economies (Sadorsky, 1999; Hamilton, 2003; Edelstein and Kilian, 2007; Kilian, 2008, among others), the effectiveness of economic policies strongly depends on the identification of the major causes of energy prices movements. Since Greenspan (2004)'s intervention about the existence of speculators in oil market, a popular view about the origins of price surge is that these movements cannot be attributed to economic fundamentals (such as changes in supply and demand conditions), but are caused by the increasing financialization of commodities. This financialization should in turn cause volatility clustering phenomena, extreme movements, higher comovements between oil, financial assets, and commodity prices, as well as increased impact of financial investors decisions (such as hedge funds, swap dealers, ...). The question of the influence of financial investors on energy prices is of primary importance from both economic and political points of view. Economically, the role of speculation in energy markets raises the question of the trade-off between private and public interests, since financialization is often defined as being benefical from private perspective without any benefical considerations from a social planner's point of view. Politically, the debate is even more relevant since it brings credibility about regulation of commodity derivatives markets in the same way that the G20 governments try to regulate financial markets by limiting speculative behaviors.[1]

Therefore, there has been a renewal of interest in the academic literature for this topic, even if no clear cut conclusion has emerged. Indeed, the question about the role of speculation in commodity markets is not trivial; identifying and quantifying this phenomenon being a difficult task because trader positions are relatively opaque. Some studies define the phenomenon as the consequence of increased comovements between markets, while some others consider markets as composed by different shocks which affect price dynamics. However, these approaches mainly focus on the oil market without considering other energy prices, whereas the same movements occur in these markets. More importantly, they assume that the market is efficient in the sense that investors are rational and representative, and the oil price fully reflects all the available information. Oil market efficiency was however rejected by GjØlberg (1985), and Moosa and Al-Loughani (1994). Moreover, according to Kirman (1992), aggregation arguments under ratio-

[1] In 2010, the U.S government has initiated the Dodd-Frank Wall Street Reform and Consumer Protection Act on commodity markets to limit speculative behaviors by mandatoring centralized clearing of OTC standard contracts and automation of the Securities and Exchange Commission.

nal behaviors are insufficient to reduce markets to a single representative agent. Indeed, following Townsend (1983) and Singleton (1987) it seems reasonable to consider heterogeneous expectations, and it appears optimal for each agent to forecast the forecasts of others. Fundamentals are important but a variety of different models may be relevant to explain behaviors in energy markets. The purpose of this paper is precisely to bring new theoretical elements to understand who and what drive the markets.

Another important limitation in the existing literature is that it has been based on an analysis of risk as opposed to uncertainty.[2] Therefore, previous studies suppose that agents have no considerations about uncertainty on their models, their priors or the future evolution of prices, although allowing uncertainty could be relevant to account for some "anomalies" and stylised facts of markets.

Previous analyses thus evolve in a constrained world where agents are rational and where uncertainty does not exist. To deal with these limits we propose a new theoretical and empirical framework to investigate what drives energy price fluctuations. Our theoretical model overcomes the restrictive assumption of rationality by considering that heterogeneous expectations could be the cause of recent prices movements. We propose to extend the traditional heterogeneous agent model (HAM) of Brock and Hommes (1997, 1998) in the same way as Kozhan and Salmon (2009) to account for uncertainty in the markets. We therefore assume that investors are faced with forming energy price expectations and consider the worst outcome within the set of different models in some interval, where the size of interval is a subjective choice of agents allowing to capture different degrees of uncertainty aversion. In traditional HAM, agents are supposed to switch between different strategies characterizing heterogeneous specifications according to a cognitive learning process. We propose to extend this rule to a more realistic one which accounts for both cognitive and emotional dimensions by a regret criterion *à la* Bell (1982) and Loomes and Sugden (1982).[3]

We also estimate our model empirically using nonlinear least squares (NLS) methods to investigate whether heterogeneous expectations and uncertainty exist in the markets and can lead to strong fluctuations of energy prices. Estimations are done during both normal times and extreme movements periods[4] in order to see if the behavior of prices can be different depending on the intensity of the markets.[5] The theoretical model is then compared to

[2] By risk we consider that agents know the probability distribution of a random variable, as opposed to uncertainty when agents have no knowledge about it.

[3] According to the seminal work of Damasio (1994), emotion can also affect behavior and play a crucial role in the decision process, where lack of feelings leads to suboptimal choices.

[4] Normal times are approximated by price movements in the mean of the distribution, while extreme fluctuations periods are in the quantiles.

[5] By intensity of the markets, we consider price movements during normal times and extreme prices' fluctuation periods.

a random walk (RW) in terms of predictive ability. To our best knowledge, investigating the relative impact of financialization on energy price fluctuations through behavioral and emotional aspects under uncertainty during normal and extreme situations has never been done before.

2 Results & Conclusion

In this paper we provide an original behavioral and emotional analysis of the impact of financialization on energy markets under uncertainty. For this purpose we suppose that energy price fluctuations can be caused by heterogeneous expectations, as well as uncertainty in decision-making process. Our stylized heterogeneous agent model allows investors to switch between different strategies according to market circumstances.
Turning to the empirical analysis of oil, gas, coal and electricity markets over the January 2005 to December 2010 period, our results indicate that the proportion of each trader in the markets is different depending on the degree of uncertainty considered, as well as the intensity of fluctuations. Energy prices fluctuations are mainly governed by fundamentalist expectations when agents in the markets evolve under certain context, while both fundamental and speculative behaviors are the source of prices movements under uncertain world. We have also shown that trader weights could be different if we look at extreme situations. The proportion of uncertainty averse agents increases during extreme downward movements leading to situations where the fundamental nature of the markets fades in benefit to irrational fluctuations as "cascading behaviors". The conclusion is more parsimonious regarding extreme upward movements since price increases are the consequence of both fundamental and chartist traders. All in all, our paper shows the limit of previous literature considering a too restrictive framework. We see that if we extend the analytical framework, we could have better perception and understanding of what drive energy markets. Our model has obviously some limitations. Chartists have usually more complex behavior than a simple trend follower specification, and fundamentalist behavior could be also more sophisticated to account for the specific nature of each energy market. Despite these limitations the model outperforms standard benchmarks, and provides a first step toward the analysis of behavioral and emotional attitudes of energy investors facing uncertainty. Further work should be done to give a concise definition of what we call excessive "commodity speculation", as well as to explore more precisely if it can be costly in terms of social welfare.

3 Some References

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