# REPORT: PROJECT EIF 2017 CLUSTERS AND INFORMATION FLOW: MODELING, ANALYSIS AND IMPLICATIONS.

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## 2 Main results

The purpose of the project was to investigate the very important feature of financial markets, that is clustering effects in order to propose new models able to overcome some usual assumptions in mathematical finance as instance Poissonian distribution of jumps, fat tails, etc. Usual financial models are not able to exhibit volatility clustering or capture the leverage effect, both of which are well-known features of equity markets, but similar behaviour can appear in fixed income, commodities and energy markets. In particular, the pioneering works of Mandelbrot and Fama show that the tails of stock returns can be easily described by Pareto law. This power law is a recurring topic in economics able to explain surprising regularities in economics and finance, as for example incomes and wealth, cities size, stock returns, trading volume.

In the paper [3], we have proposed an extension of Heston setup called the $\alpha$-Heston model, where the instantaneous variance process contains a jump part driven by $\alpha$-stable processes. In this framework, we have examined the implied volatility and its asymptotic behavior for both asset and VIX options. Furthermore, we have studied the jump clustering phenomenon observed on the market. We provide a jump cluster decomposition for the variance process where each cluster is induced by a "mother jump" representing a triggering shock followed by "secondary jumps" characterizing the contagion impact. The $\alpha$-Heston model is able to reproduce in a parsimonious way the implied volatility of S&P and VIX option.

In the paper [4], we have investigated empirically the functional link between the variance swap rate and the spot variance. Using S&P500 data over the period 2006-2018, we have founded overwhelming empirical evidence supporting the affine link implied by exponential affine stochastic volatility models. Tests on yearly subsamples suggest that exponential mean-reverting

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variance models provide a good fit during periods of extreme volatility, while polynomial models are suited for years characterized by more frequent price jumps.

Focusing on commodities, and in particular energy, other phenomena which are highlighted in literature, like the so-called Samuelson effect, are not fully ex-plained by the models available in the literature. In particular, several recent investigations tried to explain it in a more rigorous and quantitative way. In energy markets, and more specifically in power markets, this effect is strongly evident. One of the goals of the present project is to propose a new model class for asset prices, especially but not exclusively in energy markets, explaining the-se phenomena in a parsimonious and unified way.

Another puzzling phenomenon exhibited by power markets is the sudden and un-predictable behavior of the risk premium, defined as the difference between the spot and forward price of power. From a theoretical point of view, the risk premium is the difference between the expectations of the underlying price at maturity with respect to the historical and the risk-neutral measure. The term structure of power risk premium often exhibits a sign change describing a move from contango to backwardation and vice versa. Very few model classes can explain this phenomenon in a consistent way and often they need the introduction of very artificial and complicated relations between the historical and risk-neutral probability measures in order to justify its existence.

Focusing on credit risk applications, we have applied the Hawkes setup to the modeling and the pricing of Collateralized Loan Obligations. Our model assumes that the underlying credit risk is driven by a marked Hawkes process, involving both clustering effects on defaults and random recovery rates. We have provided a sensitivity analysis of the CLO price with respect to the parameters of the Hawkes process using a change of probability and a variational approach. We also provide a simplified version of the model where the intensity of the Hawkes process is taken as the instantaneous default rate. Finally we have proposed a moment-based formula for the expected survival probability.

The project “clusters and information flow: modeling, analysis and implications" has given birth to four publications in main journal [1, 2, 3, 4]. In all the paper the Institut Louis Bachelier/Europlace Institut of Finance grant is acknowledge.

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