REPORT: PROJECT EIF 2019
The impact of information on financial markets: Detecting, analysing and modelling abrupt changes in prices resulting from news arrivals

Simone SCOTTI*

December 28, 2021

1 Team

- Giulia LIVIERI (Scuola Normale Superiore, Italy)
- Sergio PULIDO (ENSIIE, France)
- Simone SCOTTI (Université de Paris, France).

2 Main results

The goal of the proposed project was to detect, characterize and model abrupt price movements across markets exploring the information content of microstructural data. To conduct our study we will capitalize on the relation, already documented in the financial literature, between the occurrence of these market-wide events and macroeconomic announcements. We expect that our research will be able to reveal the way exogenous information, and in particular macroeconomic news, is incorporated into market prices, which will provide insights for asset allocation and risk management. Time series of high-frequency price-returns belonging to different asset classes (e.g. stocks, interest rates, FX rates, credit spreads, commodities, etc.) exhibit common features. These include fat-tails, long-range autocorrelation, correlation between assets, and, last but not least, volatility clustering, simultaneous (co-jumps) and not-simultaneous (jumps) discontinuities. In particular, volatility clusters, jumps and co-jumps can be partially explained by the release of (financial) news such as macro-economic statistics (e.g. growth and unemployment rates) and announcements about mergers or acquisitions. Consequently, regulatory agencies encourage or request important firm-specific news to be published when markets are closed. In practice, however, markets are not systematically closed at the announcement times and the arrival of information can, to a certain extent, be properly anticipated. The target federal funds rate deserves a special mention to illustrate the above-mentioned issues. A large body of literature shows that a relevant part of annual oscillations and trading volumes on bonds and stocks are concentrated around the Federal Open Market Committee?s (FOMC) announcement of the federal funds rate. For example, on December 11, 2007, liquid stocks of many financial companies collapsed all together in the afternoon, with a contemporaneous log-return of approximately -3%. In that day, a FOMC meeting was taking place, ending with the decision of lowering the target for federal funds rate 25 basis points, due to “slowing economic growth reflecting the intensification of the housing correction" and “financial strains" (FOMC press release, December 11,2007). After the collapse, both the stocks? volatility and their correlation

*LPSM, Université de Paris, France. E-mail: scotti@lpsm.paris.

increased significantly, and all industry portfolios in the next four days experienced further large negative returns. In addition, previous studies in behavioural finance have demonstrated that the reactions of the markets to announcements are often excessive and that markets at times under- or over-react by overestimating the positive or negative impact of the news.

In the paper, [1], we have proposed a model to describe the evolution of an index and their components in a parsimonious but flexible way and to produce trading signals based on this model. The trading signals are an extension of the widely used Bollinger bands to infinite dimensional, functional indicators. Our main objective was to deal with non linear indices like credit default swap (CDS) indices. Other possible applications are the VIX index and the vanilla options used to compute it. Outside financial data, there are several frameworks where data are collected and then summarized by space average. The significant innovation of the paper [1] is to deal with the whole components and not only the index, using a diffusion process with values in a functional space. An additional challenge in our approach is that we need to deal with a stochastic process of distributions. These kind of models are poorly addressed in the Bayesian literature, and the modeling problem might be linked to a Functional Time Series problems, as we deal with a stochastic sequence of functions. Nevertheless, this kind of framework is not adapted to the need of dealing with an interpretable model adapted to mathematical finance framework. An important innovation of our work is to introduce a continuous time functional process, while Functional Time Series are discrete time. This is the reason why we need to deal with the existence and properties of our model. Thanks to that, we are able to link well-understood scalar continuous time processes to the evolution of the distribution.

In the paper, [3], we have generalized the Barndorff-Nielsen and Shephard continuous-time model in order to accommodate for the feedback effect from the underlying to the volatility. A large empirical literature, see, e.g., Engle and Patton, supports the presence of persistency in volatility time series, that is, the presence of “clustering of large and small moves" of the asset price. For instance, Aït-Sahalia stress that “from mid-September to mid-November 2008, the US stock market jumped by more than 5% on 16 separate days. Intraday fluctuations were even more pronounced: during the same two months, the range of intraday returns exceeded 10% during 14 days". The observed persistency (also known as long memory) of the volatility represents one of the main justifications behind the use of rough volatility models, especially at the microstructure level. However, evidence appears to be conflicting. For instance, Bates emphasizes that SVCJ models “assign a 90% risk-neutral probability of observing at least 1 weekly move of 10% in magnitude over 1988-93; none was observed", thereby suggesting that empirical data not always comply with theoretical predictions of co-jump models. The way we have proposed to reconcile these contrasting empirical results, is to suppose that the jump intensity is not constant but increases after each jump, as implied by Hawkes processes. Under this hypothesis, one obtains jump clustering and the replacement of the Poisson process with an Hawkes driver in the BNS model reproduces “clustering of large and small moves" and thus the volatility persistence. Up to some extent, this replacement covers the same gap existing between ARCH and GARCH processes. In particular, we will show that the Hawkes setup exhibits an important autocorrelation of the squared returns. In the paper [3], we achieve two main results. Firstly, we derive a feasible maximum-likelihood procedure to estimate the parameters driving the jump intensity of Hawkes-driven models from sample asset prices. The effectiveness of the procedure is tested with simulated data. Secondly, we evaluate the goodness-of-fit of alternative jump intensity specifications with empirical data. To do so, we focus on the S&P 500 index, sampled at the 5-minute frequency, over the period May 1, 2007- August 6, 2021. It emerges that the relatively best fit is obtained when the intensity of the Hawkes process is a linear transformation of the variance process.

Finally, in the work in progress [2], we develop a new model based on Barndorff-Nielsen and Shephard continuous-time model driven by Hawkes process but we assume that the kernel of the Hawkes process is not exponential. We show that this model is easy to implemented and to calibrate. Moreover, compared with the usual exponential kernel, the Volterra setup is able to reproduce the level of implied volatility of stock and VIX simultaneously.

The project “clusters and information flow: modeling, analysis and implications" has given birth to one publication in main journal [1], a submitted paper [3] and a working paper [2]. In

all the papers the Institut Louis Bachelier/Europlace Institute of Finance grant is acknowledge.

References

[1] Bernis, G., Brunel, N., Kornprobst A. and Scotti, S. (2021) Stochastic Evolution of Distributions and Functional Bollinger Bands. *Applied Stochastic Models in Business and Industry*, in press. doi://10.1002/asmb.2665

[2] Bondi A., Livieri, G.; Pulido, S. and Scotti S. (in progress) Volterra equation models with common jumps. work in progress.

[3] Raffaelli, I., Scotti, S. and Toscano, G. (2021) Hawkes-driven stochastic volatility models: goodness-of-fit testing of alternative intensity specifications with S&P500 data.