Are Financial Markets Becoming Systemically More Unstable?

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1 Extended abstract

Financial market players have always been very keen to adopt new technologies to stay ahead of competitors and to improve the returns on their financial activities and speculations. Following this trend, technology heavily entered the Capital Markets trading space, to the extent that all major exchanges are now trading exclusively using electronic platforms. At the same time, the trading activity is changing from the old phone conversation or click and trade on a screen to software programming. Market statistics confirm that automated algorithms carry out a significant fraction of the trading activity on US and Europe electronic exchanges. As algos feed on data and require low latency transactional channels, all major exchanges are now offering fine grain data feeds and co-location services. Indeed, providing infrastructure and data to support algorithmic trading has become a major source of revenues for the companies that run the exchanges.

The automation of the trading activity is generating new market dynamics that are still not completely understood. For instance, the dramatic growth of algorithmic trading has increased the level of synchronization between different markets and asset classes. The information is processed much faster and this allows large price movements to propagate very rapidly through different assets and exchanges. This synchronization effect had its most spectacular appearance during the May 6, 2010 Flash Crash. The crash started from a rapid price decline in the E-Mini S&P 500 market and in a very short time the anomaly became systemic: the price drop propagated towards ETFs, stock indices and their components, and derivatives. For example, the Dow Jones Industrial Average plunged about nine percent, only to recover those losses within minutes.

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The contagion effect can be extremely rapid in liquid markets and leads to a strongly synchronized movement of the price of many assets.

Regulators are very worried by these emerging trends and are reacting with very strict regulations on algorithmic trading, trying to protect investors against unfair behaviours.

In QuantLab, a joint research laboratory started by Scuola Normale Superiore and LIST, we have been concentrating on the analysis of such systemic instabilities since 2011.

We have devised a statistically sound model based on Hawkes processes to identify price fluctuations larger than four standard deviations, which we generically refer to as jump events. We have then extended this model to include multi-asset events, dubbed as asset cojumps and we have applied our methodology to a portfolio of highly liquid stocks belonging to the Russell 3000 Index and traded at the US market from 2001 until 2012. Our research has enlightened a remarkable evidence (see Fig. 1 for details). Since 2001 the total number of extreme events involving single assets is significantly diminished, but the number of occurrences where a sizable fraction of assets has jumped together has increased. This trend is more and more pronounced as we consider events of higher and higher multiplicity.

What are the factors responsible for the appearance of extreme movements? Jumps can have both an exogenous and an endogenous origin: the former is linked to the release of macroeconomic news which genuinely affect the price dynamics, while the latter may result from unstable market conditions, such as a temporary lack of liquidity. In order to test the impact of news on the market we investigate a dataset of announced macro-news. A preliminary analysis shows that the systemic events when all the 140 assets jump together are associated with a macro announcement. On the contrary, only a minor fraction (up to 40%) of the cojumps involving a large (but not the totality) number of assets can be attributed to exogenous news. The remaining 60% suggests that a more intriguing mechanism is taking place.

We are now faced with the challenge of finding a predictive model to anticipate the occurrence of systemic events. The ability to anticipate flash crash is relevant for all market participants: exchanges could incorporate this knowledge to efficiently stabilize market prices, market participants could avoid taking unnecessary risks associated with the systemic instability and regulators would be able to devise very effective regulations to prevent harm to the investors.

Conventional statistical approaches have not provided, so far, significant improvements in the ability to identify precursors of the occurrence of a sudden collective drop of the prices on the market. Can artificial intelligence techniques provide an answer?

The task is very challenging both from the modelling and technological point of view. The model should be robust (few or no false positives), it will have to be applied thousands or millions of data points and it must provide reliable signals in a very short time.

As the trading activity becomes dominated by human written / machine driven algorithms, will we be able to use artificial intelligence to control the globalized electronic markets?

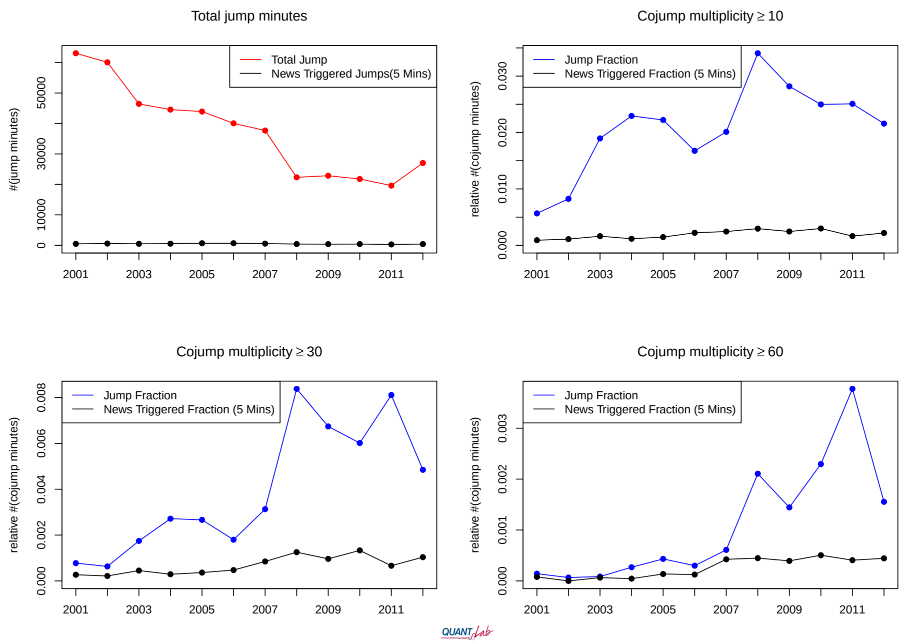

Fig. 1. We consider price series with a time resolution of one minute. We classify as jump events those minutes with anomalous price movements. In the top left panel we graph the total number of minutes in each year where at least one of the 140 assets had a jump event (red points) and the number of such events which are triggered by the release of a macroeconomic news in the nearest past five minutes (black points). In the other panels we graph the fraction of events represented by red points where a cojump event occurred with at least 10, 30, 60 assets jumping synchronously (blue points) and the fraction of news-triggered cojump events (black points).

References

1. G. Bormetti, L. M. Calcagnile, M. Treccani, F. Corsi, S. Marmi, F. Lillo, *Modelling systemic price cojumps with Hawkes factor models*, submitted. Preprint available at arXiv:1301.6141.