High-frequency trading and regulatory policies. A tale of market stability vs. market resilience

by Sandrine Jacob Leal and Mauro Napoletano

Over the past decades, high-frequency trading (HFT) has sharply increased in US and European markets. HFT represents a major challenge for regulatory authorities, partly because it encompasses a wide array of trading strategies (AFM (2010); SEC, 2010), and partly because of the big uncertainty yet surrounding the net benefits it has for financial markets (Lattemann *and al*. (2012); ESMA (2014); Aguilar, 2015). Furthermore, although HFT has been indicated as one potential cause of extreme events like flash crashes, no consensus has yet emerged about the fundamental causes of these extreme events. Some countries' regulations have already accounted for HFT,[1] but, so far, this has led to divergent approaches across markets and regions.

Overall, the above-mentioned open issues call for a careful design of regulatory policies that could be effective in mitigating the negative effects of HFT and in hindering flash crashes and/or dampening their impact on markets. On these grounds, in a new research paper published in the *Journal of Economic Behavior* and Organization we contribute to the debate about the regulatory responses to flash crashes and to the potential negative externalities of HFT by studying the impact of a set of policy measures in an agent-based model (ABM) where flash crashes emerge endogenously. To this end, we extend the ABM developed in Jacob Leal *et al*. (2016) to allow for endogenous orders' cancellation by high-frequency (HF) traders, and we then use the model as a test-bed for a number of policy interventions directed towards HFT. This model is particularly well-suited and relevant in this case because, differently from existing works (*e.g.,* Brewer *et al*, 2013), it is able to endogenously generate flash crashes as the result of the interactions between low- and high-frequency traders. Moreover, compared to the existing literature, we consider a broader set of policies, also of various natures. The list includes market design policies (circuit breakers) as well as command-and-control (minimum-resting times) and market-based (cancellation fees, financial transaction tax) measures.

After checking the ability of the model to reproduce the main stylized facts of financial markets, we run extensive Monte-Carlo experiments to test the effectiveness of the above set of policies which have been proposed and implemented both in Europe and in the US to curb HFT and to prevent flash crashes.

Computer simulations show that slowing down high-frequency traders, by preventing them from frequently and rapidly cancelling their orders, with the introduction of either minimum resting times or cancellation fees, has beneficial effects on market volatility and on the occurrence of flash crashes. Also discouraging HFT via the introduction of a financial transaction tax produces similar outcomes (although the magnitude of the effects is smaller). All these policies impose a speed limit on trading and are valid tools to cope with volatility and the occurrence of flash crashes. This finding confirms the conjectures in Haldane (2011) about the need of tackling the “race to zero” of HF traders in order to improve financial stability. At the same time, we find that all these policies imply a longer duration of flash crashes, and thus a slower price recovery to normal levels. Furthermore, the results regarding the implementation of circuit breakers are mixed. On the one hand, the introduction of an ex-ante circuit breaker markedly reduces price volatility and completely removes flash crashes. This is merely explained by the fact that this type of regulatory design precludes the huge price drop, source of the flash crash. On the other hand, ex-post circuit breakers do not have any particular effect on market volatility, nor on the number of flash crashes. Moreover, they increase the duration of flash crashes.

To sum up, our results indicate the presence of a fundamental trade-off characterizing HFT-targeted policies, namely one between market stability and market resilience. Policies that improve market stability – in terms of lower volatility and incidence of flash crashes – also imply a deterioration of market resilience – in terms of lower ability of the market price to quickly recover after a crash. This trade-off is explained by the dual role that HFT plays in the flash crash dynamics of our model. On the one hand, HFT is the source of flash crashes by occasionally creating large bid-ask spreads and concentrating orders on the sell side of the book. On the other hand, HFT plays a positive role in the recovery from the crash by contributing to quickly restore liquidity.

[1] Some unprecedented actions and investigations by local regulators were widely reported in the press (Le Figaro, 2011; Les Echos, 2011; 2014; Le Monde, 2013; Le Point, 2015).

Rock around the Clock: an explanation of flash crashes

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On May 6 2010, contemporaneously with the unprecedented price decrease of the E-Mini S&P500[5], many US equity indices, including the Dow Jones Industrial Average, nosedived by more than 5% in few minutes, before recovering much of the loss. During this "flash crash", most asset prices lost any informational role, as over 20,000 trades across more than 300 securities were executed at prices more than 60% away from their values just moments before. Many were executed at prices of a $0.01 or less, or as high as $100,000, before prices of those securities returned to their "pre-crash" levels (CFTC and SEC, 2010). Such a huge mispricing was associated with a sudden evaporation of market liquidity, swelled volatility and a prolonged crisis in market confidence (average daily volumes were down for several months after the crash). Furthermore, extreme asset misalignments could also be a source of systemic crises in light of mark-to-market financial accounting practices, according to which banks' and other financial institutions' assets are evaluated at current market prices.

The flash crash of May, 6 2010 widely reported in the press was not an isolated incident. Similar episodes have been observed since then in many financial markets. Moreover, because of their disruptive consequences on the orderly functioning of markets, flash crashes attracted the attention of regulators, politicians and academic researchers. In the last four years, many conjectures have been advanced to clarify the origins of the phenomenon and to propose regulatory measures able to prevent its emergence and/or to mitigate its effects. Most theories focused on the role of high-frequency trading (HFT). Indeed, as suggested by a SEC report, high-frequency (HF) traders may have had a fundamental role in fueling the crash by increasingly selling their positions. However, no convincing explanation has emerged yet and the debate on the benefits and costs of HFT, and its role in flash-crash events, is still unsettled. Some studies suggest that HFT can negatively affect market efficiency, exacerbating market volatility, reducing market liquidity and possibly fueling flash crashes. Others suggest that high-frequency traders are "modern" market makers, who provide an almost continuous flow of liquidity, thus reducing transaction costs and fostering price discovery and market efficiency.

The lack of a consensus on the net benefits of HFT is not surprising, as the ultra-fast algorithms adopted by high-frequency traders represent a genuine financial innovation, whose social impacts are difficult to assess given the legion of associated –often unintended– externalities and the underlying complexity of financial markets. In such a context, agent-based models (ABMs) may represent a powerful tool to study the impact of financial innovations such as HFT on market dynamics. Indeed, ABMs allow the researcher to build artificial markets where price fluctuations can emerge from direct interactions occurring among heterogenous traders, endowed with a repertoire of different trading strategies, ranging from simple to very sophisticated ones (as those employed by HF traders).

Following this intuition, in a OFCE Working Paper n°2014-03, we develop an ABM of a limit-order book (LOB) market, wherein heterogeneous HF traders interact with low-frequency (LF) ones. Our main goal is to study whether HFT is responsible for the emergence of flash crashes and more generally for periods of higher volatility in financial markets. Furthermore, we want to shed some light on which salient features of HFT are relevant in the generation of flash crashes and in the process of price-recovery after a crash.

The model portrays a market wherein LF agents trade a stock, switching between fundamentalist and chartist strategies according to their profitability. HF agents differ from LF ones not only in terms of speed, but also in terms of activation and trading rules. First, contrary to LF strategies, which are based on *chronological* time, the algorithmic trading required by HFT naturally leads HF agents to adopt trading rules which rest on event time. As a consequence, LF agents, who trade at exogenous and constant frequency, co-evolve with HF agents, whose participation in the market is endogenously triggered by price fluctuations. Second, HF agents adopt *directional* strategies that exploit the price and volume information released in the LOB by LF traders. Finally, HF traders keep their positions open for very short periods of time and they typically display high order cancellation rates. To study the model, we run extensive numerical simulations. Our results show that flash crashes together with high price volatility occur *only* when HF agents are present in the market. Why do flash crashes occur in our model in presence of HF traders? We clearly show that the emergence of flash crashes is not only related to the faster trading speed of HF agents, but more important to the use of specific trading strategies which enable them both to siphon liquidity off the market, leading to high bid-ask spreads[6], and to synchronize on the sell-side of the LOB, when the market crucially needs liquidity.

Finally, we explore the effects of HF agents' order cancellation rate on market dynamics. Order cancellation has received much attention in recent public debates, because HF traders can use it strategically to move prices in the desired directions by filling the LOB with fake orders within few microseconds only to cancel them just as quickly. We find that high rates of order cancellations have an ambiguous effect on price fluctuations. Indeed, a larger rate of order cancellations leads to higher volatility and more frequent flash crashes, but also to faster price recoveries, which in turn reduce the duration of flash crashes. We therefore suggest that order-cancellation strategies extensively employed by HF traders cast more complex effects than thought so far, and that regulatory policies aimed to curb these practices should take

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[5] A futures contract on the S&P 500 index.

[6] The difference between the highest price a buyer is willing to pay for an asset and the lowest price a seller is willing to sell this same asset.