Order Book Microstructure and Policies for Financial Stability

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Every time a financial crisis occurs, a recurring and stimulating question is asked: is it possible to predict and neutralize such phenomena? Indeed, after a crash on markets, many harmful consequences affect economic systems. Thus, many observers remain stuck in front of the evidence that the predictive skills of economic models is continuously challenged by repeated confutations. This is not a matter of "wrong" models. The point here is to distinguish between the assumptions of many economic models and the true context of actual markets. The great majority of macroeconomic topics are examples of complex systems, where the interaction among several individual parts generate aggregate outcomes which qualitatively differ from its constituents.

Many relevant economists of the past, as for example, Keynes (1936), Schumpeter (2013), von Hayek (2015), and Leijonhufvud (1993), focused on implications of complexity. The argument is still central in modern contributions, as in Simon (1957) and Kahneman and Tversky (1974), where the psychological dimension of the economic decisions has been explained as a possible source of unpredictability: see also Camerer (2003), Barberis and Thaler (2003), Colander (2009), Kahneman and Tversky (1979).

It is natural to refer to the systemic perspective when it comes to discuss about financial instability. Nonetheless, the design of policies aimed to reduce volatility and prevent bubbles and crashes can derive from the micro-structural analysis of the market. Indeed, Mitchell (2009) suggests that order book dynamics is a valid example of a complex system, because it emerges as a global result of local individual interactions among traders. Thus, the global extreme events which characterize the behavior of actual markets, such as bubbles and crises, are possibly determined by how orders are eventually managed and negotiated.

The motivation of this paper is to build a model of a financial market with a realistic order book, in order to assess the efficacy of simple policies aimed to pursue the financial stabilization, by tuning basilar elements of the micro-structural framework.

Many contributions dealing with financial order books exist in literature. Most of them are critically surveyed in Chakraborti *et al.* (2011), Slanina (2008), Parlour and Seppi (2008). It is possible to divide such a vast literature in two groups: the first is *trader-centric*, because models of this class have been mainly based on frameworks aiming to derive fully rational optimal trading strategies, as in Chakravarty and Holden (1995), Foucault (1999), Parlour (1998), Hollifield *et al.* (2004), Hollifield *et al.* (2006), Rosu (2009), Rosu (2010); the second is *facts-centric*, because models of this class usually tended to study more the statistical features of the market as a dynamic process than the individual characterization of investors, as in Bak *et al.* (1997), Maslov (2000), Daniels *et al.* (2003), Farmer *et al.* (2005), Bouchaud *et al.* (2009), Cont *et al.* (2010).

A third stream of literature is inspired by the computational approach of agent-based models (ABMs) in economics. Such models, developed since the Nineties, have shown to be able to

describe many aspects neglected by the orthodox modeling, as explained in Tesfatsion (2006). Examples are, among others, Brock and Hommes (1997), Brock and Hommes (1998), Chiarella (1992), Chiarella and He (2001), Day and Huang (1990), Franke and Sethi (1998), Hommes (2001), Lux (1995), Lux (1998), Lux and Marchesi (1999). The heterogeneity of individuals and the global properties emerging from their interaction can be analyzed by means of specific statistical tools Mantegna and Stanley (2000) and assume a determinant descriptive role in models of financial markets, as in Hommes (2006), LeBaron (2006), and in models of order books, as in Raberto *et al.* (2001), Chiarella and Iori (2002), Consiglio *et al.* (2005), Gil-Bazo *et al.* (2007), Chiarella *et al.* (2009), Tedeschi *et al.* (2012).

The agent-based model here presented enriches the existing literature on the topic with regards to four aspects: first of all, traders have been differentiated not only in terms of behavioral attitude (as usually happens between fundamentalists and chartists) but also with respect to their individual informative sets; secondly, orders (which can have variable quantity) have a time validity and they can be canceled before execution; third, the double auction mechanism governing the order-book results in a true contracts-driven price formation, in such a way that the simulated price series is entirely generated by the model and never added by any fictitious data; fourth, the quantity management system designed for market orders. A further innovative aspect is that the present model is based on a truly operative system, which is realistic. Thus, the simulated price series is always authentic: the order book registers prices really used for negotiations. In other models, as in Chiarella and Iori (2002) and in Chiarella *et al.* (2009), an average price is registered in their simulated series whenever a transaction does not occur.

Shown results give evidence that fat tails of financial returns can be effectively reduced, i.e. a stabilization of the market dynamics can be attained, by some specific policies aimed to: *1)* increase the heterogeneity of investors, both in terms of behavioral attitude for market participation and of differentiation of opinions; *2)* favour the introduction of random traders, i.e., investors who show insensibility with regards to market information; *3)* counterbalance the strategies adopted by traders in order to manage the price impact of their orders, i.e., reduce the allowed number of counterparts for any market order; *4)* reduce the time validity of orders; *5)* maintain flexibility and efficient bargaining, reduce transaction costs, and avoid Tobin taxes (whose actual implementation, instead, exacerbated instability).

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