Research proposal

Scientific supervisor: Fabrizio Lillo

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Decentralized finance (DeFi) is an emerging financial technology based on secure distributed ledgers, which makes it possible to exchange financial products without the need of intermediaries or organized exchanges. The use of decentralized exchanges is nowadays mostly limited to the exchange of cryptocurrency, but it is foreseeable that its use might also revolutionize the exchange and trading activity of more traditional asset classes. While decentralized markets represent an intriguing development of market structure, the implications of the new structure for the role of information in the price discovery process, the measurement, control, and determinants of liquidity and transactions costs, as well as the implications for the efficiency, welfare, and how markets should be designed have not yet been sufficiently explored. Moreover, the systemic implications of the adoption of DeFi and in general of unregulated exchanges are not understood, but are clearly extremely important. The Financial Stability Board has very recently (2022) issued a document highlighting the importance of the assessment of risks to financial stability from crypto-assets and DeFi.

The aim of this research project is to contribute to fill the gap in the understanding of the market microstructure of decentralized exchanges and of the channels of propagation systemic risk brought by this new technology. This will be done by performing a strict comparison of centralized (CEX) and decentralized exchange (DEX), with the aim of highlighting the specificity of DeFi. We consider economic, econometric and computational models to understand and quantify systemic in crypto markets as well as risk spill-overs from crypto markets to core financial markets.

This project comprises two main lines of research:

Liquidity, market quality and price discovery in centralized and decentralized markets

The management of asset trading transaction costs represents a crucial concern in implementing investment decisions. When executing an order, there is a trade–off between immediacy - which may move the price, incurring the so–called market impact of a trade - and market risk. Waiting or trading too fast increases the uncertainty about future prices. Both translate into cost components, since the revelation of trading intention adversely affects asset prices. This is well documented by the large body of empirical analyses of the price impact resulting from a trade (see Bouchaud, Farmer, Lillo 2009), a classical topic in traditional market microstructure research. However, most of the literature assumes that liquidity, i.e the response of price to trades and orders, is constant or evolves slowly with

time. Interestingly, very little is known about market impact in DEX and AMM. Despite the fact that immediate impact in AMM is defined by design, the long term effect of trade, which should convey its information content, is hard to measure and of great importance. In this project we plan to compare liquidity metrics between CEX and DEX and to model jointly their dynamics. In particular, we will compare the information content of trades in CEX and DEX by using as a starting point the traditional approach of (Hasbrouck 1991) and considering recent generalizations to non-linear and time-varying settings.
This discussion is naturally connected with price discovery and its measurement. When an asset is traded in multiple venues, it is natural to ask the contribution of each of them to the price formation process. Information Share and its generalizations are standard measures and UNIBO team has contributed recently to clarify some subtle aspects of its application to high frequency data (Buccheri et al 2021b). We will quantify the contribution of CEX and DEX to price discovery of cryptoassets by using a battery of methods and we will study how market conditions (e.g. volatility or liquidity) affect the relative contribution of the two main segments. Clearly, from a policy point of view it is extremely relevant to understand how the new market structure of AMM contributes to price discovery.

Apart from being latent, liquidity is dynamic and it can suddenly disappear leading to abrupt illiquidity crises as testified by the innumerous mini flash crashes which plague modern electronic markets. Thus one might question the adequacy of the standard econometric models casted on the assumption of constant parameter values, especially those related to price impact. In this part of the project we will investigate if market impact models with constant parameters provide a suitable description of the interaction between trades and prices. A first negative answer has been recently provided by one of us (Mertens et al. (2019)) by applying a Kalman filter approach to a very specific linear model of market impact of liquid equities. But we only scratched the surface of the problem. From a methodological point of view we will apply Score-Driven models (Creal et al. (2013) and Harvey (2013)) to filter in real time the latent parameters describing the univariate and multivariate liquidity and in particular those related to market impact. This approach will also allow us to move to a non-linear (and more realistic) setting. From a domain-specific perspective, instead, we will measure how liquidity varies when we consider an asset which is traded in a fragmented market composed of CEXs and DEXs. Finally, we will focus on abrupt illiquidity crises, identifying them looking at large price changes and/or sudden depletions of orders in the market. In particular we will look for precursors of these events by looking at the dynamics of provided liquidity (i.e. LOB state for CEX and queues for DEX) or from the filtered parameters describing time-varying market impact.

Systemic risk in centralized and decentralized markets

Although connections between crypto-assets (as well as futures and other derivatives referencing them) and systemically important financial institutions has remained limited until today, the growing institutional investor participation (for example hedge funds) in cryptoassets may lead to a significant deterioration of financial stability and risk could spill-over from crypto markets to core financial markets. This is of course exacerbated by the absence of effective regulation and supervision. Systemic risk assessment using balance sheets and portfolio compositions can be hampered by the lack of high resolution data, due to coarse graining, low observation frequency, and reporting delays. An effective alternative approach is to use market data and econometric techniques to identify risk spillovers between assets or markets. Granger-like causality tests, partial correlation analysis, and variance decomposition in multivariate models has proven to be very useful in this respect, especially when the set of synchronous and lagged dependencies is mapped into a network and tools of graph theory are used to extract useful information. Thanks to the strong experience of the UNIBO unit in this field, we will adopt several existing methods, and develop new ones, to infer the channels of propagation of risk spillovers between crypto-markets and core markets, as well as within the realm of crypto-assets. Methodologically, being mostly interested in the propagation of extreme events, we will be focusing on Granger-in-tail causality which we have successfully applied to fixed income (Corsi et al. 2018) and equities (Mazzarisi et al 2020). The main innovation we foresee is the introduction of time-varying parameter versions of such models, since the strength of risk spillover is unlikely constant in time. To this end, we will use Score-Driven models (Creal et al. 2013 and Harvey 2013) which we have successfully applied to high frequency financial data (Buccheri et al 2021a).

Plan of activities

The role of the researcher will be the development and analysis of new statistical models for CEX and DEX crypto markets using tools from market microstructure, time series analysis, econometrics, financial mathematics and Monte Carlo methods.

Months 1-2: literature review. Months 3-6: critical analysis of the methodologies. Months 7-24: development of new solutions, numerical investigation in a controlled setting (Monte Carlo), and empirical analysis of the data.

The activity of dissemination of results will be carried out by giving seminars in Italian and international universities and participating as a speaker to the major conferences of the field.

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