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Heterogeneous beliefs in over-the-counter markets

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ABSTRACT

The behavior and stability of over-the-counter markets is of central concern to regulators. Little is known, however, about how the structure of these markets determine their properties. In this paper we consider an over-the-counter market populated by boundedly rational heterogeneous traders in which the structure is represented by a network. Stability is found to decrease as the market becomes less well connected, however, the configuration of connections has a significant effect. The presence of hubs, such as those found in scale free networks increases stability and decreases volatility whilst small-world short-cut links have the opposite effect. Volatility in the fundamental value increases market volatility, however, volatility in the riskless asset returns has an ambiguous effect.

1. Introduction

Over-the-counter (OTC) markets are key to the operation of the modern financial system. Much of the world's trade in derivatives, foreign currency, and many other assets, is conducted in these exchanges. They provide flexibility to financial institutions, however, this comes at a cost. During adverse conditions, their decentralized nature can cause traders to be unable to identify counter-parties and as a result the markets may lose liquidity and fail. This happened during the 2008 financial crisis when the sparse structure of OTC markets was blamed for a lack of transparency and an inability for institutions to identify prices of assets and to trade (Brunnermeier, 2009). As a result this has led to calls for trade to be moved away from OTC markets towards centralized exchanges to increase stability. There is, however, very little work comparing these two types of institutions. This paper aims to address a key aspect: the stability and dynamics of prices. In particular it will look at how the pattern of interactions between institutions, the structure of an OTC market, affects the market behavior. The markets considered in this paper will contain heterogeneous speculative traders which base their trading decisions on their valuation of the asset. Each trader's valuation is itself dependent on their strategy and the information the trader gains through trading with its counterparts. As a result the structure of the market will affect the behavior of traders.

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OTC markets allow investors to trade assets directly between each other rather than through centralized exchanges. They are particularly prevalent when assets are illiquid, are traded in very large quantities or when there is scope for bespoke contracts. The largest OTC markets are those for currency exchange and swaps. In these markets investors buy or sell directly from dealers, however, each customer may only know a subset of the dealers within the market, limiting their ability to observe the best price. The dealers themselves trade with each other in order to balance inventory, meet liquidity needs and speculate, again however, each dealer may only interact with a subset of the other dealers. Lyons (1997) captures this interaction in a formal model and shows that this market setup can reduce the amount of information in prices. Duffie et al. (2005) show how constrained trading opportunities and search costs in OTC markets affect prices and the resulting bid–ask spread, whilst Koeppl et al. (2012) use a mechanism design approach to examine the effect of the clearing arrangements (centralized versus bilateral) on stability in both types of markets.

Inter-bank lending markets also generally operate on an OTC basis. In this case the 'price' is the interest rate at which a bank or financial institution may lend or borrow. The nature of the contracts (length of borrowing, size of borrowing, time) and the participants (credit ratings of borrower, history, etc.), all affect the interest rate a particular institution will be offered. An OTC structure provides the flexibility necessary for this type of trade. Theoretical studies have shown that the linkages between banks (lending and borrowing relationships) have an important effect on stability (Allen and Gale, 2000). Several papers have considered the effect of particular network structures e.g. Battiston et al. (2012), Georg (2013), Iori et al. (2006), Ladley (2013), Lorenz and Battiston (2008) and have shown that the connectivity (the number of links between traders in the network) and the configuration of linkages both play a role in market stability.

The structure of OTC markets, as defined by the interactions of the institutions within them, may be highly complex. Network theory offers an effective analogy to capture and analyze their detail. An OTC market may be represented as a graph in which nodes correspond to traders and edges represent potential trading relationships. Within the network each financial institution is restricted only to interact and gain information from those to whom it is directly connected. Seminal work by Watts and Strogatz (1998), Barabási and Albert (1999), Newman (2003) and others have provided tools applicable to a wide range of systems, from friendship groups to gene regulation which may be employed in this setting.

Within this paper we represent the OTC market as a network. The traders within the market follow one of two strategies which differ in their estimation of future market prices. Chartists look at previous trends in the market price to extrapolate future price changes, whilst fundamentalists know the true value of the asset and assume that the market price will move back towards this value. We use numerical simulation in order to analyze the behavior of the model. The results show that the market structure has a significant effect on price dynamics and market stability. The more heavily a market is connected, i.e. the more easily information may flow between traders, the more frequently stable dynamics are observed. As the number of connections is reduced, the market dynamics deviate more often from the fundamental, as sections of the market diverge in their valuation of the asset. The presence of hubs increases stability whilst the inclusion of 'small world' type short-cut connections has the opposite effect. Markets are also shown to be less stable if they contain an above average number of chartist traders. Volatility in the underlying fundamental or riskless asset returns are amplified by the network structure, particularly the locally connected market. In some markets, however, low levels of riskless asset return volatility were found to synchronize the traders and reduce price volatility. Overall, the model is found to have much in common with the underlying Chiarella (1992) model in terms of the parameter combinations which lead to non-equilibrium prices and the effect of those parameters on the amplitude of cycles, although the network structure has marked influence on this.

The paper proceeds as follows. Section 2 discusses literature relevant to our model. Section 3 details the model of the interaction of heterogeneous traders in OTC markets. Section 4 presents the results, first focusing on the behavior of individual traders and then looking at the role of the number of connections, network structure, parameters, compositions of traders and volatile fundamentals. Section 5 concludes.

2. Related literature

The analogy of a network has been used in a body of work looking at the effects of market structures on trade.[1] Evstigneev and Taksar (2002) show that equilibria within these markets exist and that the networks formed can maximize overall efficiency (Kranton and Minehart, 2001) although Gofman (2011) shows that with insufficient numbers of connections an inefficient allocation becomes almost certain. The dynamics of these markets are also highly dependent on network structure, e.g. Bell (1998) and Tassier and Menczer (2008). Both the number of connections and the pattern of connectivity play important roles. For instance, Wilhite (2001) shows that 'small world' connections, those connecting otherwise distantly separated sections of the market, have a large effect on reducing search costs. The behavior of traders within these markets has also been shown to vary with their location (Ladley and Bullock, 2008). Importantly, this is not just dependent on their trading opportunities but also on their information linkages (Ladley and Bullock, 2007). Babus and Kondor (2012) consider how information diffuses across OTC markets showing that with private valuations the information efficiency of prices is maximized when all traders trade with all others. Information linkages may also be external to the market. Panchenko et al. (2013) examine this issue explicitly. They extend the model of Brock and Hommes (1998) to allow

[1] See Wilhite (2006) for a review.