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Chasing trends at the micro-level: The effect of technical trading on order book dynamics

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ABSTRACT

Technical traders attempt to exploit trends in market prices and the order flow. Despite this little is known about how these traders behave in a micro-structure context. We consider a model of an order book based financial market. The market contains two groups: informed traders and technical traders. A numerical technique is used to identify a Markov perfect equilibrium of the trading game and so determine the optimal strategies. We find that technical trading rules are profitable and allow traders to increase their returns. The effect of technical traders on the market, however, is ambiguous. They decrease volatility and pricing errors but also increase trading costs despite primarily acting as liquidity suppliers.

1. Introduction

The strategies and profitability of technical traders have received much attention in the finance literature, however, relatively little is known about the behavior of these traders in a micro-structure context. The rise of high frequency trading has made understanding this area increasingly important. Key to the strategies of many of these traders is the identification of trends or momentum in the market. Early identification allows traders to beat other market participants to the best prices and to make profits. Whilst for longer term investment the micro-structure costs and implications of trading may be ignored, for high frequency firms these are significant. Traders in these firms often turn over positions within a few seconds meaning that micro-structure considerations such as liquidity and price impact are vital.

In this paper we present a model of the interaction of informed and technical traders in a dynamics order book market. Informed traders know the fundamental value of the asset whilst technical traders trade based on trends in the order flow. The order submission strategies of both groups of traders are conditioned on the state of the market, the configuration of the order book, and, in the case of technical traders, the technical rules. We use a numerical approach in order to identify a Markov perfect equilibrium in which both types of traders behave optimally. The dynamics of the model are analyzed in order to understand how the presence of technical traders impacts the micro-structure dynamics and market quality including liquidity, stability and efficiency. The behavior of both groups of traders are examined and their strategies characterized.

Technical traders use information about past trades in order to predict future price movements. To do this they use a variety of approaches including data analysis, e.g. moving averages, break out rules etc., and visualization techniques, such as candle charts or Fibonacci arcs. Perhaps the most common are momentum based rules which attempt to identify trends in market price movements. Once these trends are identified traders may take positions to benefit from further price movements in the predicted direction. The economic evidence supporting the effectiveness of technical rules is mixed, for instance Marshall et al. (2006) find that candle stick strategies do not outperform the Dow Jones whilst Allen and Karjalainen (1999) are unable to find technical rules able to make excess returns on the S&P500 index. In contrast Neely and Weller (2013) find that technical rules may give positive returns in FX markets and that rules which do this may be found computationally (Neely et al., 1997). Brock et al. (1992) test two key

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momentum based technical trading strategies finding that they make positive returns on the Dow Jones. Taylor (2014), however, finds that these positive returns may be restricted to certain historical periods. Despite the mixed evidence, these rules are employed by significant numbers of traders within financial markets, particularly at high frequencies. For instance Allen and Taylor (1990) and Taylor and Allen (1992) find that 90% of traders used technical analysis and that this was particularly common at short horizons.

Recent empirical work has suggested that technical trading profits are moving from longer time periods to intra-day or possibly even shorter timescales (Schulmeister, 2009). This has coincided with a marked increase in the speed of trading. Prior to the late 1980s the majority of equity trade was conducted through market makers who set a bid price and offer price against which individuals could transact. With the rise of electronic market places this began to change. Computer technology meant that the order book could be maintained and trades matched electronically. Importantly this information could be fed to traders continuously. At the same time changes in regulation meant that individual traders could supply liquidity and compete with market makers. These shifts in market architecture have led to the rise of day trading and more recently algorithmic trading.[1] A key strategy for both of these groups of traders is to attempt to make profits by predicting and riding short term trends in the market. Brogaard et al. (2014) notes that these traders are able to predict prices changes several seconds in advance.

Despite the rise in high frequency trading and the shortening of timescales over which technical traders may make profits there is little work considering the effect of technical traders in a micro-structure context. Closest to the work presented in this paper is that of Chiarella and Iori (2002) and Chiarella et al. (2009) who examine the role of chartists and fundamentalists in order book markets. Possibly the greatest challenge in these studies comes from the specification of trader's order submission strategies. Even without the necessity of analytical tractability, finding optimal or even reasonable behaviors is difficult. As a result the information sets or strategies are often radically simplified or the order submission rules chosen based on rules of thumb. Here we employ a numerical technique that allows us to identify optimal strategies in a more general setting for traders who value assets using technical rules. This numerical approach was originally employed by Goettler et al. (2005) in their extension of the analytical model of Parlour (1998) to include a realistic micro-structure. This change, however, made the model analytically intractable, necessitating a numerical approach in order to identify a Markov perfect equilibrium and to analyze the behavior of the market. The requirements for this are very strict, in particular, in order that all payoff relevant information was contained in the state it was only possible to model a single type of trader who had a fixed distribution of valuations and could not modify orders after they were submitted. In later work Goettler et al. (2009) furthered this analysis for the case of asymmetric information with the possibility of traders canceling and resubmitting orders over time. Bernales (2014) used the same technique to look at the effect of trading speed on the profitability of high frequency traders and market quality. As a result of these changes traders types were not identical and the models no longer met the Markov perfect equilibrium requirement – the recent history of order submissions contained information not present in the order book. It was not possible to include this information in the state and still have a model which could feasibly be analyzed numerically. As a result whilst the converged state was not strictly a Markov perfect equilibrium, the result of the optimization was instead a stable set of strategies which were optimal given the available information.[2]

In this paper we build on the approach above to model the interaction of technical and informed traders in a dynamic order book based financial market. We focus on technical traders who use momentum based rules. This category of rules are widely used in real markets and have, in some circumstances, been shown to be profitable. By using the numerical approach of Pakes and McGuire (2001) and Goettler et al. (2009) we are able to derive optimal strategies such that conditional on the state of the market both groups of traders submit and modify their orders in such a way as to which maximize their expected payoff. Analysis of this model shows that traders using technical information make greater profits than those who do not. These profits are increasing as trader's information about the fundamental value becomes less precise. The presence of technical traders has an ambiguous effect on the market quality. The spread decreases but at the same time the number of orders in the book falls. The effective spread for informed traders increases indicating higher transaction costs. Price efficiency increases – the market price tracks the fundamental more accurately and volatility goes down. Analysis of the strategies of technical traders shows that they predominantly act as liquidity suppliers – using limit order more frequently, and market orders less frequently, than informed traders with the same valuations when technical traders are not present. These results contrast with the findings of Hendershott et al. (2011) high frequency traders, many of whom use momentum based strategies, increase liquidity within markets. Whilst technical traders within our model do supply liquidity their overall effect is ambiguous.

We find that the presence of technical traders results in the structure of the order flow better matching certain empirical observations. This suggests that these traders are vital in accurately capturing the behavior of markets at a micro-structure level. If technical traders do not have access to up-to-date fundamental information their profits are less than informed speculators who make money from their mispricings. Whilst technical information may be beneficial to the traders using it and the market as a whole it is not sufficient to protect these traders from exploitation by better informed individuals at short time intervals.

The paper proceeds as follows. Section 2 sets out the details of our model whilst Section 3 first describes aggregate market dynamics under the converged strategies before analyzing the trading behaviors. Section 4 concludes.

2. Model

We consider a continuous time model of the trade of a single financial asset through an order book based market. The order book is defined as a discrete set of prices $\Pi = \{p^i\}_{i=-\infty}^{\infty}$ where the distance between adjacent prices is constant and is referred to as the tick size δ_P. At each price there is a queue of unfilled orders, l_t^i. These orders are sorted by submission time from earliest to latest. We adopt the convention that positive values in l_t^i refer to buy orders and negative values to sell orders. Together these define the order book $L = \{l_t^i\}_{i=-\infty}^{\infty}$. The best bid is then given as

[1] As of 2010 approximately 70% of American and 30–40% of European equity volume was conducted by these firms (Haldane, 2010).

[2] There are, additionally several papers which consider boundedly rational traders within these markets. For instance Ladley and Schenk-Hoppé (2009) use a model with zero intelligence traders to show that statistical features of order flow are in many cases a result of market micro-structure and not necessarily strategic behavior. Pellizzari (2011) uses an evolutionary approach to find optimal linear trading strategies for continuous double auctions. Lensberg et al. (2012) evolve ecology's of portfolio management and order submission strategies using genetic programming in order to quantify the effects of short selling bans and transaction taxes in order book markets.