Journal of Economic Dynamics & Control 90 (2018) 408–433

Contents lists available at ScienceDirect

Journal of Economic Dynamics & Control

journal homepage: www.elsevier.com/locate/jedc

Market-making strategy with asymmetric information and regime-switching

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ARTICLE INFO

Article history:
Received 13 June 2017
Revised 1 April 2018
Accepted 7 April 2018
Available online 13 April 2018

Keywords:
Triggering events
Asymmetric information
Regime shifts
Optimal market-marking strategies
Information delay

ABSTRACT

An event-triggered regime-switching jump-diffusion model is introduced with a view to incorporating the impact of asymmetric information on optimal trading decisions. The modeling structure is novel in the sense that it can disentangle the optimizing behavior of different types of traders, namely uninformed, partially informed and informed traders. Instead of establishing equilibrium results, all of the three types of traders are supposed to be price takers and determine their optimal trading strategies based on an "exogenously" given mid-price process. It is shown that traders, who have an access to more information about potential market turmoils, such as triggering events, are more aggressive on trading profits which are reflected in higher required liquidity premiums. The informed traders are more cautious in inventory controls through lowering their trading positions prior to the triggering events. With potential regime shifts, the feature of "information delay" about market efficiency is captured by allowing that the security market has a response time for a market shock. It is also shown that traders, who are informed about the information delay, not only gain a higher return, but also a higher level of standard deviation than traders who do not have the information.

1. Introduction

Market makers play a crucial role in securities markets where they are responsible for providing liquidity to market participants by quoting prices to buy and sell the assets being traded. The first issue faced by a market maker when providing liquidity is that by accepting one side of a trade, the market maker will hold an asset for an uncertain period of time, i.e., the time it takes for another person to come to the market with a matching demand for liquidity. During that time, the market maker is exposed to the risk that the price moves against him. Another issue faced by a market maker is informational

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https://doi.org/10.1016/j.jedc.2018.04.003
0165-1889/

differences. Many trades originate not because someone needs cash and sells an asset, or has extra cash and wants to invest, but because one party has better information about what the price is going to do than what is reflected in current prices. In this paper, we study the optimal submission strategies of bid and ask orders in the presence of asymmetric information.

The history of information-based models may be traced back to Bagehot (1971), where the bid-ask spread was explained by the differential information of informed and uninformed traders. Copeland and Galai (1983) proposed a single-period information-based model for optimal pricing of market makers in the presence of informed and uninformed traders. Two approaches were adopted in Copeland and Galai (1983) to determine the bid and ask prices. The first approach was based on the maximization of an expected profit of a risk-neutral dealer while the second approach was based on considering bid and ask prices as call and put options. The single-period information-based model in Copeland and Galai (1983) cannot reveal information signals induced by trades of informed traders to uninformed traders, which partly stimulates the development of dynamic information-based models by Glosten and Milgrom (1985) and Easley and O'Hara (1987). In Glosten and Milgrom (1985), traders are supposed to be risk-neutral and inventory risk does not play a role. In both models by Glosten and Milgrom (1985) and Easley and O'Hara (1987), the impacts of uninformed traders' and market makers' learning from trading signals of informed traders on bid and ask prices are incorporated. A more recent paper by Chiarella et al. (2015) introduced a genetic algorithm learning approach to investigate the impacts of the learning of market information by uninformed and informed traders on a limit order market with a view to establishing an unified modeling framework for both the agent-based models and market microstructure.

Dynamic information-based models offer richer economic insights from their single-period counterparts. In particular, as discussed above, dynamic information-based models may provide important economic insights into understanding how learning of uninformed participants from trading signals of informed participants may determine optimal pricing and trading strategies. Other important economic insights from dynamic models may perhaps be that they incorporate the impacts of the price dynamics of the underlying asset and that they capture how the information flows over time can affect optimal trading and pricing strategies. There could be different ways to specify the structure of information flows and the price dynamics of the underlying asset which may give rise to different economic insights and interpretations. In this paper, different from the way the structure of information flows is specified in some classic dynamic information-based models, we start with "passive" market makers, who are price takers and profit from making the spreads, and must be prompt to adapt to the changing market conditions. We address the asymmetric information problem in optimal market making with a novel approach. It is based on an event-triggered regime-switching model that is one of the major classes of econometric models and provides a natural way to describe how economic regimes affect economic or financial dynamics such as price dynamics. See, for example, Hamilton (1989, 1990), for uses of regime switching models in econometrics and economics. Also see, for example, Costabile et al. (2014), Elliott et al. (2007), Elliott et al. (2011), Florescu et al. (2012), Liew and Siu (2010), Sakamoto (2014) and Zeeuw and Zemel (2012), Guo et al. (2004) and Driffill and Sola (2000), for some uses of regime switching models in mathematical finance and economics. Because we are focusing on "passive" traders' submission strategies, it is natural to assume that their trading do not affect the price process. In other words, instead of deriving any economic equilibrium results, all traders, no matter what information they have acquired, are supposed to be price takers and determine their optimal trading strategies based on their acquired information about market regimes and an "exogenously" given mid-price process of the underlying stock, which is supposed to be governed by a regime-switching jump-diffusion model.

Unlike some classic dynamic information-based models such as the model in Glosten and Milgrom (1985), the main difference of market participants in our model lies in their asymmetric information about the triggering events. In the current modeling framework, a regime switch is supposed to be triggered by a certain "scheduled" economic event. Informed traders are well-informed of the timing and influence while uninformed traders are not. In addition to the informed and uninformed traders, we also consider the partially informed traders. Examples of this kind of traders include financial analysts, speculators and investment professionals. They do not have complete information about the triggering event. They infer and act based on the best available information before the event occurs. An optimal submission strategy of bid and ask orders is derived under *mean–variance* preferences. This differs from some classical information-based models which suppose that a trader is risk-neutral and inventory costs do not play any role. We show that prior to the "scheduled" event, traders who have received this information, whether perfect or not, would adjust their quoting strategies to hedge their exposure to the potential market turbulence. Specifically, it is shown that informed traders require higher liquidity premiums to compensate for the risk they are undertaking. Furthermore, it is also shown that informed traders tend to reduce the risk from their trading positions through lowering the trading positions prior to market triggering events. Consequently, their optimal trading positions give rise to higher returns and lower inventory risks. With potential regime shifts, the effect of "information delay" on market efficiency is incorporated by allowing the security market a response time to a market shock. It is shown that, traders who are informed about information delay, not only gain a higher return, but also achieve a higher level of standard deviation than traders who do not have the information. This seems to make economic sense since traders who are aware of the information delay do not know exactly the delay time. They infer and act according to the best available information. Due to the uncertainty about the delay time, they bear relatively higher risks. In the "mainstream" literature of market microstructure, it seems that the inventory models and information-based models are two distinct approaches, where the impacts of information asymmetry of the traders on their trading behavior are often investigated in the information-based models, see, for example, O'Hara (1989). The proposed model here may integrate the impacts of both information asymmetry of the traders and the inventory risks. In particular, it provides implications of information asymmetry