Quantitative Finance > Trading and Market Microstructure

Optimal High Frequency Trading in a Pro-Rata Microstructure with Predictive Information

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We propose a framework to study optimal trading policies in a one-tick pro-rata limit order book, as typically arises in short-term interest rate futures contracts. The high-frequency trader has the choice to trade via market orders or limit orders, which are represented respectively by impulse controls and regular controls. We model and discuss the consequences of the two main features of this particular microstructure: first, the limit orders sent by the high frequency trader are only partially executed, and therefore she has no control on the executed quantity. For this purpose, cumulative executed volumes are modelled by compound Poisson processes. Second, the high frequency trader faces the overtrading risk, which is the risk of brutal variations in her inventory. The consequences of this risk are investigated in the context of optimal liquidation. The optimal trading problem is studied by stochastic control and dynamic programming methods, which lead to a characterization of the value function in terms of an integro quasi-variational inequality. We then provide the associated numerical resolution procedure, and convergence of this computational scheme is proved. Next, we examine several situations where we can on one hand simplify the numerical procedure by reducing the number of state variables, and on the other hand focus on specific cases of practical interest. We examine both a market making problem and a best execution problem in the case where the mid-price process is a martingale. We also detail a high frequency trading strategy in the case where a (predictive) directional information on the mid-price is available. Each of the resulting strategies are illustrated by numerical tests.

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