Order book model with feedback effects

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Abstract

We constructed the new order book model based on the Maslov model. We developed the model by adding feedback effects which are caused by dealers' observation of trends and volatility. Our modified model reasonably reproduced all major statistical properties such as a power law distribution of price changes and properties of transaction intervals.

Keyword: Econophysics, Order book, Stochastic process

We introduce a new order book model which reproduces all major stylized facts such as a power law distribution of price changes, abnormal diffusions and distribution of transaction intervals.

Maslov introduced a basic order book model[1] which describes the dynamics of an order book as a stochastic process. Namely in this model we give the dynamics of limit orders and market orders stochastically. The Maslov model reconstructs a power law distribution of price changes, however the market price produced by the Maslov model shows much greater oscillation than the real data and the diffusion properties of price are also different from the real data.

In order to construct a more realistic model, we analyze the order book data of financial markets and give the base model the characteristics observed from the data. We find an important rule for the position where a new limit order is placed, that is the place of a new limit order depends on the volatility. When the market is volatile, limit orders tend to be placed in a deep position where the distance is away from the best price, while on the other hand when the market is stable limit orders tend to be placed in shallow positions. We also find the normalized distance by volatility follows the unique exponential distribution except for the special day such as government intervention. This feedback of volatility implies that dealers observe the volatility and they tend to extend their spread between bid(buying) and ask(selling) price when the market is volatile.

The revised model, which contains the properties of a new limit order position, reproduces the power law distribution of price changes. We can also find volatility clustering and temporal non-uniformity of dispersion in time series of price changes as seen in the real data.

We also give two more effects to the revised model in order to reproduce abnormal diffusion of the market price, potential properties[2] observed from the market price and the statistical properties of transaction intervals: first is the trend follow effect, i.e. feedback effect of price changes, and second is the expansion and contraction effect of phycological time, i.e. feedback effect of transaction intervals. These effects are discussed in the dealer model[3].

From our analysis, these three feedback effects are very important to describe real market fluctuations in the market prices and transaction intervals, and these endogenous feedback effects are caused by dealers' observation of trends and volatility in the market price and market activities. We can simulate various situations such as a government intervention in our new model by adding special properties which are observed in the government intervention from the data.

References

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