

A Tutorial on Stock Trading Via Control-Theoretic Methods with Suggestions for Research and Applications

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Abstract

This two-part tutorial covers an ongoing line of research involving the use of control-theoretic methods in stock trading. No significant knowledge of stock trading will be assumed. In addition, the selection of topics to be covered is strongly biased by the speaker's transformation from theoretician to practitioner over the last decade. To elaborate on this point, the speaker, having participated heavily in markets, both personally and through his LLC over the last twenty-five years, will begin the tutorial by describing, both mathematically and anecdotally, his evolution to the following point of view: Stock trading algorithms which rely significantly on price modelling and prediction—especially those based on the abstract tools of financial mathematics such as stochastic differential equations—can be highly unreliable and of questionable worth. Suffice it to say, given the highly nonstationary nature of the market dynamics, control scientists seeking to get involved in stock trading research would be well served by concentrating their efforts on the development of so-called model-free algorithms and associated backtesting—applying the algorithm to selectively chosen past market data to determine what performance would have occurred historically. Given that the speaker's main objective is to motivate control community members to get involved in stock trading research, we consider a selected subset of topics in the literature which can be easily understood and for which it is possible to quickly get up to speed. Accordingly, mathematical details will be intentionally deemphasized in favor of big-picture ideas.

With the above considerations in mind, Part 1 of the tutorial will cover a number of the “nuts and bolts” and “rules of the road” for stock trading. This includes the most common types of buy and sell orders such as market, limit and stop, an introduction to short selling and a description of what happens to orders once they arrive at the exchange. This involves operation of the so-called “Limit Order Book” which matches up buyers and sellers using data time stamps at the nanosecond level. Finally, this first part of the tutorial will include methods for reformulation of a trading scheme in terms of modern control theory and writing simple Matlab simulation codes which are suitable for backtesting. In this setting, the emphasis will be on data-driven control using a so-called “recipe” to drive the controller which does not include a price model. Part 2 of this tutorial will cover some classes of trading strategies which, in the opinion of the speaker, are promising for research via control-theoretic methods. This includes trend-following algorithms, methods which are called “model-free” such as Simultaneous Long-Short and trading algorithms based on the theory of Kelly Betting which originated in the world of gambling. This part of the tutorial will also include a brief introduction to the use of options without reliance on mathematical preliminaries such as the Black-Scholes theory. Instead, the argument in favor of using options will be made using good old-fashioned “common sense” and the so-called profit-loss diagram.