

ON STOCK MARKET TRADING AND PORTFOLIO OPTIMIZATION: A CONTROL SYSTEMS PERSPECTIVE

A Proposal for a Pre-Conference One Day Workshop
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ORGANIZERS

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On Trading Via Fundamental Analysis

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A Quantitative Approach to Pairs Trading

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1. Workshop Overview

The purpose of this one-day workshop is to explain how control theoretic tools and associated mathematical concepts can be used in stock and option trading. While introducing the requisite mathematical tools, the speakers will also provide a number of case studies to demonstrate application of various trading algorithms, portfolio balancing techniques and the use of both technical and fundamental analysis. The topic of back-testing of candidate trading strategies will also be discussed and we will describe and demonstrate various simulation codes. Finally, the workshop will include formulation of a number of new and exciting research problems for the control field. A number of trading concepts will be explained in the context of a basic feedback loop with the control corresponding to modulation of the amount invested as a function of time. A state space setting will be used and both stochastic and deterministic models will be considered. We will pose new research problems which are aimed at both certification of robust performance and portfolio optimization.

2. Intended Audience

This workshop will target members of the control community that are seeking an easy-to-digest introduction to trading from a systems theoretic point of view. In this context, our goal is to bring the attendee “up to speed” and then go on to describe new classes of research problems having both theoretical and applied components. Modelling of markets will be described under the assumption that the audience is only minimally familiar with trading mechanics. Accordingly, considerable time will be dedicated to tutorial material and existing literature in the financial journals. This tutorial material will include a review of basic terminology such as margin, short selling, bid-ask spreads, liquidity, put and call options, volatility and various technical indicators. Finally, to provide a balanced perspective to the technical analysis methods which we describe, the workshop will also include a lecture on stock trading based on fundamental analysis. This suggests a number of new lines of research on trading which are based on combining both fundamental and technical indicators.

3. Workshop Outline

The workshop will consist of seven sessions whose approximate durations are indicated below. In addition, adequate breaks for coffee and lunch will be provided.

Stock Market Basics (1 hour): Long positions, short positions, brokerage costs, bid-ask spreads, market orders, limit orders, stop orders and variants thereof, margin, performance metrics, benchmarks, quality of execution, capital preservation and draw-down, psychological factors, option basics. (Barmish)

Useful Mathematical Tools for Stock Market Research (1 hour): Basic stochastic processes, Brownian motion and geometric Brownian motion, stochastic differential equations, Ito’s lemma, modelling of stock prices, wealth dynamics, utility functions, portfolio optimization problems. (Primbs)

Optimal Trading with Connections to Control (1 hour): Stochastic dynamic programming, growth optimal portfolios, log-optimality, Merton’s model, factor models for returns, advanced portfolio optimization models, technical trading strategies. (Primbs)

A Quantitative Approach to Pairs Trading (1 hour): In this guest lecture, Professor Yamada explains a quantitative approach to the optimal trading of pairs. The pairs trading strategy involves finding a pair of stocks that trades in a predictable relationship to each other. When this relationship is violated, one trades by assuming a return to the standard relationship. This lecture will use case studies involving pairs (such as Walmart and Target) to show how one quantitatively models and then optimally executes a pairs strategy based on a control theory paradigm.

New Research Directions for Control Scientists (1.5 hours): Model development and trading using output feedback, idealizing assumptions and liquidity, integration of financial concepts with control concepts, saturation issues, performance metrics, new research

problems, market simulation, back-testing, simulation of trading algorithms. (Barmish)

On Trading Via Fundamental Analysis (1 hour): In this guest lecture, Professor Miller describes an approach to trading based on fundamental analysis. In contrast to the other workshop sessions which heavily rely on technical indicators such as price and volume, fundamental analysis involves the use of detailed information about the specific company being traded and the market sector in which it performs. To provide focus, this lecture will concentrate on a number of case studies involving the trading of commodities such as gold, oil, silver and wood. Professor Miller will also describe an approach to enhancement of trading results via reliance on the opinions of experts within the sector of interest.

Options and Advanced Trading Techniques (1.5 hours): An introduction to options, mechanics of puts and calls, time value, intrinsic value, profit-loss diagrams, classical trades such as spreads, collars and butterflies, Black-Scholes formula, dynamic hedging, trading volatility, combining stocks with options. (Primbs and Barmish)

4. Workshop Organizers

James A. Primbs is an assistant professor in the Management Science and Engineering department at Stanford University. He holds undergraduate degrees in Mathematics and Electrical Engineering from UC Davis, a Masters degree in Electrical Engineering from Stanford, and a PhD in Control and Dynamical System from Caltech. At Stanford, he is an award winning teacher of courses such as Investment Science and Financial Engineering. His research crosses the boundary between control theory and financial engineering. In control theory, he has made contributions in receding horizon control (model predictive control) for linear, nonlinear, and stochastic systems. His research in financial engineering uses a control, optimization, and systems perspective to address problems of portfolio optimization, dynamic hedging, market modeling, and option pricing.

B. Ross Barmish received the Bachelor's degree in Electrical Engineering from McGill University in 1971. In 1972 and 1975 respectively, he received the M.S. and Ph.D. degrees, both in Electrical Engineering, from Cornell University. From 1975 to 1978 he served as Assistant Professor of Engineering and Applied Science at Yale University, and from 1978 to 1984, he was as an Associate Professor of Electrical Engineering at the University of Rochester. In August 1984, he joined the University of Wisconsin, Madison, where he is currently Professor of Electrical and Computer Engineering. From January 2001-December 2003, he was with the Department of Electrical Engineering and Computer Science at Case Western Reserve University where he served as Department Chair and held the Eric Nord Endowed Chair.

Professor Barmish is a Fellow and has received the the Best Paper Award for Journal Publication from IFAC on two consecutive occasions (1987-1989 and 1990-1992). Other highlights of his career include a number of plenary lectures, the 1994 publication of his textbook, *New Tools for Robustness of Linear Systems* and service to IEEE Control Systems Society in many capacities. This includes associate editorships, chairing of prize

paper committees, chairing of the ACC Program committee and service on the Board of Governors. Over the last two decades, Professor Barmish has also served as a consultant on a number of industrial projects including an extensive period collaborating with Centro Ricerche Fiat in the early nineties.