

## ON THE BASICS OF STOCK OPTIONS: CONTROL PARADIGMS, RESEARCH DIRECTIONS AND RETIREMENT STRATEGIES

A Proposal for a Pre-Conference One Day Tutorial Workshop  
2010 American Control Conference  
Baltimore, MD

### ORGANIZERS

**James A. Primbs and B. Ross Barmish**

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**1. Workshop Overview:** The main goal of this workshop is to teach the attendees the basics of option trading from a control theoretic point of view. In addition to coverage of the basics, some new research directions will be described and strategic use of options in a retirement context will be highlighted as an application. The tutorial workshop will include a review of the relevant part of the literature which will be helpful to those with little or no familiarity with this area. By the end of the workshop, participants should be able to price options via classical theory, understand the control perspective on options, use options for hedging in their own portfolios and be aware of possible research opportunities for the Control Community.

*A Myth About Options:* Contrary to popular belief, it is untrue that most option traders are inclined to take higher risks than their stock trading counterparts. The truth of the matter is that many professional traders use options as a vehicle for reduction of risk. For example, holding stock in combination with “put options” can provide the bullish trader insurance against losses. Similarly, the bearish trader can take out insurance on short selling via the purchase of “call options.” The workshop will go into detail on a number of ways that options can be used in a hedging context.

*Options for Strategic Retirement:* When we highlight “strategic retirement” as an application, it will be shown how options can be used in a capital preservation context. In fact, a retiree who is knowledgeable in option trading can play highly volatile stocks with controllable downside and unlimited upside.

*Educational Emphasis:* While a number of fruitful lines of research will be described, applications and educational aspects will be given highest priority. A background in economics will not be assumed. One of the main points of the workshop will be the following: In the world of trading, “arbitrageurial thinking” is far more important than formal economic theory. In fact, in this context, the instructors will argue that understanding options from a control theoretic point of view makes it possible to both conduct research and manage one’s investments.

*Interactive Sessions and Studies on Retirement Investing:* The workshop will include case studies and hands-on problem solving sessions, as well as a unique project session where attendees will use what they have learned to design and test retirement investment strategies using real stock and option data. The examples and hands-on sessions will also serve to expose interesting research directions and address gaps between theory and practice.

**2. Intended Audience:** We envision two groups of attendees. The first group, perhaps motivated by the market crash over the last two years, no longer wants to blindly trust an “advisor” to make financial decisions. This attendee, being a member of the control community, has a degree of technical expertise, and can easily master the concepts underlying option trading. Some of these attendees may want to master the workshop material so that they can reduce volatility of their personal investments in these turbulent financial times. In this regard, wanting to do research in this area is *not* a prerequisite for attendance at the workshop.

The second group of attendees, while certainly not disjoint from the first, is the control researcher who is looking for new and exciting problems to solve. Since our main goal is to get the control community “up to speed” on option trading, new research problems, while certainly discussed, will receive somewhat lower priority than educational aspects. However, our point of view is that once the “rules of the road” are well understood, the science-minded members of the field are intelligent enough to formulate and solve many important new research problems. In fact, as evidenced by the instructors’ activities and publications, this area is ripe for control theory research.

### 3. Outline of Workshop

1. *Discounted Cash Flows, Stocks and Bonds* (1.00 hours): The time value of money, present and future value, internal rate of return. Bond and stock basics.
2. *Option Basics* (1.25 hours): Mechanics of puts and calls, time value, intrinsic value, profit-loss diagrams, classical trades such as spreads, collars and butterflies and an introduction to arbitrage, properties of options. *Exercises:* Using options and stocks to shape payoffs.
3. *Classical Option Pricing Theory* (1.25 hours): Classical theoretical results on option pricing such as Ito and binomial process models, the Black-Scholes pricing formula, Delta hedging and a number of results addressing the importance of volatility. *Exercises:* Pricing American options via the binomial lattice.
4. *Control Systems Approach to Options* (1.25 hours): Control systems based approach to option pricing and hedging. The dynamic hedging problem for an option as a stochastic control problem. LQ and receding horizon control methodologies and new control oriented research opportunities. Comparison with traditional methods. *Case Study:* Profiting from a dynamic arbitrage opportunity.
5. *Conservative Retirement Strategies* (1.25 hours): Dividend theory, Merton’s pricing model with dividends, low-risk trades with capped downside. Option trade assessment using stock price, time to expiration, volatility and time versus intrinsic value. *Exercises:* Trading high volatility stocks.

6. *Retirement Portfolio Planning with Options* (1.25 hours): Project oriented session with attendees using control and finance principles from the workshop to solve a retirement portfolio problem. Empirical data will be used to model, design and test trading strategies in the context of retirement planning, and results will be compared against actual market performance. This session will give attendees the chance to reduce theory of options to practice via a relevant and realistic example.

**4. Instructors' Perspective:** Integrated into the topics will be the instructors' personal perspectives based on many years of trading. Limitations of stochastic price models will be discussed and it will be shown how options can be used to shape the system performance in many situations. It is important to note that without the use of options, no meaningful "robustness guarantees" can be given; e.g., for the long unmargined trader, the worst-case scenario is a 100% loss. For the case of short-selling, the theoretical worst-case loss is unbounded.

## 5. 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.