Coleman Fung Center Grant Proposal: Does Delta-Hedging Affect Volatility and Prices of Underlying Assets

J. Bradford DeLong, Principal Investigator
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Department of Economics, University of California, Berkeley
February 4, 2011

1. Project Summary

The focus of this research is to model and quantify the effect of delta hedging on the prices and volatility of underlying assets. So far, most of the research claims that option introduction affects both variables. However, the evidence presented is not convincing. These papers ignore the fact that according to the Black-Scholes formula, options are redundant assets and therefore the introduction of options in general, and delta-hedging in particular, should have no effect on the prices and volatility of underlying prices. This paper will contribute to the literature by applying the regression discontinuity analysis to options traded on the CBOE and CME to see whether the introduction of options affects the prices and volatility of underlying prices. Our main hypothesis is that the introduction of options has no effect on the
prices and volatility of underlying assets, and that it is the rise of volatilities across the board that increases the profit potential of option introduction, therefore creating incentives for exchanges to introduce new options.
2. Project Description

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This research is focused on modeling and quantifying the effect of delta hedging on the prices and volatility of underlying assets. So far, most of the research claims that option introduction affects both variables. For example, Conrad (1989) uses an event study methodology for the period 1974-1980 to suggest that it is the introduction and not the announcement of the introduction that causes a permanent price increase and a decline in the volatility of underlying asset. Detemple and Jorion (1990) look at a sample of 300 optioned securities for the period from April 1973 to December 1986. They discover a noticeable increase in the price of the optioned stock around the listing date and a significant decrease in the volatility of the optioned stock.
after the listing date. Sorescu (2002) and Ho and Liu (1997) show that ultimately underlying stock prices decrease after an option is introduced. In addition, Ho and Liu (1997) find that the variance of the return and the systematic risk of the underlying stocks do not seem to be affected by option introduction. On the other hand, Mayhew and Mihov (2004) compare the price changes of optioned stocks from 1980 to 1997 with the price changes of similar stocks (in terms of market capitalization) that are not optioned, and conclude that option introduction has no appreciable effect on underlying stocks. At the same time, Lundstrum and Walker (2006) conclude that the introductions of LEAPS (long-term equity options) are associated with small declines in the prices of underlying stocks. So clearly there is no agreement here.

All these papers ignore the fact that according to the Black-Scholes formula, options are redundant assets and therefore the introduction of options in general, and delta-hedging in particular, should have no effect on prices of underlying prices. Our hypothesis is based on this well-known theorem below.

**THEOREM:** Suppose the No Arbitrage Condition holds. Then markets are complete iff the number of linearly independent securities is equal to the
number of states of nature.

So if we have enough linearly independent tradable assets, then every Arrow-Debreu security can be replicated by the respective portfolios of these tradable assets. Therefore, introducing any redundant asset should have no effect on equilibrium prices of state-contingent claims. As a consequence, given No Arbitrage Condition, equilibrium prices of all tradable assets will be left unchanged. On the other hand, Polemarchakis and Bon-II Ku (1990) showed that when the asset market is incomplete, competitive equilibria may fail to exist and when competitive equilibria fail to exist, the options are not redundant assets. Whether or not markets are complete is debatable. Therefore, we need to test the effect of option introduction empirically. To see whether the introduction of options affects the prices and volatility of underlying assets we will apply the regression discontinuity analysis to options traded on CBOE and CME.

We thus run the regression

\[ Y = a + D \cdot \tau + b \cdot X + \epsilon, \]

where \( Y \) is the price of underlying asset,

\( \tau \) measures the effect of option introduction,

\( \epsilon \) is the error term,
and $D$ is defined as

$$D(X) = \begin{cases} 
1 & \text{for } X \geq c \text{ (The value of } c \text{ to be determined)} \\
0 & \text{for } X < c 
\end{cases}$$

Our main hypothesis is that $\tau = 0$, i.e. that the introduction of options has no effect on the prices of underlying assets and that it is the rise of volatilities across the board that increases the profit potential of option introduction and therefore causes exchanges to introduce new options.

This methodology will be developed collaboratively by J. Bradford DeLong, Professor of Economics (the PI), and Konstantin Magin, Lecturer in Economics and Lecturer in Business at U.C. Berkeley. We anticipate that at least two of the papers to emerge from the project will become single authored publications by Konstantin Magin. The project will run for one calendar year, from the Summer semester of the 2011 through the Fall and Spring semester of the 2011-12 academic year.

**Bibliography**


3. Curricula Vitae

**J. BRADFORD DeLONG**

**A. Education**

Ph. D., Department of Economics, Harvard University, Cambridge, MA (June 1987).

B. A. summa cum laude, Committee on Degrees in Social Studies, Har-
vard University, Cambridge, MA (June 1982).

**B. Positions**

Chair, Political Economy of Industrial Societies Major, University of California at Berkeley, Berkeley, CA (July 2001-present).

Professor, Department of Economics, University of California at Berkeley, Berkeley, CA (July 1997-present).

Associate Professor, Department of Economics, University of California at Berkeley, Berkeley, CA (July 1993-June 1997).

Frederick S. Danziger Associate Professor, Department of Economics, Harvard University, Cambridge, MA (July 1991-June 1993).

Assistant Professor, Department of Economics, Harvard University, Cambridge, MA (July 1988-June 1991).

Assistant Professor, Department of Economics, Boston University, Boston, MA (July 1987-June 1988).


Research Associate, National Bureau of Economic Research, Cambridge, MA (October 1995-present).
C. Principal Academic Research Publications


J. Bradford DeLong (2003), "Bequests: An Historical Perspective," in


J. Bradford DeLong (2000), "Overstrong Against Thyself: War, the State, and Growth in Europe on the Eve of the Industrial Revolution", in Mancur Olson and Satu Kahkohnen, eds., A Not-So-Dismal Science: Development


KONSTANTIN A. MAGIN

Education:


Employment:

2007-present, Lecturer, UC Berkeley

2003-2007, Post-doctoral Fellow, UC Berkeley

Publications:


“The Last Bubble Was Brief, But It Was Still Irrational” with Bradford

**Papers:**


“Finance and the Future of Nanotechnology: Looking Forward by Looking Back”

“Understanding the 1987 Stock Market Crash: An Analysis”
4. Budget

The budget requested is $79,496: $66,440 for salary plus benefits for a 67% appointment of Konstantin Magin as a Research Specialist for the Summer and Fall semesters of 2011 and the Spring semester of 2012 and $13,056 for a one-ninth one-month summer salary for J. Bradford DeLong.