

# Coleman Fung Center Grant Proposal: The Pricing of “Troubled” Assets

J. Bradford DeLong, Principal Investigator

Konstantin Magin, Assistant Researcher

Department of Economics, University of California, Berkeley

April 30, 2009

## 1. Project Summary

The Troubled Assets Relief Program (TARP) authorized and appropriated by Congress in 2008 enables the Secretary of the Treasury to purchase on the government’s behalf so-called “troubled assets” the purchase of which is necessary in order to promote economic stability. Troubled assets include mortgages, pools of mortgages, mortgage-backed securities, and further derivative securities.

The most difficult problem of implementation faced by the TARP is that of the pricing of “troubled” assets. Liquid markets for most of them simply do not exist. It is of vital importance to the government and the country to determine how to establish the appropriate values at which these securities should be purchased.

The main goal of this proposal is to develop a methodology to price “troubled” assets. We are going to start with pricing individual “troubled” mortgages. Then we shall proceed to pricing pools of mortgages. Finally, we should be able to price collateralized debt obligations.

## 2. Project Description

# Coleman Fung Center Grant Proposal: The Pricing of “Troubled” Assets

J. Bradford DeLong, Principal Investigator

Konstantin Magin, Assistant Researcher

Department of Economics, University of California, Berkeley

April 30, 2009

### The Problem

The Troubled Assets Relief Program (TARP) authorized and appropriated by Congress in 2008 enables the Secretary of the Treasury to purchase on the government’s behalf so-called “troubled assets” created on or before March 14, 2008 the purchase of which is necessary in order to promote economic stability. Troubled assets include mortgages, pools of mortgages, mortgage-backed securities, and further derivative securities.

The most difficult problem of implementation faced by the TARP is that of the pricing of “troubled” assets. Liquid markets for most of them simply

do not exist. It is of vital importance to the government and the country to determine how to establish the appropriate values at which these securities should be purchased.

The main goal of this proposal is to develop a methodology to price “troubled” assets. We are going to start with pricing individual “troubled” mortgages. Then we shall proceed to pricing pools of mortgages. Finally, we should be able to price collateralized debt obligations.

Fortunately for this project, new investment vehicles are currently being created. Standard & Poors licensed MacroMarkets to create products based on the Case-Shiller Home Price Indexes. The CSI-based ETF will begin trading on the NYSE Arca this Fall.<sup>1</sup> According to ETF Express, the Case-Shiller Home Price Index is aimed at tracking the price path of single family homes using the repeat sales technique developed by Karl Case and Robert Shiller. The index is weighted in 10 metropolitan areas throughout the U.S. and includes Boston, Chicago, Denver, Las Vegas, Los Angeles, Miami, New

---

<sup>1</sup><http://online.wsj.com/article/SB123897667301591301.html>

York (commuter index), San Diego, San Francisco and Washington, D.C.<sup>2</sup>

In addition, in 2006 the Chicago Mercantile Exchange (CME) launched futures and options written on S&P/Case-Shiller Home Price Index (CSI). The modelling and pricing of these new vehicles was pioneered by Case, Shiller and Weiss (1993), (1998), Shiller and Weiss (1999)<sup>3</sup>

The main goal of this proposal is to develop a methodology to price “troubled” assets. The first step will be to apply the standard Black-Scholes methodology to the problem of valuing “troubled” assets, as outlined in the model section below. What prices for “troubled” assets would be consistent with futures prices for the CSI as traded on markets? Using market prices of futures contracts written on S&P/Case-Shiller Home Price Index traded on

---

<sup>2</sup>[http://www.etfexpress.com/articles/pdf\\_page.jsp?content\\_id=267240](http://www.etfexpress.com/articles/pdf_page.jsp?content_id=267240)

<sup>3</sup>Index-Based Futures and Options Markets in Real Estate. Case,-Karl-E, Jr; Shiller,-Robert-J; Weiss,-Allan-N, Journal-of-Portfolio-Management. Winter 1993; 19(2): 83-92

Home Equity Insurance.Shiller,-Robert-J; Weiss,-Allan-N, Journal of Real Estate Finance and Economics, 19:1, 21-47 (1999)

CME we can obtain the implied market volatility to estimate the variance of this index. Then we are going to use this estimate to calculate the Black-Scholes price of call options written on CSI-based ETF. Then we can design a hedging strategy that replicates mortgages going into default next period. This strategy is going long on this mortgage's collateral (shares of CSI-based ETF) and short on the call option written on CSI-based ETF. So, we obtain prices of mortgages going into default. This, however, can only be a first and preliminary run at the problem. So, we are going to generalize the model. We are going to model the situation, where there is an uncertainty whether or not mortgage is going into default. We shall model the number of mortgages going into default next period as a function of future values of CSI-based ETF and other macroeconomic variables. Constructing this model will help us to capture the very essence of the current mortgage crisis and open the door to pricing pools of mortgages and collateralized debt obligations.

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 2009 through the fall and spring semester of the 2009-10 academic year.

## The Model

*Definition :* We call loan a troubled asset if borrower is not making minimum payment.

The following theorem below proposes hedging strategy to replicate and price troubled asset.

*Theorem :* Suppose investor maximizes

$$U = E \left[ \frac{1}{1-\lambda} C_t^{1-\lambda} + b \frac{1}{1-\lambda} C_{t+1}^{1-\lambda} \right] .$$

Let  $PL_t$  be the price of troubled asset at period  $t$ ,  $p_t$  be the price of the loan's collateral at period  $t$ . Suppose also that  $x = \ln \left( \frac{p_{t+1}}{p_t} \right)$  and  $y = \ln \left( b \left( \frac{c_{t+1}}{c_t} \right)^{-\lambda} \right)$  are bivariate normally distributed with expectations

$$(E[x], E[y]) = (\mu_x, \mu_y)$$

and the variance-covariance matrix

$$V = \begin{pmatrix} \sigma_x & \rho\sigma_x\sigma_y \\ \rho\sigma_x\sigma_y & \sigma_y \end{pmatrix} .$$

Suppose also that  $PR_{t+1}$  is the loans's principal balance left at period  $t+1$ .

Then

$$PL_t = p_t (1 - N(Z + \sigma)) + \frac{PR_{t+1}}{1+r_f} N(Z),$$

where

$$N(z) = \int_{-\infty}^z \frac{1}{\sqrt{2\pi}} e^{-\frac{v^2}{2}} dv$$

and

$$Z = \frac{\ln \frac{p_t}{PR_{t+1}} + \ln R_f}{\sigma} - \frac{1}{2}\sigma.$$

*Proof* : Note first that the lender's period  $t + 1$  pay off on troubled loan originated at period  $t$  is  $\min [PR_{t+1}, p_{t+1}]$ , where  $PR_{t+1}$  is the loans's principal balance left at period  $t + 1$  and  $p_{t+1}$  is the price of the loan's collateral at period  $t + 1$ . We know that the price of this risky bond  $PL_t$  with return  $R = 1 + r = \min [PR_{t+1}, p_{t+1}]$  is given by

$$PL_t = p_t - Call(p_t, PR_{t+1}).$$

We also know that

$$Call(p_t, PR_{t+1}) = p_t N(Z + \sigma) - \frac{PR_{t+1}}{1+r_f} N(Z),$$

where

$$Z = \frac{\ln \frac{p_t}{PR_{t+1}} + \ln R_f}{\sigma} - \frac{1}{2}\sigma.$$

Hence,

$$\begin{aligned} PL_t &= p_t - p_t N(Z + \sigma) + \frac{PR_{t+1}}{1+r_f} N(Z) = \\ &= p_t (1 - N(Z + \sigma)) + \frac{PR_{t+1}}{1+r_f} N(Z) \blacksquare. \end{aligned}$$

### 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 Cal-  
ifornia 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, Cam-  
bridge, MA (July 1988-June 1991).

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

Deputy Assistant Secretary for Economic Policy, United States Department of the Treasury, Washington, DC (April 1993-May 1995).

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

### **C. Principal Academic Research Publications**

J. Bradford DeLong and Konstantin Magin (2009), "The U.S. Equity Return Premium," *Journal of Economic Perspectives* 23:1 (Winter), pp. 193-208.

Marco Becht and J. Bradford DeLong (2006), "Corporate Control in the United States: An Historical Perspective," in Randall Morck, ed., *Historical Patterns of Corporate Control* (Chicago: University of Chicago).

Dean Baker, J. Bradford DeLong, and Paul Krugman (2005), "Asset Returns and Economic Growth," *Brookings Papers on Economic Activity* 2005:1.

J. Bradford DeLong (2004), "India Since Independence: An Analytic Growth Narrative," in Dani Rodrik, ed., *Modern Economic Growth: Analytical Country Studies*.

J. Bradford DeLong (2003), "Productivity Growth in the 2000s," *NBER Macroeconomics Annual* 2003.

Steven Dowrick and J. Bradford DeLong (2003), "Globalisation and Convergence," in Michael Bordo et al., ed., *Globalization in Historical Perspective* (Chicago: University of Chicago Press).

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

Alicia Munnell and Annika Sunden, eds., *Death and Dollars: The Role and Impact of Gifts and Estates* (Washington: Brookings Institution).

J. Bradford DeLong and Barry J. Eichengreen (2002), "Between Melt-down and Moral Hazard: Clinton Administration International Monetary and Financial Policy," in Jeffrey Frankel and Peter Orszag, eds., *American Economic Policy in the 1990s* (Cambridge: MIT Press).

J. Bradford DeLong and Lawrence H. Summers (2002), "The New Economy: Background, Questions, Speculations," in *Economic Policies for the Information Age* (Kansas City: Federal Reserve Bank of Kansas City).

J. Bradford DeLong (2002), "Review of Robert Skidelsky (2000), *John Maynard Keynes, volume 3, Fighting for Britain*," *Journal of Economic Literature*.

J. Bradford DeLong and A. Michael Froomkin (2000), "Speculative Microeconomics for Tomorrow's Economy," in Brian Kahin and Hal Varian, eds., *Internet Publishing and Beyond: The Economics of Digital Information and Intellectual Property* (Cambridge: M.I.T. Press).

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 Kahkonen, eds., *A Not-So-Dismal Science: Development*

and the Political Economy of Institutions (Oxford: Oxford University Press), pp. 138-167.

J. Bradford DeLong (2000), "The Triumph [?] of Monetarism," *Journal of Economic Perspectives* (Winter).

J. Bradford DeLong (1999), "Seeing One's Intellectual Roots: A Review Essay on James Scott's *Seeing Like a State*," *Review of Austrian Economics* 12:2, pp. 257-64.

J. Bradford DeLong (1999), "Why We Should Fear Deflation," *Brookings Papers on Economic Activity* (Spring).

J. Bradford DeLong (1997), "American Fiscal Policy in the Shadow of the Great Depression", in Michael Bordo, Claudia Goldin, and Eugene White, eds., *The Defining Moment: The Great Depression and the American Economy in the Twentieth Century* (Chicago: University of Chicago Press).

J. Bradford DeLong (1997), "America's Peacetime Inflation: The 1970s," in Christina Romer and David Romer. eds., *Reducing Inflation: Motivation and Strategy* (Chicago: University of Chicago Press).

J. Bradford DeLong (1996), "Keynesianism, Pennsylvania-Avenue Style: Some Economic Consequences of the 1946 Employment Act," *Journal of Economic Perspectives* 10:3 (Summer), pp. 41-53.

J. Bradford DeLong, Christopher L. DeLong, and Sherman Robinson (1996), "In Defense of Mexico's Rescue", *Foreign Affairs* 75:3 (May/June), pp. 8-14.

J. Bradford DeLong and Barry Eichengreen (1993), "The Marshall Plan: History's Most Successful Structural Adjustment Programme," in Rüdiger Dornbusch, Wilhelm Nölting, and Richard Layard, eds., *Postwar Economic Reconstruction and Lessons for the East Today* (Cambridge, MA: M.I.T. Press), pp. 189-230.

Robert B. Barsky and J. Bradford DeLong (1993), "Why Does the Stock Market Fluctuate?" *Quarterly Journal of Economics* 108: 2 (May), pp. 291-312.

J. Bradford DeLong and Lawrence H. Summers (1993), "Macroeconomic Policy and Long-Run Growth," *Federal Reserve Bank of Kansas City Quarterly Review*.

J. Bradford DeLong and Kevin Lang (1992), "Are All Economic Hypotheses False?" *Journal of Political Economy* 100:6 (December), pp. 1257-72.

J. Bradford DeLong and Andrei Shleifer (1993), "Princes and Merchants: City Growth Before the Industrial Revolution," *Journal of Law and Economics* 36 (October), pp. 671-702.

J. Bradford DeLong (1992), "Productivity and Machinery Investment: A Long Run Look 1870-1980," *Journal of Economic History* 53: 2 (June), 307-24.

J. Bradford DeLong and Andrei Shleifer (1992), "Closed End Fund Discounts: A Yardstick of Small-Investor Sentiment," *Journal of Portfolio Management* 18:2 (Winter), pp. 46-53.

J. Bradford DeLong (1991), "Did J. P. Morgan's Men Add Value?: An Economist's Perspective on Financial Capitalism," in Peter Temin, ed., *Inside the Business Enterprise: Historical Perspectives on the Use of Information* (Chicago, IL: University of Chicago Press for NBER), pp. 205-36.

J. Bradford DeLong and Andrei Shleifer (1991), "The Stock Market Bubble of 1929: Evidence from Closed-End Funds," *Journal of Economic History* 52: 3 (September), pp. 675-700.

J. Bradford DeLong and Lawrence H. Summers (1991), "Equipment Investment and Economic Growth," *Quarterly Journal of Economics* 106: 2 (May), pp. 445-502.

J. Bradford DeLong, Andrei Shleifer, Lawrence H. Summers, and Robert J. Waldmann (1991), "The Survival of Noise Traders in Financial Markets," *Journal of Business* 64: 1 (January), pp. 1-20.

J. Bradford DeLong, Andrei Shleifer, Lawrence H. Summers, and Robert J. Waldmann (1990), "Noise Trader Risk in Financial Markets," *Journal of Political Economy* 98: 4 (August 1990), pp. 703-738.

J. Bradford DeLong (1990), "'Liquidation' Cycles: Old-Fashioned Real Business Cycle Theory and the Great Depression" (Cambridge, MA: Harvard University Department of Economics).

J. Bradford DeLong, Andrei Shleifer, Lawrence H. Summers, and Robert J. Waldmann (1990), "Positive-Feedback Investment Strategies and Destabilizing Rational Speculation," *Journal of Finance* 45: 2 (June), pp. 374-397.

Robert B. Barsky and J. Bradford DeLong (1990), "Bull and Bear Markets in the Twentieth Century," *Journal of Economic History* 50: 2 (June), pp. 1-17.

J. Bradford DeLong (1990), "In Defense of Henry Simons' Credentials as a Classical Liberal," *Cato Journal* 9: 1 (Winter), pp. 105-122.

J. Bradford DeLong, Andrei Shleifer, Lawrence H. Summers, and Robert J. Waldmann (1989), "The Size and Incidence of Losses from Noise Trading," *Journal of Finance* 44: 3 (July), pp. 681-696.

J. Bradford DeLong (1988), "Productivity Growth, Convergence, and Welfare: Comment," *American Economic Review* 78: 5 (December), pp.

1138-1154.

J. Bradford DeLong and Lawrence H. Summers (1986), "Is Increased Price Flexibility Stabilizing?" *American Economic Review* 76: 5 (December), pp. 1031-1044.

J. Bradford DeLong and Lawrence H. Summers (1986), "The Changing Cyclical Variability of Economic Activity in the United States," in Robert J. Gordon, ed., *The American Business Cycle: Continuity and Change* (Chicago, IL: University of Chicago Press for the National Bureau of Economic Research), pp. 679-719.

## KONSTANTIN A. MAGIN

### **Education:**

Ph.D. 2003, U.C. Berkeley. Dissertation: Corruption in Russia in the 1990s: A ‘Time Bomb’ and a ‘Necessity of Business’

B.A. 1991, Leningrad Institute of Economics and Finance

### **Employment:**

2007-present, Lecturer, UC Berkeley

2003-2007, Post-doctoral Fellow, UC Berkeley

### **Publications:**

“The U.S. Equity Return Premium” with Bradford DeLong, *Journal of Economic Perspectives* 23:1 Winter 2009, pp. 193-208.

“Why Liberals Should Enthusiastically Support Social Security Personal Accounts”, *The Economists’ Voice*, December 2007, Vol. 4 : No. 6, Article 1.

“Contrary to Robert Shiller’s Predictions, Stock Market Investors Made Much Money in the Past Decade: What Does This Tell Us?” with Bradford DeLong, *Economists’ Voice*, July 2006, Vol. 3 : No. 7, Article 2.

“The Last Bubble Was Brief, But It Was Still Irrational” with Bradford  
DeLong, Financial Times, April 19, 2005.

**Papers:**

“Equity Risk Premium and Insecure Property Rights”, The Coleman Fung Risk Management Center Working Paper # 2009-01

”Is The Potential For High Investor Leverage A Threat To Social Security Privatization?”, The Coleman Fung Risk Management Center Working Paper # 2008-02

”The U.S. Equity Return Premium: Past, Present and Future” with Bradford DeLong, The Coleman Fung Risk Management Center Working Paper # 2008-02

“A Short Note on the Size of the Dot-Com Bubble” with Bradford DeLong, NBER Working Paper 12011, February 2006

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

“Understanding the 1987 Stock Market Crash: An Analysis”

#### 4. Progress Report

No research has been funded by the center.

## 5. Budget

The budget requested is \$55,577: \$36,360 for salary for a 75% appointment of Konstantin Magin as an Assistant Researcher and \$6,161 for fringe benefits; and \$13,056 for a one-ninth one-month summer salary for J. Bradford DeLong.