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This Week's Citation Classic®

Black F & Scholes M. The pricing of options and corporate liabilities. *J. Polit. Econ.* 81:637-54, 1973.
[University of Chicago, IL and Massachusetts Institute of Technology, Cambridge, MA]

If options are correctly priced in the market, it should not be possible to make sure profits by creating portfolios of long and short positions in options and their underlying stocks. The paper demonstrates how a theoretical valuation formula for options can be derived using this principle. [The *SSCI*® indicates that this paper has been cited in over 500 publications.]

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My paper with Myron Scholes giving the derivation of our option formula appeared in the spring of 1973. But the work that led to the formula began in the spring of 1969; the background work began in 1965.

Jack Treynor sparked my interest in finance. He was at Arthur D. Little, Inc., when I started work there in 1965. In 1961 he had developed an equilibrium model for the pricing of securities and other assets; this model is now called the "capital asset pricing model." William F. Sharpe,[1] John Lintner,[2] and Jan Mossin[3] developed more or less independent versions of the capital asset pricing model, and their versions began to be published in 1964 and 1965. Treynor's papers were never published.

The notion of equilibrium in the market for risky assets had great beauty for me. It implies that riskier securities must have higher expected returns, or investors will not hold them. I started trying to apply the capital asset pricing model to assets other than common stock. I looked at bonds, cash flows within a company, and even monetary assets.

With this background, I started working on a formula for the value of a warrant. The equation I wrote said simply that the expected return on a warrant should depend on the risk of the warrant in the same way that it does for a common stock. I used the capital asset pricing model to write down how the discount rate for a warrant varies with time and the stock price. This gave me a differential equation for the warrant formula. I spent many days trying to find the solution to that equation. I have an AB in physics, but I didn't recognize the equation as a version of the well-known "heat equation," which has well-known solutions. So I laid the problem aside and worked on other things.

In 1969 Scholes came to MIT. I had earlier set up my own office near Boston, where I did both research and consulting in finance. We started working together on the problem and began to make rapid progress. Rather suddenly, the solution came to us. Case M. Sprenkle[4] had found a warrant formula using assumptions related to ours. By making some substitutions in his formula, we obtained the solution to our equation.

As we worked on the paper, we had long discussions with Robert C. Merton, who was also working on the valuation of options.[5] He suggested a method for deriving the formula that became the principal derivation in the paper.

We sent the first draft of our paper to the *Journal of Political Economy* and promptly got back a rejection letter. We then sent it to the *Review of Economics and Statistics* where it was also rejected.

Merton Miller and Eugene Fama at the University of Chicago then took an interest in the paper and gave us extensive comments on it. They suggested to the *Journal of Political Economy* that perhaps the paper was worth more serious consideration. The *Journal* then accepted the paper, conditional on further revisions suggested by the referees. Meanwhile, we had written an article on the results of some empirical tests of the formula that appeared in May 1972 in the *Journal of Finance*.[6] The *Classic* paper was finally published by the *Journal of Political Economy* in May of 1973.

The paper is cited frequently because options appear so often in problems in finance and because the methods we used have been used to value many other derivative securities.

1. **Sharpe W F.** Capital asset prices: a theory of market equilibrium under conditions of risk. *J. Finance* 19:425-42, 1964. (Cited 1,035 times since 1966.) [See also: **Sharpe W F.** Citation Classic. *Contemporary classics in the social and behavioral sciences*. Philadelphia: ISI Press, 1987. p. 320.]
2. **Lintner J.** The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Rev. Econ. Statist.* 47:768-83, 1965. (Cited 715 times since 1966.)
3. **Mossin J.** Equilibrium in a capital asset market. *Econometrica* 34:768-83, 1966. (Cited 410 times.)
4. **Sprenkle C M.** Warrant prices as indicators of expectations and preferences. *Yale Econ. Essays* 1:178-231, 1961.
5. **Merton R C.** Theory of rational option pricing. *Bell J. Econ. Manage. Sci.* 4:141-83, 1973. (Cited 290 times.)
6. **Black F & Scholes M.** The valuation of option contracts and a test of market efficiency. *J. Finance* 27:399-417, 1972. (Cited 95 times.)

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