Review of Key Risk and Uncertainty Theories Influencing Contemporary Financial Economics

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ABSTRACT

Ironically, the 2008 credit crisis and the subsequent global financial meltdown were brought about by efforts of those whose stated purpose was to manage risk. Somehow, the efforts of financial regulators to manage and contain uncertainty created the greatest downside risk experienced since the Great Depression. At this juncture in financial history, it is purposeful to examine the meaning of risk and uncertainty, how it is priced, the assumptions one makes when one uses market-priced risk hedges, and the degree to which the modern science of financial risk management informs or obfuscates the very nature of risk. This paper performs such a retrospective analysis of key risk theories and how they impact financial markets, through the developments of innovators: Daniel Bernoulli, Carl Friedrich Gauss, Louis Bachelier, Jacob Marschak, Harry Markowitz, William Sharpe, Paul Samuelson, Fischer Black, and Myron Scholes. This paper makes an additional contribution to the literature by identifying unresolved issues that require additional research to improve risk management in financial markets. In particular, this paper concludes that while the author have numerous tools to manage risk, they have few tools to manage uncertainty, the latter of which is where future research should be undertaken.

Keywords: Financial Economics, Financial Risk, Risk Management, Risk Theory, Uncertainty Theory

INTRODUCTION

Risk is everywhere. Nature is riddled with uncertainty, and almost every human decision creates an outcome that cannot be predicted with complete certainty. The disciplines of finance and economics are built upon the notion that every decision has a cost, and not all costs can be known in advance, even if their probabilities may. But while human decision-making and finances are riddled with uncertainties, our understanding of risk is relatively new and remains incomplete.

The purpose of this paper is to describe the roots underpinning the study of risk in decision making, and its evolution and refinement with improvements in economic theory and applied mathematical techniques. In particular, the
objective is to explain how the risk measures are incorporated into the sophisticated models of the financial economics discipline.

**LITERATURE REVIEW**

I begin by describing the first analytic model of risk, from the work of two Bernoulli cousins and their attempts to understand games of chance. First, I describe how the applied mathematicians of the nineteenth century began to measure and incorporate uncertainty into mathematics, and how a mathematician named Louis Bachelier used these measures to price risk. I then turn to the originator of the modern definition of risk, and father of the Chicago School, Frank Hyneman Knight. Afterwards, I treat the economics pioneer Jacob Marschak. Followed by a description of how his description of the risk-return tradeoff inspired his graduate student, Harry Markowitz, to expand Marschak’s definition of the risk-return tradeoff into Modern Portfolio Theory. Next, I show how William Sharpe and his contemporaries evolved Markowitz’ Modern Portfolio Theory into a technique to ‘price’ individual securities of uncertain returns. I then demonstrate how Fischer Black and Myron Scholes reinvented Bachelier’s work in the development of the most common method to price risk and volatility in derivatives markets, through the Black-Scholes options pricing model. I conclude by assessing the current state of our understanding in financial risk management.

**Science of Risk Fundamentals**

For centuries, games of chance had fascinated mathematicians before a chance exchange between two brothers who shared perhaps mathematics’ most famous pedigree revolutionized risk. The Bernoulli family, best known for dozens of innovations in mathematics, but especially for the Bernoulli Effect that keeps airplanes in the air, are descendants of Nicolas Bernoulli (1623-1708), the family patriarch. Nicolas’ grandson, Daniel Bernoulli (1700-1782), received a correspondence from his cousin that posed a simple question, which is now known as the St. Petersburg Paradox. Should one be willing to bet one ducat for a fair coin toss that will yield two ducats if heads, or zero ducats if tails? If so, why would few be willing to instead bet 1,000 ducats for a 50/50 chance of winning two thousand ducats, assuming they could afford it?

This coin flipping gamble was a common game at the time. The mathematics of the problem seemed simple enough. It also afforded the Bernoulli’s an excellent opportunity to better understand uncertainty.

The risk of this problem was one that could be quantified in advance. The uncertainties were of known probabilities, in this case a 50/50 chance a coin would come up heads or tails. Bernoulli recognized that these known probabilities could be used to calculate not only the expected winnings, but also the expected valuation of the wins and losses to the gambler. In his paper, written in Latin in 1738, and hence lost to modern risk managers until the 20th Century translation by Louise Sommer, Bernoulli defined an expected value. These expected values are computed by multiplying each possible gain by the number of ways in which it can occur, and then dividing the sum of these products by the total number of possible cases, each of which has the same probability.

From this insight, Bernoulli put forth the paradox that “if a very poor fellow obtains a lottery ticket that will yield with equal probability either nothing or twenty thousand ducats, will this man evaluate his chance of winning at ten thousand ducats? Would he not be ill advised to sell this lottery ticket for nine thousand ducats? To me it seems that the answer is in the negative. On the other hand I am inclined to believe that a rich man would be ill-advised to refuse to buy the lottery ticket for nine thousand ducats. If I am not wrong then it seems clear that all men cannot use the same rule to evaluate the gamble. The rule established (in the previous quote) must, therefore, be discarded. But anyone who considers the problem with
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