THE CAPITAL ASSET PRICING MODEL IN THE 21ST CENTURY

ANALYTICAL, EMPIRICAL, AND BEHAVIORAL PERSPECTIVES

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The Capital Asset Pricing Model in the 21st Century

Analytical, Empirical, and Behavioral Perspectives

The Capital Asset Pricing Model (CAPM) and the mean-variance (M-V) rule, which are based on classic expected utility theory (EUT), have been heavily criticized theoretically and empirically. The advent of behavioral economics, prospect theory, and other psychology-minded approaches in finance challenges the rational investor model from which CAPM and M-V derive. Haim Levy argues that the tension between the classic financial models and behavioral economics approaches is more apparent than real. This book aims to relax the tension between the two paradigms. Specifically, Professor Levy shows that although behavioral economics contradicts aspects of EUT, CAPM and M-V are intact in both EUT and Cumulative Prospect Theory (CPT) frameworks. There is, furthermore, no evidence to reject CAPM empirically when *ex-ante* parameters are employed. Professionals may thus comfortably teach and use CAPM and behavioral economics or CPT as coexisting paradigms.

Haim Levy is Miles Robinson Professor of Business Administration at the Hebrew University of Jerusalem and Dean of the Academic Center of Law and Business, Israel. He is the author of hundreds of articles in leading academic journals and nineteen books. Based on publications in sixteen core journals in finance, he has obtained the ranking of the most prolific researcher in finance covering the fifty-year period through 2002. A coauthor with Nobel Laureates Harry Markowitz and Paul Samuelson, Professor Levy's major research contributions have been in the field of stochastic dominance in financial economics, which sets forth the criteria for decision making under conditions of uncertainty. He has also developed economic models for risk management. Professor Levy received Hebrew University's Prize for Excellence in Research in 1996 and the EMET Prize in 2006. He has served as economic adviser to the Bank of Israel and has held academic positions at the University of California, Berkeley, and the Wharton School, University of Pennsylvania. He received his Ph.D. from Hebrew University in 1969 and has held a full professorship there since 1976.

Preface

Modern finance is relatively new. Before the breakthrough "Portfolio Selection" article was published by Markowitz in 1952, research in finance was basically nonquantitative and the use of quantitative models in teaching and in research was rare. A glance at finance textbooks that were used in teaching before 1952 and textbooks that are currently used suffices to reveal the revolution induced in the finance profession by the publication of this 1952 Mean-Variance (M-V) article. The next revolutionary papers in portfolio selection and equilibrium pricing were published by Sharpe, Lintner, and Black in 1964, 1965, and 1972, respectively. These three papers use Markowitz's M-V model as a springboard in developing equilibrium prices of risky assets in the capital market and in identifying beta rather than sigma as the risk measure of an individual asset in a portfolio context. The model developed by Sharpe and Lintner, known as the Capital Asset Pricing Model (CAPM), is used in virtually all research studies that deal with risk and return and occupies a substantial portion of textbooks on investments and corporate finance.

The other pillars of modern finance are the papers published by Modigliani and Miller in 1958, which focus on the optimal capital structure, and the two breakthrough papers published by Black and Scholes and by Merton on option pricing in 1973. No wonder Markowitz, Sharpe, Scholes, Merton, Modigliani, and Miller have all been awarded the Nobel Prize in Economics for their revolutionary contributions (the other researchers mentioned were not alive in relevant years when the prizes were awarded). Because this book focuses on portfolio selection and the CAPM, we mainly discuss and analyze

the contributions of Markowitz, Sharpe, Lintner, and Black to the financial literature.

The publication of the Prospect Theory (PT) article by Kahneman and Tversky in 1979, for which Kahneman won the Nobel Prize in Economics in 2002, has shaken the foundations of the Expected Utility Theory (EUT); and, as the M-V framework and the CAPM have been developed within the EUT framework, PT indirectly has also shaken the foundations of these two models.

PT's criticism of EUT is based on experimental findings. Additional criticism of the CAPM is based on empirical findings, showing that beta has very little or even no explanatory power at all. Leading this criticism is the 1992 empirical study of Fama and French, revealing that the coefficient of the CAPM's beta is statistically insignificant; hence, in contradiction to the CAPM, beta does not explain the cross section of stock returns. Therefore, this finding allegedly casts doubt on the validity of beta as a measure of risk.

Thus, we have the M-V and the CAPM, which are widely used in teaching, in research, and by practitioners on the one hand, and PT's experimental findings and empirical studies that criticize these two models on the other hand. Because PT has been known since 1979 and the empirical studies that criticize the M-V and the CAPM models have also been known for decades, one must wonder why academics as well as professional investors keep adhering to the M-V and the CAPM and why virtually all curriculums in finance still heavily rely on these two models. We devote this book to this question. We show that PT and M-V and the CAPM can coexist, even though PT and EUT cannot. We also show that although the CAPM is rejected with *ex-post* parameters, it cannot be rejected with *ex-ante* parameters.

We hope that after reading this book, professors of finance can comfortably teach the M-V and the CAPM, as well as the behavioral PT model, as we show that there is no contradiction between these two frameworks. Also, this book provides a somewhat different interpretation of the CAPM's empirical studies, which, in a nutshell, asserts that the M-V and the CAPM cannot be rejected with the *ex-ante* parameters. Similarly, professional investors and consulting firms can continue relying on the M-V and the CAPM models, although some modifications may be needed.

In this book, we present all the material needed to achieve the integration of the M-V, CAPM, and Cumulative PT (CPT). For example, EUT and stochastic dominance rules are discussed, as we employ both to show that the M-V and the CAPM do not contradict CPT. Of course, we could refer the reader to this material in other books or articles but, to facilitate the reading of this book, we prefer to have all the relevant material contained in one place. The same principle is valid regarding PT and CPT material needed to prove that the behavioral model and the classical portfolio models can coexist. Finally, although we rely on the CPT, which is the modified version of PT, realizing the growing role of behavioral finance in recent years, we also devote a chapter to the original PT.

This book is mainly written for professors of finance and professional investors who use the M-V framework and the CAPM and who are also certainly aware of the criticisms of these two models. We hope that this book will resolve some conflicts and increase their confidence in the employed models. The book can be used in advanced courses in economics and finance and in Ph.D. classes in these two areas.

The book could not achieve its present form and level without the help of many people. I would like to thank Turan Bali, Rob Brown, Harry Markowitz, Richard Roll, William Sharpe, Jim Yoder, and an anonymous reader for their many helpful comments. It is a pleasure for me to thank Moshe (Shiki) Levy and Michal Orkan, who read the whole manuscript and provided me with many detailed comments.

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Introduction

1.1. THE MEAN-VARIANCE RULE AND THE CAPITAL ASSET PRICING MODEL: OVERVIEW

Harry Markowitz and William Sharpe were awarded the Nobel Prize in Economics in 1990 for the development of the Mean-Variance (M-V) framework and the Capital Asset Pricing Model (CAPM), respectively. In 2002, this prize was awarded to Daniel Kahneman for the development of Prospect Theory (PT), which contradicts Expected Utility Theory (EUT), on which the M-V framework and the CAPM are based. Is the Economics Nobel Committee inconsistent?

The PT criticism of EUT, which indirectly also criticizes the M-V model and the CAPM, is just one of the mounting empirical and theoretical criticisms of the M-V framework in general, and, in particular, the CAPM, criticisms that imply that one cannot conduct theoretical research or implement practical investment strategies *with them*. However, the observed extensive academic research and investment strategies, which rely on the M-V and the CAPM, indicate that by the same token, academics and practitioners cannot conduct their research, teaching, and financial analysis and services *without them* either.

Indeed, as we shall see in the forthcoming chapters, the M-V rule and, in particular, the CAPM are heavily criticized both theoretically and empirically. Briefly, the CAPM is empirically rejected because the risk index – beta – does not explain the cross-section variability of returns. In addition, the CAPM is rejected because the hypothesis

of normal distribution of returns – which is an essential component of this model – is empirically rejected.

Regarding the M-V rule, there are three main approaches to justify its use. The first approach, like the CAPM, assumes risk aversion and normal distribution of returns. With this assumption, the M-V rule is optimal and is consistent with expected utility maximization (for the proof of this claim, see Tobin[1] and Hanoch and Levy[2]). By the second approach the normality assumption is relaxed, and one assumes expected utility maximization with quadratic utility function (for this approach, see Tobin[3] and Hanoch and Levy[4]). These two approaches are criticized because the normal distribution is empirically rejected and the quadratic utility function is too specific and, in addition, has several unaccepted characteristics. The third approach to justify the M-V rule is the one suggested by Markowitz[5] in his 1959 book: he shows that one can use the quadratic approximation to expected utility for a wide class of utility functions (see also Levy and Markowitz[6]). Markowitz[7] recently wrote:

> I never – at any time – assumed that return distributions are Gaussian.... Nor did I ever assume that the investor's utility function is quadratic. Rather, I noted that quadratic approximation to traditional utility function is often quite good over a surprisingly large range of returns.

To the best of our knowledge, this approach has not been criticized. However, having an approximation to expected utility rather than a precise expected utility has a vague implication to the validity of the CAPM.

[1] J. Tobin, "Liquidity Preference as Behavior towards Risk," *Review of Economic Studies*, 1958.

[2] G. Hanoch and H. Levy, "The Efficiency Analysis of Choices Involving Risk," *Review of Economic Studies*, 1969.

[3] See Tobin, *op. cit.*

[4] G. Hanoch and H. Levy, "Efficient Portfolio Selection with Quadratic and Cubic Utility," *Journal of Business*, 1970.

[5] H. M. Markowitz, *Portfolio Selection: Efficient Diversification of Investments*, 2nd edition, Cambridge, MA: Basil Blackwell.

[6] H. Levy and H. M. Markowitz, "Approximating Expected Utility by a Function of Mean and Variance," *American Economic Review*, 1979.

[7] H. M. Markowitz, "Portfolio Theory: As I Still See It," *Annual Review of Financial Economics*, 2010.

The M-V and the CAPM are also experimentally rejected, as EUT, on which these models are based, is rejected. Therefore, it is puzzling why the M-V rule and the CAPM are extensively employed by academics as well as professional investors despite all these criticisms.

The M-V rule and the M-V efficiency analysis were published in 1952 by Markowitz,[8] and the CAPM was published by Sharpe[9] and Lintner[10] in 1964 and 1965, respectively. Although the M-V analysis was slightly criticized after its publication in 1952, the CAPM, as an equilibrium model, has been heavily criticized. The first phase of empirical tests of the CAPM revealed mixed results: most studies support the CAPM at least partially because beta and cross-section average returns have been found to be positively correlated, as predicted by the CAPM. However, the model has also been found to be incomplete because some other variables – for example, the individual stock's variance, σ^2, skewness, and β^2 – also substantially explain the cross section of mean returns, in contradiction to the CAPM. People who use beta realize that it provides an explanation for a relatively small portion of the cross-section variation of returns. Therefore, to have better explanatory power of the cross section of returns by beta, some econometric models have been employed to account for possible measurement errors and some other errors in the variables.

In the second phase of the empirical studies, the tests reveal that when explaining cross-section returns with the CAPM, some anomalies stubbornly emerge. The most profound anomalies reported in the empirical studies are the Weekend Effect, the Small Firm Effect (SFE), the Value Premium, and the Momentum Effect. All these effects imply that cross-section returns are not fully explained by beta and that some other variables, which are not included in the CAPM, also explain the variation in cross-section market returns. Because the CAPM does not explain these phenomena, the effects mentioned here are called *market anomalies*. It is worth noting, however, that some of these anomalies (e.g., the Monday Effect) have vanished in recent

[8] H. M. Markowitz, "Portfolio Selection," *Journal of Finance*, 1952.

[9] W. F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium," *Journal of Finance*, 1964.

[10] J. Lintner, "Security Prices, Risk and the Maximal Gain from Diversification," *Journal of Finance*, 1965.

years[11] (probably because once they became well known to the public, they were exploited by professional investors).

The highly cited study of Fama and French,[12] which was published in 1992 (and many other studies that followed), presents the most severe empirical criticism of the CAPM. Fama and French have claimed that beta has no explanatory power at all! Thus, their study constitutes a much more severe criticism of the CAPM than the criticisms of previous studies, which revealed that beta and the cross-section returns are positively and significantly associated – albeit beta provides only partial explanatory power.

Specifically, in the various regressions reported by Fama and French, the regression coefficient corresponding to beta is insignificant and other variables – not related to the CAPM – turn out to be significant factors in explaining the cross section of returns. Therefore, Fama and French suggest the Three-Factor Model as a substitute to the CAPM. The Three-Factor Model can be theoretically justified by the Arbitrage Pricing Theory (APT) with three factors. However, the selected factors are not motivated by theory, as is the explanatory factor, beta, in the CAPM. The selected three factors rather rely on the observed empirical connection between the cross-section returns and several variables. The Three-Factor Model of Fama and French includes the following three explanatory variables: (1) beta, (2) the SMB (a variable that is related to firm size difference, where SMB stands for "small minus big" size of firms), and (3) the HML (a variable related to the differences in the book/market value of firms, where HML stands for "high minus low" book-to-market values). Thus, it is interesting to note that even the Three-Factor Model, which reveals that beta is insignificant, does not give it up! This implies that beta is considered to be an important explanatory variable, albeit not the *main* explanatory variable, even by this model, which criticizes the CAPM.

Despite these severe empirical criticisms of the CAPM, this model – and particularly beta – and the CAPM's alpha are probably

[11] See G. W. Schwert, "Anomalies and Market Efficiency," in G. Constantinides, M. Harris, and R. M. Stulz (editors), *Handbook of the Economics of Finance*, North Holland, 2003.

[12] E. F. Fama and K. R. French, "The Cross–Section of Expected Stock Returns," *Journal of Finance*, 1992.