1

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.

the most widely employed financial measures used by academic researchers, and it is even more intensively used by investment firms and practitioners. If, as according to the CAPM's first severe criticisms published decades ago, beta and alpha are economically meaningless, why are they still so intensively employed? How then can one explain the heavy use of these two models in the face of the overwhelming reported evidence rejecting them or rejecting the assumptions that underline these models? This tension is precisely the focus of this book. Specifically, we address the following related issues:

a) The CAPM is stated with *ex-ante* parameters, whereas the empirical tests are conducted with *ex-post* parameters. This difference is of particular importance when measuring beta. Can this be the source of the contrast between the widely employed CAPM and the empirical criticisms?
b) Most empirical tests that refute the CAPM employ monthly (or even shorter horizon) rates of returns, whereas the typical investment horizon is about one year. Can this gap in the two investment horizons explain some of the observed anomalies that constitute evidence against the CAPM? Can the SFE be explained by this horizon difference?
c) Can the seemingly unrealistic assumptions that underline the M-V efficiency analysis and the CAPM be the reason for the empirical rejection of these two models?
d) The M-V and the CAPM have been derived in the expected utility framework. EUT assumes that people are rational. However, psychologists and behavioral economists reveal that in many cases people make irrational investment decisions. The criticisms of expected utility (and hence of the M-V and CAPM) in this regard have mounted after the publication of the highly influential PT study by Kahneman and Tversky[13] and the Cumulative Prospect Theory (CPT) by Tversky and Kahneman.[14] Can the M-V rule and the CAPM coexist along

[13] D. Kahneman and A. Tversky, "Prospect Theory: An Analysis of Decision under Risk," *Econometrica*, 1979.
[14] A. Tversky and D. Kahneman, "Advances in Prospect Theory: Cumulative Representation of Uncertainty," *Journal of Risk and Uncertainty*, 1992.

> with the suggested irrational behavior, specifically with CPT, whereas expected utility cannot? Because these behavioral economic criticisms of the M-V rule, and, in particular, of the CAPM, have been well known for years, the following nagging question arises: Do all the people who use the CAPM simply ignore the experimental criticisms of the EUT, which is the theoretical foundation of the CAPM?

In this book, we show that people who continue to use the M-V and the CAPM, albeit with some statistical modifications, are not, in fact, irrational. In the following chapters, we demonstrate the fact that the M-V and the CAPM are still being used extensively and probably will continue to be pillars in investment decision making for many more years to come, and for good reason. First, it is explained that the M-V and the CAPM cannot be empirically rejected with *ex-ante* parameters. Second, we show that the M-V and the CAPM can coexist with the modified version of the PT, the CPT.

This does not mean that the stable CAPM should be used. On the contrary, because the *ex-ante* parameters are unknown, efforts should be made by academics and practitioners alike to employ sophisticated methods to improve the estimates of the *ex-ante* beta, as well as the *ex-ante* risk premium, for example, by relying on the Conditional CAPM, which assumes that current information may affect the various parameters in some systematic way. This search for a better estimate does not contradict the M-V analysis and the CAPM, which are theoretically stated with *ex-ante* parameters.

Thus, we claim that investors and researchers are well aware that relying on *ex-post* parameters in a world with many dynamic and drastic changes may lead to wrong decisions. However, they are equally aware of the fact that the M-V and the CAPM are probably the best available investment tools and hence continue to employ these investment vehicles, albeit not naively. Namely, because the *ex-post* parameters are not ideal estimates of the *ex-ante* parameters, investors and researchers try to use all the information they have to improve the relevant estimates, thereby improving the effectiveness of these tools. This is accomplished by using various methods, including reliance on additional market and accounting supplement variables that may serve as proxies for the *ex-ante* parameters.

The purpose of the rest of this introductory chapter is to show that nowadays the CAPM and, in particular, alpha and beta, are widely used among academics and even more intensively employed among practitioners, despite the well-known criticisms. Thus, the evidence clearly shows that neither academics nor practitioners are willing to give up the M-V analysis and the CAPM as viable investment frameworks. One possible explanation for this behavior may be because these models cannot be easily rejected or perhaps because no better models exist. This evidence of the wide use of the M-V and the CAPM, despite the surrounding empirical and experimental criticisms, is the raison d'être for writing this book.

1.2. THE INTENSIVE USE OF THE MEAN-VARIANCE AND THE CAPITAL ASSET PRICING MODEL AMONG PRACTITIONERS

In this section, we demonstrate the widespread use of the M-V and the CAPM and, in particular, the CAPM's beta. To support our claim, we provide several case samples. This small sample of cases is sufficient to show the important role that the M-V and the CAPM play in the financial arena. However, a word of caution is called for: when one talks about beta, it is generally referring to beta derived from the CAPM. However, when one talks about alpha, it could be the CAPM's alpha or the alpha corresponding to any other model – for example, the Fama and French Three-Factor Model – because alpha measures the abnormal profit (or loss) beyond what is expected by the suggested model. In this chapter, however, when we discuss or report *alpha* we mean the CAPM's alpha.

We begin our analysis with extracts of a standard financial website. PracticalStockInvesting.com offers definitions and clarifications of a number of basic concepts. A substantial part of the article given in this website is dedicated to defining and giving a brief explanation of Markowitz's main investment principle. Alpha and beta are also widely discussed.[15] From the discussion and information given in this website, it is clear that practitioners consider the CAPM's alpha and beta very important investment tools. For example, it asserts:

[15] See http://practicalstockinvesting.com/category/basic-concepts/academic-theories/alpha-and-beta/.

β is a commonly-used tool. Value Line, among others, lists calculations in its publications, so they're easy to find.

Although alpha and beta are commonly employed, the view is that beta is more intensively employed than alpha:

> You can often hear an investment professional say, "That's a high-Beta stock." Less frequently, you may see the claim, normally in writing, that someone "is searching for alpha."

Thus, it is more common to classify stocks as high (or low) beta stocks than to classify stocks using alpha.

However, the article also presents some reservations related to the implementation of these tools in practice:

> There's a practical problem, though. If the universe has only two or three stocks in it, calculating this information is straightforward. If the universe is the S&P 500, however, figuring out all the interrelationships among all the stocks becomes a real pain in the neck. . . . There's a much bigger problem, though. The virtues of short-term price volatility as a measure of risk is that the data are easily available for many stocks and that variance is part of an established mathematical framework. So it has been widely adopted by academics and consultants. Unfortunately, it's otherwise not very informative, I think. It's like saying that the risk in an airplane flight should be measured by the amount of air turbulence en route. By this measure, the plane that recently took a smooth ride into the Hudson River would be classified as a safe flight.

Thus, it is obvious from this article that beta and alpha occupy the minds of professional investors, even though they raise legitimate questions regarding the implementation of the M-V optimization model:

> True, CAPM has crazy "simplifying" assumptions . . . although it's still taught to MBAs, nobody much believes in it anymore. Still, CAPM would be a lot easier to make fun of if we could produce more people with credible claims to have achieved positive α over long periods of time. On the other hand, if you could do this, why in the world would you ever tell someone else?

Sharpe[16] realizes the technical difficulty of handling many assets and therefore suggests the Single Index Model (SIM), which facilitates the investment diversification task when a relatively large number of assets are involved. In addition, it is well known that "a little

[16] W. F. Sharpe, "A Simplified Model for Portfolio Analysis," *Management Science*, 1963.

diversification goes a long way";[17] hence, most of the risk-reduction benefits are obtained by holding only a few assets.[18] Thus, one can adhere to the article's argument and invest in only a small number of assets without losing the main gain derived from diversification. Indeed, the segmented market CAPM (which is a generalization of the CAPM, obtained by relaxing one of the assumptions that underline the CAPM) fits the case presented in the article: it allows for the holding of an optimal portfolio containing only a small number of assets. The good news is that this segmented market model also suggests a risk-return equilibrium, whose structure is similar to the CAPM.

Capital market researchers recognize that there are many real-world impediments to achieving perfect diversification. These impediments include transaction costs, constraints on short selling, and taxations, among many others. Considering these impediments to efficiency, Sharpe[19] suggests a model to determine asset prices without negative holdings. According to this model, a portfolio containing only a small number of assets may be optimal, which is in line with the segmented-market CAPM and in agreement with the argument raised in the preceding article regarding the difficulties in handling the risk-reduction processes with many assets. Of course, with a model implying less than perfect diversification, the market portfolio may be M-V inefficient and the maximal gain from diversification may not be achieved. However, in regard to this matter, Sharpe concludes[20]:

> Happily, technological advances and a greater understanding of the principles of financial economics are reducing costs and constraints of this type at a rapid pace. As a result, capital markets are moving closer to the conditions assumed in some of the simpler types of financial theory.

[17] See H. Levy and H. M. Markowitz, "Approximating Expected Utility by a Function of Mean and Variance," *American Economic Review*, 1979, p. 314.

[18] It has been shown empirically that increasing the number of assets in the portfolio beyond ten only slightly affects the reduction in the portfolio's risk. See J. L. Evans and S. H. Archer, "Diversification and Reduction in Dispersion: An Empirical Analysis," *Journal of Finance*, 1968. However, a more recent study reveals that the idiosyncratic risk tends to increase over time; hence, the number of stocks needed to obtain any given amount of portfolio diversification has also increased. See J. Y. Cambell, M. Lettau, B. G. Malkiel, and Y. Xu, "Have Individual Stocks become More Volatile? An Empirical Exploration of the Idiosyncratic Risk," *Journal of Finance*, 2001.

[19] W. F. Sharpe, "Capital Asset Prices with and without Negative Holdings," *Journal of Finance*, 1991.

[20] See Sharpe, *op. cit.*, p. 508.

One of the preceding citations also makes a valid point regarding the investment horizon: we agree that for, say, the one-year horizon investor, the beta calculated with weekly rates of returns is irrelevant and may be misleading. However, recall that the M-V and the CAPM assume that some investment horizon exists, and these two models are derived based on the assumed investment horizon. Indeed, we show in this book that using a shorter horizon than the actual holding period in the empirical tests may be a source of many biases in these tests.

We shall demonstrate the extent to which the M-V, the CAPM, and particularly beta, are employed. Table 1.1 presents a sample page of the standard financial analysis provided by Value Line. Specifically, the page provides financial information on the stock of American Medical Systems Holdings Inc., which trades on the NASDAQ. From this typical page, we can conclude two things. First, beta, which is reported at the top left corner of Table 1.1 (see zoom-in box), is a standard reported parameter as an index of risk. Second, professional investors recognize that the *ex-post* beta may be a misleading indicator of the *ex-ante* risk; thus, they add many other parameters that may aid in measuring the risk involved with the investment in the stock under consideration (e.g., see the SAFETY index and various financial ratios).

This is in line with our claim asserting that the relevant *ex-ante* beta (risk) is unknown; hence, academic and professional investors alike employ many other variables, presumably as a proxy to the *ex-ante* beta.

Tables 1.2.a and 1.2.b present sample financial analyses of some indexes, as well as individual stocks, respectively, supplied by Merrill Lynch's *Security Risk Evaluation*, also known as the "beta book." Unlike in Table 1.1, here the entire table is concerned with the CAPM: it reports the CAPM's alpha and beta, as well as some statistical information regarding these two CAPM variables.

The beta parameter is calculated by using the S&P 500 index as a proxy to the market portfolio. Thus, as expected, the S&P 500 index beta is 1, and the corresponding alpha is 0 with a correlation of $+1$ (see Table 1.2.a). Let us now demonstrate the given information in these pages with ATC HEALTHCARE INC given at the end of Table 1.2.b. As we can see, the beta of this stock is equal to 0.68; hence,