MODERN REGULATORY FINANCE

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2021
PUR Books

statistically significant return compensation when betas are estimated from time-series regressions of annual portfolio returns on the annual return on an equally weighted market index. In a December 1995 paper, Kim[5] found that, once corrected for the errors in variables problem, there was more support for the role of beta. In yet another 1996 paper, Jagannathan & Wang[6] showed that when betas are allowed to vary over the business cycle, the empirical support of the CAPM is very strong. Finally, Nobel-Prize winning economist William Sharpe refuted the Fama-French criticism in "Revisiting the CAPM," *Dow Jones Asset Manager* (May-June 1998).

To sum up, at the empirical level, there have been countless tests of the CAPM to determine to what extent security returns and betas are related in the manner predicted by the CAPM. The results of the tests support the idea that beta is related to security returns, that the risk-return tradeoff is positive, and that the relationship is linear. The burning question remains as to whether the relationship between return and beta conforms to the predictions of the CAPM.

CAPM Understatement

There is a fly in the ointment, however. It is well-known and generally accepted in the finance literature that the process of estimating equity betas via regression analysis and inserting those estimates into the CAPM formula produces outputs that are systematically biased. In particular, there is strong and consistent evidence that the CAPM-estimated returns with betas below 1.0 are systematically lower than the returns that are actually generated by those assets.

This evidence is generally considered to be so robust that it is now part of the standard finance curriculum and appears in the academic literature and in finance textbooks. For example, Fama & French (2004) show that this result has proven to be consistent through time – low-beta stocks generate higher returns than the CAPM would imply and high-beta stocks earn lower returns than the CAPM would imply.[7] With respect to the early tests of the CAPM, Fama & French summarize the state of play as:

> *The early tests firmly reject the Sharpe-Lintner version of the CAPM. There is a positive relation between beta and average return, but it is too "flat."*

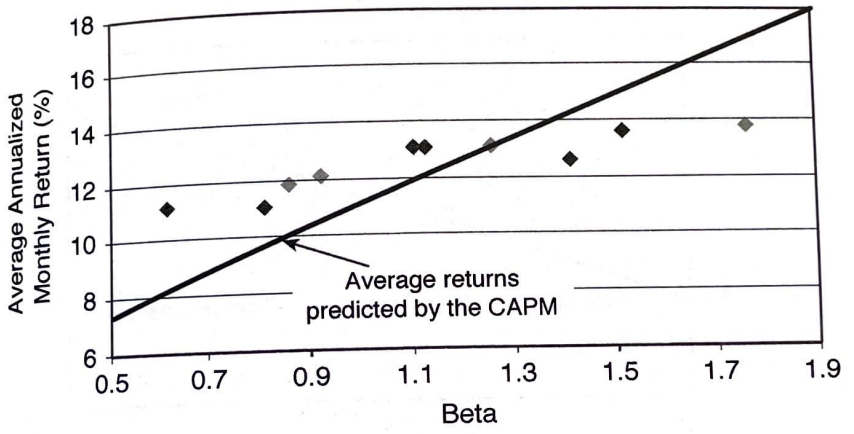
Fama & French then provide an updated example of the evidence using monthly returns on U.S.-listed stocks over 76 years from 1928 to 2003. This analysis is summarized in Figure 7-1 below.[8] Consistent with the early evidence, realized returns

5. Dongcheol Kim, "The Errors in the Variables Problem in the Cross-Section of Expected Stock Returns," *Journal of Finance* Vol. 50, No. 5 (1995).
6. Ravi Jagannathan & Zhenyu Wang, "The Conditional CAPM and the Cross-Section of Expected Returns," *Journal of Finance* Vol. 51, No. 1 (1996).
7. Fama, E.F. and French, K.R. "The Capital Asset Pricing Model: Theory and Evidence." *Journal of Economic Perspectives Finance*, Vol. 18, No. 3, 2004, pp. 25-464.
8. Fama & French (2004) op.cit.

on low-beta stocks are higher than predicted by the CAPM, and realized returns on high-beta stocks are lower than predicted by the CAPM. Stocks with the lowest beta estimates had average returns of 11.1% per year, but the CAPM says the expected return was 8.3% per year. Stocks with the highest beta estimates had average returns of 13.7% per year, but the CAPM says the expected return was 16.8% per year.

Figure 7-1

Average Returns vs Beta Over An Extended Time Period (1928-2003)



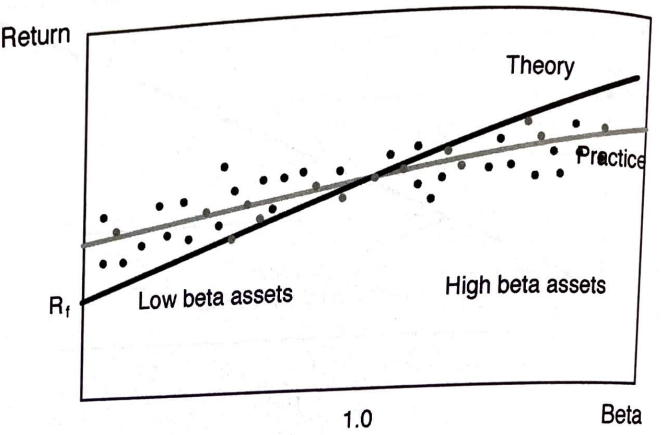
Brealey, Myers, and Allen (2017), among many others,[9] provide more recent empirical evidence very similar to the relationship depicted in Figure 7-1. In fact, Brealey, Myers and Allen (2017) extend previous analyses to the end of 2014, and provide a similar chart to that presented by Fama and French (2004). The upward-sloping line on Figure 7-1 represents the relationship between beta and return that is implied by the CAPM and each dot represents the observed return for a particular portfolio. Clearly, the low-beta portfolios still earn higher returns than the CAPM would imply. Goyal (2011) also found a security market line flatter than that predicted by the CAPM.[10] With few exceptions, the empirical studies agree that the implied intercept term exceeds the risk-free rate and the slope term is less than predicted by the CAPM. That is, low-beta securities earn returns somewhat higher than the CAPM would predict, and high-beta securities earn less than predicted. This is one of the most well-known results in finance, and is particularly pertinent for public utilities whose betas are typically less than 1.00.

9. For a summary of the empirical evidence on the CAPM, see Jensen (1972) and Ross (1978). The major empirical tests of the CAPM were published by Friend and Blume (1975), Black, Jensen, and Scholes (1972), Miller and Scholes (1972), Blume and Friend (1973), Blume and Husic (1973), Fama and Macbeth (1972), Basu (1977), Reinganum (1981B), Litzenberger and Ramaswamy (1979), Banz (1981), Gibbons (1982), Stambaugh (1982), Shanken (1985), Black (1993), and Brealey, Myers, and Allen (2017). Evidence in the Canadian context is available in Morin (1980, 1981).

10. Goyal, Amit, "Empirical Cross-Sectional Asset Pricing: A Survey," Swiss Society for Financial Market Research, 2011. Published online: December 2011.

In short, the currently available empirical evidence indicates that the simple version of the CAPM does not provide a perfectly accurate description of the process determining security returns. The observed and predicted relationship between risk and return is depicted in Figure 7-2. The black line shows the predicted CAPM relationship and the gray line displays the observed relationship between return and beta. Explanations for this shortcoming include some or all of the following:

Figure 7-2
Risk vs Return: Theory vs Practice



1. The CAPM excludes other important variables that are important in determining security returns, such as size, skewness, and taxes.
2. The market index used in the tests excludes important classes of securities, such as bonds, mortgages, and business investments. There is a further argument that the CAPM can never be really tested and that such a test is infeasible. This is because the market index proxy used in empirical tests of the CAPM is inadequate; since a true comprehensive market index is unavailable, such tests will be biased in the direction shown by the actual empirical results.[11] Moreover, the CAPM is a forward-looking expectational model and in order to test the model it is necessary to predict investor expectations correctly. Any empirical test of the CAPM is thus a test of the joint hypothesis of the model's validity and of the function used to generate expected returns from historical returns.
3. Constraints on investor borrowing exist contrary to the assumption of the CAPM.
4. Investors may value the hedging value of assets in protecting them against shifts in later investment opportunities. See Merton (1973) and Morin (1981).

11. See Roll (1977).

Expanded CAPM models have been proposed relaxing the above constraints, each model varying in complexity, each model attempting to inject more realism into the assumptions. Ross (1978), Tallman (1989), and Guo (2004) present excellent surveys of the various asset pricing theories and related empirical evidence. These enhanced CAPMs produce broadly similar expressions for the observed relationship between risk and return and engender a SML that is flatter than the CAPM prediction, in line with the empirical evidence.

In the remainder of this chapter, Section 7-2 focuses on the more tractable extensions of the CAPM that possess some applicability to public utility regulation. Section 7.3 discusses the Empirical CAPM. Section 7.4 describes the Arbitrage Pricing Model, a viable alternative to the CAPM. Section 7.5 discusses the Fama-French Three-Factor Model ("FF3F) and the Fama-French Five-Factor Model ("FF5F") of asset pricing. The Market-Derived Pricing Model is described in Section 7.6. Section 7.7 offers some concluding remarks.

7.2 CAPM Extensions

Several attempts to enrich the CAPM's conceptual validity and to ameliorate its applicability have been advanced. One popular explanation of the CAPM's inability to explain security returns satisfactorily is that beta is insufficient and other systematic risk factors affect security returns. The implication is that the effects of these other independent variables should be quantified and used in estimating the cost of equity capital. The impact of the supplementary variables[12] can be expressed as an additive element to the standard CAPM equation as follows:

Letting 'a' stand for these other effects on return, the CAPM equation becomes:

$$K = R_f + a + b(R_m - R_f) \tag{7-1}$$

To capture the variables' impact on the slope of the relationship, a coefficient 'b' is substituted for the market risk premium. The revised CAPM equation becomes:

$$K = R_f + a + b \times \beta \tag{7-2}$$

The constants 'a' and 'b' capture all the market-wide effects that influence security returns, and must be estimated by econometric techniques. Principal factors purported to affect security returns include dividend yield, skewness, and company size. Each factor is discussed individually below.

12. To illustrate, the Arbitrage Pricing Model and the Fama-French three-factor asset pricing model, discussed in a later section, include factors other than the market that explain observed security returns.