CHAPTER 9
The Capital Asset Pricing Model

Introduction

Like supply-and-demand models of economics, models for determining the equilibrium return on a security or a portfolio involve finding that unique return toward which the return naturally tends. The two most widely used models for determining the equilibrium return on an investment are the Capital Asset Pricing Model (CAPM), which was first discussed in Chapter 6, and the Arbitrage Pricing Theory (APT). The CAPM was the first general equilibrium model for determining an investment return, and it is based on the single-index model discussed in Chapter 8. The APT, on other hand, is based on a multifactor model. As we will see, both models are rooted in portfolio theory. In this chapter, we examine the CAPM, and in Chapter 10 we look at APT.

Overview[1]

One of the implications of portfolio analysis is that in an efficient market rational investors would prefer portfolio investments to individual security investments because unsystematic risk can be diversified away with a portfolio. In the 1960s, Sharpe (1964), Lintner (1965), and Mossin (1966) showed that if investors make their investment decisions in a portfolio context, then the selection of individual securities would be based solely on that security's contribution to the overall portfolio's expected return and risk. As a result, a security's undiversified or unsystematic risk would not affect the security's equilibrium price and return.

The idea that a security is important only in a portfolio context is the foundation of CAPM. CAPM can be stated in terms of the following proposition:

> *The equilibrium return on an investment is determined by its systematic risk as measured by its beta and not by unsystematic factors that investors can diversify away with a portfolio.*

Recall that beta is the slope of the characteristic line: $r = \alpha + \beta R^M$. It is a measure of the change in a security's rate of return to a change in the market rate of return: $\beta = \Delta r / \Delta R^M$. If r and R^M are linearly related, then beta also measures the proportional relationship between r and R^M. Thus, a security with a β = 1.5 would change by 15 percent for a 10 percent change in the market. Statistically, beta measures a security's variability relative to the market's variability. Thus, a security with a $\beta = 1$ has the same variability as the market; one with a $\beta > 1$ has greater variability than the market, and one with $\beta < 1$ has less variability.

In terms of the CAPM, a stock with a $\beta > 1$ has more risk than the market and therefore, in equilibrium, should be priced so its equilibrium expected rate of return, $E(r)^*$, is greater than the expected market rate of return: $E(r)^* > E(R^M)$. If such a stock were priced such that its expected rate of return were equal to or less than the market, then there would be little if any demand for the security. The lack of demand would cause the stock's price to drop and its expected rate of return to increase until the equilibrium condition of $E(r)^* > E(R^M)$ was satisfied. In contrast, a stock with a $\beta < 1$ in equilibrium should be priced so its expected rate of return is less than the market rate: $E(r)^* < E(R^M)$. If such a security were priced such that its expected rate equaled or exceeded the market rate, then there would be a high demand for this security with relatively low risk. This demand, in turn, would increase the price of the security and lowers its return until $E(r)^* < E(R^M)$. A security with $\beta = 1$ by definition has the same risk as the market and therefore should be priced such that its expected rate is equal to the expected market rate: $E(r)^* = E(R^M)$. Finally, if investors hold portfolios that diversify away unsystematic risk, then a security with a beta equal to zero should be priced in equilibrium such that its rate of return is equal to the risk-free rate: $E(r)^* = R_f$.

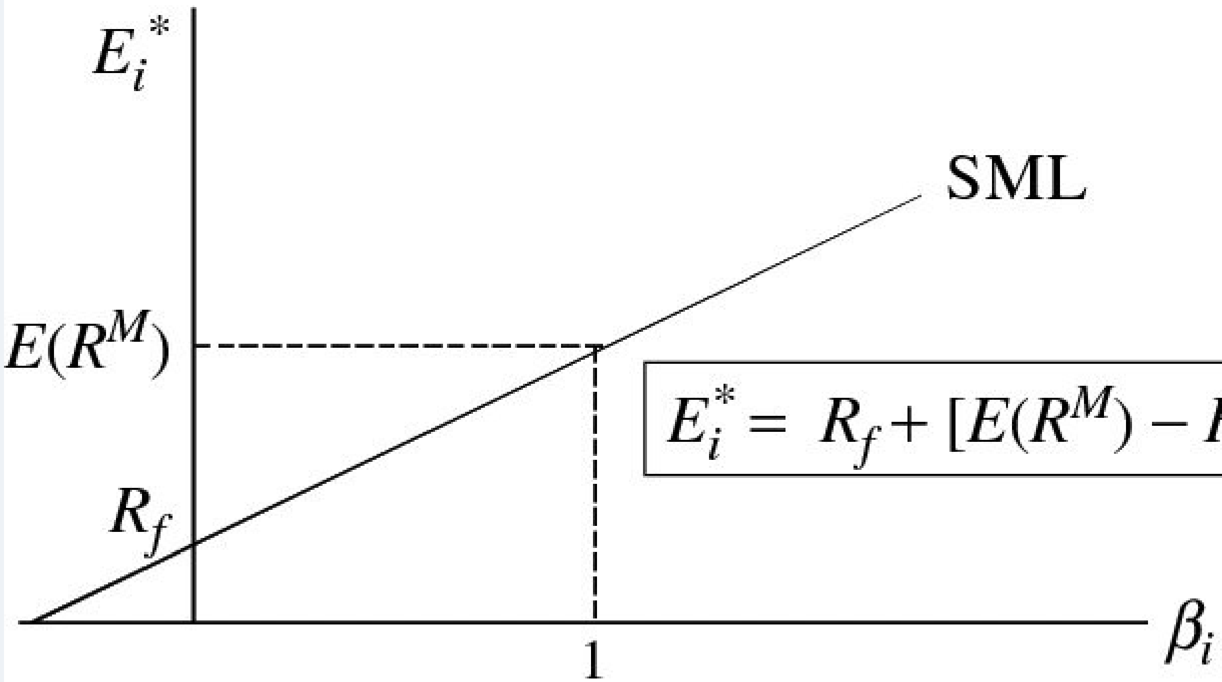
It should be noted that a security with a negative beta would in equilibrium have an expected return less than the risk-free rate: $E(r)^* < R_f$. That is, for investors who make decisions based on the security's contribution to their portfolio, a negative beta security yielding at least the same rate of return as the risk-free security would be considered more valuable than the risk-free security since its addition to the portfolio would serve to reduce the portfolio's risk more than the addition of a risk-free security. Thus, if a security with a $\beta < 0$ were priced such that $E(r) \geq R_f$, then there would be a high demand for the security, causing its price to increase and its return to decrease until $E(r)^* < R_f$.

The relationships between beta and a security's equilibrium return are graphically depicted in Exhibit 9.1. The line in the exhibit shows the relation between any security's equilibrium return and its beta. As noted in Chapter 6, this line is known as the *security market line* (*SML*). The line has an intercept of R_f (i.e., when $\beta = 0$, $E(r)^* = R_f$) and a slope equal to the market risk premium $E(R_M) - R_f$. The equation for the SML is

$$E(r_i)^* = R_f + [R(R^M) - R_f]\beta_i \tag{9.1}$$

where: *i* represents any investment *i*.

- CAPM: Relation
- Security Market Line (SML): Depicts the equilibrium relationship between any investment's equilibrium return and its beta.



$$E_i^* = R_f + [E(R^M) - R_f]\, \beta_i$$

In equilibrium, the security

β **Risk** **is priced such that**

β>1	Security has more risk than the market	$E(r)^{*}>E(R^{M})$
β=1	Security has the same risk as the market	$E(r)^{*}=E(R^{M})$
β<1	Security has less risk than the market	$E(r)^{*}<E(R^{M})$
β=0	Security has no systematic risk	$E(r)^{*}=R_{f}$
β<0	Security lowers portfolio risk	$E(r)^{*}<R_{f}$

EXHIBIT 9.1 Security Market Line

The CAPM as depicted by the SML represents a cross-sectional model showing the equilibrium return and beta combinations for any security or portfolio. For example, if the risk-free rate were 6 percent and the market risk premium were 4 percent, then a security with a β = 0.5 would have an equilibrium return of 8 percent; another security with a β = 1 would have an equilibrium return of 10 percent; and another security with a β = 1.5 would have an equilibrium return of 12 percent. It should be emphasized that in the CAPM, systematic risk is the only factor determining a security's equilibrium return, or equivalently, unsystematic risk (industry risk and firm risk) is unimportant. This feature is based on the assumption that investors make decisions in a portfolio context; that is, since investors can eliminate unsystematic risk through simple diversification, there are no additional returns to them for bearing such risk.

Derivation of the CAPM

The above overview of the CAPM is not a derivation, but rather an explanation of the model. A formal derivation of the model is presented in Appendix 9A (text Web site). In general, the model assumes:

1. Ideal market conditions in which all investors are assumed to have similar expectations with respect to each investment's expected return, variance, and covariance, and where there are no transaction costs, securities are perfectly divisible and marketable, and there are no taxes that would make investors differentiate between returns in the form of capital gains and income.
2. Investors make decisions solely in terms of each investment's contribution to their portfolio's expected return and risk.

The first assumption of ideal market implies that the optimum portfolio of risky securities held by any investor will be identical to the optimum portfolio held by any other investor. If all investors have the same portfolio, then in equilibrium that portfolio must be the market portfolio: The portfolio of all risky securities, with each security's weight equal to the proportion of its market value to the market value of all securities:

$$w_i = \frac{\text{Market Value of Security } i}{\text{Market Value of All Securities}}$$

The CAPM is often described by the borrowing-and-lending line that is tangent to the efficiency frontier constructed for all securities and associated with the equilibrium risk-free rate. This special borrowing and lending line is known as the *capital market line (CML)*. In equilibrium, all investors will end up somewhere along the CML with a portfolio yielding an expected return and risk of $E(R_I)$ and $\sigma(R_I)$ obtained by investing in the market portfolio (defined as the best Markowitz efficient portfolio) with a return and risk of $E(R^M)$ and $\sigma(R^M)$ and by going long or short in a risk-free security. As shown in Exhibit 9.2, the CML's intercept is the equilibrium risk-free rate, R_f, and its slope is the market portfolio's risk-premium per risk: $[E(R^M) - R_f]/ \sigma (R^M)$:

$$E(R_I)^* = R_f + \left[\frac{E(R^M) - R_f}{\sigma(R^M)}\right] \sigma(R_I)$$

- **Capital Market Line (CML)**: The CML is formed with the risk-free security and the market portfolio. The CML shows the different return-risk combinations investors can obtain from different allocations in the risk-free securities and the market portfolio.

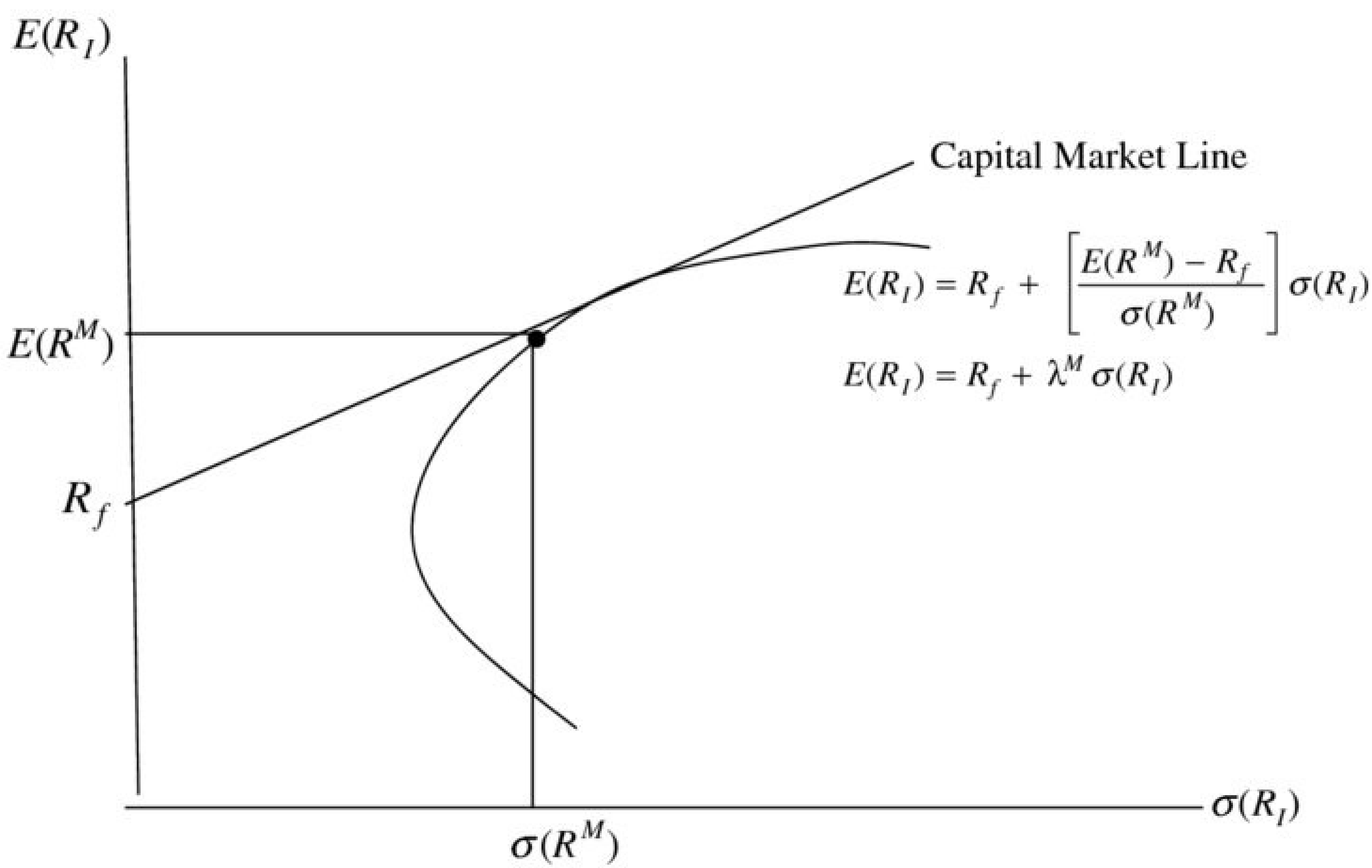


EXHIBIT 9.2 Capital Market Line

Note that not all security or portfolio return-risk combinations lie along the CML; that is, the CML shows only the Markowitz return-risk combinations that investors hold in equilibrium. The SML, on the other hand, shows the equilibrium return-risk combinations of all investments (securities, efficient portfolios, and nonefficient portfolios). The SML, in turn, can be derived from the equilibrium risk-free rate and market portfolio defined by the CML using an arbitrage argument.

The second CAPM assumption, that investors make decisions in a portfolio context, implies that they diversify away unsystematic risk. As a result, the only risk relevant for investors in evaluating securities to include in their portfolios would be systematic risk, and the only relevant factors for investors in evaluating any security would be its expected rate of return, $E(r_i)$ and its β_i. Interestingly, if all securities and investments are explained by just two factors ($E(r_i)$ and β_i), then all of the equilibrium return and beta combinations available in the market can be generated from the return and beta combinations formed from a portfolio of the market portfolio (with an expected return of $E(R^M)$ and beta of one) and the risk-free security (with a rate of R_f and beta of zero).

To see this, first consider any two investments, A and C, with the following features:

Investments	$E(r)$	β
A	10%	0.5
C	15%	1.5

By forming a portfolio with these two investments, we can generate an unlimited number of expected return and beta combinations. All of the portfolio return and beta combinations formed with these securities will lie along the straight line RABCD shown in Exhibit 9.3. Points A and C on the line consist of investments only in A and C, respectively; point B, in turn, shows the portfolio return and beta combination of $E(R_p)$ = 12.5% and β_p = 1 constructed from an equally weighted portfolio:

$$E(R_p) = w_A E(R^A) + w_C E(R^C) = (0.5)(10\%) + (0.5)(5\%) = 12.5\%$$
$$\beta_p = w_A \beta_A + w_C \beta_C = (0.5)(0.5) + (0.5)(1.5) = 1$$

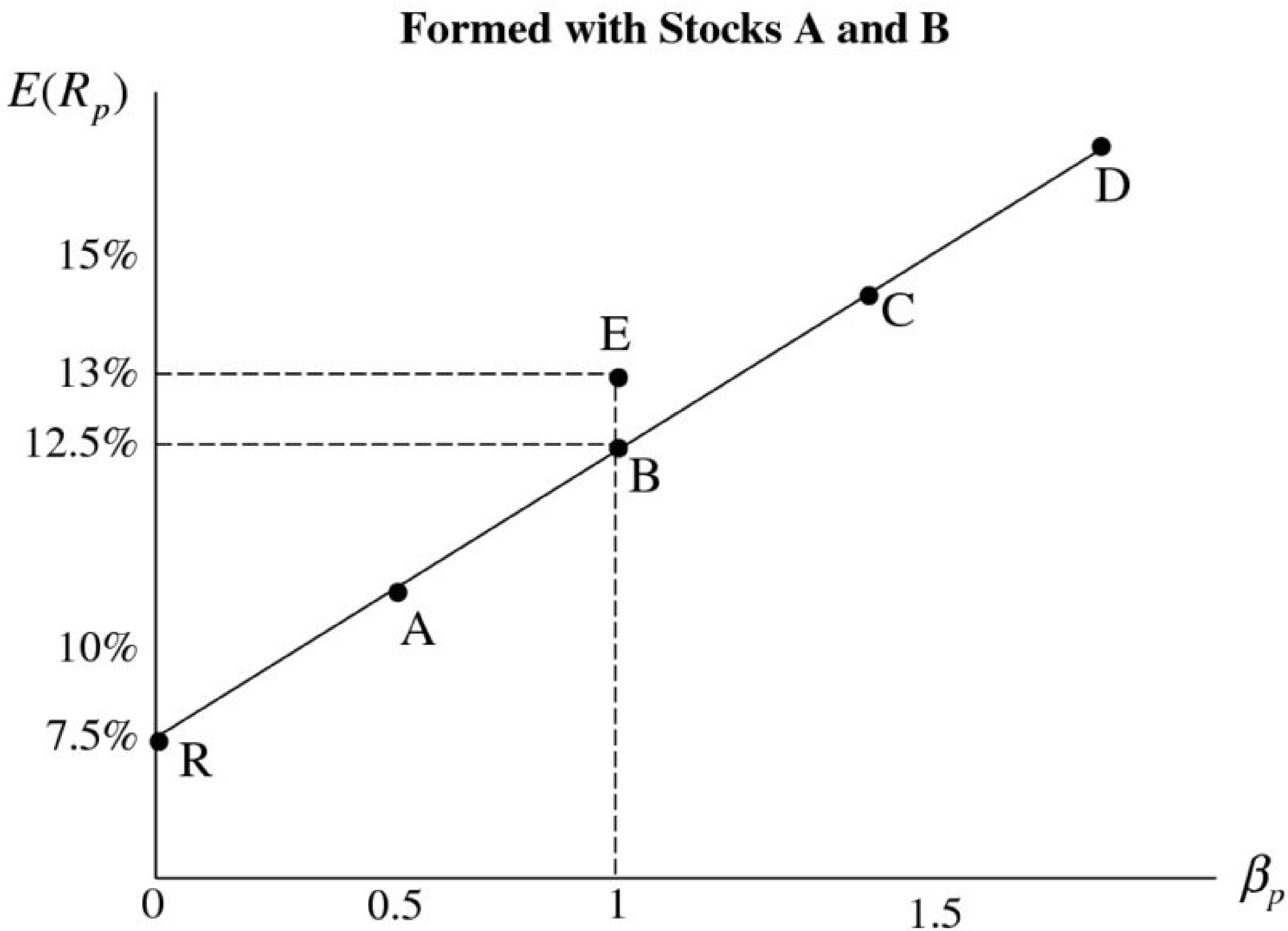


EXHIBIT 9.3 Portfolio Return and Beta Combinations Formed with Stocks A and C

In addition, by taking short positions in C and long positions in A, return and beta combinations extending from point A to the vertical axis and beyond can also be generated. For example, by going short in C by an amount equal to 50 percent of one's investment funds ($w_C = -0.5$) and by investing in A by an amount equal to 150 percent ($w_A = 1.5$), the return and beta combination of 7.5 percent and 0 defining the vertical intercept R is obtained. In contrast, by taking short positions in A and long positions in C, one can obtain a higher return and beta combination than C's.

Given the linearly related return and beta combinations formed with securities A and C, consider now a third security E with a beta of one and an expected return of 13 percent. This security's return and beta combination lies above the line RABCD. If investors are rational and informed, this investment opportunity would not last long. That is, since this security yields the same risk as the equally allocated portfolio of A and C, but has a greater return, it would pay investors to short the equally allocated portfolio of A and C and then use the proceeds from the short sale to invest in security E. Investors executing this strategy would earn a positive cash flow with no risk and no investment—an arbitrage:

	Investment	Expected Return	Beta
Long Security E	\$100	\$13.00	1
Short Portfolio A and B	−\$100	−\$12.50	−1
Arbitrage Portfolio	0	\$0.50	0

Eventually, efforts to go short in A and C and long in security E would change the prices and returns on these securities until E yielded the same return as the portfolio of A and C. This equilibrium condition would be met when security E's return and beta combination was on the return and beta line generated from securities A and C.[2] Moreover, this same arbitrage argument can be applied to any security or portfolio investment with return and beta combinations not on line RABCD. The line RABCD in Exhibit 9.3 therefore depicts the equilibrium return and beta combination for any investment (stock or portfolio), not just for portfolios formed with A and C. Thus, in equilibrium all investments must lie along a straight line in return-beta space.

Since the line RABCD can be formed with any two securities or investments, consider the straight line in return and beta space that is generated with the market portfolio and the equilibrium risk-free security as defined by the CML. The market portfolio has a return of $E(R^M)$ and a beta of one; the risk-free security has a return of R_f and a beta of zero. Just as we did with securities A and C, we can generate an infinite number of return and beta combinations with portfolios formed with the market portfolio and the risk-free security, and we can argue again that arbitragers would ensure that any investment's return and beta combination would have to be on that line. For example, if there was an investment with beta of one and return less than the market rate, then arbitrageurs could earn a riskless return by going short in the investment and long in the market (e.g., index fund). Furthermore, investors would have no demand for the investment. Arbitrageurs and investors would therefore drive the price of the security down and its return up until its return is equal to the market return, $E(R^M)$. Thus, the line in return-beta space formed with the market portfolio and the risk-free security defines the equilibrium return-beta combinations for all investments. Moreover, this line, which has an intercept of R_f and a slope of $E(R^M) - R_f$, is the SML that we defined earlier (see Exhibit 9.4).

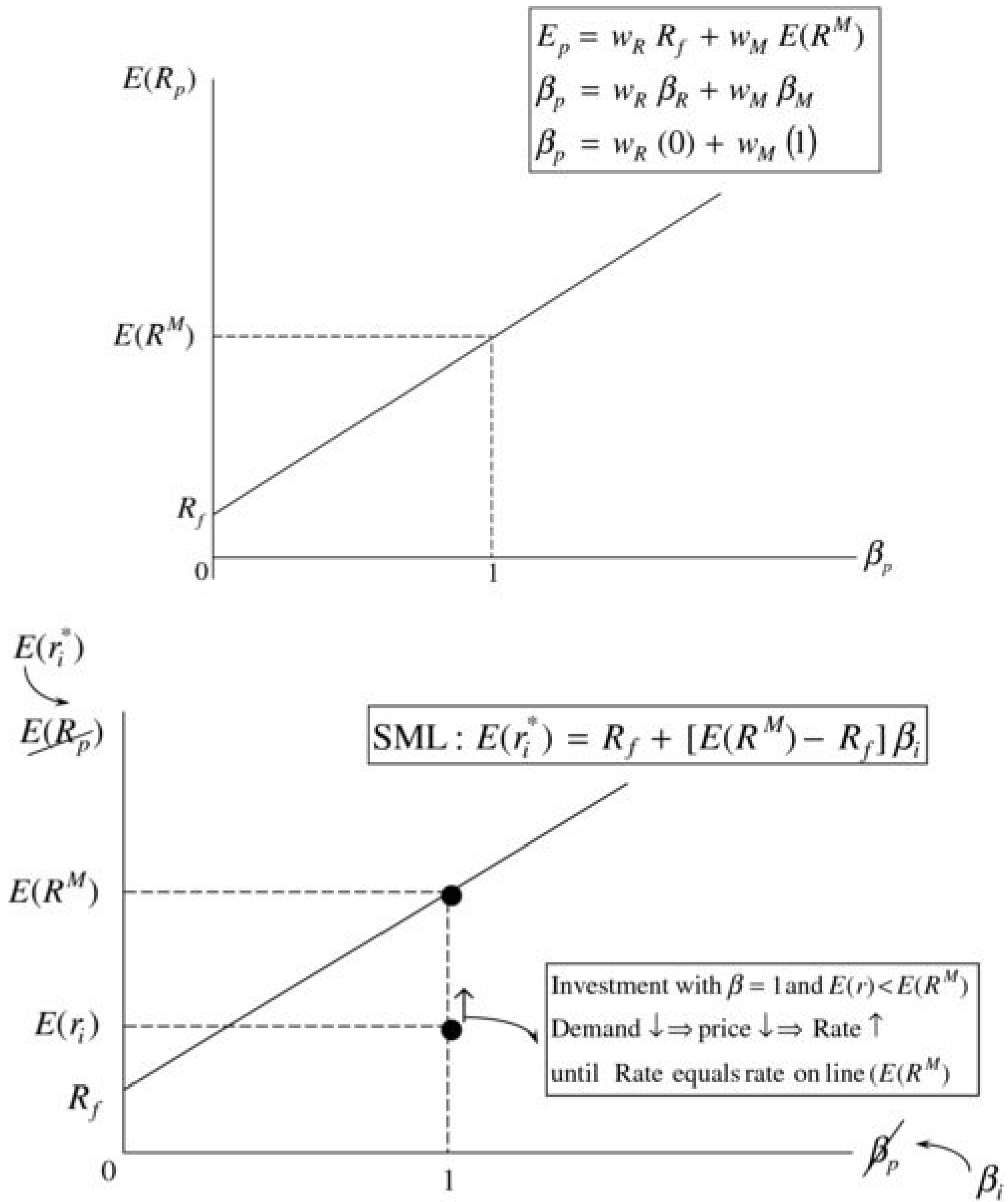


EXHIBIT 9.4 Portfolios Formed with Market Portfolio and Risk-Free Security Market Line

Summary

The CAPM can be described in terms of the SML equation:

$$E(r_i)^* = R_f + [R(R^M) - R_f]\beta_i$$

The equation shows that an investment's equilibrium return is linearly and positively related to the investment's systematic risk, as measured by its beta—the greater an investment's systematic risk, the greater its equilibrium return. The SML shows that an investment's equilibrium return depends only on its systematic risk. The omission of other explanatory factors is based on the CAPM assumption that investors make security decisions based on a portfolio return-risk criterion. To recapitulate, this assumption means that since investors can diversify away unsystematic risk by forming portfolios, the market will not reward any investor for bearing such risk.

EXAMPLE USING BLOOMBERG INFORMATION TO GENERATE AN EX-POST SML

A graph of return and beta combinations with portfolios formed with the S&P 500 (SPX) and the risk-free security is shown in Bloomberg Web Exhibit 9.1 (text Web site).

Empirical Tests of the CAPM

There has been an extensive amount of empirical testing of the CAPM. The objective in many of these tests is to empirically estimate the SML to see how it compares with the theoretical SML. In estimating the SML, many researchers use first- and second-pass tests. In the first pass, time-series regressions are used to estimate the betas of securities or portfolios, and in the second pass, a cross-sectional regression is used to estimate the SML.

One of the first studies using a first- and second-pass methodology was done by Lintner. Using the average annual returns for 301 stocks over a sample period, Lintner first estimated each stock's beta by regressing its yearly return, r_{it}, against the average return for all the stocks in the sample, $R^M{}_t$; that is:

$$r_{it} = \alpha_i + \beta_i R_t^M + \varepsilon_{it}$$

In the second pass, Lintner regressed the average returns of the 301 stocks against their estimated betas and their residual variances, $V(\epsilon_i)$, obtained from the first pass:

$$\bar{r}_i = \gamma_0 + \gamma_1 \beta_i + \gamma_2 V(\varepsilon_i) + \varepsilon_i$$

For the CAPM to be valid, the regression intercept, γ_0, should be equal to the risk-free rate, the slope coefficient γ_1 should be equal to the market risk premium, $R_M - R_f$, and the coefficient γ_2 should be zero, indicating that unsystematic risk as measured by $V(\epsilon)$ has no impact on an investments' equilibrium return. Compared to the estimated market rate and risk-free rate for that period, Lintner's regression intercept, γ_0, was considered too large and his estimated risk premium, γ_1, was considered too small. In addition, Lintner's regression also showed that unsystematic risk as measured by the residual variance was statistically significant. Thus, Lintner's statistical results questioned the validity of the CAPM.

Empirical tests of equilibrium models constructed similar to those of Lintner are often subject to two types of errors: *measurement errors* and *stochastic errors*. In the Lintner study, measurement errors could have occurred as a result of using unadjusted betas. That is, Lintner's estimated betas were obtained from historical regressions. Given the results of the Blume study (discussed in Chapter 6) that showed the poor statistical quality of regressions of stock returns against the market, the betas used in Lintner's study were considered poor estimates of the stocks' true betas. The measurement errors resulting from using historically estimated betas can be redressed by using either adjusted betas or using betas of portfolios instead of stocks. Stochastic errors, on the other hand, occur when the model is incorrectly specified. In Lintner's test of the CAPM, the form of the cross-section regression test implied that the risk-free rate was constant. If the risk-free rate changes and is correlated with the market rate, then Lintner's first-pass regressions would be subject to biases. One way to rectify this problem, is to regress the security's risk-premium, $r_i - R_f$ against the market risk premium, $R^M - R_f$.

The measurement and stochastic errors germane to the Lintner study were redressed in an early study conducted by Black, Jensen, and Scholes (BJS). Instead of using stock returns in their first-pass test, BJS regressed the risk premiums of portfolios, grouped in the order of their betas, against the market risk premium:[3]

$$R_{pt} - R_{ft} = \alpha + \beta[R_t^M - R_{ft}] + \varepsilon$$

In their second-pass tests, BJS regressed the average excess returns of the portfolios against their betas:

$$\bar{R}_{pi} - R_f = \gamma_0 + \gamma_1 \beta_i + \varepsilon_i$$

BJS found a relatively high correlation between the portfolio risk premiums and their beta and a slope co-efficient, γ_1, that was consistent with the market risk premium.

Similar to the BJS study, Fama and MacBeth also used portfolio returns in their first- and second pass-tests. The cross-sectional equation they tested was of the form

$$\bar{R}_{pi} = \gamma_0 + \gamma_1 \beta_{pi} + \gamma_2 \beta_{pi}^2 + \gamma_3 \sigma(\varepsilon_{pi}) + \varepsilon_i$$

Fama and MacBeth found γ_1 significant and consistent with the size of the market risk premium. Furthermore, they found that over the sample period the coefficients γ_2 and γ_3 were small and not significantly different from zero, indicating that residual errors and β^2 were not significant explanatory variables.[4] Thus, in contrast to the Lintier study, the Fama and MacBeth study provides support that there is a linear relation between investment returns and systematic risk and that systematic risk is the only relevant factor in determining an investment's equilibrium return.

BLOOMBERG: AN APPLICATION OF FIRST- AND SECOND-PASS TESTS

The average returns and betas for stocks, portfolios, or investment funds can be generated in RV.

EXAMPLE

1. Create a portfolio in PRTU of stocks or funds (e.g., 20 investment funds with different investment styles selected using FMAP).
2. Bring up the RV screen for one of the securities and type RV.
3. On the security's RV screen, import the portfolio into RV (Comp Source: Portfolio; Name).
4. Customize the RV screen (e.g., creating new columns for beta and returns by typing adjusted beta or beta and total returns in the amber box).
5. Click “Excel” in the Output dropdown to export the RV information to Excel.
6. In Excel, use the Excel commands to find the intercept and slope and other regression statistics (see Exhibit 6.13).

Data for conducting cross-sectional analysis also can be done using the Bloomberg Add-In for Excel (see Chapter 2 for a description on Bloomberg Excel Add-In). On the Bloomberg Add-In, click “Real/Current” from the “Import Data” and “Real-Time/Historical” dropdowns (see the Bloomberg exhibit box in Chapter 6: Bloomberg Excel Add-In: Cross-Sectional Multiple Regression).

BLOOMBERG HRA AND BETA APPLIED TO PORTFOLIOS AND FUNDS

The regression of a diversified portfolio (put in a CIXB basket) or a diversified investment fund against the S&P 500 often shows a regression with a high R^2 and t-statistic, suggesting that portfolios often diversify away the unsystematic risk. In contrast, examining stocks regressed against the market using HRA or Beta, often shows low R^2 and high t-statistics.

See Bloomberg Web Exhibit 9.2.

Application of CAPM: Wells Fargo Stock Selection Approach

Today, many practitioners estimate betas or use estimated betas found in several investment publications to determine the required returns on capital investment projects and stocks they are evaluating. Several years ago Wells Fargo used as one of its investment strategies a first and second test empirical model as part of their stock investment approach. The Wells Fargo stock selection approach consisted of four steps:

- **Step 1:** An analyst estimates the rate of return on a stock using the three-period discounted cash flow valuation model (see Chapter 3). This requires estimating dividends per share for next year, D_1, the growth rate in dividends, g, for the next five years, determining the length of the transitional period, and estimating the steady state growth rate. Given this model, the analyst then solves for the discount rate, k_e, given the current market price of the stock. The table in Exhibit 9.5 shows an example of an estimated dividend flow for a stock using the three-stage growth model. The rate of return on the stock is k = 7.5% given the stock is trading in the market at $40.40. This rate is obtained by solving for the discount rate k that equates the present value of the estimated dividend flow to the price of $40.40:

$$P_0 = \$40.40 = \frac{\$0.80}{(1+k)^1} + \frac{\$0.97}{(1+k)^2} + \frac{\$1.17}{(1+k)^3} + \frac{\$1.39}{(1+k)^4} + \frac{\$1.63}{(1+k)^5} + \frac{\$1.75}{(1+k)^6} + \frac{\$1.85}{(1+k)^7} + \frac{\$1.94}{(1+k)^8} + \frac{\frac{\$2.02}{k-0.04}}{(1+k)^8} \Rightarrow k = 0.075$$

- **Step 2:** The analyst estimates the beta of the stock. This could be the stock's historical beta, adjusted beta, or a forecasted one. For the above stock, suppose the analyst estimates its beta to be 0.80.
- **Step 3:** Wells Fargo takes the estimated *k* and beta combinations for all stocks being analyzed and runs a cross-sectional regression to generate an ex-ante SML. See the figure in Exhibit 9.5.
- **Step 4:** Wells Fargo includes stocks in the portfolio with positive excess returns (stocks with *k* and beta coordinates above the estimated SML) and rejects stocks with negative excess returns (those with coordinates below the line). The stock in this example would be accepted.

Period	Year	Earnings per Share	Earnings per Share	Dividend/ Earnings	Dividends per Share
	1	$2.00	$2.00	0.4	$0.80
	2	$2.00(1.08)	$2.16	0.45	$0.97
Growth = 8%	3	$2.14(1.08)	$2.33	0.5	$1.17
	4	$2.29(1.08)	$2.52	0.55	$1.39
	5	$2.45(1.08)	$2.72	0.6	$1.63
Transitional	6	$2.93(1.07)	$2.91	0.6	$1.75
Growth = 7%, 6%, and 5%	7	$6.38(1.06)	$3.09	0.6	$1.85
	8	$6.89(1.05)	$3.24	0.6	$1.94
Steady State: Growth Rate = 4%	9	$7.38(1.04)	$3.37	0.6	$2.02

Period	Year	Earnings per Share	Earnings per Share	Dividend/ Earnings	Dividends per Share

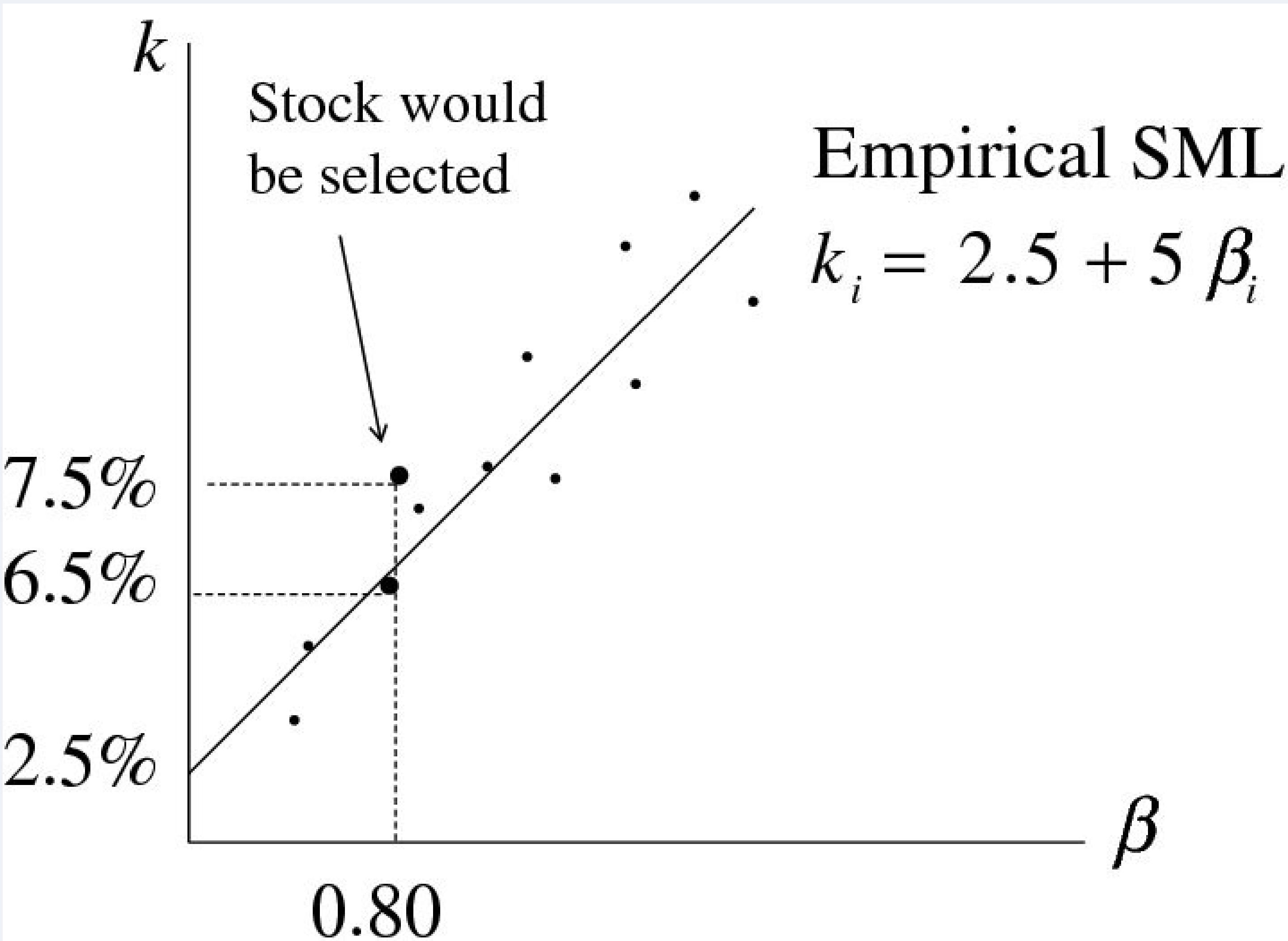


EXHIBIT 9.5 Wells Fargo

APPLYING THE WELLS FARGO APPROACH USING BLOOMBERG'S DDM MODEL AND ADJUSTED BETAS

The Bloomberg's DDM model estimates the intrinsic value of a selected equity using a three-stage growth model. The model also estimates the IRR: The discount rate that equated the present value of the stock's dividends and terminal value at beginning of the maturity stage. The model is similar to the methodology used by Wells Fargo analysts to estimate a stock's return (*k*).

- On 8/30/2013, the Bloomberg DDM screen for Procter & Gamble showed P&G with a market price of 77.89 and an IRR of 8.614%. The Beta screen for P&G on 8/30/2013 showed P&G with an adjusted beta of 0.706 for the regression period from 8/30/2006 to 8/30/2013.
- If an analyst concurred with the default assumptions underlying the DDM model and the adjusted beta as the best estimate of P&G's true beta, then she could include them as one-return beta stock.

BLOOMBERG EXCEL ADD-IN

Data for conducting cross-sectional analysis can be done using the Bloomberg Add-In for Excel (see Chapter 2 for a description on Bloomberg Excel Add-In). Steps to run a cross-sectional regression of DDM returns against betas are as follows:

- On the Bloomberg Add-In, click “Real/Current” from the “Import Data,” “Real-Time/Historical,” and “Historical/Current” dropdowns.
- On the Bloomberg Data Wizard Box, Step 1, click “indexes” in the “From” dropdown and “Dow Jones Average” from the “Indexes” dropdown, and then click “Add All.” This will bring up the Dow stocks. Once loaded, click “Next.”

- On the Bloomberg Data Wizard Box, Step 2, search for DDM by typing DDM in "Search Text" box and hit <Enter>. From the list, select "DDM Internal Rate," and then click "Add."
- On the Bloomberg Data Wizard Box, Step 2, search for the adjusted beta by typing beta in "Search Text" box and hit <Enter>. From the list, select "Overridable Adjusted Beta," and click "Add."
- After loading DDM and beta, click "Next."
- On the Bloomberg Data Wizard Box, Step 3, click "Finish" to export the data to Excel.

BLOOMBERG RVC SCREEN—RETURN-BETA SPACE

The RVC displays scatter data for a security (stock or fund) and its peer group. The screen allows you to select from a variety of analysis criteria and peer group types and sizes. By selecting return and beta combinations for stocks or funds and their peers you can create an ex-post return and beta space for identifying stocks or funds with abnormal returns.

See Bloomberg Web Exhibit 9.3.

Conclusion

The empirical work examining the validity of the CAPM is not definitive. Although studies by Fama and MacBeth, as well as some more recent studies, provide some support for the standard form of the CAPM, there are other studies (some discussed in the next chapter) suggesting that factors other than systematic risk are important in determining a security's equilibrium return. There is also some empirical evidence supporting nonstandard forms of the CAPM, that is, CAPMs derived from relaxing some of the model's assumptions: different borrowing and lending rates, tax impacts, nonmarketable securities, and heterogeneous expectations. The empirical evidence supporting the nonstandard forms of the CAPM are also nonconclusive. Finally, there has been strong criticism directed at the empirical methodology used to test the CAPM. In a 1977 article in the *Journal of Financial Economics*, Richard Roll argued that the CAPM may not be amendable to testing. He contended that tests using any portfolio other than the true market portfolio are not appropriate tests of the CAPM; rather, they are simply tests of whether the portfolio being used is a good proxy for the market portfolio.

Although the evidence in support of CAPM may not be conclusive, and Roll's criticism has merit, the CAPM is still an important model in finance. Since its introduction in the 1960s, the CAPM has been used by analysts and academics to determine required returns on stock investment and to solve capital budgeting problems. Today, many practitioners estimate betas or use estimated betas found in several investment publications to determine the required returns on capital investment projects and stocks they are evaluating. In addition to determining required returns for valuation, the CAPM has also been used in many academic studies to determine whether abnormal returns (returns significantly different from the CAPM's equilibrium return) can be earned from certain types of investments. Some of these studies will be discussed in Chapter 15, when we examine the efficient market hypothesis. Finally, the CAPM has been used to define and justify investment strategies, such as the construction of index funds with a portfolio beta of one, and market timing in which active investors move into high beta stocks in anticipation of a bull market or low beta stock in anticipation of a bear market.

EQRP: BLOOMBERG'S EQUITY RISK PREMIUM SCREEN

The EQRP screen shows a stock's risk premium. The premium is equal to the forecasted market risk premium $E(R^M) - R_f$ times the stock's beta. The forecasted market risk premium forecast the market rate based on a projected market rate and risk-free rate. The risk-free rate is the 10-year Treasury for the country. Beta is the historical beta. The user can change the market risk-premium and beta. The screen also shows the historical premiums and betas.

Notes

1. This section is based on our earlier discussion of the security market line. See Chapter 6.

2. For a security with a return and beta combination below line RABCD, arbitrageur would short the security and use the proceeds to invest in a portfolio of A and C with the same beta as the security.

3. In constructing portfolios, BJS began by using the first five years of monthly data in their sample to estimate the betas of each stock. They next ranked the stocks in the order of their betas, formed 10 descile portfolios, and then calculated the monthly rates of returns for the portfolios for the sixth year. BJS then took the stock return data for years two through six in the sample to estimate betas, rank stocks, and form the descile portfolios; they then calculated the monthly rates of returns for portfolios for year seven. BJS repeated this process until they obtained 35 years of data for each descile portfolio.

4. The β^2 term makes the regression equation nonlinear if its coefficient is significantly different from zero. Fama and MacBeth found the coefficient was not significantly different from zero, supporting a linear relationship.

Selected References

Black, Fisher, N. Jensen, and M. Scholes. 1972. The capital asset pricing model: Some empirical tests. In *Studies in the Theory of Capital Markets*. Edited by M. Jensen. New York: Praeger.

Elton, Edwin, and Martin Gruber (eds). 1979. *Portfolio Theory 25 Years Later*. Amesterdam: North Holland.

Elton, Edwin J. 1999. Presidential address: Expected return, realized return, and asset pricing tests. *Journal of Finance* 54 (August): 1199–1220.

Fama, Eugene. 1973. Risk, return, and equilibrium: Empirical test. *Journal of Political Economy* 79 (January/February): 30–55.

Fama, Eugene. 1976. *Foundations of Finance*. New York: Basic Books.

Fama, Eugene, and James MacBeth. 1973. Risk, return, and equilibrium: Empirical test. *Journal of Political Economy* 38: 607–636.

Grossman, S., and R. Shiller. 1987. Estimating the continuous-time consumption-based asset-pricing model. *Journal of Business and Economic Statistics* 5: 315–328.

Jarrow, Robert, and Andrew Rudd. 1983. A comparison of the APT and SML. *Journal of Banking and Finance* 7 (June): 295–303.

Kroll, Yoram, and Haim Levy. 1992. Further tests of the Separation Theorem and the Capital Asset Pricing Model. *The American Economic Review* 82 (June): 664–670.

Lintner, John. 1965. Security prices, risks, and maximum gains from diversification. *Journal of Finance* (December): 587–615.

Mossin, J. 1966. Equilibrium in a capital asset market. *Econometrika* 34 (October): 768–783.

Roll, Richard. 1973. Evidence on the "Growth-Optimum" Model. *Journal of Finance* 28 (June): 551–556.

Ross, Stephen. 1978. A simplified approach to the valuation of risky streams. *Journal of Business* 51 (July): 453–475.

Roy, A. D. 1952. Safety first and the holding of assets. *Econometrics* 10 (July): 432–449.

Sharpe, William F. 1963. A simplified model for portfolio analysis. *Management Science* (January): 277–293.

Sharpe, W.F. 1964. Capital asset price: A theory of market equilibrium under conditions of risk. *Journal of Finance* (September): 425–442.

Bloomberg Exercises

1. Use Bloomberg FMAP, FSRC, or SECF (see "Bloomberg Funds Search Box" in this exercise section) to select a number of different types of equity funds, such as, index, value, growth, small-cap, and large-cap fund: See Bloomberg Box: "Bloomberg: An Application of First- and Second-Pass Tests."
    1. Conduct a first-pass test for each fund using the HRA screen by regressing the fund's returns against market returns. Use S&P 500 (SPX) or Russell 3000 (RAY) and select a data time period you think is appropriate.
    2. Comment on your regression findings. Based on your findings, comment on the CAPM premise: "Investors with a portfolio can diversify away unsystematic risk."
    3. Using the Fund's COMP screen as a guide, determine each fund's total return. On the COMP screen, specify the data time period and then use the annualized return appearing in the upper right corner of the screen.
    4. Using Excel, conduct a second-pass test with the returns and betas you found in 1a and 1b. See Bloomberg Exhibit Box: "Bloomberg: An Application of First- and Second-Pass Tests."

Bloomberg Funds Search

1. FMAP <Enter>.
2. FSRC Search: Use FSRC to search for funds.
   Click Results tab.
   Create a portfolio of the funds in PRTU.
3. SECF: Click Funds Tab.
4. RUSS <Enter>; Click “Russell Index Ticker” to bring up a PDF with Ticker listing.
5. SPX <Enter> to bring up screen for identifying S&P indexes and tickers.

---

2. Create a portfolio of different types of indexes. To find a listing of different types of Russell indexes go to the Russell page (RUSS) <Enter> and click “Russell Index” to bring up a PDF with a listing of Russell indexes. For S&P indexes, enter: SPX <Enter>. Indexes can also be found using the SECF screen.
   1. Use the CORR screen to create a nonsymmetrical matrix of your indexes: CORR <Enter>; click Create tab; enter data time period; enter index's ticker in the row matrix and the S&P 500 (SPX) in the column matrix. Compare the R^2's, betas, and alphas of the indexes. Comment on the systematic and unsystematic risk you observe for the indexes.
   2. Examine several of your indexes using the HRA or beta screen: Fund Ticker <Index> <Enter>; HRA. You may want to consider the period from 2008 to the present.
   3. Find the total returns for the indexes you analyzed in 2b using the fund's COMP screen. The annualized return appears in the right corner of the screen. Consider the period from 2008 to the present.
3. Generate a graph of the portfolio return and beta combination obtained from the market portfolio and the risk-free security. For the market portfolio, calculate the average return for the S&P 500 (SPX), and for the risk-free rate, use the average yield for 10-year U.S. Treasury (USGG10yr). For the S&P 500, you may want to use the S&P 500 COMP screen (SPX <Index> <Enter>; COMP) and consider the

period from 2008 to the present. For the 10-year Treasury yield, you may want to use the average yield for the same period (USGG10yr <Index>; GP screen; Ask yield, and look for average in the screen's summary box).

   1. Are the return and beta combinations of the indexes you analyzed in 2 above or below the line you generated? Explain the arbitrage portfolio you would construct if an index is not on the line.
   2. Comment on the following statement: "If all securities and investments are explained by just two factors—expected return and beta—then all of the equilibrium return and beta combinations available in the market can be generated from the return and beta combinations formed from any two investments."

4. The RVC displays scatter data for a security (stock or fund) and its peer group. The screen allows you to select from a variety of analysis criteria and peer group types and sizes. Select a stock or investment fund and then use its RVC screen to create an ex-post return and beta space for identifying stocks or funds with abnormal returns. For an example, see the Bloomberg Web Exhibit 9.3 (text Web site).
5. Select a number of stocks to analyze using the Wells Fargo Stock Selection Approach. In selecting your stocks, you may want to consider some of the stocks that make up an index or all the stocks that are included in the Dow.
   1. Use Bloomberg's DDM model to estimate each of your stock's returns (IRR). You can use Bloomberg's default assumptions used in their DDM model or change them.
   2. Use the Bloomberg's Beta screen for each of your stocks to estimate their betas. Select a time period you think is appropriate and use either the raw beta or adjusted beta.
   3. Estimate an ex-ante SML relation by running a cross-sectional regression of the returns and betas of your stocks. To use Excel for your regressions, see Exhibit 6.16 and Bloomberg Exhibit Box: "Bloomberg: An Application of First- and Second-Pass Tests."
   4. Calculate the excess return of each stock to determine which stock you would include in your portfolio.

6. Use the Bloomberg Excel Add-in to run a second-pass test in Excel. Consider: for your stocks, the stocks composing the DJIA or the S&P; for rates of return, the internal rates of return calculated from Bloomberg's DDM model; and for betas, the stocks' adjusted betas. See Bloomberg Exhibit Box, “An Application of First- and Second-Pass Tests,” for an example of using regression analysis in Excel. For a guide to using the Bloomberg Excel Add-in, see Bloomberg Web Exhibit 9.2 (text Web site) and Bloomberg box: “Applying the Wells Fargo Approach Using Bloomberg's DDM Model and Adjusted Betas.”