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where: $E(K)$ = expected return, or cost of capital
$E(R_F)$ = expected risk-free rate
$E(\beta)$ = expected beta
$E(R_M)$ = expected market return

The difficulty is that the CAPM model is a prospective model while most of the available capital market data required to match the three theoretical input variables (expected risk-free return, expected beta, and expected market risk premium) are historical. None of the input variables exists as a separate identifiable entity. It is thus necessary in practice to employ different proxies, with different results obtained with each set of proxy variables. Each of the three required inputs to the CAPM is examined below.

5.4 CAPM Application: Risk-free Rate

To implement the CAPM methodology, an estimate of the risk-free return is required. As a proxy for the risk-free rate, long-term rates are the relevant benchmarks when determining the cost of common equity rather than short-term or intermediate-term interest rates.[4] There are several reasons for this, both conceptual and practical.

At the conceptual level, because common stock is a long-term investment and because the cash flows to investors in the form of dividends last indefinitely, the yield on very long-term government bonds, namely, the yield on 30-year Treasury bonds, is the best measure of the risk-free rate for use in the CAPM and Risk Premium methods.[5] The expected common stock return is based on long-term cash flows, regardless of an individual's holding time period. Utility

[4] The absence of new long-term Treasury bond issues does not negate the use of long-term Treasury bond yields as proxies for the risk-free rate in the CAPM. For example, in the early 2000s, the Treasury temporarily ceased to issue 30-year Treasury bonds. In the same way that we can use stock prices in the application of the DCF model to a given company even though that company has not issued stock in the recent past, we still can rely on bond prices of 30-year Treasury bonds and the implied yields. As long as such bonds are actively traded on secondary markets, they provide useful price/yield signals and proxies for the risk-free rate.

[5] By definition, the beta of risk-free securities is zero. Financial theory, for example Modigliani-Miller's capital structure paradigm, generally assumes that debt, particularly government, is risk free, that is, that it has no default risk or that default risk is completely diversifiable (Beta = 0). Most financial scholars and finance textbooks make the commonplace assumption that the beta of debt is zero. Although it is difficult to measure the beta risk of a bond because a bond's maturity and coupon have a significant effect on the volatility of its prices, the beta of debt is very close to zero in practice.

asset investments generally have long-term useful lives and should be correspondingly matched with long-term maturity financing instruments. Moreover, short-term Treasury Bill yields reflect the impact of factors different from those influencing the yields on long-term securities such as common stock. For example, the premium for expected inflation embedded into 90-day Treasury Bills is likely to be far different than the inflationary premium embedded in the yields of long-term securities. On grounds of stability and consistency, the yields on long-term Treasury bonds match more closely with expected common stock returns. Finally, yields on 90-day Treasury Bills typically do not match the investor's planning horizons. Equity investors generally have an investment horizon far in excess of 90 days.

At the practical level, short-term rates are volatile, fluctuate widely, and are subject to more random disturbances than are long-term rates, leading to volatile and unreliable equity return estimates. Short-term rates are also largely administered rates. For example, Treasury Bills are used by the Federal Reserve as a policy vehicle to stimulate the economy and to control the money supply, and are used by foreign governments, companies, and individuals as a temporary safe harbor for money.

While long-term Treasury bonds are potentially subject to interest rate risk, and are not theoretically "risk-free," this is only true if the bonds are sold prior to maturity. A substantial fraction of bond market participants, usually institutional investors with long-term liabilities[6] (pension funds, insurance companies), in fact, hold bonds until they mature, and therefore are not subject to interest rate risk.

Another way in which institutional investors immunize themselves against interest rate risk is by buying a pure discount bond (also known as a zero-coupon bond) with a maturity equal to their investment horizon and holding that bond until it matures.[7] This works because there are no cash flows to

[6] The case of pension funds is noteworthy. If the assets of a pension fund are invested in bonds, the duration (i.e. weighted maturity) of the assets can be computed. The duration of the obligations to retirees, analogous to interest payments on debt, can be calculated as well. Managers of pension funds therefore choose pension assets whose duration is matched with the duration of the liabilities. In this way, changing interest rates do not affect the net worth of the pension fund. In a similar fashion, insurance firms invest on bonds where the duration of the bonds is matched to the duration of the future death benefits.

[7] The question arises as to whether the yield on coupon-paying bonds differs from the yield on the zero-coupon bonds. Whether a zero-coupon bond has a higher or lower yield than a coupon-paying bond of the same maturity is a function of investor expectations as to future interest rates (shape of the yield curve), that is, at what rate the coupons are to be reinvested. The important point is that when considering

reinvest and there is no price risk if the bond is held to maturity. Holding a zero coupon bond eliminates reinvestment risk and interest rate risk as well if held to maturity. In the case of coupon bonds, this simple strategy has to be refined. It is still true that price risk is avoided if the bonds are held to maturity, but there remains reinvestment-rate risk since the coupons need to be reinvested at some unknown rate. Immunization is achieved by purchasing a coupon bond whose weighted maturity ("duration") is equal to the investment horizon. This works regardless of interest rate movements. If rates decrease, the investor is forced to reinvest coupons at a lower rate but also makes a capital gain on the sale of the bonds at the end of the investment horizon. If rates increase, the capital loss on the sale at the horizon date is offset by the extra cash flow generated from investing the coupon payments at the new higher rate.

In short, institutional bondholders neutralize the impact of interest rate changes by matching the maturity of a bond portfolio with the investment planning period, or by engaging in hedging transactions in the financial futures markets. The merits and mechanics of such immunization strategies are well-documented by academicians and practitioners.

While the spot yield on long-term Treasury bonds provides a reasonable proxy for the risk-free rate, the CAPM specifically requires the expected spot yield. Market forecasts of rates on Treasury bonds are available in the form of interest rate futures contract yields, and can be employed as proxies for the expected yields on Treasury securities. Appendix 5-B discusses the use of interest rate forecasts as proxies for the risk-free rate.

5.5 CAPM Application: Beta Estimate

In Chapter 3, it was shown that beta is a useful, simple, objective measure of risk when used to gauge the relative risks of securities. The relative risk ranking of securities is somewhat immune to the beta estimation method. The situation is different when the objective of estimating beta is to obtain an absolute estimate of the cost of equity for an individual security. In this case, the reliability of the beta estimation technique has a direct effect on the confidence in the CAPM estimate of equity cost.

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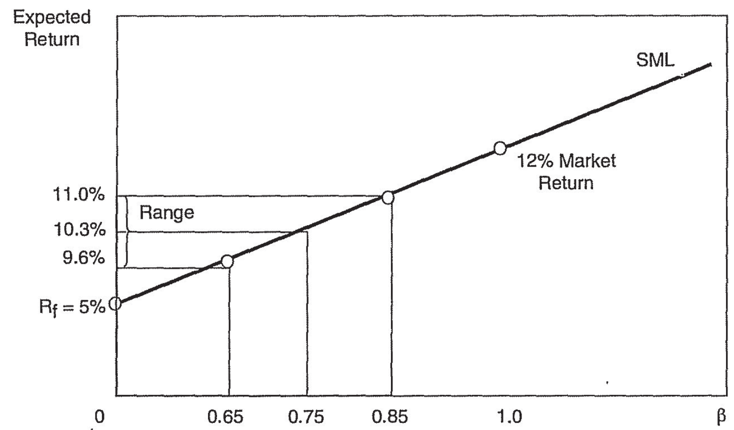
bonds with interim cash flows over the investment horizon, the total return is no longer a sure thing. Changing interest rates can cause the reinvested value of these interim payments to change. In the case of a zero-coupon bond, this problem can be avoided entirely, as no interim cash flows have to be reinvested, and the total return from holding a zero-coupon bond is a sure thing assuming the U.S. government makes the principal payment at maturity.

FIGURE 5-4
CAPM ESTIMATES WITH DIFFERENT BETA ESTIMATES



call option premiums can reveal on a timely basis whether investor risk perceptions are changing and whether beta is changing in some predictable manner.

The final CAPM estimate of equity cost can be sensitized over a range of beta estimates to produce a range of estimates of the cost of equity. A 95% confidence interval, based on the standard error of estimate, around the best estimate of the beta coefficient, can be derived. For example, for a risk-free rate of 5% and a market return of 12%, the CAPM estimate of equity cost for a utility with a beta of 0.75 is 10.3%; if the standard error of estimate of beta is 0.10, beta estimates range from 0.65 to 0.85, with a corresponding range of equity cost of 9.6% to 11.0%. This is shown in Figure 5-4.

5.6 CAPM Application: Market Risk Premium

The last required input to the CAPM is the expected market risk premium return ($R_M - R_F$), which is the difference between the market return and the risk-free rate. There are essentially two methods of estimating the market risk premium: historical and prospective.

Historical Market Risk Premium

The principal approach to assessing the expected market risk premium ("MRP") in the finance literature has been to examine the historical data of realized returns over long time periods. The focus in this literature has been on the U.S. equity market because: 1) it has the most developed capital market, 2) it represents a large proportion of the international capital markets, and 3) it has long time-series of available historical data. More recently, these results have been supplemented by international analyses.

Rationale of the Historical Risk Premium Approach

Expected returns are not directly observable. As a result, realized returns are frequently used as a proxy for expected returns. This is based on the assumption that arbitrage will result in deviations between expected returns and realized returns (''surprises'') that are unpredictable and are zero-mean, that is, will cancel out, in which case realized returns provide an unbiased estimate of what returns had been expected for that period. Although realized returns for a particular time period can deviate substantially from what was expected, it is reasonable to believe that long-run average realized returns provide an unbiased estimate of what were expected returns. This is the fundamental rationale behind the historical risk premium approach. Analysts and regulators often assume that the average historical risk premium over long periods is the best proxy for the future risk premium.

Given the significant period-to-period variations in the risk premium, altering the sample period when calculating the average is dangerous because it can markedly influence the estimate. To avoid data mining, a reasonable solution is to use the entire period for which reliable data is available. Finer partitioning of the sample data, even when performed with the best intentions, raises the specter of introducing bias.

Arithmetic vs Geometric Average

One major issue relating to the use of realized returns when estimating the market risk premium from historical return data is whether to use the ordinary average (arithmetic mean) or the geometric mean return. Because valuation is forward-looking, the appropriate average is the one that most accurately approximates the expected future rate of return. The best estimate of expected returns over a given future holding period is the arithmetic average. As was thoroughly discussed in Chapter 4 and Appendix 4-A, only arithmetic means are correct for forecasting purposes and for estimating the cost of capital. There is no theoretical or empirical justification for the use of geometric mean rates of return as a measure of the appropriate discount rate in computing the cost of capital or in computing present values. In any event, the CAPM is developed on the premise of expected returns being averages and risk being measured with standard deviation. Since the latter is estimated around the arithmetic average, and not the geometric average, it is logical to stay with arithmetic averages to estimate the market risk premium. If in fact annual returns are uncorrelated over time, and the objective is to estimate the market risk premium for the next year, the arithmetic average is the best unbiased estimate of the premium.

Length of Historical Period

To estimate the MRP, one should rely on returns realized over long time periods rather than returns realized over more recent time periods because realized returns can be substantially different from prospective returns anticipated by investors, especially when measured over short time periods. But over very long periods, investor expectations coincide with realizations; otherwise, investors would never invest any money. A risk premium study should consider the longest possible period for which data are available. Short-run periods during which investors earned a lower risk premium than they expected are offset by short-run periods during which investors earned a higher risk premium than they expected. Moreover, the use of the entire study period in estimating the appropriate market risk premium minimizes subjective judgment and encompasses many diverse regimes of inflation, interest rate cycles, and economic cycles. There is no compelling reason to weigh recent returns more heavily than distant returns because of the random behavior of the market risk premium.

From a statistical viewpoint, to the extent that the historical equity risk premium estimated follows what is known in statistics as a random walk, one should expect the equity risk premium to remain at its historical mean. The best estimate of the future risk premium is the historical mean. Since, as discussed in Chapter 4, there is little evidence that the MRP has changed over time, it is reasonable to assume that these quantities will remain stable in the future. Clearly, the accuracy of the realized risk premium as an estimator of the prospective risk premium is enhanced by increasing the number of years used to estimate it. By analogy, one cannot predict with any reasonable degree of accuracy the result of a single, or even a few, flips of a balanced coin. But one can predict with a good deal of confidence that approximately 50 heads will appear in 100 tosses of the coin. Under these circumstances, it is most appropriate to estimate future experience from long-run evidence of investment performance.

Historical Market Risk Premium: U.S. Capital Markets

Ibbotson Associates' annual valuation yearbook is a primary source of data on U.S. capital market returns. This annual publication compiles monthly returns to various asset classes from 1926 to date. From Ibbotson Associates (2005), a broad market sample of U.S. common stocks outperformed long-term U.S. government bonds by 6.6% over the 1924–2004 period. The historical market risk premium over the income component of long-term Treasury bonds rather than over the total return is 7.2%. Ibbotson Associates recommend the use of the latter as a more reliable estimate of the historical market risk premium. This is because the income component of total bond return (i.e. coupon rate) is a far better estimate of expected return than the total return (i.e. coupon rate + capital gain), as realized capital gains/losses are largely unanticipated by investors. This is not the case with total returns, which can be biased by unanticipated capital losses due to adverse interest rate movements. Bond income returns are a valid measure of expectation, whereas historical bond total returns are biased estimates of the expected return.[10] Stocks do not have an easily observable measure of expected return comparable to a bond's yield to maturity, and therefore total stock returns must be employed.

Dimson, Marsh and Staunton (2002) compile historical rates of return on stocks and bonds for the 1900–2000 period for U.S. capital markets. Brealey, Myers, and Allen (2006) update the results to 2003. Since 1900, Treasury bills have provided an average return of 4.1% while common stocks provided an average return of 11.7%, inferring a risk premium of 11.7% − 4.1% = 7.6% over the return on Treasury bills.

It has been common practice to assume that this historical result provides an adequate basis for the expected MRP. In their best-selling aforementioned textbook, Brealey, Myers, and Allen (2006) review the current state of the research and state:

> We have no official position on the exact market risk premium, but we believe a range of 6 to 8.5 percent is reasonable for the United States. We are most comfortable with figures toward the upper end of the range.

Because they are referring to the premium over Treasury Bills which is about 1.5% greater than the premium over bonds according to Ibbotson (2005), this implied that they would look to the upper end of a range of 4.5% to 7% for the MRP.

Some authors, Siegel (1999) for example, have examined historical data over even longer time series, including data prior to 1926, some dating back to 1802. An obvious question is whether data on capital market behavior from

[10] The income return represents the truly risk-free portion of the bond return. Interest rates generally rose over the 1926–2004 period, causing capital losses on the long-term bond historical series. This negative return is due to the risk of unanticipated changes in interest rates. Any anticipated changes in interest rates are already priced into the bond yield by market participants. Thus, the total return on the bond series does not represent the risk-free rate of return. The income component better represents the risk-free rate because an investor can hold a bond to maturity and is certain of obtaining the income return and return of principal with no capital loss.

the 19th century are relevant for estimating return in the 21st century. The major concern with the Siegel data for a period beginning in 1802 is the reliability of the data. The stock market of the early 1800s was severely limited, embryonic in scope, with very few issues trading, and few industries represented. Dividend data were unavailable over most of this early period and stock prices were based on wide bid-ask spreads rather than on actual transaction prices. The difficulties inherent in stock market data prior to the Great Depression are discussed by Schwert (1990).

Booth (1999) examines both nominal and real equity risk premiums from 1871 to 1997. He concludes that the real equity return has been about 9% over this period. He suggests adding the expected inflation rate to this number to estimate the expected return on equity. For example, if the expected inflation rate is 3%, the market return on equity is 9% + 3% = 12%. If the risk-free rate is 5%, the market risk premium is therefore 12% − 5% = 7%.

Market Risk Premium: International Capital Markets

Dimson, Marsh, and Staunton (2002) report on returns over the period 1900 to 2000 for twelve countries, representing 90% of today's world market capitalization. They report an average risk premium over long-term bond returns over all countries of 5.6%, with the U.S. at 7.0%. The premium was generally higher for the second half century than for the first. For example, the U.S. had 5% in the first half, compared to 7.5% in the second half.

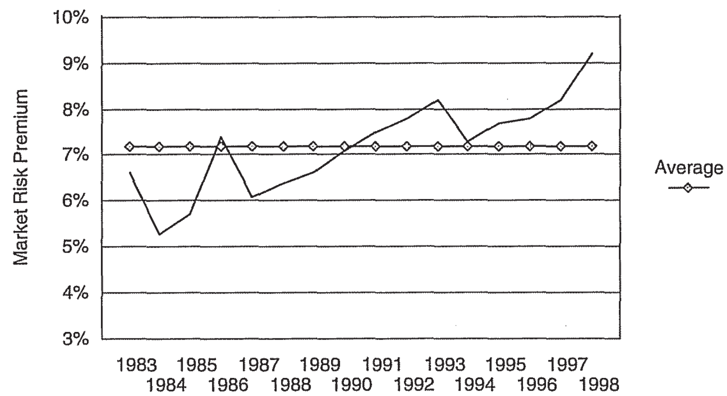
The Hatch-White (1988) compilation of historical returns on Canadian securities from 1950 to 1987 shows that a broad market sample of common stocks outperformed long-term Canada bonds by 6.9%, or close to 7%. The annual update to the Canadian Institute of Actuaries study,[11] *Report on Canadian Economic Statistics 1924–2004*, shows that the average observed aggregate risk premium between stocks and long-term government bonds over a very long period is equal to 5.2%. Of course, the historical market risk premium over the income component of long-term bonds rather than over the total return is presumably higher, probably some 60 basis points higher if we rely on the U.S. studies over the same period, but is unreported in that study.

Prospective Market Risk Premium

A second approach to estimate the MRP is prospective in nature and consists of applying the DCF model to a representative market index, such as the Standard & Poor's 500 Index, Value Line Composite, or the New York Stock Exchange Index. For reasons of consistency, the market index employed

[11] Annual updates are available on the Canadian Institute of Actuaries Web site.

FIGURE 5-5
MARKET RISK PREMIUM ESTIMATE
1983–1998



Source: Harris, Marston, Mishra, O'Brien (2003).

should be the same as the market index used in deriving estimates of beta. If risk premiums are volatile, this method of directly measuring R_M is preferred. Subtracting the current risk-free rate from that estimate produces a valid estimate of the market risk premium. The previous chapter outlined the specifics of the methodology to measure the aggregate market return based on the DCF method.

Typical of the approach are the empirical studies by Harris and Marston (2001) and Harris, Marston, Mishra, and O'Brien (2003) that provide estimates of the expected returns for S&P 500 companies over the period 1983–1998. The authors measure the expected rate of return (cost of equity) of each dividend-paying stock in the S&P 500 for each month from January 1983 to August 1998 by using the constant growth DCF model. The prevailing risk-free rate for each year is then subtracted from the expected rate of return for the overall market to arrive at the market risk premium for that year. Figure 5-5 displays the estimated prospective risk premium for each year from 1983 to 1998. The average market risk premium estimate for the overall period is 7.2%.

Another good example of the prospective approach to estimate the MRP is provided by VanderWeide (2005), who finds an MRP of 7.5%. A similar prospective study by Ibbotson and Chen estimates an MRP of 5.90% on an arithmetic basis. It is noteworthy that the authors conclude their paper by stating that their estimate of the equity risk premium is ''*far* closer to the historical premium than being zero or negative.''

In his 2001 presidential address to the American Finance Association, just prior to the stock market's debacle, Constantinides (2002) presented the results of his research on the unconditional equity premium based on average historical stock returns. After adjusting the average returns downward by the change in price-earnings in order to eliminate the change in valuations in an unconditional state, his estimates of the MRP over the 3-month T-Bill rate are 8.0% and 6.0% for 1926 to 2000 and 1951 to 2000, respectively. These results suggest that with a maturity premium of Treasury bonds over Treasury bills of 1%–1.5%, the resulting MRP estimate over Treasury bonds is 5% to 7%.

Finally, in yet another line of research, Kaplan and Ruback (1995) compared published cash flow forecasts for management buyouts and leveraged recapitalization over the 1983 to 1989 period against the actual market values that resulted from these transactions. Based on a careful analysis of actual major investment decisions rather than realized market returns, Kaplan and Ruback estimate an MRP of 7.97% over long-term Treasury bond yields.

A study by Mehra and Prescott (2003) questioned the magnitude of historic equity risk premiums relative to fundamentals. There are two revealing passages from Professors Mehra and Prescott's review of the theoretical literature on the MRP:

> Even if the conditional equity premium given current market conditions is small, and there appears to be general consensus that it is, this in itself does not imply that it was obvious either that the historical premium was too high or that the equity premium has diminished.
>
> In the absence of this [knowledge of the future], and based on what we currently know, we can make the following claim: over the long horizon the equity premium is likely to be similar to what it has been in the past and the returns to investment in equity will continue to substantially dominate that in T-bills for investors with a long planning horizon.

Market Risk Premium: Survey Techniques

Surveys of academics and investment professionals, for example the Welch (2000, 2001) surveys, provide another technique of estimating the MRP. While this technique has the benefit of being forward-looking, it is subject to the well-known shortcomings of survey techniques. There are several reasons to place little weight on survey results relative to the results from other approaches. First, return definitions and risk premium definitions differ widely. Second, survey responses are subject to bias. Surveys may tell more about