Chapter 13

International Capital Market Equilibrium

A manager should allocate capital to an investment project when the present value of the net cash flows generated by the project exceeds the current investment outlay. Applying this net present value principle requires a discount rate. It is one of the hallmarks of modern finance that this discount rate—the cost of equity capital—is set by investors in the capital markets. When investors finance a firm by purchasing its equity shares, they forgo the opportunity to invest in the equities of many other firms. Therefore, investors demand to be compensated for the opportunity cost of their investment with an appropriate expected rate of return. Consequently, the manager of a firm in a capital budgeting situation should set the discount rate for a project to be the expected return for the firm's investors as if they were investing directly in that project.

Chapter 11 showed that the international bond market sets the cost of a company's debt equal to the risk-free (government) interest rate on bonds plus a risk premium to compensate for the possibility that the company may default on the debt. The appropriate rate for discounting the equity cash flows of any project similarly depends on how risky the investors in the firm view the cash flows from that particular project to be. However, thinking about risk in increasingly global equity markets is difficult because there are many more factors involved.

How, then, do investors determine the riskiness of an investment, and how do managers know the required rate of return on a risky investment? Unfortunately, there are no easy answers to these questions, and there are competing theories. This chapter develops the theories necessary to determine the cost of equity capital. It then demonstrates how these theories apply in an international context. Because investors set the cost of equity capital, we start with a detour through the fascinating world of international investing and the theory of optimal portfolio choice. The idea of portfolio diversification figures prominently, and we will argue that international diversification is highly desirable. BlackRock, the world's largest asset manager with over $3 trillion, has this advice on its iShares Web site (http://us.ishares.com/home.htm) in response to the question, "Why invest internationally?":[1]

> A strategic allocation to international securities may enhance a portfolio's risk-adjusted returns, provide portfolio diversification, and offer opportunities to seek higher performance. And when those securities are not hedged, international investing can offer pure exposure to local equity and currency returns.

> Let's explore why they think this.

---

[1]BlackRock's iShares are exchange-traded funds (ETFs), which are securities that trade on stock exchanges like ordinary equity shares are managed to replicate the performance of a specific country index or industrial sector.

13.1 RISK AND RETURN OF INTERNATIONAL INVESTMENTS

The old saying "Don't put all your eggs in one basket" should entice investors to explore foreign stocks, perhaps in exotic places. As Chapter 12 indicates, global stock markets offer investors an incredible menu of choices, offering potentially higher rates of return and different types of risks. To understand the benefits and pitfalls of international investments, we must fully understand what determines risk and return in international markets. This necessitates that we understand how currency fluctuations affect international investments.

The Two Risks of Investing Abroad

When a U.S. investor is bullish about the British stock market, she must realize that investing in the British equity market also implies an exposure to the British pound. Let us analytically derive the dollar return on British equity investment. Let $S(t)$ be the $/£ exchange rate, and let $s(t+1) = [S(t+1) - S(t)]/S(t)$ indicate the rate of appreciation of the pound relative to the dollar. We are interested in the dollar rate of return on British equity, which we denote by $r(t+1, \$)$. This return will have two components: the pound rate of return on British equity, denoted by $r(t+1, £)$, and the rate of change in the value of the pound, $s(t+1)$. This reasoning is identical to the derivation of the return on a foreign money market investment in Chapter 6. In this case, however, we replace the foreign interest rate with the foreign equity rate of return. We first convert from dollars to pounds to get $1/S(t)$ pounds, which we will invest. Each pound earns the pound return $1 + r(t+1, £)$ in the equity market. Subsequently, the total pound return is sold for dollars at $S(t+1)$. Thus, the dollar return on a British equity investment is

$$1 + r(t+1, \$) = [1/S(t)] \times [1 + r(t+1, £)] \times S(t+1)$$

Subtracting 1 from each side and using $\dfrac{S(t+1)}{S(t)} = 1 + s(t+1)$ gives

$$r(t+1, \$) = [1 + r(t+1, £)] \times [1 + s(t+1)] - 1$$

or

$$r(t+1, \$) = r(t+1, £) + s(t+1) + r(t+1, £) \times s(t+1)$$

We see that the dollar rate of return on a foreign investment depends on the local equity rate of return plus the currency return plus a cross-product term (the product of the two rates of return). The cross-product term is often small relative to the other two terms because it is percentages of percentages, and it is thus often ignored.

Example 13.1 Determining the Dollar Return of a British Equity Investment

Rob Dickinson of the Catherine Wheel Fund is bullish on British equity and wants to invest $10 million in the British equity market. The spot exchange rate is $1.60/£. At that exchange rate, Rob can convert $10 million into $10/(\$1.60/£) = £6.25 million. He then invests the £6.25 million in the British equity market. Suppose he plans to hold on to the investment for 1 year. During this time, he hopes to earn dividends plus a capital gain. Let's consider three scenarios for the return in the British equity market: an increase in the market value of the stock by 10%, a decrease of 10%, and no change.

After earning the British equity return, Rob can then sell his pound return, which is $(£6.25 \text{ million}) \times [1 + r(£)]$, for dollars. An appreciation of the pound enhances his dollar return, and a depreciation of the pound diminishes his dollar return. Let's consider three possible scenarios for the change in the value of the pound as well: a 10% appreciation (to $\$1.60/£ \times 1.10 = \$1.76/£$), a 10% depreciation (to $\$1.60/£ \times 0.9 = \$1.44/£$), and no change. Consequently, there are a total of nine possible outcomes:

		DOLLAR–POUND EXCHANGE RATES		
		10% Depreciation of the Pound $1.44/£	No Change $1.60/£	10% Appreciation of the Pound $1.76/£
Pound	£5.625 million (−10%)	$8.1 million −19%	$9.0 million −10%	$9.9 million −1%
Stock Returns	£6.25 million (0%)	$9.0 million −10%	$10.0 million 0.0%	$11.0 million 10%
	£6.875 million (+10%)	$9.9 million −1%	$11.0 million 10%	$12.1 million 21.0%

Each cell illustrates the exact dollar returns—that is, the exact percentage change, including the cross-product term. If the news is all good, the pound and the British equity market both appreciate by 10%, and the approximation, which ignores the cross-product term, yields an estimated 20% return. The true number is 21% because the cross-product term is $0.10 \times 0.10 = 0.01$ in this case. Analogously, if the British equity market indeed increases by 10%, as Rob hopes, but at the same time the pound depreciates by 10%, then perhaps you would guess that the return would be zero, as the approximation suggests. The true answer is −1% because now the cross-product term is a negative 1%. For return horizons of 3 months or less, though, the cross-product term is small and can be ignored in computations.

The Volatility of International Investments

Exhibit 13.1 lists several characteristics of the equity markets of the G7 countries. The data are from Morgan Stanley Capital International (MSCI) for the period from January 1980 to August 2010. We first focus on the three volatility columns. Remember that volatility, Vol[r], is defined to be the standard deviation, which is the square root of the variance, Var[r]; it indicates how much returns vary around the mean or average return.

The Volatility of Currency and Equity Returns
For a U.S. investor, such as fund manager Rob Dickinson in Example 13.1, international investments appear to have two problems. First, the volatilities of equity returns in foreign currencies exceed the volatility of U.S. equity returns. In fact, the U.S. market appears to be the least volatile market, with a volatility of only 15.6%. The second-least-volatile market is the United Kingdom, with a volatility of 18.9%. The other three European markets have volatilities exceeding 20%.

Second, Exhibit 13.1 (second to last column) shows that currency changes are pretty variable themselves, with volatilities around 11%, for the most part. The only exception is the substantially lower volatility of the Canadian dollar, which is driven by the close economic

Exhibit 13.1 Characteristics of Foreign Equity Returns, 1980–2010

	Means			Volatilities		
	Market Return	Currency Return	Dollar Return	Market Return	Currency Return	Dollar Return
United States	11.52%	0.00%	11.52%	15.58%	0.00%	15.58%
Canada	10.72%	0.54%	11.73%	17.00%	6.73%	20.64%
Japan	5.21%	4.10%	9.28%	19.22%	11.76%	22.51%
United Kingdom	12.98%	−0.65%	12.17%	16.45%	10.50%	18.91%
France	12.56%	−0.21%	12.14%	20.12%	11.00%	21.93%
Germany	11.00%	1.12%	11.91%	21.13%	11.21%	23.06%
Italy	14.26%	−1.48%	12.51%	24.35%	10.89%	25.59%

Notes: The original data are monthly total equity returns (including capital gains and dividends) taken from Morgan Stanley Capital International (MSCI) for the period January 1980 to August 2010. Means and volatilities are expressed as annualized percentage rates by multiplying monthly means by 12 and monthly volatilities by $\sqrt{12}$. The market return is in foreign currency; the currency return is the change in the value of the foreign currency relative to the dollar.

ties between the United States and Canada and episodes during which Canadian monetary policy focused on exchange rate stability.

Adding Up Volatility

We know that the volatility of the exchange rate affects the volatility of the dollar return on a foreign equity. But the volatility of the dollar return on foreign equity is generally much less than the sum of the exchange rate volatility and local equity return volatility. That is, the return to a foreign investment is well approximated by the sum of a local equity return and the currency return, $r(t+1, \$) = r(t+1, FC) + s(t+1)$, with FC denoting foreign currency. Volatility is not additive because it is the square root of the variance, and the variance of the sum of two variables involves their covariance. Thus,

$$\mathrm{Var}[r(t+1, FC) + s(t+1)] = \mathrm{Var}[r(t+1, FC)] + \mathrm{Var}[s(t+1)]$$
$$+ 2\,\mathrm{Cov}[r(t+1, FC), s(t+1)]$$

Recall that the covariance of two variables equals the **correlation** between the variables multiplied by the product of the two volatilities, and the correlation is a number between −1 and 1 that indicates how closely related the variations are in the two variables. Rewriting the variance as a function of the correlation, ρ, is informative:

$$\mathrm{Var}[r(t+1, FC) + s(t+1)] = \mathrm{Var}[r(t+1, FC)] + \mathrm{Var}[s(t+1)]$$
$$+ 2\rho\mathrm{Vol}[r(t+1, FC)]\mathrm{Vol}[s(t+1)]$$

Suppose the correlation is 1. Then, because the variance is the square of the volatility and using $(A + B)^2 = A^2 + B^2 + 2AB$, we see that

$$\mathrm{Var}[r(t+1, FC) + s(t+1)] = \mathrm{Vol}[r(t+1, \$)]^2$$
$$= \{\mathrm{Vol}[r(t+1, FC)] + \mathrm{Vol}[s(t+1)]\}^2$$

Hence, if $\rho = 1$, the volatility of the dollar return on foreign equity is indeed the sum of the foreign equity volatility and currency return volatility. Because of the perfect correlation, there is no natural diversification advantage to having exposure to two sources of risk. However, as long as $\rho < 1$, the total dollar volatility will be less than the sum of the two volatilities.

Exhibit 13.1 shows that the volatilities of dollar-denominated foreign equity returns are often not much above the original volatility in the local currency. This indicates that

Exhibit 13.2 Correlations of Equity Returns in Foreign Currencies with $/FC Returns

Country	Correlation
Canada	0.42
Japan	−0.02
United Kingdom	−0.09
France	−0.10
Germany	−0.09
Italy	−0.09

Notes: The original monthly data are taken from MSCI and cover the period January 1980 to August 2010.

the correlation between exchange rate changes and local equity market returns is low. It is sometimes argued that it should be negative, appealing to the competitiveness ideas of Chapter 9. When countries experience real depreciations (usually brought about by nominal exchange rate depreciations), exporting firms and import competing firms in that country experience a boost to their competitiveness and profitability, which might increase local stock market values. Under this scenario, the exchange rate and the stock market move in opposite directions. As shown in Exhibit 13.2, in most countries, the correlation between exchange rate changes and local stock market returns is indeed slightly negative.

In Canada, the correlation is positive. For such a country, the primary forces may be foreign capital flows that appreciate both the foreign currency and the stock market as investors enter the capital markets and depreciate both markets when foreign investors repatriate capital. Nevertheless, the main conclusion of Exhibit 13.2 is that dollar currency returns and foreign currency–denominated equity returns show little correlation.

Expected Returns

Average Returns
In efficient markets, risky securities should earn returns higher than the risk-free rate. In Exhibit 13.1, we also report the average (mean) returns earned in the various markets over the 31 years as a measure of the expected return, $E[r]$. If these returns are representative of true expected returns, they do not indicate that volatility is rewarded in the international marketplace. Whereas the most volatile market (Italy) does have the highest average local currency return (over 14%) and in dollars (over 12.5%), the two low-volatility markets (the United States and the United Kingdom) have relatively high average returns as well. Moreover, although Japan is a comparatively high-volatility country, it has low average stock market returns. Something else must drive average returns. We explore this issue later in this chapter.

Currency Components of Returns
Exhibit 13.1 splits up the average dollar return into the average equity return in the foreign currency and the average currency return. The currency returns range between −1.5% (Italy) and 4.1% (Japan). It should not be a surprise that countries such as Japan and Germany feature positive currency returns and that countries such as France, Italy, and the United Kingdom feature negative currency returns. In the long run, currency changes reflect nominal interest rate differentials (recall our discussion of uncovered interest rate parity in Chapter 7), and these interest rate differentials partially reflect inflation differentials. For example, Japan and Germany are both countries with historically low inflation and interest rates. In contrast, prior to the adoption of the euro, France and Italy historically experienced relatively high inflation and high nominal interest rates. The United Kingdom

Exhibit 13.3   Sharpe Ratios for the G7, 1980–2010

Country	Sharpe Ratio
United States	0.42
Canada	0.33
Japan	0.19
United Kingdom	0.38
France	0.33
Germany	0.30
Italy	0.29

Note: Ratios are computed as the average return from Exhibit 13.1 minus 5% (our estimate for the sample risk-free rate) divided by the volatilities in Exhibit 13.1.

similarly witnessed high inflation in the first part of the sample, but reformed its monetary policy in the 1990s to focus on inflation targeting.

Sharpe Ratios

Investors naturally like high returns and dislike losses. The more variable the returns, the greater is the probability of loss. Recall from Chapter 7 that the Sharpe ratio is one summary statistic of the risk–return trade-off inherent in a security or a portfolio of securities. The Sharpe ratio is measured as the average excess return relative to the volatility of the return:

$$\text{Sharpe ratio} = \frac{E[r] - r_f}{\text{Vol}[r]}$$

where r_f is the risk-free rate. It would be natural for investors to choose portfolios with high Sharpe ratios because investors want a high excess return (as measured by the numerator of the Sharpe ratio) and a low volatility (as measured by the denominator of the Sharpe ratio). The historical Sharpe ratios for the G7 countries are presented in Exhibit 13.3.

Note that the U.S. equity market produces the highest Sharpe ratio, with only the United Kingdom getting somewhat close. It is tempting to conclude that because the U.S. equity market offers the best possible Sharpe ratio, international diversification is a bust for U.S. investors. It is also tempting to conclude that Japan is the worst place to invest because it offers the lowest Sharpe ratio. The next section shows that these conclusions are naïve and erroneous.

13.2 THE BENEFITS OF INTERNATIONAL DIVERSIFICATION

Risk Reduction Through International Diversification

Exhibit 13.4 updates a classic study by Solnik (1974b) who was one of the first to demonstrate the benefits of international diversification. The horizontal axis in Exhibit 13.4 depicts the number of stocks in a particular portfolio, and the vertical axis shows the typical variance of a portfolio. For the top line, we consider a universe of only U.S. stock and compute the average variance of a typical individual U.S. stock, which is normalized to 1. Then, we consider equally weighted portfolios of two stocks (one-half each), find the average variance of this portfolio expressed as a fraction of the average variance of one stock to produce a second point on the graph, and so on.

Because of the imperfect correlation between stocks, the relative portfolio variances decline with the addition of stocks. The graph shows that the portfolio variance falls quickly as more stocks are added, but after including around 30 stocks, it becomes difficult to reduce the variance

Exhibit 13.4   The Case for International Diversification

Risk Reduction Through Domestic and International Diversification
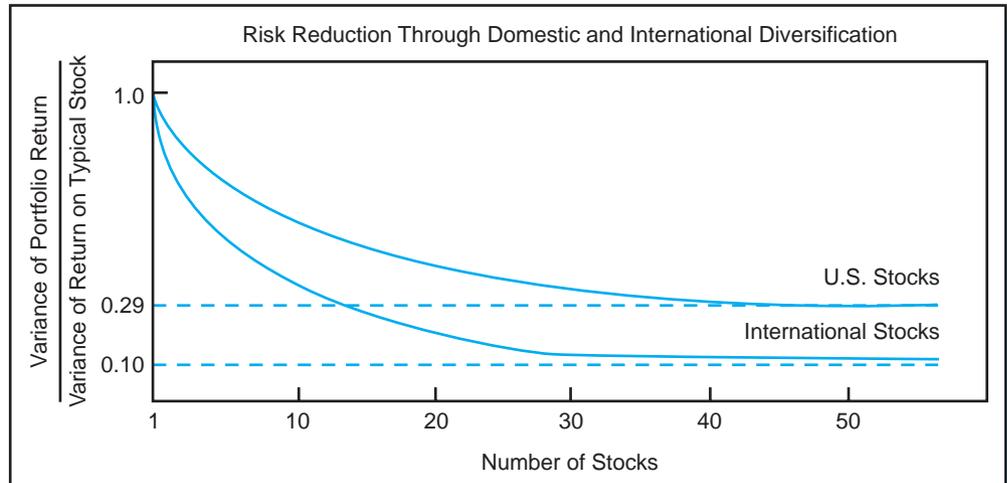
Note: Author's calculations with the assistance of Xiaoyan Zhang. The sample period is 1999 to 2008.

further. The curve finally settles at a level of about 29% of the beginning variance. In other words, more than 70% of the variance of a typical stock can be eliminated through diversification. The part of the variance that can be diversified away is called **nonsystematic variance**.

The lower line in Exhibit 13.4 repeats the exercise, but now stocks can be added from the United States and the major developed stock markets. Because there is even less correlation between U.S. and foreign stocks, the variance of the equally weighted portfolios goes down much more quickly as more stocks are added. The variance of the portfolio falls to barely 10% of the variance of a typical U.S. stock.

Recall that the appendix to Chapter 7 demonstrates that the variance of a large, equally weighted portfolio equals the average covariance among the stocks in the portfolio. Consequently, the variance of U.S. portfolios cannot be reduced further because there are systematic sources of variation that affect all stocks in the United States in the same way. The macroeconomic forces driving stock returns are factors that affect the cash flow prospects of firms and the discount rates used by investors to value these cash flows. We know that stock returns are sensitive to interest rates, which, in turn, depend on monetary policies and business cycles. Business cycles of course affect cash flow prospects, but they may also affect discount rates, as investors may become more risk averse in recessions and less risk averse during booms. These risks cannot be diversified away in a single domestic portfolio.

Notice, though, that when foreign stocks are added to the portfolio, these risks can, to some extent, be diversified away because U.S. monetary policies and business cycles are not perfectly correlated with those of the rest of the world. However, for the most part, stocks are positively correlated, so you cannot diversify away all of a portfolio's variance, no matter how many international stocks you add to the portfolio. Because the average covariance is positive, even a large portfolio of international stocks will have a positive variance. We call the variance that cannot be diversified away the **systematic variance** or **market variance**. The important insight here is that when an investor holds a diversified portfolio, a stock's contribution to the variance of the portfolio depends on its covariance relative to the other stocks in the portfolio.

Idiosyncratic Variance Changes over Time
The variance of a firm's return can be split up into an idiosyncratic component and a systematic component, with the latter variance being the source of risk. For most firms, the

idiosyncratic variance constitutes between 60% and 75% of the total variance of the firm's return. This may sound like a lot, but Exhibit 13.4 shows that this idiosyncratic variance disappears relatively quickly when a portfolio is constructed with securities that are less than perfectly correlated.

Recent research by Bekaert et al. (2010) demonstrates that idiosyncratic volatility, both in the United States and other G7 countries, seems to go through low- and high-volatility regimes. These findings provide a different interpretation of the results in Campbell et al. (2001), who argued that the general level of idiosyncratic risk in the U.S. market substantially increased from the early 1960s to 1997, whereas the level of long-run systematic risk roughly remained constant. In periods of high idiosyncratic volatility, more stocks are needed to achieve full diversification than the 30 that Exhibit 13.4 suggests.

International Return Correlations

Exhibit 13.5 reports a full correlation matrix of the stock market returns of 23 developed countries. The sample period starts in 1980 for most countries. The correlations range from 0.23 for Japan and Greece to 0.79 for Germany and the Netherlands. It is striking that the stock returns of countries that are in close geographic proximity to one another and have significant exports and imports to one another correlate more highly. This is true for Canada and the United States, and it is also true for European Union countries (in particular, Belgium, France, Germany, and the Netherlands). Ireland and the United Kingdom are also highly correlated, at 0.71; New Zealand and Australia returns have a correlation of 0.73. This suggests that trade increases correlations, presumably because importing and exporting firms are affected by the economic factors in the other countries.

Exhibit 13.5 Correlation Matrix for Developed Countries

	AT	BE	CA	DK	FR	DE	HK	IT	JP	NL	NO	SG	SP	SE	CH	UK	US	GR	PT	IE	FI	NZ
AU	0.40	0.46	0.67	0.43	0.50	0.48	0.51	0.39	0.39	0.55	0.60	0.56	0.52	0.54	0.48	0.62	0.56	0.39	0.45	0.57	0.52	0.73
AT		0.59	0.43	0.49	0.58	0.65	0.35	0.46	0.31	0.59	0.54	0.37	0.50	0.43	0.58	0.51	0.38	0.53	0.55	0.58	0.38	0.50
BE			0.50	0.61	0.74	0.70	0.36	0.54	0.42	0.75	0.64	0.42	0.57	0.53	0.67	0.64	0.56	0.50	0.59	0.66	0.40	0.42
CA				0.53	0.56	0.53	0.52	0.47	0.40	0.64	0.63	0.57	0.50	0.56	0.52	0.64	0.75	0.36	0.47	0.52	0.55	0.53
DK					0.59	0.62	0.35	0.52	0.41	0.65	0.61	0.41	0.54	0.56	0.58	0.57	0.52	0.42	0.56	0.62	0.48	0.41
FR						0.78	0.38	0.61	0.45	0.76	0.64	0.40	0.65	0.61	0.68	0.67	0.62	0.51	0.61	0.60	0.55	0.45
DE							0.42	0.57	0.38	0.79	0.60	0.43	0.63	0.66	0.72	0.61	0.60	0.50	0.59	0.63	0.57	0.46
HK								0.36	0.31	0.51	0.47	0.63	0.43	0.45	0.39	0.52	0.46	0.29	0.41	0.41	0.41	0.46
IT									0.42	0.57	0.45	0.34	0.60	0.55	0.47	0.51	0.44	0.49	0.57	0.52	0.54	0.43
JP										0.46	0.37	0.36	0.46	0.43	0.45	0.47	0.37	0.23	0.37	0.47	0.39	0.41
NL											0.70	0.52	0.62	0.66	0.74	0.75	0.71	0.49	0.64	0.70	0.56	0.55
NO												0.52	0.53	0.61	0.58	0.66	0.58	0.44	0.54	0.60	0.53	0.54
SG													0.42	0.49	0.41	0.53	0.58	0.33	0.39	0.47	0.42	0.55
SP														0.62	0.56	0.60	0.53	0.54	0.71	0.62	0.54	0.55
SE															0.58	0.60	0.60	0.44	0.59	0.59	0.67	0.57
CH																0.65	0.58	0.42	0.58	0.56	0.43	0.49
UK																	0.66	0.43	0.57	0.71	0.55	0.53
US																		0.37	0.47	0.64	0.58	0.48
GR																			0.57	0.44	0.33	0.36
PT																				0.54	0.44	0.48
IE																					0.48	0.47
FI																						0.44

Notes: The countries are Australia (AU), Austria (AT), Belgium (BE), Canada (CA), Denmark (DK), France (FR), Germany (DE), Hong Kong (HK), Italy (IT), Japan (JP), the Netherlands (NL), Norway (NO), Singapore (SG), Spain (SP), Sweden (SE), Switzerland (CH), the United Kingdom (UK), the United States (US), Greece (GR), Portugal (PT), Ireland (IE), Finland (FI), and New Zealand (NZ). The data are monthly dollar returns from MSCI for the period from January 1980 to August 2010, although for some countries, the sample starts later.

The lowest correlations are observed for Japan and Greece. Greece has a correlation of less than 0.30 with Japan and Hong Kong. The correlations with non-European countries are invariably below 40%. Even within Europe, Greece does not correlate very highly with most other markets, although the correlations are always higher than 40%. Interestingly, the highest correlation Greece has with any other country is with Portugal, another ex-emerging market. Portugal naturally correlates most closely with its neighbor and trading partner Spain.

What Drives Correlations of Returns?

Apart from trade patterns, what drives the different return co-movements we observe in Exhibit 13.5? To analyze this, it is best to first think of pure fundamental factors. Think of a country as a set of firms. Then figure that each firm is priced rationally, using a discounted cash flow analysis. In such a world, common variations in discount rates and common variations in expected cash flow growth rates will lead to correlations among the firms.

The first fundamental factor that may drive the correlations of stock returns in different countries is their industrial structures. Firms in the same industry are likely to be buffeted by the same shocks affecting cash flows and profitability. Moreover, it is likely that their systematic risks also move together, so both their discount rates and expected cash flow variations are closely related. Both Canada and Australia have many firms operating in the mining industry, for example. This might explain why Australia is highly correlated with Canada but not with Germany.

A long debate has ensued about the importance of industry factors when it comes to return correlations across countries. Some researchers have found that industry factors are starting to dominate country factors [see Brooks and Del Negro (2004) for example]. It used to be the case that country factors clearly dominated when markets were less integrated and discount rates were not highly correlated across countries. Moreover, limited trade across countries and relatively independent monetary policies implied that business cycles showed little correlation across countries, resulting in low correlations among cash flows in different countries. Consequently, policies affecting the degree of integration and the independence of business cycles appear to be important determinants of cross-country correlations. For example, the adoption of a common currency has helped synchronize business cycles in Europe. In contrast, emerging markets typically act more independently of integrated countries. This may explain why Greek stock market returns have historically not been highly correlated with the returns of other countries. If Greece continues to integrate into the European Union, we would expect these correlations to increase, but Greece's recent sovereign debt crisis obviously jeopardizes the integration process.

Finally, irrational investor behavior may induce excess correlations across equity markets, especially during crisis periods. We already talked about this contagion phenomenon in Chapter 5 and simply repeat that increased volatility may lead to temporarily increased correlations.

Asymmetric Correlations?

Because the correlations overall are so far from unity, there are ample opportunities for investors to internationally diversify their portfolios. Some investors may be less impressed and argue that they really only care about diversification when their home market is going down. Longin and Solnik (2001) confirm what casual observations may have led you to suspect: International diversification benefits evaporate when you need them the most—that is, in bear markets. To demonstrate this rather annoying fact, Longin and Solnik computed "bear market correlations" (correlations using returns below the average for both of the stock

markets) and "bull market correlations" (correlations using returns above the average) for various developed markets.

The results are striking: The bear market return correlations are much higher than the bull market correlations. This finding does not justify staying at home with your equity portfolio, however. Research by Ang and Bekaert (2002) shows that these asymmetric correlations do not negate the benefits of international diversification because bear markets remain imperfectly correlated.

The Effect of International Diversification on Sharpe Ratios

Portfolio Risk and Return

Exhibit 13.3 shows the U.S. Sharpe ratio to be historically higher than the Sharpe ratios for the other G7 countries. Even so, international diversification makes perfect sense for U.S. investors. This is because it is not the Sharpe ratio of the foreign asset that the U.S. investor should care about but the Sharpe ratio of the portfolio that results from international diversification. Intuitively, because equity markets in other countries are not perfectly correlated with the U.S. market, part of their volatility disappears through portfolio diversification.

Let's consider formally how international diversification affects Sharpe ratios. Imagine putting a fraction w of your all-U.S. portfolio in international equity. Let's denote the U.S. return by r and the foreign return (in dollars) by r^*. The expected return of the new portfolio is the weighted average of the expected returns on the individual assets with the weights equal to the fractions of wealth invested in each asset, $(1 - w)E[r] + wE[r^*]$. Expected returns aggregate linearly. As we already know, volatility does not aggregate linearly. The volatility of the new portfolio equals

$$\{(1 - w)^2 \text{Var}[r] + w^2 \text{Var}[r^*] + 2w(1 - w)\text{Cov}[r, r^*]\}^{1/2}$$

Because the covariance is a function of the correlation, correlations really matter.

When Does International Diversification Improve the Sharpe Ratio?

Suppose you start with an all-U.S. portfolio. The U.S. Sharpe ratio is $E[r - r_f]/\text{Vol}[r]$, and the Sharpe ratio on the foreign equity is $E[r^* - r_f]/\text{Vol}[r^*]$. We denote the correlation between the U.S. and foreign returns as ρ. From a zero investment in foreign equities, the Sharpe ratio goes up when you add a little bit of foreign equity exposure, if the following condition holds:

$$\frac{E[r^*] - r_f}{\text{Vol}[r^*]} > \rho \frac{E[r] - r_f}{\text{Vol}[r]} \tag{13.1}$$

The appendix to this chapter proves this statement formally. Equation (13.1) states that your Sharpe ratio improves when you add a little bit of the foreign asset to your portfolio if the Sharpe ratio of the new asset is higher than the Sharpe ratio of the U.S. portfolio multiplied by the correlation between the U.S. return and the international return. In other words, the lower the correlation with the U.S. market, the lower the Sharpe ratio of the foreign market needs to be for it to become an investment that increases your Sharpe ratio. This is because markets that have low correlation with the U.S. market are the best diversifiers of a U.S. portfolio. Another way to see this is to bring ρ to the other side and notice that it is not the foreign asset's volatility that matters when computing the return to risk ratio but, rather, volatility adjusted for correlation ($\rho\text{Vol}[r^*]$). The lower ρ is, the lower this adjusted risk number becomes, and the easier it is to exceed the U.S. Sharpe ratio.

Investment Hurdle Rates

Given the correlations and volatilities provided earlier, we can compute hurdle rates on international investments for U.S.–based investors. The *hurdle rate* is the lowest possible expected foreign return that must be earned for investors with purely domestic assets to improve their Sharpe ratio when they invest in that foreign market and when the expected return on the U.S. market takes a specific value.

To find the hurdle rates, we fill in $E[r]$ in Equation (13.1) with a reasonable number (for instance, 10%), and we use the data to estimate correlations and volatilities, leaving $E[r^*]$ as an unknown variable. The minimum $E[r^*]$ we need for the Sharpe ratio with some foreign investment to be at least as large as the U.S. Sharpe ratio is the one that equates the two sides of the equation. That is,

$$\text{Hurdle rate} = \rho \frac{E[r] - r_f}{\text{Vol}[r]} \text{Vol}[r^*] + r_f$$

The hurdle rate is higher when the U.S. market has a high Sharpe ratio, the foreign market is more volatile, or there is high correlation between foreign and U.S. stock returns.

Whereas Exhibit 13.1 reports the dollar volatilities of the various international equity market returns, and Exhibit 13.3 reports their Sharpe ratios, Exhibit 13.6 reports their correlations with the U.S. market. The market returns of Canada and the United Kingdom have the highest correlations with U.S. returns, whereas Japanese and Italian market returns have the lowest correlations. For France and Germany, the correlations are about 60%.

The hurdle rates for the countries with low correlations will be low. Let's illustrate the computation of the hurdle rate for Japan, when the expected return for the United States is $10\%\,(E[r] = 0.10)$. The number is

$$0.05 + 0.37 \times \frac{0.10 - 0.05}{0.156} \times 0.225 = 0.0767, \text{ or } 7.67\%$$

The risk-free rate is 0.05, and the correlation between Japanese and U.S. equity returns is 0.37, the U.S. Sharpe ratio is $(0.10 - 0.05)/0.156$, and the volatility of the Japanese equity return is 0.225. Hence, a U.S. investor should put some money in Japanese equity even if he believes the expected dollar return on Japanese equity is only 7.67%.

Hurdle rates appear in Exhibit 13.7. The correct conclusion is that international diversification can easily improve performance for U.S. investors because the hurdle rates for expected dollar returns on foreign investments are low. In fact, they are lower than the expected return on the U.S. equity market in every case. It is difficult to imagine that foreign equity markets have such dramatically lower expected returns relative to the U.S. market. Italy and Japan have the lowest correlation with the United States and therefore offer the easiest performance enhancement.

Exhibit 13.6   Correlations Between Foreign and U.S. Equity Market Returns, 1980–2010

Country	Correlation
Canada	0.75
Japan	0.37
United Kingdom	0.66
France	0.61
Germany	0.60
Italy	0.43

Notes: All returns have been converted to U.S. dollars. The original monthly data are taken from MSCI.

Exhibit 13.7 Hurdle Rates for Foreign Investments

Country	E[r] = 10%	E[r] = 12%
Canada	9.96%	11.94%
Japan	7.67%	8.74%
United Kingdom	9.01%	10.61%
France	9.32%	11.05%
Germany	9.41%	11.17%
Italy	8.57%	9.99%

Notes: The hurdle rate equals $r_f + \rho \dfrac{E[r] - r_f}{\text{Vol}[r]} \text{Vol}[r^*]$. The correlation number is taken from Exhibit 13.6; the volatility numbers (in dollars) are taken from Exhibit 13.1 (both for the United States and the foreign country); r_f is set at 5%; and $E[r]$ is the U.S. expected return specified on top of the two columns. Data are from MSCI, and the sample is from January 1980 to August 2010.

How to Diversify at Home

Retail investors do not necessarily need to call a foreign broker to invest in far-flung places. Many investment vehicles can be used to accomplish international diversification. First of all, would Coca-Cola not constitute an ideal international investment? After all, Coke sells its flagship product in more than 200 countries around the world. Hence, its cash flows must be influenced by the local economies of all those countries. It was long thought that a portfolio of multinational companies would capture the benefits of international diversification. While the recent literature does indicate that the stock returns of multinational companies behave quite internationally [see, for example, Diermeier and Solnik (2001)], Rowland and Tesar (2004) find that restricting oneself to domestically traded multinational companies remains a flawed diversification strategy. The best diversification opportunities may be exactly the companies for which local factors remain important drivers of their returns.

Chapter 12 notes that many companies cross-list in the United States using American depositary receipts (ADRs). Why not simply buy these companies? Again, the problem is one of representation: The ADR companies tend to be the larger, more internationally focused companies, and they may not give full exposure to foreign stock markets.

Another possibility is to invest in **closed-end funds**, or **investment trusts**, which trade on the local equity market. These funds represent a fixed portfolio that may invest in the world markets, sometimes restricted to a region (Latin America, for instance) or a particular country, in which case they are called **country funds**. The only way to buy into this portfolio is for the investor to buy the fund from another investor selling it. Therefore, closed-end funds can trade at prices that are different from the value of the portfolio, especially when they invest in emerging markets. Hence, it is conceivable that closed-end fund returns fail to offer the same diversification benefits as the underlying portfolio (see Section 13.6). This is not a problem with **open-end funds**, where the portfolio grows with new investments and contracts with redemptions, and the fund is not traded on an exchange. These represent the bulk of the international funds available to retail investors.

Finally, a hybrid alternative that is rapidly gaining popularity is the **exchange-traded fund (ETF)**, which trades on an exchange but where prices are kept close to the value of the underlying portfolio through arbitrage activities by a few institutional investors. Both diversified funds and funds focusing on one country, mimicking the performance of the corresponding MSCI indices, are now available. As the availability of these vehicles expands, an internationally diversified portfolio is only a phone call away for U.S. investors.

13.3 OPTIMAL PORTFOLIO ALLOCATION

We have established that diversifying internationally is likely to reduce risk and improve your Sharpe ratio. But how much should you invest internationally? This is a portfolio choice problem—one of the most fundamental finance problems, and one that brings us very close to a formula for the cost of equity capital.

To solve for the **optimal portfolio**, we must first specify feasible portfolios, which are all portfolios that use up all wealth. Let's consider the G7 example. An investor can invest in the risk-free asset or in seven different equity markets. We can represent the investor's feasible portfolios by a series of wealth fractions—the proportions of wealth devoted to each asset—and these proportions must add to 1. For example, putting 50% of your portfolio in the risk-free asset and 50% in the U.S. equity market is a feasible portfolio. The combination of all feasible portfolios constitutes the investor's menu. Of course, there is an infinite number of possible portfolios, so to figure out which portfolio is best for any investor seems like a daunting task.

Luckily, finance theory has come up with some rather simple answers. We start by defining investors' preferences regarding risk and return, and then we consider a simplified set of ingredients: one risky asset and one riskless security. After we extend the ingredients to multiple risky assets, we can solve the portfolio problem. For example, we will find that no smart investor should ever choose the 50–50 portfolio we proposed.

Preferences

In economics, preferences are typically represented by **utility functions**. Typically, a utility function mathematically links the consumption of units of real goods to a level of satisfaction. Here, we specify a utility function for the individual investor in terms of the statistical properties of the portfolio that the investor holds—that is, expected returns and portfolio variance. We assume that investors would like to generate the highest possible expected return with as little variance as possible, but each investor may have a different risk tolerance. A simple function that captures the trade-off the investors face is

$$U = E[r_p] - \frac{A}{2}\sigma_p^2$$

where the subscript p indicates the portfolio, $E[r_p]$ is the expected return on the portfolio, and σ_p is the volatility of the portfolio. The parameter A in this **mean-variance preference** function indicates the penalty the investor assigns to the variance of the portfolio. The higher A is, the more the investor dislikes variance or risk; in other words, A characterizes the investor's risk aversion.

Example 13.2   The Investor's Utility Calculation

Suppose the expected portfolio return is 9.87%, and its standard deviation is 7.84%. For an investor with $A = 4$, utility equals

$$9.87\% - \frac{1}{2} \times 4 \times (7.84\%)^2 = 9.87\% - 1.23\% = 8.64\%$$

One interpretation of this number is that the investor in this portfolio achieves the same utility as he would by investing in a completely risk-free portfolio with a return of 8.64%.

The Case of One Risky Asset

The portfolio problem is considerably simplified and much intuition is gained if we begin by restricting the set of ingredients to one single risky asset and the risk-free asset. Let's introduce

some notation. Let the risk-free return be r_f, let the risky return be r, and let the weight on the risky asset be w.

If the proportion w of the portfolio is invested in the risky asset, then $1 - w$ is invested in the risk-free asset. Hence, the return on a portfolio is

$$r_p = w \times r + (1 - w) \times r_f = r_f + w \times (r - r_f)$$

The variable $r - r_f$ is the excess return. Therefore, the portfolio's expected return is $E[r_p] = r_f + w \times E[r - r_f]$, which increases linearly with the weight in the risky asset when the expected excess return is positive. To find the variance of the portfolio return, note that the risk-free rate is known with certainty. Therefore, we simply have $\sigma_p^2 = w^2\sigma^2$, where σ^2 is the variance of the risky return, r. Hence, the volatility of the portfolio is $\sigma_p = w\sigma$, and the risk of the portfolio is also linear in w. Now, use this volatility expression to substitute for w in the expected return expression, and find

$$E[r_p] = r_f + \frac{E[r] - r_f}{\sigma}\sigma_p \tag{13.2}$$

This expression describes the relationship between the expected return on the portfolio and its standard deviation. Consequently, Equation (13.2) fully describes the "menu," or the possible risk–return combinations, for this simple case. Also, note that the relationship is of the form $y = a + bx$, with $y = E[r_p]$ and $x = \sigma_p$, which is the equation for a straight line.

We call the line describing the risk–return trade-off in the single risky asset case the **capital allocation line (CAL)** because it describes the ways capital can be allocated in the single risky asset case. The CAL is graphed in Exhibit 13.8.

Exhibit 13.8 The Capital Allocation Line
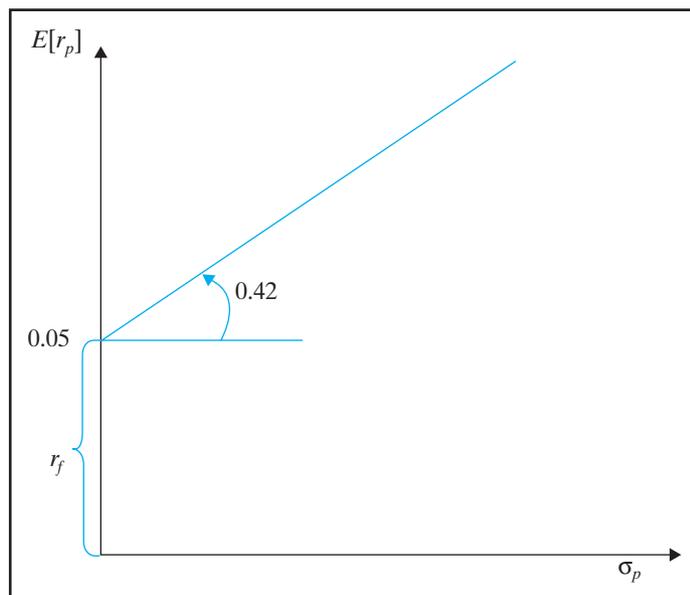
Notes: The vertical axis shows the expected return, and the horizontal axis is the standard deviation of the portfolio. The line is the capital allocation line of feasible risk–expected return patterns. It emanates at the risk-free rate (5% in this example) and slopes upward with the Sharpe ratio of the risky asset, $\frac{E(r) - r_f}{\sigma}$, as its slope.

Example 13.3   The Capital Allocation Line

Let's take the U.S. equity market as the risky asset, with expected return of 11.52%, and $\sigma^2 = (15.58\%)^2$ (see Exhibit 13.1), and let $r_f = 5\%$. Then, the CAL is given by

$E[r_p] = 0.05 + SR \times \sigma_p$, with $SR = \dfrac{E[r] - r_f}{\sigma} = \dfrac{0.1152 - 0.05}{0.1558} = 0.42$, where

we recognize the Sharpe ratio, SR, as the return premium per unit of risk.

The Optimal Portfolio

To find the optimal portfolio, we must combine the CAL menu with the investor's preferences. The mathematical problem can be written as

$$\max_w U = \max_w [E[r_p] - \tfrac{1}{2}A\sigma_p^2]$$

In words, we try to find the weight on the risky asset (w) that maximizes the utility function. We can substitute the expressions for $E[r_p]$ and σ_p^2 to obtain

$$\max_w [r_f + w[E[r] - r_f] - \tfrac{1}{2}Aw^2\sigma^2]$$

To solve for the optimal w, denoted w^*, we must take the derivative of this function with respect to w and set it equal to zero, in which case we find

$$E[r] - r_f - Aw^*\sigma^2 = 0$$

Solving for the optimal portfolio gives a very intuitive solution:

$$w^* = \frac{E[r] - r_f}{A\sigma^2} \qquad \text{(13.3)}$$

The allocation to the risky asset is increasing in the expected return on the asset, decreasing in its variance, and decreasing in the investor's risk aversion.
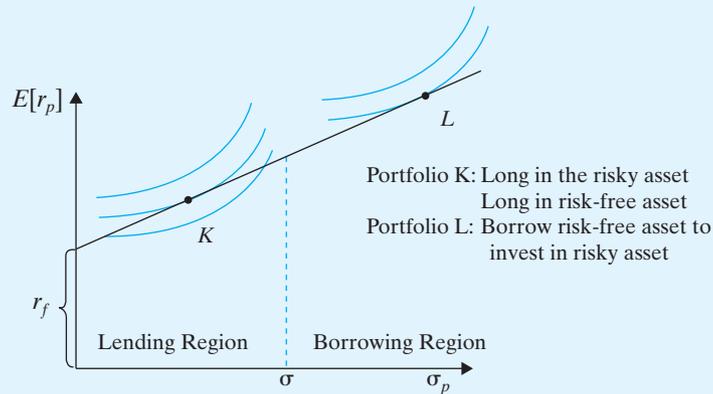
Example 13.4   Calculations of Optimal Portfolios

Let's apply the formula to investors who have different levels of risk aversion:

A	w^*	$E[r_p]$ (in%)	σ_p (in %)
1.0	2.69	22.51%	41.85%
2.0	1.34	13.76%	20.92%
3.0	0.90	10.84%	13.95%
4.0	0.67	9.38%	10.46%

To fill in the numbers of the table, we use the formula for w^*, and then the expected return is $E[r_p] = r_f + w^*E[r - r_f]$ and the volatility is $\sigma_p = |w^*|\sigma$.

Note that $w^* = 1$ implies that 100% of wealth is invested in the risky asset. As risk aversion increases, the weight on the risky asset decreases, which decreases the expected return and the standard deviation. Because we stay along the CAL, the risk–return trade-off (Sharpe ratio) of the portfolio, $[E(r_p) - r_f]/\sigma_p = 0.42$, remains the same because it is the slope of the line. Exhibit 13.9 demonstrates this graphically.

Exhibit 13.9   Optimal Portfolios

Portfolio K: Long in the risky asset
Long in risk-free asset
Portfolio L: Borrow risk-free asset to
invest in risky asset

Note: Investors with different preferences toward risk and return invest in different portfolios, represented by different points on the capital allocation line.

For low A, we are at a point such as L. The investor is more than 100% invested in the risky asset ($w > 1$), and the investor finances this position by borrowing. For example, for $A = 1$, the investor borrows $1.69 for every dollar of his own wealth invested, and he invests the $2.69 in the stock market. For high A, the investor combines stock investing with an investment in the T-bill—that is, $w < 1$. For example, for $A = 4.0$, the investor places 67% of her wealth in the risky asset and 33% in the risk-free asset.

The Mean–Standard Deviation Frontier

What if there are multiple risky assets? Consider Exhibit 13.10. The circles represent the expected returns and standard deviations of various assets. Even with just two risky assets, many different capital allocation lines are available. After all, we could consider all feasible

Exhibit 13.10   The Mean–Standard Deviation Frontier
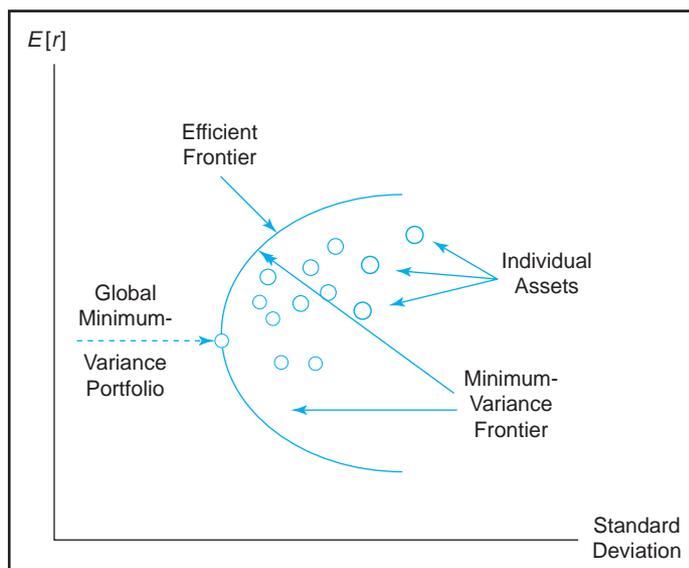
risky portfolios as "the risky asset." What is the optimal risky portfolio? Economist Harry Markowitz (1952) won the Nobel Prize in 1990 for showing us how to proceed.

First, we must get rid of a large number of "inefficient" portfolios by creating the **mean–standard deviation frontier**, which is the locus of the portfolios in expected return–standard deviation space that have the minimum variance for each expected return. It is therefore also often referred to as the **minimum-variance frontier**. For two assets, the frontier would have a shape similar to the one graphed in Exhibit 13.10. Imagine combining a low expected return–low variance asset (say asset X) with a high expected return–high variance asset (say asset Y). Starting from a portfolio 100% in asset X, adding some of asset Y to the portfolio increases the expected return of the portfolio in a linear fashion. However, unless assets X and Y have perfectly correlated returns, the standard deviation will not change in a linear fashion. In fact, it may even decrease at first, but in any case, when it starts to increase, imperfect correlation makes the standard deviation of the portfolio increase at a rate lower than linear, giving rise to the curved shape also seen in Exhibit 13.10.

Creating the frontier for multiple assets as in Exhibit 13.10 is the solution to a complex mathematical problem. We want to minimize the return variance for a portfolio of N securities, for each possible expected return:

$$\min_{\{w_1,\ldots,\,w_N\}} \left[\sum_{i=1}^{N} w_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq 1}}^{N} w_i w_j \operatorname{cov}\left[r_i, r_j\right] \right] \Rightarrow \text{Minimum variance}$$

such that

$$\sum_{i=1}^{N} w_i = 1 \Rightarrow \text{Feasible portfolio} \quad \sum_{i=1}^{N} w_i E[r_i] = \bar{r} \Rightarrow \text{Target return}$$

By varying $\bar{r}$, we trace out the frontier. Although analytical solutions are possible, using Excel Solver is a popular way of finding minimum-variance portfolios.

Two-Fund Separation (Advanced)

Interestingly, when this problem is solved for two target returns, we are done. This is called **two-fund separation**: The minimum-variance frontier is said to be spanned (or generated) by any two minimum-variance frontier portfolios. That is, if we find two portfolios—say, portfolio X with weights $\left[w_1^X, w_2^X, \ldots, w_N^X\right]$ and portfolio Y with weights $\left[w_1^Y, w_2^Y, \ldots, w_N^Y\right]$— that are on the frontier, we can generate the whole frontier by taking combinations of these two portfolios. If there are only two assets, then the mean–standard deviation frontier can be found by simply mixing the two assets in all possible combinations with weights adding up to 1. Two-fund separation says that with multiple assets, all portfolios on the frontier can be viewed as a mix of any two frontier portfolios.

The Efficient Frontier

Once we have determined the mean–standard deviation frontier, we can focus on a rather limited set of possible portfolios. Clearly, no one will want to invest in a portfolio on the inside of the frontier: You can either lower risk at the same expected return or increase the expected return at the same risk. Also, no one will invest in a portfolio on the portion of the frontier below the global minimum-variance portfolio, which is indicated on Exhibit 13.10. The **global minimum-variance portfolio** is the portfolio with the least variance among all possible portfolios. If you are below that portfolio, you can increase expected return without increasing volatility.

What remains is the upper portion of the frontier, starting at the global minimum-variance portfolio. This set of risky portfolios is called the **efficient frontier**. It yields a large

number of "efficient" risky portfolios that could be combined with a risk-free asset to form a capital allocation line.

The Mean-Variance-Efficient (MVE) Portfolio

Starting from the risk-free rate on the vertical axis of 5%, we can consider any portfolio on the mean–standard deviation frontier as a potential risky asset. We can draw a potential capital allocation line (CAL) from the risk-free rate to the risky portfolio's point on the graph. As before, the slope of the CAL is the Sharpe ratio. People with utility functions that depend positively on the expected return and negatively on the variance of the portfolio would naturally prefer higher Sharpe ratios. Once we have a CAL, we know how to optimally combine the risky portfolio with the risk-free asset from our previous analysis.

For example, consider Exhibit 13.11. It graphs the mean–standard deviation frontier for two assets, the U.S. and Japanese equity markets, using the expected return and volatility properties reported in Exhibit 13.1 and the correlation reported in Exhibit 13.6. Clearly, the "best" CAL has the steepest slope, or highest Sharpe ratio. This is the line emanating from the risk-free return to the point where the line is tangent to the mean–standard deviation frontier. This portfolio is called the **mean-variance-efficient (MVE) portfolio**, and it represents the risky portfolio that maximizes the Sharpe ratio.

The theory is surprisingly powerful. It states that there is a superior risky portfolio that all investors will prefer: Of course, preferences toward risk still differ, and investors can combine the MVE portfolio with the risk-free asset in different ways. Portfolios to the left (right) of the tangency represent the MVE portfolio for the more (less) risk-averse investors. Notice how the risky efficient frontier is completely below the CAL going through the MVE portfolio. By borrowing at the risk-free rate and investing more than 100% in the MVE portfolio, investors use leverage and can achieve a much higher expected return for the same risk than if they only considered risky assets. The actual weight on the MVE portfolio versus the risk-free asset can be determined using Equation (13.3).

Exhibit 13.11   Finding the MVE Portfolio
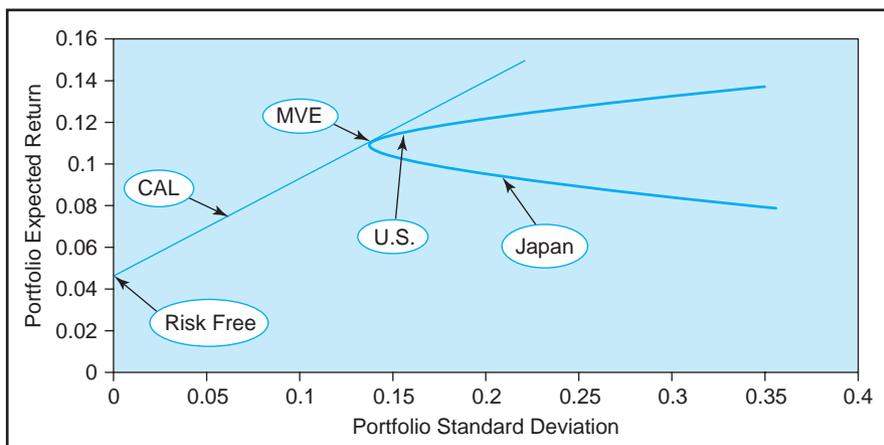
Notes: We form the mean–-standard deviation frontier from two assets. The U.S. portfolio has a mean return of 11.52% and a standard deviation of 15.58%. The Japanese portfolio has a mean return of 9.28% and a standard deviation of 22.51%. The correlation between the two returns is 0.37. The mean-variance-efficient portfolio dominates either individual portfolio.

13.4 THE CAPITAL ASSET PRICING MODEL

This section describes the most popular model underlying computations of the cost of capital: the capital asset pricing model (CAPM). We describe its origins, provide a formal derivation and interpretation, and discuss the difference between domestic and international CAPMs.

Assumptions and Origins

The **capital asset pricing model (CAPM)** underlies all modern financial theory. It was derived by Sharpe (1964), Lintner (1965), and Mossin (1966), using principles of diversification, with simplified assumptions building on the original mean-variance optimization analytics developed by Markowitz. Markowitz and Sharpe won the 1990 Nobel Prize in economics for their efforts. The CAPM requires a long list of rather strong assumptions:

- There is a single-period investment horizon.
- Individual investors are price takers.
- Investments are limited to traded financial assets.
- There are no taxes and transaction costs.
- Information is costless and available to all investors.
- Investors are rational mean-variance optimizers.
- Expectations are homogeneous; that is, all investors agree on the expected returns, standard deviations, and covariances between security returns.

The CAPM then derives the optimal asset demands of all investors and derives restrictions on expected returns by imposing that markets have to clear (that is, supply must equal demand), implying that all assets must be willingly held. Given these assumptions, it is not surprising that the CAPM yields strong predictions:

- All investors hold the same portfolio of risky assets—the **market portfolio**.
- The market portfolio contains all securities, and the proportion of each security is its market value as a percentage of total market value.
- The risk premium on the market depends on the average risk aversion of all market participants.
- The risk premium on an individual security is a function of its covariance with the market portfolio.

Although no one literally believes that the assumptions underlying the CAPM hold in the real world, the CAPM is one of the most useful models in finance. For example, it serves as a benchmark for evaluating portfolio managers, and it provided an impetus for the development of **index funds**. Index funds are open-end funds that passively track a stock index such as the S&P 500 without trying to outperform it. Finally, the CAPM is the basis for cost-of-capital computations; it is this application of the CAPM that is most useful for this book. The next section provides a technical introduction to the main CAPM equation. The following sections help interpret it and illustrate its practical use in a global context, where exchange rate movements may complicate the model's application.

A Derivation of the CAPM (Advanced)

To derive the CAPM, recall the results of the diversification problem. We argued that adding a little bit of that new asset to a portfolio improves the investor's Sharpe ratio when Equation (13.1) holds; that is, when

$$SR_{\text{NEW}} \geq \rho \times SR_p$$

where ρ is the correlation between portfolio, p, and the new asset; SR_{NEW} is the Sharpe ratio of the new asset; and SR_p is the Sharpe ratio of the present portfolio. The correlation of the new asset return with r_p, which now contains some of the new asset, increases as we add more of the new asset, making the condition harder to satisfy. We should keep adding the asset until

$$SR_{\text{NEW}} = \rho \times SR_p \qquad \text{(13.4)}$$

At that point, further additions no longer increase the Sharpe ratio; that is, we have reached the portfolio that maximizes the Sharpe ratio, implying that we have found the MVE portfolio. Thus, r_p should now be interpreted as the return on the MVE portfolio. Rewriting Equation (13.4) using the definition of the Sharpe ratio and bringing ρ to the other side gives

$$\frac{E(r_{\text{NEW}}) - r_f}{\rho \times \sigma_{\text{NEW}}} = \frac{E(r_p) - r_f}{\sigma_p}$$

Substituting $\rho = \dfrac{\text{Cov}(r_{\text{NEW}}, r_p)}{\sigma_{\text{NEW}}\sigma_p}$ gives

$$\frac{E(r_{\text{NEW}}) - r_f}{\text{Cov}(r_{\text{NEW}}, r_p)} = \frac{E(r_p) - r_f}{\sigma_p^2} \qquad \text{(13.5)}$$

This relationship holds for any security i. Equation (13.5) implies that expected excess returns per unit of covariance risk are the same for all assets and are equal to $\dfrac{E(r_p) - r_f}{\sigma_p^2}$.

The relevant risk for a security is its covariance with the MVE portfolio. Rewriting Equation (13.5) for security i gives

$$E(r_i) - r_f = \frac{\text{Cov}(r_i, r_p)}{\sigma_p^2} \times [E(r_p) - r_f] \qquad \text{(13.6)}$$

Equation (13.6) establishes a relationship between the expected excess return on an individual asset and the expected return on the MVE portfolio.

We are almost finished. Let's review the major findings of the previous section on optimal asset allocation:

1. The efficient frontier is a set of "dominant" portfolios in risk–return space. Non-efficient portfolios would not be held by any mean-variance investor.
2. If a risk-free asset exists, one portfolio of risky securities offers the best risk–return trade-off: the MVE portfolio.

Now, if everybody is a mean-variance investor facing the same frontier, what must the MVE portfolio be for there to be no excess demand or supply for any security? It must be the market portfolio—and that is what the CAPM says! The implication is

$$E(r_i) - r_f = \frac{\text{Cov}(r_i, r_m)}{\sigma_m^2} \times [E(r_m) - r_f]$$

where the subscript m represents the market portfolio. The relationship between the expected return on an individual security and the expected return on the market portfolio depends on the statistical construct $\dfrac{\text{Cov}(r_i, r_m)}{\sigma_m^2}$, which is called the *beta* (β) of security i.

Interpreting the CAPM

The CAPM is often used as a benchmark to determine the required rate of return on risky equity capital. The CAPM provides a formula for the required rate of return on an equity investment, which is its expected rate of return, $E(r_e)$.

The CAPM Equilibrium

Equity investors require compensation for the time value of money based on the risk-free rate, r_f. In addition, they require compensation for the systematic, or non-diversifiable, risk of the investment. Systematic risk is measured by the beta of the equity, β_e, multiplied by the risk premium on the market, $[E(r_m) - r_f]$. An equity's **beta** is the covariance of the rate of return on the equity with the rate of return on the market portfolio divided by the variance of the rate of return on the market portfolio:

$$\beta_e = \frac{\text{Cov}(r_e, r_m)}{\text{Var}(r_m)}$$

Hence, the CAPM states that

$$E(r_e) = r_f + \beta_e[E(r_m) - r_f] \tag{13.7}$$

The logic of the CAPM begins with the assumptions that investors prefer higher expected returns but are averse to risk. From the investor's perspective, risk is measured by the variance of the return on the investor's overall portfolio. Given the expected future cash flows of the assets, changes in the market prices change the assets' expected returns and their variances and covariances. In equilibrium, the market prices of assets adjust such that the expected returns on the different assets and their variances and covariances allow the market portfolio to be willingly held by investors. This will happen when the expected excess returns per unit of covariance risk are equalized across assets and are equal to the expected excess return on the market divided by its variance, as in Equation (13.5). In equilibrium, all investors are thought to be holding the market portfolio because they are assumed to have the same expectations and the same investment opportunities. The market portfolio is the MVE portfolio.

The Risk Premium on the Market

The risk premium on the market portfolio is the amount by which the expected return on the market exceeds the risk-free rate. The CAPM actually predicts that this risk premium will depend on the average risk aversion of investors and the variance of the market portfolio return. To see this, consider Equation (13.3) but applied to the market portfolio. Because every investor chooses to combine the market portfolio with the risk-free asset according to her preferences, someone with average risk aversion, say $\overline{A}$, will hold exactly the market portfolio.

Consequently, $w^* = 1 = \dfrac{1}{\overline{A}} \dfrac{E(r_m) - r_f}{\sigma_m^2}$, or

$$E(r_m) - r_f = \overline{A}\sigma_m^2 \tag{13.8}$$

Hence, the **market risk premium** balances the variance of the market portfolio to reflect the average risk aversion of the investors in the market.

Individual Expected Returns and the Role of Beta

In the CAPM equilibrium, if an equity return is not correlated with the return on the market portfolio, that equity's expected return is equal to the risk-free rate because investors do not need to be compensated for bearing the uncertainty associated with that particular return. In Equation (13.7), if $\beta_e = 0$, then $E(r_e) = r_f$. If an asset does not covary with the market portfolio, it becomes effectively riskless when it is held in a large, diversified portfolio that mirrors the market portfolio.

Equity returns that covary positively with the return on the market portfolio contribute to the variance of the return on the market portfolio. Consequently, these positive beta assets require an expected rate of return that is greater than the risk-free rate. On the other hand, an asset with a negative beta, whose return covaries negatively with the return on the market

portfolio, actually reduces the overall variance of the portfolio. Investors willingly hold this asset even though its expected return is driven below the return on the risk-free interest rate in the competitive equilibrium. Most equities have positive betas, however, because the market environment tends to affect all stocks the same way.

Notice that an asset's beta measures its relative risk because the beta is the covariance of the asset's return with the return on the market portfolio divided by the variance of the return on the market portfolio. For example, if the beta is 1, the covariance of the asset's return with the return on the market portfolio equals the variance of the return on the market, and the asset's expected return is the same as the market's expected return.

Domestic Versus World CAPMs

In a **domestic CAPM**, the market portfolio is defined as the aggregate asset holdings of all investors in a particular country. Many real-world applications of the CAPM use domestic CAPMs. For example, the beta for a U.K. firm that is listed on the London Stock Exchange (LSE) would be calculated relative to the LSE value-weighted market return, and the beta for a Japanese firm that is listed on the Tokyo Stock Exchange (TSE) would be calculated relative to the TSE value-weighted market return.

What are the implications of this assumption? The domestic CAPM assumes that assets of a country are held only by investors who reside in that country. In such a case, there would be no international diversification of risk, and countries' capital markets would be completely internationally segmented. We discuss the concept of a segmented and integrated market more fully in Section 13.6. When the CAPM was first developed in the 1960s, international segmentation seemed reasonable because capital flows and portfolio investments were limited. Today, in an increasingly globalized world, it makes more sense to use an internationally diversified portfolio of securities as the market portfolio. This CAPM is called the **world CAPM**.

The Role of Exchange Rates

One major theoretical problem with using the world CAPM is that the development of the theory assumes that investors share the same expectations about the real returns on different assets. Given the observed deviations from purchasing power parity and fluctuations in real exchange rates discussed in Chapter 8, there is a substantial amount of evidence contrary to this premise. When real exchange rates fluctuate, investors in different countries have different perceptions about the real returns on different assets. Let's illustrate this with an example.

Let r_e be the real equity return on a U.S. security for a U.S.–based investor, and let r_f be the real risk-free rate in the United States. The world CAPM states

$$E(r_e) - r_f = \beta_e [E(r_m) - r_f] \tag{13.9}$$

where r_m is the real return on the world market portfolio. Because we are defining real returns for a U.S.–based investor, they are computed relative to the U.S. consumption basket, using the U.S. price level. For example, the real rate of return on equity, r_e, can be computed by subtracting 1 from 1 plus the nominal rate of return divided by 1 plus the U.S. rate of inflation: $\dfrac{1 + r_e(\$)}{1 + \pi(\$)} - 1$. Similarly, from Chapter 10, we know that r_f, the *ex ante* real interest rate, is the expected value of the *ex post* real interest rate:

$$r_f = r_f(\text{US}) = E\left[\frac{1 + i(\$)}{1 + \pi(\$)} - 1\right]$$

where $i(\$)$ is the nominal interest rate.

Now, what is the expected real return on the same U.S. security for a German investor? The German investor cares about real German returns, hence

$$\frac{1 + r_e(\text{\euro})}{1 + \pi(\text{\euro})} = \frac{[1 + r_e(\$)](1 + s)}{1 + \pi(\text{\euro})}$$

with s representing the percentage change in the euro–dollar exchange rate. But the expression for the dollar-based version of the CAPM contains the real return for the U.S. investor, $\frac{1 + r_e(\$)}{1 + \pi(\$)}$. This only equals the real return for the German investor when $\frac{1 + s}{1 + \pi(\text{\euro})} = \frac{1}{1 + \pi(\$)}$, or $1 + s = \frac{1 + \pi(\text{\euro})}{1 + \pi(\$)}$. In other words, the real returns for the U.S.–based and German-based investors are identical only when purchasing power parity (PPP) holds.

What about the risk-free rate? For the German-based investor, it should be defined relative to her consumption basket. Consequently, the *ex ante* German risk-free rate is $r_f(G) = E\left[\frac{1 + i(\text{\euro})}{1 + \pi(\text{\euro})}\right] - 1$. If we assume that PPP holds, we find that $r_f(G) = E\left[\frac{1 + i(\text{\euro})}{(1 + s)(1 + \pi(\$))} - 1\right]$. Of course, $E\left[\frac{1 + i(\text{\euro})}{1 + s}\right]$ is the dollar return on an investment in the euro money market. For the real interest rates to be equalized across countries, we need more than just PPP to hold. We also need the real expected returns on money market investments to be equal across countries—that is, we need a real version of uncovered interest rate parity to hold.[2] We conclude that translating the world CAPM to the other country's perspectives works only when all the international parity conditions hold.

So far, we have focused on real returns as the theory demands. However, in practice, CAPMs are mostly applied to nominal returns. Let the nominal equity return be denoted by $r_e(\$)$, and let $i(\$)$ represent the money market interest rate in the United States. The world CAPM for the U.S.–based investor is then formulated as follows:

$$E[r_e(\$) - i(\$)] = \beta_e E[r_m(\$) - i(\$)] \qquad \text{(13.10)}$$

where the equity return is earned over a short interval such as 1 month, and the interest rate is the 1-month Treasury bill rate known at the beginning of the month. For such small intervals of time, Equations (13.9) and (13.10) are indeed nearly equivalent. This is because, by definition, $r_e = \frac{1 + r_e(\$)}{1 + \pi(\$)} - 1 \approx r_e(\$) - \pi(\$)$. Moreover, $r_f = E\left[\frac{1 + i(\$)}{1 + \pi(\$)} - 1\right] \approx E[i(\$) - \pi(\$)]$. It is easy to see that the inflation rates cancel out of the equation.

Of course, the beta computation in the two equations is different, involving real returns in Equation (13.9) and nominal excess returns in Equation (13.10). Because equity returns are much more variable than inflation and interest rates, these differences are immaterial from a practical perspective.

International CAPMs (Advanced)

The conditions for the world CAPM to apply to all countries are rather stringent. With deviations from the parity conditions, theory suggests more complex models where inflation and exchange rate risks enter the expected return computation. Many models of international capital market equilibrium have been developed, but none has attained a dominant status.[3] Most models allow for currency risk premiums in one form or another.

---

[2] In Chapter 10, we derived that real interest rates are equalized across countries when PPP, uncovered interest rate parity, and the Fisher hypothesis hold.
[3] See Adler and Dumas (1983) for an early model.

An example of the most popular model in this class builds on the theories of Solnik (1974a) and Sercu (1980) and forms the counterpart to the nominal returns model in Equation (13.10):

$$E[r_j(\$) - i(\$)] = \beta_j E[r_w(\$) - i(\$)] + \sum_{k=1}^{K} \gamma_{j,k} E[s_k(t+1) - fp_k(t)] \qquad \textbf{(13.11)}$$

We assume that the dollar is the numeraire and that risk is measured for a U.S. investor.[4] The first term represents the standard world market risk; the other terms represent exchange rate risk, with s_k representing the rate of foreign currency appreciation and fp_k representing the forward premium on currency k. Exchange rates are thus measured as $ per currency k. Recall that

$$E[s_k(t+1) - fp_k(t)] = E\left[\frac{S_k(t+1) - F_k(t)}{S_k(t)}\right],$$

which is the expected excess dollar return to a long forward market position in currency k.

The $\gamma_{j,k}$'s in Equation (13.11) measures the exposures of the j-th firm's returns to the various exchange rate risks. For example, an exporter with many unhedged foreign currency receivables may exhibit positive γ. That is, if these currencies appreciate substantially, the firm's return will be high as well. Of course, if uncovered interest rate parity holds, this model collapses to the world CAPM. To compute the cost of capital in such a setting, we must run a multivariate regression of excess returns for security j onto the world market return and various relevant currency returns. In practice, people use only a few major currencies or even a currency basket.

It is not clear whether the **international CAPM** is a better model than the world CAPM. Research by Dumas and Solnik (1995) and Zhang (2006) suggests that exchange rate risk is priced and that adding exchange rate factors to cost of capital computations is important. Other studies, such as that by Griffin and Stulz (2001), cast doubt on this conclusion. Because of the continuing academic controversy and the scant use of such models in practical capital budgeting situations, we will not discuss them further.

13.5 THE CAPM IN PRACTICE

As Chapter 15 explains in detail, firms need expected returns on their equity to get appropriate discount rates when doing capital budgeting. These expected returns represent what investors demand as compensation for giving capital to the firm. The CAPM delivers such discount rates. Let's be very concrete about how to compute the cost of equity capital.

A Recipe for the Cost of Equity Capital

Recall the CAPM equation for security j:

$$E(r_j) = r_f + \beta_{jm}\left[E(r_m) - r_f\right] \qquad \textbf{(13.12)}$$

---

[4]One problem with the many variants of the international CAPM, including the one presented here, is that the exact outcome of the cost-of-capital computation may depend on the numeraire currency.

where $\beta_{jm} = \dfrac{\mathrm{Cov}(r_j, r_m)}{\mathrm{Var}(r_m)}$. You find the expected nominal return on security j by taking these steps:

Step 1. Get data on the market portfolio return, the equity returns on security j, and the T-bill interest rate, r_f.

Step 2. Determine the market risk premium, $\left[E(r_m) - r_f\right]$. The market risk premium is the expected excess return on a portfolio that approximates the market portfolio.

Step 3. Obtain an estimate of β_{jm}.

Step 4. Compute the expected return on security j from Equation (13.12).

This recipe reveals three problems in applying the CAPM to a practical capital budgeting situation: the choice of a benchmark (how to measure the market portfolio), the estimation of beta, and the determination of the risk premium on the market portfolio. We discuss each in turn.

The Benchmark Problem

The Market Portfolio

One problem that has plagued the CAPM since its early development is what portfolio to use as the market portfolio.[5] The theoretically correct value of the return on the market portfolio is the value-weighted return on all assets that are available for investors to purchase. If the return on the market portfolio is measured in dollars, it would consequently include the dollar-denominated returns on the equities of all the corporations of the different countries of the world, the dollar-denominated returns on the bonds of all the corporations and the governments of these countries, and the dollar-denominated returns on real estate and assets such as gold and land.

No one has ever attempted to use this version of the theory because its data requirements are too stringent. We simply do not have all the data. More importantly, though, financial markets are too imperfect to allow us to think that highly illiquid assets, such as real estate, would be bought and sold like stocks and bonds. Because data on the returns on corporate and government bonds in many countries are also difficult to obtain, in practice, people use the CAPM as if it were a theory that relates individual equity rates of return to a market portfolio composed of only equities.

World Market Proxies

When the CAPM is applied for a particular company's project, the proxy for the market portfolio should in theory represent the well-diversified portfolio that the firm's investors are holding. In practice, many U.S. companies use the U.S. stock market index as the market portfolio. With the increasing globalization of investors' portfolios (see Section 13.6), a world market index is becoming more and more appropriate. Although the availability of data on a world market index is imperfect, there are reasonable proxies available, such as the Morgan Stanley Capital International (MSCI) Index and the Financial Times Actuaries (FTA) Index.

Getting the Benchmark Wrong

We would like to know how large a mistake is made quantitatively if we use a domestic, country-specific CAPM when the assets of the country are actually priced by investors with a world CAPM. If the assets of this country are actually priced internationally, the expected return on asset j, $E\left[r_j\right]$, satisfies the world CAPM in Equation (13.12), where r_m is the return on the world market portfolio and β_{jm} is the beta of the return on asset j with respect to the world

---

[5]This issue is often called the "Roll critique" because Roll (1977) was the first to write about the problems involved in testing the CAPM. Roll argued that statistical rejections of the theory could be incorrect if a statistician did not observe the true market portfolio.

market return. We denote this "true" expected return or cost of equity capital by COE_j^{TR}. Now, suppose we postulate incorrectly that the expected return on asset j is determined by the covariance of the return on asset j with the return on the home market portfolio, r_h, as in the following version of a domestic CAPM:

$$E(r_j) = r_f + \beta_{jh}\left[E(r_h) - r_f\right] \tag{13.13}$$

Denote the cost of equity capital number resulting from this computation by COE_j^{FA}.

To compute the error in using Equation (13.13) rather than Equation (13.12), we first compute the correct expected return on the home market portfolio. The return on the home-country market portfolio is the value-weighted return on the individual assets in the country, and hence, it will also satisfy the world CAPM, as in Equation (13.12):

$$E(r_h) = r_f + \beta_{hm}\left[E(r_m) - r_f\right] \tag{13.14}$$

Using Equations (13.12) to (13.14), we can investigate the difference between the two costs of equity capital:

$$
\begin{aligned}
COE_j^{FA} - COE_j^{TR} &= \beta_{jh}\left[E(r_h) - r_f\right] - \beta_{jm}\left[E(r_m) - r_f\right] \\
&= (\beta_{jh}\beta_{hm} - \beta_{jm})\left[E(r_m) - r_f\right]
\end{aligned}
$$

Thus, the expected return on asset j will be correct if $\beta_{jm} = \beta_{jh}\beta_{hm}$. Example 13.5 provides some insight into when this expression is likely to be right and how badly things go if it is wrong.

Example 13.5 The Nestlé Cost of Equity Capital

Stulz (1995) applies the previous analysis to derive two estimates of the expected return for the Swiss company Nestlé. Stulz estimates the beta of the Swiss franc return on Nestlé with respect to the Swiss franc return on the Swiss market portfolio (β_{jh}) to be 0.885. The beta of the Swiss franc return on Nestlé with respect to the Swiss franc return on the world market portfolio (β_{jm}) using the FTA world market index is 0.585. The beta of the Swiss franc return on the Swiss market portfolio with respect to the Swiss franc return on the world market portfolio (β_{hm}) is 0.737. Hence, the pricing error in beta from using the domestic CAPM rather than the world CAPM is
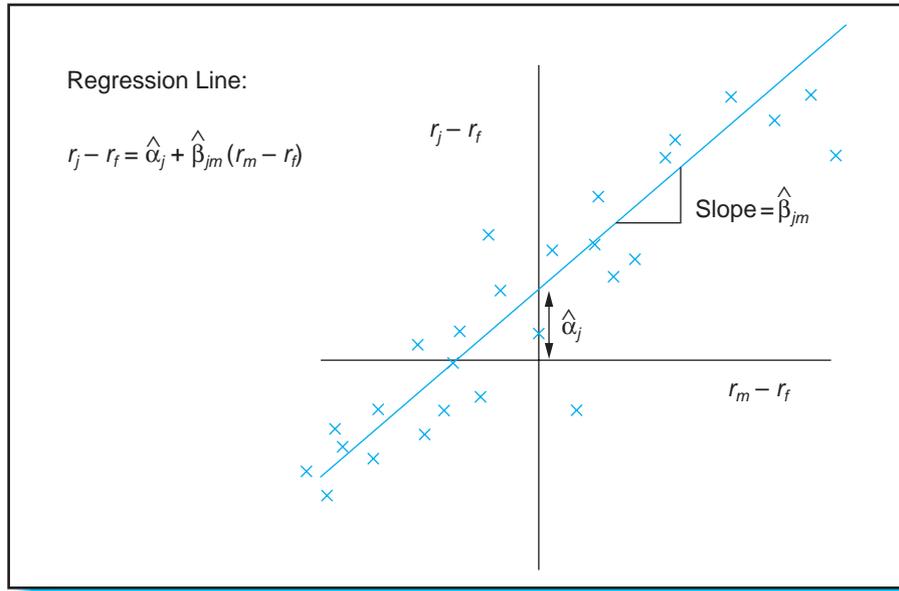
$$\beta_{jh}\beta_{hm} - \beta_{jm} = (0.885 \times 0.737) - 0.585 = 0.067$$

Stulz uses an expected excess return on the world market portfolio $[E(r_m) - r_f]$ of 6.22%, in which case the error for Nestlé from using a domestic CAPM instead of the global CAPM is $0.067 \times 6.22\% = 0.42\%$.

Thus, using local pricing instead of global pricing implies an expected return for Nestlé that is 0.42% higher than it should be. If Nestlé is priced in the world market and not the local market, its required expected return should be the risk-free return on Swiss franc bonds plus a risk premium equal to the beta with the world market portfolio multiplied by the excess return on the world market portfolio, $0.585 \times 6.22\% = 3.64\%$. If Nestlé is priced in the local market, its required expected return would be the risk-free return on Swiss franc bonds plus a risk premium equal to $3.64\% + 0.42\% = 4.06\%$.

This example demonstrates that, at least for Nestlé, the error from using a domestic CAPM when the world CAPM is appropriate does not seem to be too big. Estimation error in the betas and the mean return on the world market portfolio could easily lead one to consider discount rates that are in this range when doing sensitivity analysis. In a similar exercise, Harris et al. (2003) show that the world CAPM and the domestic CAPM led to similar cost-of-capital estimates for S&P 500 firms.

Exhibit 13.12 Estimating Beta

Regression Line:

$$r_j - r_f = \hat{\alpha}_j + \hat{\beta}_{jm}(r_m - r_f)$$

$r_j - r_f$

Slope $= \hat{\beta}_{jm}$

$\hat{\alpha}_j$

$r_m - r_f$

Note: The CAPM implies $\hat{\alpha}_i = 0$. The *x*'s represent a combination of the excess return on the *j*-th asset and the excess return on the market portfolio.

Beta Estimation

Recall that the beta for security j is given by $\beta_j = \dfrac{\text{Cov}\left[r_j, r_m\right]}{\text{Var}\left[r_m\right]}$. Astute readers will recognize that β_j is the regression coefficient from regressing $r_j - r_f$ onto $r_m - r_f$ (see the appendix to Chapter 7). Suppose you have data on excess returns for security j, $r_j^e(t)$, and for the market, $r_m^e(t)$. You obtain β_j by running a regression:

$$r_j^e(t) = \alpha_j + \beta_j r_m^e(t) + \varepsilon_j(t)$$

where $\varepsilon_j(t)$ is the error term in the regression. Exhibit 13.12 demonstrates graphically what we would find in a regression framework.

Many firms use the CAPM in their capital budgeting analyses. They can estimate the beta of a firm directly by choosing a portfolio to represent the market portfolio that is held by their investors and run the regression just described. Firms such as Barra and Value Line do the regressions and sell the information. Typically, the regression analysis uses only 60 months of data to accommodate the possibility that the risk profiles of companies change over time.

Estimating a beta using a regression is often imprecise because a firm's returns exhibit considerable idiosyncratic volatility. That is, much of the variation in a firm's return is driven by firm-specific events. This idiosyncratic volatility reduces the fit of the regression and increases the standard errors of the estimates. Therefore, some beta providers (such as Bank of America–Merrill Lynch) shrink the estimates toward 1, which is the value we would expect without other information. Another approach is to use industry portfolios. If firms in the same industry have about the same systematic risk, their betas will be about the same as well. A portfolio of firms diversifies away a lot of idiosyncratic risk and is consequently much less variable than an individual firm's stock returns. Therefore, beta estimates from industry portfolios are more precise.

Example 13.6 Comparing Firm and Industry Betas

Yahoo's financial Web site (www.finance.yahoo.com) provides estimates of betas for free. Let's compare beta estimates obtained from there on March 21, 2011, with beta estimates obtained from Aswath Damodaran's Web site at New York University (http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html) for industry portfolios. The Yahoo estimates use 5 years of individual stock returns on a monthly basis, whereas the industry estimates also use 5 years of data, but at a weekly frequency:

Firm	Yahoo Beta	Industry	Industry Beta
Ford	2.52	Automotive	1.50
McDonald's	0.40	Restaurants	1.33
Wells Fargo	1.51	Banks	0.75
Microsoft	0.95	Software	1.06
Merck	0.57	Drugs	1.11

The individual stock betas vary between 0.40 (McDonald's) and 2.52 (Ford), whereas the industry estimates are much closer to 1.0.

There are good reasons for some companies to have betas that deviate from the industry average. For instance, they may have more or less financial leverage (debt value relative to equity value). If equity holders have to pay off bondholders before laying claim to the firm's assets, their claims are riskier. Nevertheless, betas of only 0.40 for McDonald's and 2.52 for Ford are almost surely due to unusual idiosyncratic movements of the firm's stock prices over the sample period and are unlikely to give rise to reliable cost-of-capital estimates. A firm's beta also changes over time as its business changes. Microsoft used to be a growth company with a very high beta. As it has become more mature with a more steady cash flow, its beta has also converged to 1.

The Risk Premium on the Market

Historical Estimates

It is surprising how little consensus there is about the magnitude of the **equity risk premium**.[6] To estimate the risk premium, the first logical step is to look at history. Because stock returns are so volatile, it is important to take a long-run perspective. Dimson et al. (2007) collected 106 years' worth of data, and Exhibit 13.13 reproduces the historical risk premiums for 17 countries. These equity premiums vary between 4.51% for Denmark and 10.46% for Italy. The estimate for the United States is 7.41%.

Caveats

Historical estimates, even for long samples, are still prone to large sampling errors, and different subperiods give very different answers. The recent global financial crisis illustrates how sensitive risk premium estimates can be. Many stock markets decreased by 40% or more in 2008. Even with 100 years of data, such dramatic outcome would lower the average by approximately 40 basis points. When shorter time periods are relied on, the effect would be even more dramatic.

---

[6]A direct perspective on this issue can be gleaned from Ivo Welch's survey of the opinions of professional economists. Welch's 2009 survey puts the average estimate at 6%.

Exhibit 13.13 Equity Risk Premiums Around the World

Country	Arithmetic Mean	Standard Deviation
Australia	8.49	17.00
Belgium	4.99	23.06
Canada	5.88	16.71
Denmark	4.51	19.85
France	9.27	24.19
Germany[a]	9.07	33.49
Ireland	5.98	20.33
Italy	10.46	32.09
Japan	9.84	27.82
Netherlands	6.61	22.36
Norway	5.70	25.90
South Africa	8.25	22.09
Spain	5.46	21.45
Sweden	7.98	22.09
Switzerland	5.29	18.79
United Kingdom	6.14	19.84
United States	7.41	19.64
Average	**7.14**	**22.75**
World, excluding		
United States	**5.93**	**19.33**
World	**6.07**	**16.65**

Notes: Data from Dimson, Marsh, and Staunton (2006). The mean column reports the average return on equity in percentage per annum over and above a risk-free return for the period 1900 to 2005. The standard deviation column reports the annual standard deviation of these excess returns.

[a]Germany values omit 1922 to 1923.

Research has argued for smaller premiums going forward, even before the crisis. Brown et al. (1995) note that the equity markets of various countries have periodically closed or failed outright. If investors thought that the market might actually fail, but it did not, then the average return over a long period would be abnormally high and not a good estimate of the expected *ex ante* return. As another example, Fama and French (2002) argue that the high average realized equity returns post-World War II are greater than what was expected over the past 50 years because the *ex post* returns include "large unexpected capital gains" caused by a decline in discount rates. Claus and Thomas (2001) use analysts' forecasts to argue that the equity premium should be 3%, which is less than half the historical average.

It is certainly possible that risk premiums have permanently declined. Investing in the stock market was traditionally difficult, costly, and limited to a select few, but now better technology, improved communication, an efficient mutual fund industry, and 401(k) legislation have increased stock market participation to close to 50% of the U.S. populace. Broadening the base of equity holders spreads risks and should decrease the risk premium. A decline in the risk premium produces a capital gain in stocks, but these high past returns signal future lower expected returns. Lettau et al. (2008) ascribe a decrease in discount rates to a reduction in macroeconomic risk, as measured by the volatility of consumption and output growth, witnessed in the 1980s and 1990s (the so-called Great Moderation). However, although the 2007 to 2010 economic crisis surely implied much lower returns on equities, it also signaled the end of the Great Moderation. Given all of this, substantial uncertainty about a correct value for the risk premium remains. We propose to use an equity premium between 4% and 7%. In Chapter 15, we will use 5.5% as our point estimate.

The Need for Sensitivity Analysis

The imprecision in estimates of the equity premium combined with imprecision in the estimates of betas means that costs of equity capital are difficult to measure. In light of these

difficulties, conducting **sensitivity analysis** when estimating the cost of equity capital is a good idea. Considering a range of values that are $\pm 2\%$ around the estimates of the cost of capital seems appropriate.

13.6 INTEGRATED VERSUS SEGMENTED MARKETS

In this section, we first discuss investing in emerging markets and the critical role investment barriers play. We then discuss how integrated versus segmented markets affect a company's cost of capital. We end the section by describing the phenomenon of home bias.

Investing in Emerging Markets

Exhibit 13.14 reports characteristics of annualized emerging market equity returns in dollars for the period from 1988 to 2010. The average returns vary between 5.78% for Jordan to a stellar 34.00% for Brazil. However, emerging market returns are very volatile, with most of volatilities exceeding 30%. Turkey's volatility is a whopping 59%. Nevertheless, the volatility of an index of emerging market returns measured in dollars is only 24%, which is about the same magnitude as that experienced by a developed country such as Japan.

The reduced volatility of the index reflects the low correlations across the emerging markets and the substantial benefits of diversification. The last four columns of Exhibit 13.14

Exhibit 13.14 Average Returns and Volatilities in Emerging Markets

	Average Market Return	Volatility	Correlation with U.S. Returns	Correlation with Japanese Returns	Correlation with U.K. Returns	Correlation with German Returns
Argentina	31.07	55.06	0.29	0.08	0.20	0.19
Brazil	34.00	52.77	0.40	0.29	0.35	0.32
Chile	21.85	24.61	0.45	0.20	0.36	0.35
China	6.93	37.32	0.47	0.24	0.43	0.40
Colombia	23.36	32.72	0.31	0.22	0.36	0.35
Czech Republic	18.26	29.73	0.41	0.32	0.49	0.51
Egypt	23.30	33.53	0.35	0.31	0.37	0.36
Hungary	22.23	38.27	0.60	0.36	0.61	0.61
India	16.12	31.29	0.42	0.34	0.42	0.44
Indonesia	24.32	52.42	0.33	0.19	0.24	0.30
Israel	10.60	24.61	0.54	0.25	0.48	0.52
Jordan	5.78	18.74	0.19	0.15	0.20	0.16
Korea	14.54	38.94	0.43	0.49	0.39	0.34
Malaysia	13.19	29.56	0.36	0.28	0.37	0.37
Mexico	25.32	32.19	0.57	0.32	0.42	0.43
Morocco	14.73	19.59	0.14	0.16	0.25	0.25
Pakistan	13.12	39.33	0.13	0.03	0.18	0.12
Peru	24.98	33.13	0.36	0.37	0.38	0.40
Philippines	12.75	32.20	0.41	0.25	0.32	0.34
Poland	26.31	50.49	0.43	0.35	0.43	0.43
Russia	31.62	57.17	0.48	0.38	0.49	0.37
South Africa	16.61	27.96	0.55	0.53	0.58	0.58
Sri Lanka	15.54	37.99	0.18	0.21	0.28	0.17
Taiwan	13.14	37.44	0.36	0.28	0.28	0.37
Thailand	15.90	38.96	0.46	0.36	0.37	0.39
Turkey	29.07	58.93	0.33	0.19	0.31	0.38
EM Index	16.14	24.21	0.66	0.47	0.59	0.59

Notes: For most emerging markets, the monthly data run from January 1988 to August 2010. All returns are in U.S. dollars. The last line reports characteristics for returns on the Emerging Market Index, a value-weighted average of all 26 country indexes.

report the correlations of emerging market returns with the stock returns of the United States, Japan, the United Kingdom, and Germany. The correlations are generally lower than the correlations among developed countries, but there is lots of variation. The correlations vary between 0.08 for Argentina and Japan, and 0.61 for Hungary with the United Kingdom and Germany. The lowest correlations are typically observed with Japan, with the exception of Korea, which is more highly correlated with its close neighbor than with the other developed markets.

Such low correlations should make it possible to construct low-risk portfolios. Therefore, it is not surprising that early studies showed significant diversification benefits for emerging market investments. However, these studies used market indexes compiled by the International Finance Corporation (IFC) that generally ignored the high transaction costs, low liquidity, and investment constraints associated with emerging market investments. More generally, older data may no longer be relevant given that many emerging markets imposed severe investment restrictions on foreign investors in the early 1990s. For example, in Korea, most stocks were subject to strict foreign ownership restrictions (foreign ownership was limited to 10% of market capitalization for most stocks).

Research by Bekaert and Urias (1996, 1999) showed that the returns cited in the early diversification studies using market index data could not actually be realized by foreign investors. To do so, they examined the diversification benefits U.S. investors enjoyed through investing in a variety of actually available investment vehicles for emerging markets, such as closed-end funds, ADRs, and open-end funds. These assets are easily accessible to retail investors, and investment costs are comparable to the investment costs for U.S.–traded stocks. Bekaert and Urias found that investors give up a substantial part of the diversification benefits by holding these investment vehicles relative to holding the indices.[7]

These results suggest that **investment barriers** may prevent the diversification benefits of emerging markets from being fully realized. They also make it unlikely that emerging markets satisfy the strong assumptions underlying the CAPM. In particular, emerging markets may not be completely integrated with world capital markets, making the world CAPM the wrong model to use. We now clarify the crucial distinction between integrated and segmented markets.

The Cost of Capital in Integrated and Segmented Markets

Markets are integrated when assets of identical risk command the same expected return, irrespective of their domicile. The governmental interferences with free capital markets in emerging markets can prevent market integration and effectively segment the capital markets of a country from the world capital market. If foreign investors are taxed or otherwise prohibited from holding the equities of a country, then that country's assets are not part of the world market portfolio, and that country is said to be segmented from international capital markets.

The implications of segmentation for determining the cost of capital are important. Suppose we want to figure out the expected return on the Pakistani stock market. If the Pakistani stock market is integrated with world capital markets, we can simply use the world CAPM and the world market return as the benchmark portfolio. However, such an exercise would yield a very low expected return for Pakistan because the low correlation Pakistan displays with the world market translates into a low beta. Whereas this is the right computation to make for a foreign multinational corporation (MNC) investing in Pakistan, it yields a poor estimate of the true expected market return for local investors when the market is segmented.

Harvey (1995) shows that the world CAPM provides a poor description of emerging market returns in general and that the domestic CAPM fares much better. Because the Pakistani market is segmented, all securities will be priced according to their correlation

---

[7]The reduction in benefits is only partially due to investment barriers being priced in. For open-end funds, active investment management may cause a reduction in diversification benefits. Didier et al. (2010) demonstrate that mutual fund managers tend to hold concentrated portfolios that hamper full international diversification.

with the Pakistani market portfolio, but Pakistani investors will not be able to diversify the risk of the Pakistani market. Therefore, the expected return on the Pakistani market will be a function of its own volatility. This follows from aggregating the CAPM to the market level, as in Equation (13.7):

$$E[r_j] = r_f + \beta_j E[r_{pak} - r_f] \tag{13.15}$$

for every j security in Pakistan, where r_{pak} is the return on the Pakistani market. We know that the β_j is the covariance of security j with the market portfolio; hence, we can rewrite Equation (13.15) as

$$E[r_j] = r_f + \text{Cov}(r_j, r_{pak}) \frac{E[r_{pak} - r_f]}{\text{Var}(r_{pak})}$$

The expected excess return on the market portfolio divided by its variance is called the price of covariance risk. If investors hold only equities, Equation (13.8) shows that this price of risk equals the average risk aversion of the investors in Pakistan. Let's denote this by A_{pak}. Consequently, $E[r_j] = r_f + A_{pak} \text{Cov}(r_j, r_{pak})$, and aggregating over all securities in Pakistan,

$$E[r_{pak}] = r_f + A_{pak} \text{Var}(r_{pak})$$

Therefore, in **segmented markets**, expected and, hence, average returns should be related to the variance of returns rather than to the covariance with the world market return.

Example 13.7 The Expected Return in Pakistan

From data since 2000 on Pakistani stock returns, we determine that its world market beta is 0.4265. Given a risk-free rate of 5% and a world market equity premium of 5%, full integration dictates an expected return for the Pakistani market of

$$5\% + 0.4265 \times 5\% = 7.13\%$$

While some foreign investors may find this cost-of-capital estimate low, most of the risk associated with investing in Pakistan may indeed be political in nature and idiosyncratic to Pakistan. Thus, it would not represent systematic risk.

However, if Pakistan is truly segmented, the local expected return depends on the local market volatility, which stands at 39.32% in dollar terms (see Exhibit 13.14). Suppose the average risk aversion in Pakistan is 2.0. Under a domestic CAPM for Pakistan, the expected return on the Pakistani market is

$$E[r_{pak}] = 5\% + 2.0 \, (0.3932)^2 = 35.92\%$$

Clearly, the cost-of-capital estimates from the domestic CAPM and the world CAPM are very different. The fact that the domestic CAPM expected return is so unrealistically high may suggest that the Pakistani market is not fully segmented and that part of its variability is diversifiable.

Equity Market Liberalizations
Equity market liberalizations allow inward and outward foreign equity investment. The equity market liberalizations that took place in the late 1980s and early 1990s in many emerging markets form a nice laboratory to investigate the effects of potential integration into global capital markets.

If liberalization brings about integration with the global capital market, and if the world CAPM holds, what do we expect to happen? Suppose that the country is completely segmented from world capital markets before the liberalization. In this case, it is possible for the real interest rate in the country to be quite a bit higher than the world real interest rate. Also, the risk premiums associated with the equities in that country will be dictated by the variance of the return on that country's market portfolio. As we saw in Example 13.7, these risk premiums may be quite high.

Now, suppose the country unexpectedly opens its capital markets to the world economy. Two things will happen: First, the real interest rate in the country should fall dramatically because the country's residents are now free to borrow and lend internationally, and there is additional foreign supply of capital.[8] Second, the equities of the country will now be priced based on their covariances with the return on the world market portfolio, which are likely to be much smaller than the variance of the local market. Both of these effects will reduce the discount rate on the country's assets.

A big reduction in the discount rate, of course, causes the price of an asset to rise dramatically, which provides a big rate of return to the investors holding these assets. Simply put, foreign investors will bid up the prices of local stocks in an effort to diversify their portfolios, while all investors will shun inefficient sectors.[9] Thus, equity prices should rise substantially (as expected returns decrease) when a market moves from a segmented to an integrated state.

When a market is opened to international investors, though, the country's assets may become more sensitive to world events. In other words, their covariances with the rest of the world's assets may increase. Even with this effect, it is likely that these covariances will remain much smaller than the variance of the local market. The data bear out the theory. Studies by Kim and Singal (2000), Henry (2000), Bekaert and Harvey (2000), and others show that equity market liberalizations were accompanied by positive returns to integration as foreign investors bid up local prices. Postliberalization returns, in contrast, were lower on average, as the theory predicts. While the exact estimates differ somewhat, liberalization causes the cost of capital to decline by about 1%.

An interesting parallel occurs with respect to the price of a firm's shares following the issuance of an ADR. An ADR issued by a company headquartered in a country with investment restrictions can be viewed as a sort of liberalization of investment. For example, when Chile had repatriation restrictions in place, it lifted the restrictions for those companies listing their shares overseas to allow cross-market arbitrage. When an ADR is announced, we therefore expect positive announcement returns (e.g., relative to a similar firm not introducing an ADR) and lower expected returns after the liberalization. Several studies demonstrate that this effect is typically larger than 1%, and the studies find lower costs of capital after the ADR issuance. Of course, as we discussed in Chapter 12, there are many reasons, apart from liberalization, that ADR issues may result in a positive effect on the price of equity shares.

Many studies, as surveyed in Bekaert and Harvey (2003), have investigated the effects of liberalizations on other return characteristics. First, there is no significant impact on the volatility of market returns. Indeed, it is not obvious from finance theory that volatility should increase or decrease when markets are opened to foreign investment. On the one hand, markets may become informationally more efficient, leading to higher volatility as prices quickly react to relevant information, or hot speculative capital may induce excess volatility. On the other hand, in the preliberalized market, there may be large swings from fundamental values, leading to higher volatility. In the long run, the gradual development and diversification of

---

[8]It is conceivable that before the liberalization, the government may have kept interest rates artificially low—for instance, through interest rate ceilings—in which case, the interest rate may rise upon liberalization.
[9]A more formal analysis can be found in Bekaert and Harvey (2003), which builds on work by Errunza and Losq (1985).

the market should lead to lower volatility. Second, the correlation of the return and its beta with the world market increases after equity market liberalizations, and for some countries, the increase is dramatic. This is also consistent with these liberalizing emerging markets becoming more integrated with world capital markets.

Segmentation and Integration over Time

Although the empirical studies on the financial effects of equity market liberalizations confirm the intuition predicted by the simple CAPM, this does not mean that we are now living in a globally integrated capital market. In fact, using official regulatory reforms to measure liberalization is fraught with difficulties because it is difficult to know what effectively segments a market from the global capital market. There are three different kinds of barriers. The first are legal barriers, such as foreign ownership restrictions and taxes on foreign investments. An additional complication here is that the liberalization process is typically a complex and gradual one. It took Korea almost 10 years between 1991 and 2000 to gradually remove its foreign ownership restrictions. The second are indirect barriers arising from differences in available information, accounting standards, and investor protection. The third are emerging-market-specific risks (EMSRs) that discourage foreign investment. EMSRs include liquidity risk, political risk, economic policy risk, and perhaps currency risk. In general, indirect barriers and EMSRs may make institutional investors in developed countries reluctant to invest in emerging markets and segment them from the world market.

Finally, regulatory restrictions might not have posed a barrier prior to liberalization because canny investors often find ways to circumvent them. Alternatively, there may be legal, indirect ways to access local equity markets, such as through country funds or ADRs. The Korea Fund, trading on the NYSE, is a good example; it was launched in 1986, well before the liberalization of the Korean equity market. In short, determining whether a market is segmented, integrated, or something in between is far from easy.

A Model of Time-Varying Market Integration

Given the imperfections posed by official regulatory reform dates, researchers have come up with a variety of models to determine when and to what extent markets are integrated. For example, Bekaert and Harvey (1995) build on the CAPM model to measure the degree of market integration. In **integrated markets**, the covariance with the world market should determine the expected return on the domestic market. However, if the market is truly segmented, the variance of the return on the domestic market should affect the domestic expected return. Bekaert and Harvey apply an econometric framework, which allows the degree of a country's integration with the world market to vary over time, directly to equity return data. They find that the degree of equity market integration seems to vary for all countries in the sample, but variation in the integration measure does not always coincide with capital market reforms. For example, consider the market rate of return in Greece, which is completely open to foreign investors. The market return was more sensitive to the variance of the return on the Greek market in some periods than to the covariance between the return on the Greek market and the return on the world market portfolio. In contrast, Mexico has had rather strong legal restrictions on foreign investment, which would lead us to think that the variance of Mexico's stock market ought to be important when it comes to determining its expected return. But the analysis implies that Mexico is actually quite integrated with the world market. Consistent with this analysis, Exhibit 13.14 shows that Mexican equity returns have a 57% correlation with U.S. returns, whereas we already discussed the low correlation of Greek returns with other developed markets.

Bekaert et al. (2011) follow a different approach. They compare the valuation of industry portfolios in different countries with the valuation of the same industry globally by computing earnings yields (total earnings divided by market capitalization). Under some assumptions,

industry earnings yields in different countries converge toward the global earnings yields when markets are economically and financially integrated. They take the market capitalization weighted average of these earnings yields differentials for various industry portfolios to arrive at a "segmentation measure" for each country, which essentially measures the absolute difference in earnings yields with the global yield. For developed countries, these average yield differentials are 2% for 2001 to 2005, which could be generated through noise and measurement error in a fully integrated market. However, for emerging markets, these differentials were, on average, 4.3%, suggesting segmentation. Bekaert et al. also document considerable convergence of earnings yields over time and demonstrate that, apart from the regulatory liberalization process, indirect barriers (such as the quality of the regulatory and legal framework) and emerging-market-specific risks (such as the liquidity in the stock markets) play an important role in explaining variation across countries and across time in the degree of segmentation.

The Practical Implications of Segmentation and Time-Varying Integration

As a practical matter, when international managers choose a discount rate for the all-equity cash flows of a project, they must rely on a healthy dose of economic intuition and must understand the meaning of historical statistics. Let's discuss two real-world examples.[10] The first involves a Mexican company and a Swiss company bidding for the Indonesian firm PT Semen Gresik in July 1998.

Indonesia liberalized in September 1990, and PT Semen Gresik had been publicly traded for some time prior to that. In valuing PT Semen Gresik in 1998, you would have to determine an appropriate discount rate. Will any of the historical return data be of use to you? Certainly, the data prior to 1990 are worthless. The historical average rate of return will reflect both the high risk premium typical for securities in segmented countries and the one-time capital gain that occurred when Indonesia opened its international capital market.

What should you do? You should start by asking yourself what your shareholders demand as a domestic currency return if they were to invest in this project directly. If your typical shareholder is thought to be well diversified internationally, then you can attempt to determine how the domestic currency return on this foreign asset will covary with the domestic currency return on the world market portfolio. This will lead you to a domestic currency discount rate. Because PT Semen Gresik is in the cement business, the bidders could obtain a first indication by using a portfolio of either Mexican or Swiss building firms to compute an appropriate discount rate. While these firms may correctly reflect the systematic risk of globally integrated cement firms, they are not likely fully representative of the cement business in Indonesia, even after liberalization. Therefore, the beta of PT Semen Gresik's returns with respect to the world market calculated with post-1990 data should likely enter the computations as well.

Now consider the Westmore Coal Company, an actual U.S.–based firm that intended to invest $540 million in an electric power project located in Zhangze, China, in 1994. Not only were there no comparable publicly traded projects from which to compute betas, but China was a fully segmented country! As Exhibit 13.14 shows, local market volatility was very high, so the domestic discount rate would have been high, too. However, because Westmore Coal's shareholders were likely to be internationally diversified, the world CAPM should have been used. Because no data are available, the amount of risk premium that must be added to the risk-free rate becomes a business judgment. The equity risk premium should be based on the type of business that the project represents. If the business is highly cyclical and its profits are likely to covary with the return on a world market portfolio, you add more than the average risk premium. If, on the other hand, the business is highly idiosyncratic, then not

---

[10]Both examples are from Bodnar et al. (2003).

much of a risk premium may be warranted. In this case, it is likely that the power plant's cash flows in China show little correlation with the world market and that a low risk premium is called for. This may be counterintuitive because a project in China may appear risky. However, the additional risks are likely of a political nature and should be assessed separately from the project's systematic risk. We discuss political risk in Chapter 14.

Home Bias and Its Implications

Unlike what the CAPM predicts, investors in different countries are generally not very well internationally diversified. In other words, most of their portfolios have a strong home bias. **Home bias** means that British investors, for example, hold a disproportionately large share of British assets compared to the world market portfolio. Exhibit 13.15 documents home bias for equity portfolios using data from the International Monetary Fund (IMF).

The home bias in Exhibit 13.15 is measured in a "raw" and "normalized" form for 6 years between 1997 and 2005 and averaged, following Bekaert and Wang (2010). Raw

Exhibit 13.15 Characterizing Home Bias

	Raw Home Bias		Normalized Home Bias	
Least Home Biased	United States	0.386	Netherlands	0.468
	Netherlands	0.457	Norway	0.567
	Norway	0.565	Austria	0.574
	Austria	0.573	Denmark	0.630
	United Kingdom	0.626	Sweden	0.639
	Denmark	0.627	Belgium	0.664
	Sweden	0.633	New Zealand	0.687
	Belgium	0.659	Canada	0.689
	Canada	0.669	United Kingdom	0.689
	New Zealand	0.686	Argentina	0.720
	Singapore	0.717	Singapore	0.721
	Argentina	0.719	United States	0.727
	France	0.724	Finland	0.740
	Finland	0.736	France	0.757
	Italy	0.755	Italy	0.773
	Japan	0.792	Iceland	0.822
	Australia	0.814	Australia	0.829
	Iceland	0.821	Spain	0.852
	Spain	0.838	Portugal	0.876
	Portugal	0.874	Japan	0.896
	Israel	0.921	Israel	0.923
	Chile	0.957	Chile	0.960
	Venezuela	0.974	Venezuela	0.975
	Korea	0.976	Korea	0.985
	Malaysia	0.982	Malaysia	0.987
	Thailand	0.989	Thailand	0.991
Most Home Biased	Indonesia	0.997	Indonesia	0.998
Average by Group	Developed, excluding United States	0.698	Developed, excluding United States	0.715
	Emerging	0.939	Emerging	0.942
	America	0.741	America	0.814
	Europe	0.684	Europe	0.696
	Asia	0.910	Asia	0.929
	Euro zone	0.702	Euro zone	0.713

Note: Reproduced from Table 2 in Bekaert and Wang (2010).

home bias measures the difference between the portfolio share that each country invests in its own market (home market share) and the share of the country's market in the world market (world market benchmark). By this measure, the United States is by far the least home-biased market. However, this is largely true because the U.S. market represents a large fraction of the world market. The normalized home bias measure divides the raw measure by 1 – world market benchmark weight, which is nothing but the maximum bias that can occur. A fully home-biased country has a normalized measure of 1, whereas a country that invests in its own market consistent with its share in the world market has a home bias measure of zero.

Exhibit 13.15 delivers a few stark results. First, all around the world, people hold far less foreign securities than the world CAPM would dictate. Investors do not seem to take full advantage of the considerable benefits of international diversification. Second, the biases are large. Of 27 countries, only the Netherlands has a bias less than 50%. Third, the bias is much larger for emerging markets than for developed markets. This is particularly striking because the benefits of portfolio diversification are presumably larger for emerging market residents than for developed market residents, given how volatile their domestic stock markets tend to be.

Finally, it is generally known that the degree of home bias has substantially decreased over time. Cai and Warnock (2006) claim that the degree of home bias is overstated because institutional investors tend to overweight their domestic investments toward multinationals that have international exposure through their foreign operations and cash flows. Yet, even adjusting the numbers for this additional foreign exposure, home bias remains significant for most countries in the world, and it is something that is not well understood by financial economists. Let's see if Ante and Freedy can shed any light on the puzzle.

POINT–COUNTERPOINT

What Breeds Foreign Investment?

"Hmm, they are delicious," Ante sighed, while he devoured his fourth Belgian Leonidas chocolate in a row. Ante and Freedy were sitting in the salon, digesting what their father had just told them about their trust fund. Dad wanted to increase the trust's allocation to foreign equities from 15% to 30% and wondered whether Ante and Freedy knew why U.S. investors were often reluctant to invest in foreign equities, despite their obvious diversification benefits. Ante and Freedy had agreed to study the issue, and to help their thinking, they had brewed nice, frothy cappuccinos using a fancy Italian machine their father had imported.

"You know," argued Freedy, "I could think of a number of rational reasons why U.S. investors might want to be home biased. Foreign equities have currency risk and hence more volatility than U.S. equities. The U.S. market is the most efficient market in the world, and transaction costs here are lower than they are elsewhere. Plus, it is very difficult to obtain reliable accounting information on foreign companies."

"No way," mumbled Ante, while enjoying his fifth Leonidas. "These foreign equities simply are underperforming the U.S. equity market. Besides, I do not feel comfortable having our money invested in unfamiliar companies."

At this point, Suttle, who had quietly sneaked into the room when he smelled the coffee, could no longer keep quiet. "Hey, guys! I happen to have just read some articles about the home bias phenomenon. Let me fill you in. First, currency risk is not what is stopping U.S. investors from investing abroad. Because currency changes show little correlation with local equity markets, they add little to the volatility that U.S. investors face when investing in foreign equity markets. Moreover, currency volatility can be hedged. Second, arguing that the U.S. market outperforms foreign markets is short-sighted and not even true historically. Third, transaction costs may play a role, but in order to generate the observed portfolio

proportions of U.S. investors, U.S. investors would have to think that the average returns on foreign stocks were 2% to 4% per annum less than the realized average returns on foreign assets. It may be that these figures represent U.S. investors' perceived transaction costs of foreign investing, but it is unlikely. Moreover, the huge volume of international capital flows is also inconsistent with the transaction costs story, as is the fact that foreign countries are home biased. Fourth, I do not like the information story: It is easy enough to obtain information on foreign companies or to set up or use local investment managers. However, it may be that the quality of the information and a poor regulatory framework in terms of investor protection and corporate governance keep out U.S. institutional investors. This may explain why foreign companies like to list ADRs and thus can be more easily included in institutional investors' portfolios."

Suttle continued, "Although these indirect barriers are clearly important, they cannot be the full story, given the cross-border flows and home biases in other countries. Clearly, direct barriers played a huge role, and many countries have only recently dismantled these barriers. In fact, there is a trend everywhere toward increased foreign holdings, so maybe investors are slowly adjusting toward rational asset allocation."

"Aha!" shouted Ante. "You do not really have a full, rational explanation for the phenomenon, do you, Suttle?"

"Well, you've got a point with that familiarity argument of yours," replied Suttle. "I just read a few articles that claim that U.S. investors even bias their domestic investments toward companies that are 'familiar' to them. One study showed that the ownership of the shares of regional telephone companies is dominated by people living in the area served by those companies. Another study showed that U.S. investment managers exhibit a strong preference for firms headquartered within a 500-mile radius of their offices."[11]

"Oh well, maybe people do not like foreign investments, but I will surely enjoy having another Italian coffee and Belgian chocolate," smirked Freedy.

Implications for Pricing

If investors are not fully internationally diversified, should we discard the world CAPM as the benchmark model? This is a difficult issue. However, it might not be necessary for every individual in the world to be fully internationally diversified for asset returns to be well described by a world CAPM. In fact, whereas it is true that emerging market returns do not look at all consistent with a world CAPM, the evidence against other stock markets is not strong. Harvey (1991) and Hodrick et al. (1999) show that a version of the CAPM in fact works well for most developed stock markets most of the time.

Time-Varying Correlations

The trend toward less home bias, and the move toward ever-increased integration, as investment barriers, both direct and indirect, are dismantled, should also increase the correlations across countries, making international diversification less viable. Exhibit 13.16 sheds some light on this issue. It reports correlations for Japan, Canada, the United Kingdom, France, and Italy with the United States for every decade since 1970 and for the past decade (until August 2010). Until 1999, the correlations increase steadily for all countries except Japan. However, for all countries, the correlations are substantially higher during 2000 to 2010 than they were previously.

---

[11]These studies are by Huberman (2001) and Coval and Moskowitz (1999), respectively.

Exhibit 13.16 Correlations Between Foreign and U.S. Equity Market Returns

	1970–1979	1980–1989	1990–1999	2000–2010	1970–2010
Canada	0.71	0.72	0.73	0.81	0.74
Japan	0.31	0.24	0.30	0.61	0.35
United Kingdom	0.45	0.56	0.58	0.85	0.57
France	0.40	0.44	0.55	0.85	0.56
Germany	0.29	0.36	0.51	0.84	0.76
Italy	0.17	0.24	0.32	0.66	0.36

Note: The data are from MSCI.

Whether the increases in correlations are due to increased market integration and, therefore, represent a permanent change is an important question. Because temporarily higher volatility in equity markets also tends to temporarily increase the correlations between markets, it is difficult to separate temporary from permanent correlation changes. The intuition for this fact is best understood if we consider two countries satisfying the world CAPM. As a consequence, part of the return variation in both countries is driven by the returns on the world market, and this joint exposure likely induces positive correlation between the returns on the two stock markets. Intuitively, if the world market movements became extremely variable, they would dominate all return variation in the two stocks, and the correlation would converge to 1. This is relevant for the numbers produced in Exhibit 13.16, as the world market volatility at the end of the 1990s, in the early 2000s, and again during the 2007 to 2010 financial crisis was indeed relatively high. A study by Bekaert et al. (2009) concludes that return correlations within Europe have permanently increased, but their tests do not reject the hypothesis that return correlations elsewhere have remained unchanged, once account is taken of temporary changes in volatility.

13.7 ALTERNATIVE COST-OF-CAPITAL MODELS

The Usefulness of the CAPM

Even though the CAPM is not without flaws, it is viewed as a reasonable model that can be used to estimate the required rates of return needed for capital budgeting. One reason is that it incorporates an important lesson about diversification: There is no evidence that firms whose returns have had high historical standard deviations have had high average returns. In fact, research by Ang et al. (2006, 2009) shows just the opposite: Stocks with high idiosyncratic standard deviations have had low average returns, both in the United States and 23 other countries.

When we consider the overall historical record, we conclude that the cost of equity capital should reflect a risk premium that compensates the firm's investors for the systematic risk present in the investment. Suppose, though, that the CAPM is wrong. In this case, it will either overstate or understate the market's required rates of return.

The Consequences of Using the Wrong Model

Managers who use the CAPM when it overstates the market's required rates of return will forgo some profitable projects with true positive net present value that should have been undertaken. Eventually, the stock market will discipline these conservative managers by viewing them as underperformers. Conversely, if the CAPM understates project risk premiums, managers using the CAPM will undertake some projects that are actually negative net present

value, which will destroy shareholders' wealth. Now, the market will discipline these overly aggressive managers for their underperformance relative to what shareholders demand.

Given that the CAPM may be incorrect and that recent empirical tests have not been kind to the CAPM, is there an alternative model to compute the cost of capital? We now discuss two models that have been proposed as alternatives to the CAPM.

Factor Models and the Fama-French Model

A serious competitor to the CAPM is the **arbitrage pricing theory (APT)**, originally developed by Ross (1976).[12] The APT recognizes that the return on the market portfolio may not be the only potential source of systematic risks that affect the returns on equities. The APT postulates that other economy-wide factors can systematically affect the returns on a large number of securities. These factors might include news about inflation, interest rates, gross domestic product (GDP), or the unemployment rate. Changes in these factors affect future corporate profitability, and they may affect how investors view the riskiness of future cash flows. This, in turn, will affect how investors discount future uncertain cash flows.

When there are economy-wide factors that affect the returns on a large number of firms, the influences of these factors on the return to a well-diversified portfolio are still present. The influences of the factors cannot be diversified away. Consequently, the risk premiums on particular securities are determined by the sensitivities of their returns to the economy-wide factors and by the compensations that investors require because of the presence of each of these different risks. To determine these factor risk premiums, researchers construct factor-mimicking portfolios—portfolios that correlate very highly (ideally perfectly) with the economic factors. Because the APT is rarely used to compute costs of capital, we do not provide more details. However, over the last decade, a related factor model has gained prominence, following provocative research by Fama and French (1992).

The Value and the Small Firm Effects

In a 1992 paper, Fama and French questioned the ability of the traditional CAPM to explain the cross-section of stock returns in U.S. data. They found that the market value of a firm's market equity (ME), which is its price per share multiplied by the number of shares outstanding (or the firm's market capitalization), and the ratio of the accounting book value of a firm to its market value [book equity to market equity (BE/ME)] contribute significantly to the explanation of average stock returns.[13]

During their sample, average returns on firms with small market capitalizations were higher than could be explained by their betas with the market portfolio. Perhaps small firms suffer from a greater lack of communication between the firm's managers and its investors. This asymmetric information could lead investors to require higher rates of return from small firms. Firms that have high ratios of the book value of their equity to the market value of their equity (so-called value firms) also have higher average returns than can be explained by the CAPM and have outperformed growth stocks (stocks with a low BE/ME). Interestingly, these firms often suffer from financial distress. If financial distress tends to systematically occur when investors are more risk averse or face bad times, it may cause investors to demand a risk premium for bearing this risk.

Fama and French's findings are still the subject of great debate in the economic literature, and not everyone believes the results will hold up to further scrutiny. First, many mutual fund companies offer value funds and small-cap funds, which invest in high book-to-market

---

[12]For an introduction to the APT, see Chapter 11 of Ross et al. (2002).

[13]Although firms with higher betas tend to have higher average returns, Fama and French argue that the ability of beta to explain the cross-section of average stock returns is nil when the size of the firm's market equity and ratio of book equity to market equity are included as explanatory variables.

stocks and small-capitalization stocks, respectively. Hence, individual investors can easily diversify their portfolios along size and value characteristics. Second, Ang and Chen (2007) found little evidence of a value effect in a larger sample than the one used by Fama and French (1992), and several other authors have suggested that the size effect disappeared in the 1980s.[14]

The Fama-French Three-Factor Model (Advanced)

Based on their empirical findings, Fama and French (1995) developed a three-factor model to explain average equity returns. The first factor is the return on the value-weighted market portfolio in excess of the risk-free return, as in the CAPM. The second factor is the difference in the return on a portfolio of small firms and the return on a portfolio of big firms [small minus big (SMB)], in which the ratio of BE/ME is held constant in each portfolio. The third factor is the difference between the return on a portfolio of firms with high values of BE/ME and the return on a portfolio of firms with low values of BE/ME [high minus low (HML)], in which the size of firms is held constant in each portfolio. To find the sensitivities of a firm's equity return to the three factors, you merely run a regression, just as you do to find the beta in the CAPM. The difference is that now there are three explanatory variables instead of one. The average rates of return on the factor-mimicking portfolios can then be combined with the estimated sensitivities of the equity return to the returns on the factor-mimicking portfolios to provide an estimate of the required rate of return on the equity.

When Fama and French (1998) applied their model to international data,[15] they found that two factors—the return on the world market and a global version of the HML factor—sufficed to explain the cross-section of expected returns in 13 countries.

Example 13.8 The Cost of Equity Capital in the Fama-French Model

Suppose we want to estimate the cost of capital for a firm in Australia that has the same systematic risk as a portfolio of Australian stocks with high book-to-market levels. In Fama and French (1998), we find the following estimates:

	CAPM	TWO-FACTOR MODEL	
	Beta with Global Market	Beta with Global Market	Beta with HML Portfolio
Australian high book-to-market firms	0.84	0.90	0.59

If the current risk-free interest rate is 5%, and the world market equity risk premium is 5.93% (see Exhibit 13.13), from Equation (13.10), the required rate of return for the Australian firm from the CAPM is

$$r_{AUS} = 5\% + (0.84 \times 5.93\%) = 9.98\%$$

---

[14]To illustrate how divided the profession is on these issues, even the authors of this book disagree, with one of them arguing that there is a value effect to be explained and the other arguing that it is most likely statistical baloney. We have booked a meeting with Suttle Trooth to help us out. We will let you know the outcome in the next edition.

[15]It must be said that the empirical evidence against the CAPM was marginal at best in most countries, with the exception of the United States. Nevertheless, the new proposed model clearly improved the fit with the data.

We estimate the premium on the value factor-mimicking portfolio to be 3%. Therefore, the required equity rate of return implied by the Fama-French two-factor model is

$$r_{AUS} = 5\% + (0.90 \times 5.93\%) + (0.59 \times 3.00\%) = 12.11\%$$

Notice that the two estimates of the required rate of return on the stock are very different. This is true because value firms in Australia have historically provided higher average rates of return than the CAPM would imply. Although the Fama-French model has become quite popular, it remains an empirical model, not grounded in formal theory. With remaining doubts about the validity of the model and no good story for why the value effect would persist, the Fama-French model has not yet been widely adopted in practice.

13.8 Summary

This chapter develops the theories and background necessary to determine the cost of equity capital in global financial markets. Its main points are the following:

1. To determine the international cost of equity capital, we must first determine how investors view risk in a global investments context.

2. When investing abroad, an investor must assess both the returns of the international asset in its local currency and variations in the value of the foreign currency relative to the investor's home currency.

3. The volatility of an international equity investment is mostly determined by the volatility of the local equity market. Although exchange rate changes are quite variable, they are nearly uncorrelated with local stock returns.

4. International diversification results in portfolios with risk levels much lower than what can be achieved with domestic diversification alone. The main reason is that the stock market returns of different countries are not very highly correlated with one another, despite the fact that correlations among them tend to increase during bear markets.

5. Using available data on the volatilities of different markets and the correlation among them, investors can compute a "hurdle rate" of return for foreign investments. The hurdle rate is the expected return for which a small investment in the foreign equity market, starting from an all-domestic portfolio, increases the Sharpe ratio for the portfolio.

6. Among the G7 countries, a U.S. investor can most easily improve her risk–return trade-off, as measured by the Sharpe ratio, by investing in Japan. Japan has a rather poor historical return record but features the lowest correlation with U.S. returns among G7 countries.

7. It has become easier over time to invest internationally while remaining "at home," through investment vehicles such as closed-end funds, open-end funds, ADRs, and ETFs.

8. A mean-variance investor likes high expected returns but dislikes portfolio variance. If only a risk-free asset and just one risky asset are available, she will invest more in the risky asset the lower her risk aversion, the higher the expected excess return, and the lower the variance of the risky asset.

9. The mean–standard deviation frontier collects portfolios that minimize the portfolio variance for each possible expected return. The mean-variance-efficient (MVE) portfolio is the one portfolio on the frontier that maximizes the Sharpe ratio and is hence optimal. This portfolio defines the capital allocation line, which determines how the investor mixes the risk-free asset with the optimal risky portfolio, depending on her preferences.

10. The capital asset pricing model (CAPM) states that under some simplifying assumptions, the MVE portfolio ought to be the market portfolio, which contains all securities in proportion to their market capitalization.

11. The CAPM implies that the expected return of any security equals the risk-free rate plus the beta of the security multiplied by the market risk premium. The beta of the security is the covariance of its return with the return on the market portfolio divided by the variance of the market portfolio return.

12. In an international setting, the relevant benchmark for the market portfolio should be the world market portfolio, giving rise to the world CAPM. The world CAPM ignores exchange rate risk.

13. In an international setting, investors in different countries evaluate real returns using different consumption baskets and view money market investments in other countries as risky because of exchange rate risk. Although it is possible to adjust the CAPM for these considerations, the resulting international CAPMs are rarely used in practice.

14. To use the CAPM to obtain a cost of capital, we must determine the betas, the market risk premium, and a risk-free rate. The risk-free rate is usually the Treasury bill rate. The beta is estimated from a regression of excess returns on the security in question onto excess returns on the world market portfolio. Sometimes, industry portfolios are used to reduce the sampling error in estimating the betas. The risk premium on the market portfolio is the subject of much controversy. An estimate of 4% to 7% is reasonable. In any case, any cost-of-capital estimation and project evaluation should be accompanied by a sensitivity analysis.

15. Emerging equity markets display relatively low correlations with the stock markets of developed countries. Many of the emerging markets underwent a liberalization process in the 1990s that made their stock markets fully or partially accessible to foreign investors.

16. Equity markets are integrated when assets of identical risk command the same expected return, irrespective of their domicile. The many investment barriers in place in emerging markets have effectively segmented them from the global capital market. The liberalization process, however, has led to increased asset prices, higher correlations with the world market, and lower expected returns in emerging markets.

17. The benchmark used in the cost-of-capital computation should reflect the composition of the portfolio of the investors in the company, even when the project takes place in a potentially segmented emerging market. Historical data in these emerging markets may not be very useful for a cost-of-capital analysis if the market is truly segmented or if it underwent a liberalization process that caused a structural break in the return data.

18. Even in the developed world, investors have not fully internationally diversified. Instead, their portfolios are heavily invested in their home markets. This phenomenon is known as home bias.

19. There has been a gradual increase in the correlations between the G7 countries, potentially reflecting increased economic and financial integration.

20. Whereas the CAPM is the dominant model to determine the cost of capital, Fama and French (1992, 1995, 1998) proposed an alternative factor model. In addition to the market portfolio, the Fama-French factors measure the exposure of a stock to a portfolio going long in small stocks and short in large stocks and the stock's exposure to a portfolio long in high book-to-market stocks (value stocks) and short in low book-to-market stocks (growth stocks). There is some weak empirical evidence that small stocks and value stocks have outperformed large stocks and growth stocks.

QUESTIONS

1. Is the volatility of the dollar return to an investment in the Japanese equity market the sum of the volatility of the Japanese equity market return in yen plus the volatility of dollar/yen exchange rate changes? Why or why not?

2. Why is the variance of a portfolio of internationally diversified stocks likely to be lower than the variance of a portfolio of U.S. stocks?

3. How can you increase the Sharpe ratio of a portfolio? What type of stocks would you have to add to it in order to do so?

4. Why is the hurdle rate in Section 13.2 lower for Japan than for Canada? Should U.S. investors still invest in Canada?

5. What is the mean–standard deviation frontier, and what is the mean-variance-efficient (MVE) portfolio?

6. What is the prediction of the CAPM with respect to optimal portfolio choice?

7. What is the prediction of the CAPM with respect to the expected return on any security?

8. What is the beta of a security?

9. Why might it be useful to estimate the beta for a stock from returns on stocks within its industry rather than from the stock itself?

10. What does it mean for an equity market to be integrated or segmented from the world capital market?

11. What would you expect to happen to the risk-free rate and equity returns when a segmented country opens its capital markets to foreign investment?

12. What accounts for the home bias phenomenon?

13. Suppose AZT is a small value stock and that you use both the CAPM and the Fama-French model to compute its cost of capital. Under which model is the cost of capital for AZT likely to be higher?

PROBLEMS

1. The EAFE is the international index comprising markets in Europe, Australia, and the Far East. Consider the following annualized stock return data:

Average U.S. index return:	14%
Average EAFE index return:	13%
Volatility of the U.S. return:	15.5%
Volatility of the EAFE return:	16.5%
Correlation of U.S. return and EAFE return:	0.45

   a. What would be the return and risk of a portfolio invested half in the EAFE and half in the U.S. market?

   b. Market watchers have noticed slowly increasing correlations between the United States and the EAFE index, which some ascribe to the increasing integration of markets. Given that the volatilities remain unchanged, is it possible that the volatility of a portfolio that is equally weighted between the two indexes has higher volatility than the U.S. market?

2. Let the expected pound return on a U.K. equity be 15%, and let its volatility be 20%. The volatility of the dollar/pound exchange rate is 10%.

   a. Graph the (approximate) volatility of the dollar return on the U.K. equity as a function of the correlation between the U.K. equity's return in pounds and changes in the dollar/pound exchange rate.

   b. Suppose the correlation between the U.K. equity return in pounds and the exchange rate change is 0. What expected exchange rate change would you need if the U.K. equity investment is to have a Sharpe ratio of 1.00? (Assume that the risk-free rate is 0 for a U.S. investor.) Does this seem like a reasonable expectation?

3. Suppose General Motors managers would like to invest in a new production line and must determine a cost of capital for the investment. The beta for GM is 1.185, the beta for the automobile industry is 0.97, the equity premium on the world market

is assumed to be 6%, and the risk-free rate is 3%. Propose a range of cost-of-capital estimates to consider in the analysis.

4. Thom Yorke is a typical mean-variance investor, currently invested 100% in a diversified U.S. equity portfolio with expected return of 12.46% and volatility of 15.76%. Thom is considering adding the STCMM fund to his portfolio. STCMM invests in U.S. small-capitalization, high-technology firms and has an expected return of 14.69% and a volatility of 32.5%. Thom has determined its correlation with his current portfolio to be 0.7274. He is also intrigued by the LYMF fund, which invests in several emerging markets. The expected return on the fund is only 12%; it has 35% volatility and a correlation of 0.2 with his portfolio. The correlation of the LYMF fund with the STCMM fund is 0.15. Assume that the risk-free rate is 5%.

   a. If Thom is interested in improving the Sharpe ratio of his portfolio, will he invest a positive amount in one of the funds? Which one? Carefully explain your reasoning.

   b. Suppose Thom is more risk averse than his friend, Nick Cave. Both cannot short-sell securities, and both are thinking of splitting their entire portfolio between the U.S. portfolio that Thom is currently holding, the STCMM fund, and the LYMF fund. They also do not invest in the risk-free asset and do not consider levering up risky portfolios. Compare the two investors' optimal holdings. Who will invest more in the LYMF fund, and who will invest more in the STCMM fund? Why?

5. Economists continue to be puzzled by the apparent home bias of investors across countries. With mean-variance preferences, investors ought to allocate much more of their wealth to foreign equities and bonds. Three explanations for the phenomenon are given below, all of them based on empirical facts. For each one, discuss whether the statements are true or false and in what sense they help, or fail,

to rationalize the home bias puzzle. In answering the questions, assume that investors have mean-variance preferences.

   a. Investors should not hold foreign equities because they are more volatile and have been yielding lower returns than U.S. stocks in recent years.

   b. Home bias arises because investors face an additional risk when investing internationally—namely, currency risk. Because currency risk makes returns more volatile but does not lead to a higher expected return, investing more in domestic assets is rational.

   c. Home bias arises because investors have a non-traded domestic asset that they care about as well—namely human capital. The returns to this asset can be thought of as labor income. It has been empirically determined that labor income correlates quite highly with U.S. stock returns.

6. Consider Softmike, a software company. Softmike's world market beta is 1.75. Regressing Softmike's return on the world market return and the global HML factor gives betas of 1.50 and -1.2, respectively. Assume that the world equity premium is 6%, the HML premium is 3%, and the risk-free rate is 5%. Compute the cost of equity capital using both the CAPM and the Fama-French model. Is Softmike a value company or a growth company?

7. Web Question: Estimate the cost of capital for a project that has the same risk as the cash flows earned by Google. Hint: Go to Yahoo Finance and find "key statistics" for Google.

BIBLIOGRAPHY

Adler, Michael, and Bernard Dumas, 1983, "International Portfolio Choice and Corporation Finance—A Synthesis," *Journal of Finance* 38, pp. 925–984.

Ang, Andrew, and Geert Bekaert, 2002, "International Asset Allocation with Regime Shifts," *Review of Financial Studies* 15, pp. 1137–1187.

Ang, Andrew, and Joseph Chen, 2007, "CAPM over the Long Run: 1926–2001," *Journal of Empirical Finance* 4, pp. 1–40.

Ang, Andrew, Robert Hodrick, Yuhang Xing, and Xiaoyan Zhang, 2006, "The Cross-Section of Volatility and Expected Returns," *Journal of Finance* 61, pp. 259–300.

Ang, Andrew, Robert Hodrick, Yuhang Xing, and Xiaoyan Zhang, 2009, "High Idiosyncratic Volatility and Low Returns: International and Further U.S. Evidence," *Journal of Financial Economics* 91, pp. 1–24.

Bekaert, Geert, and Campbell R. Harvey, 1995, "Time-Varying World Market Integration," *Journal of Finance* 50, pp. 403–444.

_____, 2000, "Foreign Speculators and Emerging Equity Markets," *Journal of Finance* 55, pp. 565–614.

_____, 2003, "Emerging Markets Finance," *Journal of Empirical Finance* 10, pp. 3–55.

Bekaert, Geert, Campbell R. Harvey, Christian Lundblad, and Stephan Siegel, 2011, "What Segments Equity Markets," *Review of Financial Studies*, forthcoming.

Bekaert, Geert, Robert J. Hodrick, and Xiaoyan Zhang, 2010, "Aggregate Idiosyncratic Volatility," NBER Working Paper No. 16058.

Bekaert, Geert, and Michael Urias, 1996, "Diversification, Integration and Emerging Market Closed-End Funds," *Journal of Finance* 51, pp. 835–869.

_____, 1999, "Is There a Free Lunch in Emerging Market Equities?" *Journal of Portfolio Management* 25, pp. 83–95.

Bekaert, Geert, and Xiaozheng Wang, 2010, "Home Bias Revisited," working paper.

Bodnar, Gordon M., Bernard Dumas, and Richard C. Marston, 2003, "Cross Border Valuation: The International Cost of Equity Capital," National Bureau of Economic Research Working Paper No. 6224.

Brooks, Robin, and Marco Del Negro, 2004, "The Rise in Co-movement Across National Stock Markets: Market Integration or IT Bubble?" *Journal of Empirical Finance* 11, pp. 659–680.

Brown, Stephen J., William N. Goetzmann, and Stephen A. Ross, 1995, "Survival," *Journal of Finance* 50, pp. 853–873.

Cai, Fang, and Francis Warnock, 2006, "International Diversification at Home and Abroad," NBER Working Paper No. 12220.

Campbell John Y., Martin Lettau, Burton G. Malkiel, and Yexiao Xu, 2001, "Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk," *Journal of Finance* 56, pp. 1–43.

Claus, James, and Jacob Thomas, 2001, "Equity Premia as Low as Three Percent? Evidence from Analysts' Earnings Forecasts for Domestic and International Stock Markets," *Journal of Finance* 56, pp. 1629–1666.

Coval, Joshua D., and Tobias J. Moskowitz, 1999, "Home Bias at Home: Local Equity Preference in Domestic Portfolios," *Journal of Finance* 54, pp. 2045–2073.

Didier, Tatiana, Roberto Rigobon, and Sergio L. Schmukler, 2010, "Unexploited Gains from International Diversification: Patterns of Portfolio Holdings Around the World," NBER Working Paper No. 16629.

Diermeier, Jeff, and Bruno Solnik, 2001, "Global Pricing of Equity," *Financial Analysts Journal* 7, pp. 37–47.

Dimson, Elroy, Paul Marsh, and Mike Staunton, 2007, "The Worldwide Equity Premium: A Smaller Puzzle," in Rajnish Mehra, ed., *Handbook of the Equity Risk Premium*, Amsterdam: Elsevier Science, pp. 467–514.

Dumas, Bernard, and Bruno Solnik, 1995, "The World Price of Foreign-Exchange Risk," *Journal of Finance* 50, pp. 445–479.

Errunza, Vihang, and Etienne Losq, 1985, "International Asset Pricing Under Mild Segmentation: Theory and Test," *Journal of Finance* 40, pp. 105–124.

Fama, Eugene F., and Kenneth R. French, 1992, "The Cross-Section of Stock Returns," *Journal of Finance* 47, pp. 427–465.

_____, 1995, "Size and Book-to-Market Factors in Earnings and Returns," *Journal of Finance* 50, pp. 131–155.

_____, 1998, "Value Versus Growth: The International Evidence," *Journal of Finance* 53, pp. 1975–1999.

_____, 2002, "The Equity Premium," *Journal of Finance* 57, pp. 637–659.

Griffin, John M., and René M. Stulz, 2001, "International Competition and Exchange Rate Shocks: A Cross-Country Industry Analysis of Stock Returns," *Review of Financial Studies* 14, pp. 215–241.

Harris, Robert S., Felicia Marston, Dev R. Mishra, and Thomas J. O'Brien, 2003, "*Ex Ante* Cost of Equity Estimates of S&P 500 Firms: The Choice Between Global and Domestic CAPM," *Financial Management* 32, pp. 51–66.

Harvey, Campbell R., 1991, "The World Price of Covariance Risk," *Journal of Finance* 46, pp. 111–157.

_____, 1995, "Predictable Risk and Returns in Emerging Markets," *Review of Financial Studies* 8, pp. 773–816.

Henry, Peter B., 2000, "Stock Market Liberalization, Economic Reform, and Emerging Market Equity Prices," *Journal of Finance* 55, pp. 529–564.

Hodrick, Robert J., David Ng, and Paul Sengmueller, 1999, "An International Dynamic Asset Pricing Model," *International Taxation and Public Finance* 6, pp. 547–620.

Huberman, Gur, 2001, "Familiarity Breeds Investment," *Review of Financial Studies* 14, pp. 659–680.

Kim, E. Han, and Vijay Singal, 2000, "Opening Up of Stock Markets: Lessons from Emerging Economies," *Journal of Business* 73, pp. 25–66.

Lettau, Martin, Sydney Ludvigson, and Jessica Wachter, 2008, "The Declining Equity Premium: What Role Does Macroeconomic Risk Play?" *Review of Financial Studies* 21, pp. 1653–1687.

Lintner, John, 1965, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," *Review of Economics and Statistics* 47, pp. 13–37.

Longin, François, and Bruno Solnik, 2001, "Extreme Correlation of International Equity Markets," *Journal of Finance* 56, pp. 649–676.

Markowitz, Harry, 1952, "Portfolio Selection," *Journal of Finance* 7, pp. 77–91.

Mossin, Jan, 1966, "Equilibrium in a Capital Asset Market," *Econometrica* 34, pp. 768–783.

Roll, Richard, 1977, "A Critique of the Asset Pricing Theory's Tests," *Journal of Financial Economics* 4, pp. 129–176.

Ross, Stephen A., 1976, "The Arbitrage Theory of Capital Asset Pricing," *Journal of Economic Theory* 13, pp. 341–360.

Ross, Stephen A., Randolph W. Westerfield, and Jeffrey F. Jaffee, 2002, *Corporate Finance*, 6th ed., Boston: McGraw-Hill/Irwin.

Rowland, Patrick F., and Linda L. Tesar, 2004, "Multinationals and the Gains from International Diversification," *Review of Economic Dynamics* 7, pp. 789–826.

Sercu, Piet, 1980, "A Generalization of the International Asset Pricing Model," *Revue de l'Association Française de Finance* 1, pp. 91–135.

Sharpe, William, 1964, "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," *Journal of Finance* 19, pp. 425–442.

Solnik, Bruno, 1974a, "The International Pricing of Risk: An Empirical Investigation of the World Capital Market Structure," *Journal of Finance* 29, pp. 365–378.

_____, 1974b, "Why Not Diversify Internationally Rather Than Domestically?" *Financial Analysts Journal*, pp. 48–53.

Stulz, René M, 1995, "The Cost of Capital in Internationally Integrated Markets: The Case of Nestlé," *European Financial Management* 1, pp. 11–22.

Welch, Ivo, 2009, "The Results of the Equity Premium January 2009 Survey," working paper.

Zhang, Xiaoyan, 2006, "Specification Tests of International Asset Pricing Models," *Journal of International Money and Finance* 25, pp. 275–307.

Appendix

The Mathematics of International Diversification

Here, we formally prove two results that we used in this chapter.

RISK REDUCTION

Statement:

As long as the correlation between two assets is less than 1, the standard deviation of a portfolio of the two assets will be less than the weighted average of the two individual standard deviations.

Proof: Let w and $1 - w$ denote the investment proportions in the two assets. Let σ_1 and σ_2 denote the two standard deviations of the two assets. We use two statistical properties:

1. The variance of a sum of two random variables equals the sum of the variances plus twice the covariance between the variables.
2. The correlation, ρ, between two variables is their covariance divided by the product of their standard deviations.

Hence, the variance of the portfolio with weights $\{w, 1 - w\}$ is:

$$w^2\sigma_1^2 + (1 - w)^2\sigma_2^2 + 2w(1 - w)\rho\sigma_1\sigma_2$$

We want to show

$$\{w^2\sigma_1^2 + (1 - w)^2\sigma_2^2 + 2w(1 - w)\rho\sigma_1\sigma_2\}^{0.5}$$
$$< w\sigma_1 + (1 - w)\sigma_2$$

Squaring both sides gives

$$w^2\sigma_1^2 + (1 - w)^2\sigma_2^2 + 2w(1 - w)\rho\sigma_1\sigma_2$$
$$< w^2\sigma_1^2 + (1 - w)^2\sigma_2^2 + 2w(1 - w)\sigma_1\sigma_2$$

Strict inequality follows from $\rho < 1$. Hence, when ρ is smaller than 1, the variance of the portfolio is always smaller than the variance of either asset. As a special case, if $\sigma_1 = \sigma_2 = \sigma$, the variance is minimized by setting $w = 0.5$, and the portfolio variance is $0.5[1 + \rho]\sigma^2$.

IMPROVING THE SHARPE RATIO

Statement:

If $\dfrac{E[r^*] - r_f}{\text{Vol}[r^*]} > \rho\dfrac{E[r] - r_f}{\text{Vol}[r]}$, the Sharpe ratio improves when an asset with return r^* is added (marginally) to the portfolio with return r. Without loss of generality, we set the return on the risk-free asset equal to 0 in our proof.

Proof: The Sharpe ratio of the portfolio with w invested in the foreign asset is

$$SR = \frac{(1 - w)E(r) + wE(r^*)}{\text{Var}(P)}$$

where $\text{Var}(P) = (1 - w)^2\text{Var}(r) + w^2\text{Var}(r^*) + 2w(1 - w)\text{Cov}(r, r^*)$.

We want to show that if the statement holds, then $\dfrac{\partial SR}{\partial w} > 0$ evaluated at $w \equiv 0$. Taking the derivative and leaving out the (positive) denominator, we obtain:

$$\frac{\partial SR}{\partial w} > 0 \Leftrightarrow (E[r^*] - E[r])\text{Var}[P]^{0.5} - E[P]$$
$$\times \frac{1}{2}\text{Var}[P]^{-\frac{1}{2}} \times [-2\text{Var}[r] + 2\text{Cov}[r, r^*]] > 0$$

Evaluating this at $w = 0$ means that P equals the U.S. portfolio. Multiplying through with $\text{Var}[P]^{0.5}$ and simplifying, we obtain

$$E[r^*]\text{Var}[r] - E[r]\text{Cov}[r, r^*] > 0$$

or

$$\frac{E[r^*]}{\text{Var}[r^*]^{0.5}} > \frac{E[r]}{\text{Var}[r]^{0.5}} \times \frac{\text{Cov}[r, r^*]}{\text{Var}[r]^{0.5}\text{Var}[r^*]^{0.5}}$$

| Foreign Sharpe ratio | Domestic Sharpe ratio | Correlation, CORR(r, r*) |