CHAPTER 14
BOND PORTFOLIOS

Chapter Overview

This chapter describes the international bond market and examines the return and risk properties of international bond portfolios from an investor’s perspective.

The chapter begins with a brief history and the dimensions of the international bond markets. The presence of home country bias for investors toward domestic financial assets is discussed. In terms of market dimensions, the United States was the largest bond market over the 1980s and the 1990s, and debt issued by governments or government agencies accounts for two-thirds of all bonds.

The chapter then reviews the pattern of bond market returns focusing primarily on average rates of returns and volatility in returns in both individual markets and portfolios. The text demonstrates how to calculate the return and risk on a foreign bond, both on an unhedged basis and on a currency-hedged basis. In terms of the investor’s base currency, the unhedged return on a foreign bond equals the return on the bond in foreign currency terms plus the return on the foreign currency itself. The volatility of unhedged returns reflects the volatility of these two factors as well as the covariance between the returns on the foreign bond and the returns on spot foreign exchange. The return on a currency-hedged foreign bond has three pieces: the return from the predicted price change on the bond in foreign currency terms, the forward premium (or discount) on the foreign currency used to buy the bonds, and a residual term representing the unpredicted price change in the foreign bond that is valued at the future uncertain spot exchange rate.

Empirical evidence on return and risk in global bond markets are illustrated by the average annual return and risk measured in US$ terms for eight bond markets. It shows that international bond returns are weakly correlated, so international portfolios have produced superior performance in terms of risk and return compared with U.S. Treasury securities. Bond portfolios that are passively hedged have outperformed unhedged portfolios. Empirical evidence using a slightly different sample also shows that bond portfolios that are actively hedged have outperformed passively hedged portfolios.

The results shed light on several policy issues for individual investors and investment managers. They indicate that the performance gains in international bond portfolios are real, and represent a form of central bank risk diversification, which diversifies the investor’s exposure to national interest rate risks. They also show that selective currency management strategies offer a possible strategy for improving the risk-return opportunities. The chapter concludes with a discussion of two public policy themes: the market for Brady Bonds and emerging market debt, and the future of European bond markets after EMU.
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   Returns on Unhedged Bonds
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   Currency-Hedged Bonds: Is There a Free Lunch?
   Active versus Passive Currency-Hedging Strategies
   Problems in Implementing an International Bond Portfolio
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Some technical notes

1. Compounding and continuous compounding

If we denote \( A_0 \) as the principal, \( r \) the interest rate, and \( t \) the time period to maturity, and assume that interest is calculated once every period, then the principal and interest (A = P&I) payment at maturity will be

\[
A = A_0 (1 + r)^t
\]

If interest is calculated \( n \) times every period, then \( P&I \) will be

\[
A = A_0 \left(1 + \frac{r}{n}\right)^{nt}
\]

When interest is compounded continuously (that is, \( n \) approaches infinity), we have

\[
A = A_0 \lim_{n \to \infty} \left(1 + \frac{r}{n}\right)^{nt}
\]

Let \( m = \frac{n}{r} \), so when \( n \) approaches infinity, \( m \) approaches infinity, thus

\[
A = A_0 \lim_{m \to \infty} \left(1 + \frac{1}{m}\right)^{mr t}
\]

we know that

\[
\lim_{n \to \infty} \left(1 + \frac{r}{n}\right)^n = e
\]

where \( e \approx 2.718281828459045 \)

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For example, if $1,000 is invested for 1 year at a **nominal** rate of 10% compounded continuously, the future value at the end of that year is given as follows:

\[
A = 1000 \cdot e^{0.10 \cdot 1} = 1000 \cdot (2.71828)^{0.10} = 1105.17
\]

so the **effective** rate is 0.10517.

In the case where the $1,000 is invested at a nominal rate of 10% for 3 years, the future value, assuming continuous compounding, is equal to

\[
A = 1000 \cdot e^{0.10 \cdot 3} = 1000 \cdot (2.71828)^{0.30} = 1349.86
\]

The effective rate is

\[
\frac{1349.86}{1000} = \sqrt[3]{1.34986} = 1.10517
\]

Again, the effective rate is 0.10517.

To generalize, the effective rate is calculated as

\[
effective rate = e^{\text{nominal rate}} - 1
\]

Suppose the effective rate is obtained through the ratio of the value of an asset at end of the period to value of the asset at the beginning of the period, how can we get the implied nominal rate? From the above equation, we have

\[
1 + effective rate = e^{\text{nominal}}
\]
Take natural logs on both sides the equation, we obtain:

\[
\ln (1 + \text{effective rate}) = \ln (e^{r_{\text{nominal}}}) = r_{\text{nominal}}
\]

r can also be obtained as follows:

\[
r = \frac{dx}{x} = d \ln(x) = \ln(x_i) - \ln(x_{i-1}) = \ln \left( \frac{x_i}{x_{i-1}} \right) = \ln \left( 1 + \frac{x_i - x_{i-1}}{x_{i-1}} \right)
\]

2. Variance, covariance, and correlation

\textbf{Variance}

Suppose that \(X\) is a random variable with \(m = E(X)\). The variance of \(X\), denoted by \(\text{Var}(X)\), is defined as follows:

\[
\text{Var}(X) = E \left[ (X - \mu)^2 \right]
\]

\textbf{Covariance}

Let \(X\) and \(Y\) be random variables having a specified joint distribution; and let \(E(X) = m_X, E(Y) = m_Y, \text{Var}(X) = s_X^2, \text{and} \text{Var}(Y) = s_Y^2\). The covariance of \(X\) and \(Y\), which is denoted by \(\text{Cov}(X,Y)\), is defined as follows:

\[
\text{Cov}(X,Y) = E \left[ (X - \mu_X)(Y - \mu_Y) \right].
\]

\textbf{Correlation}

\[
\rho(X,Y) = \frac{\text{Cov}(X,Y)}{\sigma_X \sigma_Y}
\]

\[-1 \leq \rho(X,Y) \leq 1\]
Example:

The capital asset pricing model (CAPM) can be written as

\[ \overline{R}_i = R_F + \beta_i (\overline{R}_M - R_F) \]

where

\[ \beta_i = \frac{\sigma_{iM}}{\sigma_M^2} \]

where \( \sigma_{iM} \) is covariance of the returns of security \( i \) and the market portfolio, and \( \sigma_M^2 \) is the variance of the return of the market portfolio.

Since

\[ \sigma_{iM} = Cov(R_i, R_M) = \rho(R_i, R_M) \sigma_i \sigma_M \]

where \( \rho(R_i, R_M) \) is the correlation between \( R_i \) and \( R_M \), we have

\[ \beta_i = \frac{\sigma_{iM}}{\sigma_M^2} = \rho(R_i, R_M) \frac{\sigma_i}{\sigma_M} = \rho(R_i, R_M) \frac{\sigma_i}{\sigma_M} \]

Properties of Covariance and Correlation

\[ Cov(X,Y) = E[(X - \mu_X)(Y - \mu_Y)] \]
\[ = E(XY) - \mu_X \mu_Y \]
\[ = E(XY) - \mu_X E(Y) - \mu_Y E(X) + \mu_X \mu_Y \]
\[ = E(XY) - \mu_X \mu_Y \]

If \( X \) and \( Y \) are independent, then \( E(XY) = E(X)E(Y) \). Therefore \( Cov(X,Y) = 0 \). Also it follows that \( r(X,Y) = 0 \).
Example:

Consider the expected return and standard deviation of return for a portfolio consisting of a fraction $a$ invested in U.S. bonds and the remaining fraction, $1-a$, invested in foreign bonds. Define $r_{us}$ and $r_{rw}$ to be the expected returns on the U.S. and the rest-of-the-world bonds. Similarly, let $s_{us}$ and $s_{rw}$ be the standard deviations of the U.S. and rest-of-world portfolios. The expected return $r_p$ can be calculated as

$$r_p = a \cdot r_{us} + (1 - a) \cdot r_{rw}$$

The variance of this portfolio is

$$\sigma_p^2 = a^2 \cdot s_{us}^2 + (1 - a)^2 \cdot s_{rw}^2 + 2a(1-a)s_{us} \cdot s_{us, rw}$$

where $s_{us, rw}$ is the correlation between the returns on the U.S. and foreign bond portfolios.
Answers to end-of-chapter questions

1. What is home country bias in asset portfolios? How would you explain this phenomenon?

   Home country bias refers to the tendency of investors to hold a larger percentage of their financial wealth in home country securities than one would expect based on traditional models of international portfolio diversification. Various reasons have been suggested to explain home country bias including transactions costs for purchasing foreign securities, currency risk, country risk, information barriers, foreign taxation, and the tendency to overweight domestic goods and services in consumption patterns.

2. Compare central bank risk and interest rate risk.

   Interest rate risk refers to uncertainty about future interest rates that introduces the possibility for capital gains and losses on long-term bonds. Central bank risk refers to uncertainty about the national monetary authority to deliver monetary policy that results in a particular level of interest rate risk.

3. Suppose you hold a SFr 1 million Swiss long-term bond yielding 6% annually. The spot exchange rate is $0.60/SFr. The one-month forward exchange rate is $0.62/SFr. How would you protect your SFr investment from exchange rate fluctuations?

   To hedge a SFr asset, the investor must sell the SFr forward. The current value of the bond is SFr 1 million, and in one month we can impute SFr 5,000 of accrued interest. The investor could sell SFr 1,005,000 forward at $0.62/SFr resulting in $623,100 if the contract is settled in one month. This protects the investor against exchange rate changes over the one-month period. The investor retains residual risk since SFr interest rates may increase (decrease), causing the bond to fall (rise) in SFr value.

4. What are the obstacles you might face when trying to hedge a foreign bond portfolio?

   The first hurdle is determining how much to hedge. Since the value of the bond in one-month is uncertain, the investor cannot calculate exactly how much to hedge. Second, hedging raises the transaction costs slightly. However, taking the DM example from problem #3, if the DM appreciates by more than the forward rate, the investor will have to pay out cash to settle his forward contract at the end of the month. If the DM is unexpectedly strong, the investor may incur large out-of-pocket expenses. (Note that the investor also gains from the strong DM, by holding his DM bond. But he cannot capture these DM cash gains until the bond is sold.)

5. Compare active hedging strategies to passive hedging strategies. What are the advantages of hedging actively instead of passively?

   In a passive hedging strategy, the investor follows the same hedging plan over time independent of market conditions. For example, a rule whereby the investor always hedges
100%, or always hedges 50%, or always hedges 10% reflect passive strategies. A rule whereby the amount hedged fluctuates is an active hedging strategy. A passive hedging strategy is a low-cost means of reducing exposure to risks. With a passive strategy, the investor is sure to be protected against large negative shocks, but he also forgoes the opportunities of large gains from positive shocks. In an active strategy, the investor retains risks during certain periods. This offers the possibility of higher returns if the investor has expertise in judging when to hedge and when not to hedge.

6. Define a rolling forward hedge. Give an example for a 5-year UK£ bond.

A rolling forward hedge is a forward market hedge where the maturity of the hedge is shorter than the maturity of the underlying asset, and the hedge is renewed periodically as it matures. For an investor who holds a 5-year UK£ bond, a rolling forward hedge could reflect 60 one-month forward contracts, or 20 three-month forward contracts, each entered into in succession by closing out the first contract, and opening up the second; closing out the second and opening up the third, etc. The forward contract would sell the current value of the UK£ plus accrued interest forward.

7. Describe a perfect currency hedge for an investor in a long-term foreign bond. Why is it difficult to implement a perfect currency hedge in the real world?

A perfect currency hedge for an investor in a long-term foreign bond would sell the future value of the bond plus coupon payments forward. Because of interest rate risk, the future value of the bond is uncertain. Therefore, it is difficult to enter into a perfect hedge.

8. What are the key elements to take into consideration when investing in an international bond portfolio?

The first criterion is selecting a market with no controls on capital outflows. Other institutional considerations -- market size, liquidity, taxation -- play a role. Active portfolio decisions are made on the basis of estimated risk and return. The investor can hedge a large portion of the currency risk in foreign bonds if liquid short-term currency forward markets are available.

9. A recent report by the International Monetary Fund refers to "a secular rise in the correlation of long-term interest rates over time as a result of increasing capital market integration. The correlation of German and US 10-year bond yields (based on monthly levels) has risen from an average of just 0.191 over the 1970-1979 period to 0.908 over the 1980-1989 period and to 0.934 over the 1990-1994 period. In the case of Japanese bonds, the correlation with US bond yields has risen steadily from 0.182 in 1970-1979 to 0.826 in 1980-1989 and to 0.965 in 1990-1994. For all of G-7 countries with the exception of Italy, the correlation of government bond yields with US bond yields now exceeds 0.90." What are the implications of this trend for international bond portfolio managers? Would diversification gains still be present while investing abroad?
An increase in the correlation of government bond yields across countries lowers the potential for diversification gains in international bond portfolios. In the limit, if the correlation were perfect, there would be no diversification gains from international bond investments. As long as the correlation is imperfect, and has the future prospect of remaining imperfect, then the potential for diversification gains exists.

10. In 1989, two articles on international bond portfolio investments were published at about the same time with dramatically different conclusions. One article claimed that "currency hedging can substantially reduce volatility of foreign bonds and foreign bond portfolios, while having little effect on their returns." The other article, titled "Why There is No Free Lunch in Currency Hedging," claimed that "the amount of risk reduction available from international bond diversification in the long run is independent of whether the currency risk is hedged or not." How would you explain the differing views of the two authors?

The claim that currency hedged foreign bonds could reduce risk without affecting returns was presented as a statistical finding for the 1975-1990 period. Many authors generalized the findings for this period to conclude that substantial diversification gains would always be available. Rosenberg argued that convergence of national monetary policies would over time reduce the opportunities for diversification gains from passive currency hedging strategies.

11. How would consideration of execution costs and settlement costs influence the claim that global, currency-hedged investment provide better return and risk characteristics than all-US$ investment?

Management costs of an international bond fund are greater than for a domestic bond fund. The incremental cost of currency hedging versus no hedging is subject to dispute. Some authorities feel that the differential costs are 27-60 basis points per year. Others believe that the incremental cost of currency hedging are only 20-25 basis points per year. Since the initial and terminal spot transactions are the same, the incremental cost is for the 12 one-month rollovers in the rolling hedge.

**Answers to end-of-chapter exercises**

1. Suppose you can invest $1 million for 90 days. You are risk averse and want to invest in government issues. However, you have heard of theories claiming that international investing can enhance returns and are willing to give it a try. You have collected current 3-month rates in Japan and Germany as well as current spot rates and current 3-month forward rates. Also shown below are the actual spot exchange rates 3 months later.

<table>
<thead>
<tr>
<th></th>
<th>Interest Rates</th>
<th>Spot</th>
<th>Forward</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>3%</td>
<td>¥/$</td>
<td>100</td>
<td>100.50</td>
</tr>
<tr>
<td>Germany</td>
<td>6%</td>
<td>DM/$</td>
<td>1.50</td>
<td>1.4950</td>
</tr>
<tr>
<td>US</td>
<td>5%</td>
<td>$/$</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

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a. Calculate the unhedged returns (in US dollar terms) at the end of the three months for a Japanese and a German investment.

b. Calculate the hedged returns for the same investments.

c. Would you invest abroad? In which market? Would you hedge?

SOLUTIONS:

2. You just inherited from your English aunt £1 million in 3-year UK government bonds. The bonds are trading at par on the London bond market. The bonds have a coupon rate of 6%.

a. Assuming a flat yield curve and stable interest rates over the life of the bond, what is your average monthly return at the end of the three years?

b. The actual return (shown as a total return index) for the 3-year UK bond over its life is shown in the table below. (See spreadsheet file.) What is the average monthly return and risk for the 3-year bond in £ terms? How does it compare to the previous return?
c. As a US$-based investor, you are concerned about your returns in US$ terms. Using the spot rates shown below, calculate your average monthly return and risk in US$ terms. How does it compare to £-based risk and return characteristics?

d. How would you hedge your currency exposure? Calculate return and risk characteristics of your imperfectly hedged portfolio. (Hint: use the forward rates shown in the table below.) How does it compare to unhedged returns?

e. Suppose you could forecast the monthly returns as shown in the table and hedge accordingly. Show the return and risk characteristics for your perfectly-hedged portfolio. How does it compare to unhedged returns? How does it compare to the imperfectly-hedged returns?

SOLUTIONS:
3. This exercise relies upon the tables found below. (See spreadsheet file.) The table shows a string of bond indices from different countries: the US, Germany, Japan and the UK, as well as actual spot rates and forward rates for the DM, Yen and £. The aim of this exercise is to help students understand the effect of hedging policies on bond portfolio returns.

a. Calculate the monthly returns for each country’s bond index (Hint: use a spreadsheet program, entering bond indices and using function keys to calculate returns). What is the average return and the risk for each market, in local currency and in US dollar terms? Calculate the return / risk ratio for each market. Which one is most risky? Calculate the correlation between the US market and each of the three other markets. Is there any potential for a diversification gain?

b. Create an international bond portfolio of the three markets (Germany, Japan, and the UK) using equal weights. Repeat the calculations of question (A) for this international portfolio. How does the international bond portfolio fare compared to individual markets?

c. Repeat question (B) for a global bond fund, weighting equally all four markets including the US market. Are there any superior characteristics with the global fund as compared to the international bond portfolio?

d. Calculate return and risk for the international bond portfolio and the global bond portfolio on a perfectly-hedged basis (Hint: use the forward rates shown in the table). How do the risk and return characteristics compare to the unhedged international bond portfolio? To the all-US portfolio?

SOLUTIONS:

a. In Local Currency:

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>Germany</th>
<th>Japan</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average return:</td>
<td>0.46%</td>
<td>0.80%</td>
<td>1.06%</td>
<td>1.24%</td>
</tr>
<tr>
<td>Risk:</td>
<td>1.57%</td>
<td>1.78%</td>
<td>1.70%</td>
<td>3.87%</td>
</tr>
<tr>
<td>Return / risk:</td>
<td>0.30</td>
<td>0.45</td>
<td>0.62</td>
<td>0.32</td>
</tr>
<tr>
<td>Correlation with US</td>
<td>0.29</td>
<td>0.06</td>
<td>(0.04)</td>
<td></td>
</tr>
</tbody>
</table>

In US Dollar:

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>Germany</th>
<th>Japan</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average return:</td>
<td>0.46%</td>
<td>1.02%</td>
<td>1.16%</td>
<td>1.14%</td>
</tr>
<tr>
<td>Risk:</td>
<td>1.57%</td>
<td>3.73%</td>
<td>4.47%</td>
<td>5.41%</td>
</tr>
<tr>
<td>Return / risk:</td>
<td>0.30</td>
<td>0.27</td>
<td>0.26</td>
<td>0.21</td>
</tr>
</tbody>
</table>
b. International portfolio:

Unhedged
- Average return: 1.11%
- Risk: 3.36%
- Return / risk: 0.33

Hedged
- Average return: 0.97%
- Risk: 1.69%
- Return / risk: 0.57

c. Global portfolio:

Unhedged
- Average return: 0.95%
- Risk: 2.68%
- Return / risk: 0.35

Hedged
- Average return: 0.85%
- Risk: 1.36%
- Return / risk: 0.62

d. Global portfolio:

Perfectly hedged
- Average return: 1.34%
- Risk: 0.63%
- Return / risk: 2.13

International portfolio:

Perfectly hedged
- Average return: 1.68%
- Risk: 0.58%
- Return / risk: 2.90

The return per unit of risk measures are considerably higher with the hedged portfolios than with the unhedged portfolios.