



ACTUARIAL ASPECTS OF CURRENCY RISK

Overview

Foreign exchange may be viewed as a relationship between the term structure of interest rates of several national currencies. The foreign exchange relationship is sensitive to rates of inflation of the national economies as well as psychological, political, and economic stresses. The relationship is inherently ambiguous because of the difficulty of defining a common set of consumer needs, preferences, and utilities; these factors impact the definition of the common basket of consumer goods and the measure of inflation. *The Economist's* Big Mac Index, developed in 1986, is an innovative attempt to quantify a common basket of consumer goods. Studies, seeking to quantify the movement of exchange rates from expected values, find that rates vary from their parity values by as much as 35%.

The interest rate parity theorem provides the most commonly-held view of the long-term foreign exchange relationship: the ratio of the forward to the spot rates (expressed as the number of units of domestic currency required to purchase one unit of foreign currency) equals the ratio of one plus the domestic interest rate to one plus the foreign interest rate. Real rates of interest are relatively constant internationally. Deducting a constant real interest rate from the nominal national risk-free interest rate gives the inflation rate. Another forecasting tool is produced by the application of the purchasing power parity theorem: exchange rates vary as the difference between the inflation rates of two countries differ. Interest rate parity has generally been observed to hold in the long term as capital allocations adjust to differing national levels of inflation. Over shorter periods, foreign exchange movements often follow a random pattern reflecting forces other than inflation.

There are several key choices in managing foreign exchange risk. First, a conclusion regarding the need to hedge should be reached. If a business operates in many currencies, if the distribution of assets and income is evenly distributed across currencies, and if it is unlikely that radical political or other events will occur, aggregate expected fluctuations may be minimal. Currency fluctuations may be absorbed as normal business variations as shown in the cumulative translation account as specified by *Financial Accounting Standard 52*. Ongoing evaluation of currency risk may lead to individual currency hedging positions if one's assumptions change.

Second, a decision should be reached regarding individual asset hedging versus total-risk-aggregated portfolio basis hedging. Banks typically manage their foreign exchange risk on a total-risk-portfolio basis as described in the Basle Accord and the Group of Thirty Report. The difficulty with the portfolio approach is that differing local regulatory requirements may apply to subsets of the hedge, producing inconsistent accounting treatment and nonoffsetting transactions. However, individual asset hedging may be excessively expensive.

Third, a determination of the appropriate level of counterparty risk needs to be evaluated. Hedging instruments such as options and futures, which are traded on exchanges, provide guarantees with respect to payment of the contract. Other hedging tools, such as forwards and structured notes, typically contain counter parity risk (that is, the risk that the party on the other side of the contract will default and not make good on the contract). Exchange-traded contracts often contain limitations, such as available length of the contract.

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These limitations may sometimes be overcome with a customized contract. Customized nonexchange contracts may be less expensive than exchange-traded contracts and are often settled using netting arrangements. An extreme example of counterparty risk is the Herstatt risk named for the German bank that failed. This failure stems from the fact that the bank paid counterparties currency owed which it, in turn, was unable to collect from its defaulting counterparty.

Finally, organizational decision-making structure and communication channels with top management should be well defined. Communication between risk managers and top management or the board of directors may confound portfolio risk management processes if the directors only consider losses without regard to offsetting hedge gains in evaluating the continuance of a hedge. The case study of Metallgesellschaft, cited below, is representative of these types of problems. The Barings Bank Ltd. debacle represents another case study of corporate governance gone awry.

The Role of the Actuary

Outside of North America, life insurance companies often offer contracts subject to the specification of the contract currency by the policyholder. Currency choice products pose design, investment, and financial reporting problems not found with U.S. domestic life insurance. Product design issues include determining appropriate interest-rate guarantee periods and levels, and excess-interest crediting mechanisms. Investment decisions include determination of optimal internationally-diversified reward-to-risk portfolios, appropriate level of hedging, and use of derivatives and structured notes. Financial reporting issues include choosing consistent scenarios in multiple currencies, determining appropriate methods of translating currency effects, and defining appropriate measures of exposure. For some financial reporting bases such as U.S. GAAP, many of these issues are well defined. For other financial bases, such as internal or U.S. statutory, there is a range of potential actuarial practices which requires evaluation of alternative approaches.

Issues facing pension actuaries include determining the international asset diversification/benefit tradeoff, the optimal hedge ratio, the effect of currency fluctuations on funding positions and contribution mechanisms, and optimal asset mix by currency.

Health actuaries face issues similar to those facing other actuaries with respect to provision of postretirement health benefits.

Basic Reading List

Celebuski, Matthew J., Hill, Joanne M., and Kilgannon, John J. "Managing Currency Exposures in International Portfolios," *Financial Analysts Journal* 46, No. 1 (January/February 1990), p. 16. Also published as *Society of Actuaries Study Note 485-29-92*, 8 pages.

Clarke, Roger G. and Kritzman, Mark P. *Currency Management: Concepts and Practices*. Charlottesville, Va.: The Research Foundation of the Institute of Chartered Financial Analysts, 1996.

Derosa, David F. *Managing Foreign Exchange Risk: Advanced Strategies for Global Investors, Corporations*. Burr Ridge, Ill.: Probus, 1992.

This volume is a comprehensive discussion of foreign exchange, risk assessment, and currency convertibility. It is an institutional investor publication.

Edwards, Franklin R. "Derivatives Can Be Hazardous to Your Health: The Case of Metallgesellschaft," *Derivatives Quarterly* (Spring 1995).

MG Refining and Marketing, Inc. sought to hedge the risk of rising energy prices by acquiring long energy future positions of the New York Mercantile Exchange. Energy spot prices tumbled (instead of rising, as MG Refining and Marketing had both expected and feared).

German accounting principles required the recognition of losses but did not allow recognition of related gains. The true financial position was distorted.

At some point MG Refining and Marketing's supervisory board either failed to understand fully MG Refining and Marketing's forward contracting and associated hedging strategies or seriously misjudged the risks that MG Refining and Marketing's strategies entailed.

Fabozzi, F.J. and Fabozzi, T.D., eds. *The Handbook of Fixed Income Securities*. 4th ed. Burr Ridge, Ill.: Irwin, 1995. This is a textbook for Society of Actuaries Courses 220 and 230.

There are three chapters of particular interest: Chapter 35 "Value and Risk Analysis of International Bonds," pages 733-49; Chapter 48 "International Bond Investing and Portfolio Management," pages 1007-44; and Chapter 49 "International Fixed Income Investing: Theory and Practice," pages 1045-71.

Institute of Chartered Financial Analysts. *International Bonds and Currencies*. Homewood, Ill.: Dow Jones-Irwin, 1986.

Nesbitt, Stephen L. "Currency Hedging Rules for Plan Sponsors," *Financial Analysts Journal* 47, No. 2 (March/April 1991), p. 73. Also published as *Society of Actuaries Study Note 485-23-92*, 9 pages.

Saunders, Anthony. "Foreign Exchange Risk," Chapter 11 in *Financial Institutions Management: A Modern Perspective*. Burr Ridge, Ill.: Irwin, 1994. This is a textbook for Society of Actuaries Course F-585.

Solnik, Bruno. "The Economics of the International Environment," Chapter 1 in *International Investments*, 2nd ed., Reading, Mass.: Addison-Wesley, 1991, p. 1-36.

Vertin, James. *International Equity Investing*. Institute of Chartered Financial Analysts, March 1984.

General Interest

Rawnsley, Judith H. *Total Risk: Nick Leeson and the Fall of Barings Bank*. New York: Harper Business, 1995.

Soros, George. *Soros on Soros: Staying Ahead of the Curve*. New York: John Wiley & Sons, Inc., 1995.

Intermediate Reading List

Beder, Tanya Styblo. "VAR: Seductive but Dangerous" *Financial Analysts Journal* (September/October 1995), p. 12-25.

Value-at-risk (VAR) has gained rapid acceptance as a valuable approach to risk management. Values at risk are extremely dependent on parameters, data, assumptions, and methodology. This article calculates eight common values at risk for three portfolios. This article concludes that values at risk are not sufficient to control risk.

Dattatreya, Ravi E., Venkatesh, Raj E.S., and Vankatesh, Vijaya E. *Interest Rate & Currency Swaps*. Chicago, Ill.: Probus Publishing Company, 1994. This is a textbook for Society of Actuaries Course F-595.

This book describes how swaps work and how they can be applied to control risk. Specific topics include:

- Basic and sophisticated swaps
- Asset/liability management with swaps
- Pricing and risk analysis of swaps
- Credit risk in swaps
- Evaluating swap transactions

Derosa, David F. *Options on Foreign Exchange*. Burr Ridge, Ill.: Irwin, 1992.

This book begins with a review of elementary instruments like simple puts and calls and progresses to newer and more complex instruments. There is a thorough multi-page bibliography.

Federal Reserve Bank of New York. *Annual Report*. New York: Federal Reserve Bank of New York, 1994.

This report measures the growth to the currency options markets. It then discusses the measurement of market risk of options positions. The report categorizes techniques into two classes: simple strategy methods and value-at-risk techniques.

The second method is the more accurate. It is based on option pricing models. It yields confidence intervals and price sensitivity measures. Appendix I of this document contains "Detailed Descriptions of Value-at-Risk Rules."

Law, Kevin M. "Exchange Rate Dynamics in Mixed Currency Medical Insurance Plan Environments," *Transactions of the Society of Actuaries* XLVII (1995), p. 261-306.

Levick, Richard M., and Thomas, Lee R. "The Merits of Active Currency Risk Management: Evidence from International Bond Portfolios," *Financial Analysts Journal* (September 1993), p. 63-70.

This is a statistical discussion. It applies to institutions allowed to hedge long-term bond positions. A new statistical procedure tests for weak-form efficiency in the foreign exchange futures markets. This procedure indicates that successive exchange rates changes have not been independent.

This finding has implications for at least two groups of investors: return-seeking investors considering foreign exchange as a separate asset class; and international portfolio investors deciding whether or not to hedge the foreign exchange rate exposures embedded in their nondollar investments.

Malhotra, D.K., and Evans, John S. "Exchange Rate Risk Management Using Cross-Currency Swaps," *The Journal of Commercial Lending* 77, No. 11 (July 1995), p. 33.

The authors trace the developments of financial innovations such as cross-currency swaps and swaptions; examples are given. The superiority of swaps over forwards and futures in long-term bond holdings is discussed.

Advanced Reading List

Bilson, John, and Marston, Richard. *Exchange Rate Theory and Practice*. Chicago, Ill.: University of Chicago Press, 1984.

Dattatreya, Ravi E., and Hotta, Kensuke. *Advanced Interest Rate and Currency Swaps*. Chicago, Ill.: Probus Publishing Co., 1994.

The text is divided into two sections titled, respectively, "Analysis, Modeling, and New Products" and "Corporate and Investor Viewpoint."

This text includes discussion of:

- A portfolio approach to calculating credit exposure with currency swaps
- Differential swaps, a hybrid swap structure designed to enable the parties entering into such transactions to take positions in interest rate differentials across currencies
- Indexed amortizing swaps as hedges
- European- and American-style call and leading-edge instruments such as contingent premium options. Also includes an intuitively simple way to price such options. The authors feel that the binomial method can be applied.
- A discussion of structured notes which provides an understanding of the hedge components required to create these securities
- Portfolio theory and practice as applied to hedging activities. Includes the use of derivatives by pension fund managers.
- The "risk point" concept. The risk point concept is especially valuable in the management of portfolios.
- An extension of the analytical framework of bond valuation to determine the building blocks of a bond's value when there are embedded options.
- Application of the linear path space model to interest rate scenario simulation
- "Using Derivative Products to Manage the Risk and Return of Life Insurance Companies" (a case study)
- "Synthetic Portfolio Management in a U.S. Pension Fund" (a case study)

Dornbusch, Rudiger. *Exchange Rates and Inflation*. Cambridge, Mass.: MIT Press, 1988.

Flood, Peter and Garber, Peter. *Speculative Bubbles, Speculative Attacks, and Policy Switching*. Cambridge, Mass.: Massachusetts Institute of Technology Press, 1994.

Krugman, Paul and Miller, Marcus. *Exchange Rate Targets and Currency Bands*. Port Chester, N.Y.: Cambridge University Press, 1992.

Zheng, Henry R. "Management of Lender's Currency Exposure in Multicurrency Financing: Structural and Documentational Considerations," *Law and Policy in International Business* 22 (Spring 1991), p. 213-60.

This article discusses multicurrency lending and corresponding new risks, the most troubling of which is currency risk. The first part of the article analyzes major risk factors, hedging, and risk allocation. The next section discusses financing structures designed to minimize lenders' currency exposure. Finally, the article highlights various documentational considerations related to multicurrency loans. The discussion is in the context of banking.

Modeling Techniques

Babbel, David F. and Merrill, Craig B. "Valuing Interest Sensitive Financial Instruments," *Society of Actuaries Monograph M-F-196-1*, New Hope, Pa.: Frank J. Fabozzi Associates, 1996.

Boyle, Phelim. "Options: A Monte Carlo Approach," *Journal of Financial Economics*, 4 (1977), p. 323-38.

Bratley, Paul, Fox, Bennett L., and Schrage, Linus E. *A Guide to Simulation*. New York: Springer-Verlag, 1987.

Hull, John. *Options, Futures, and Other Derivative Securities*. 2nd ed., Englewood Cliffs, N.J.: Prentice Hall, 1993.

This text provides a unifying approach to the valuation and hedging of all derivative securities, not just financial futures and stock options. The author offers comprehensive coverage of forward contracts, futures contracts, options, swaps, and other nonstandard derivative securities. Hull goes on to discuss arbitrage arguments, explain the geometric Brownian motion model of stock price behavior, show how Black and Scholes set up a riskless portfolio, and explain the risk-neutral valuation argument.

Reider, Robert R. "Two Applications of Monte Carlo Techniques to Finance," (Ph.D. dissertation, Wharton School of Business, 1994), abstract in *Dissertation Abstracts International* 55, p. 2933.

Sherris, Michael. "A One-Factor Interest Rate Model and the Valuation of Loans with Prepayment Provisions," *Transactions of the Society of Actuaries*, XLVI (1994), p. 251-320.

Tilley, James. "An Actuarial Layman's Guide to Building Stochastic Interest Rate Generators," *Transactions of the Society of Actuaries* XLIV (1992), p. 509-64.

Wilke, A.D. "Stochastic Investment Models for 21st Century Actuaries," *Transactions of the 24th International Congress of Actuaries*, International Congress of Actuaries, 1992, p. 119-37.

Wilkie builds a three-country model (France, U.K., and U.S.). Parameter values for four economic series are developed: retail prices, dividends, dividend yields on stocks, and yields on long-term bonds. The results for the three countries separately are then connected through a new model for exchange rates.

Wei, Jason Z. "Valuing Differential Swaps," *Journal of Derivatives* (Spring 1994), p. 64-76.

Accounting/Regulatory References

Abbott, Mark, Magyar, Joel, Smith, Peter L., and Tell, Eric A. "Is Foreign Exchange Fluxuation (FEX) Affecting Your Bottom Line?" *Record of the Society of Actuaries* 21, No. 2 (1995), p. 379-98.

Aron, Paul H. "International Accounting and Financial Reporting," *Accountants Handbook*, 6th ed., Vol. II, Sect. 40, New York, N.Y.: John Wiley & Sons, 1981, p. 1-35.

Basle Committee on Banking Supervision. *Amendment to the Capital Accord to Incorporate Market Risk*. Bank for International Settlements, January 1996.

Coopers & Lybrand staff. *Currency Swaps: A Self-Study Guide to Mastering and Applying Currency Swap*. Burr Ridge, Ill.: Irwin Professional Publishing, 1994.

Financial Accounting Standards Board. "Foreign Currency Transaction," *Statement of Financial Accounting Standards Number 52*, December 1981.

Financial Accounting Standards Board. "Accounting for Derivative and Similar Financial Instruments and for Hedging Activities," *Proposed Statement of Financial Accounting Standards, Exposure Draft*, October 1996.

Hintze, John "Assessing Risk: FASB May Tweak the Whole Notion of Hedging," *CFO Alert* (May 29, 1995), p. 5.

The article is about a tentative decision from the Financial Accounting Standards Board to create three classes of risk for financial instruments: foreign exchange, interest rate, and all other.

Nobes, Christopher, and Parker, R. *Comparative International Accounting*. Homewood, Ill.: Richard D. Irwin, 1981.

White, G., Sondhi, A., & Fried, D. *The Analysis and Use of Financial Statements*. Somerset, N.J.: John Wiley & Sons, 1993.

To conclude the reading list, we note that the top journals in finance and investments are:

Journal of Finance, *Journal of Financial and Quantitative Analysis*, and the *Journal of Financial Economics*. Other financial and investment journals, generally providing more basic reading, include *Financial Analysts Journal* and *Derivatives Quarterly*.

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Fax: (215) 851-9126

The Journal of Finance
Ohio State University
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Journal of Financial Economics
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