HANDBOOK OF
EXCHANGE RATES

EDITED BY

Jessica James

Ian W. Marsh

Lucio Sarno

WILEY

Exchange Rates

Handbook of

Exchange Rates

Edited by

JESSICA JAMES
IAN W. MARSH
LUCIO SARNO

WILEY

A John Wiley & Sons, Inc., Publication

For my children Zach and Miriam, my constant sources of inspiration!
Jessica James

To my wonderful wife Michela
Ian W. Marsh

To my fantastic wife Julia
Lucio Sarno

Contents

PART ONE

Overview

PART TWO

Exchange Rate Models and Methods

6 **Purchasing Power Parity in Economic History**   **161**

PART THREE

FX Markets and Products

16 ACTIVE CURRENCY MANAGEMENT PART I: IS THERE A PREMIUM FOR CURRENCY INVESTING (BETA)   453

19 FX Reserve Management   **545**

20 High Frequency Finance: Using Scaling Laws to Build Trading Models   **563**

Preface

The Foreign Exchange market, as we know, was born in the 1970s. To us in the second decade of the third millennium, mainly accustomed to freely floating and convertible currencies, the events that led to its birth would seem almost incredible. It is huge news when a government, via its central bank, intervenes to shift its currency or keep it stable. But from the end of World War II to the mid-1970s, pegs and interventions were the norm for almost all currencies.

The post war era gave us the Bretton Woods agreement that set the United States as the world's reserve currency and pegged most others to it. The United States was backed by gold, and the stability that this system brought enabled trade flows to enormously grow worldwide. This was deliberate; in the preceding decades, the architects of the system had seen how economic stresses could lead countries to war and were driven by a desire to promote trade and allow the world economy to grow.

However, the Vietnam war brought a growing US trade deficit and a drift of the alignment of the United States and the US dollar with the rest of the world. Pressure grew on the exchange rates and one by one, led by the Japanese yen, the currency became freely convertible and floating. By 1976, the gold standard was no more present and the majority of the world's currencies had the form we know today.

From that not-so-auspicious beginning grew the world's largest market. Today, according to the 2010 BIS report, currencies to the value of over US$4 trillion are traded each working day in global markets. The total value of global equity is a fraction of this amount. In most countries, the traded volume of the currency vastly exceeds the total amount of government debt. Foreign exchange has indeed come of age.

But what is it like, compared to other rates? It is not an interest rate. An interest rate is highly predictable and stable between close to zero, and perhaps exceptionally 15%. Outside these ranges, interest rates historically do not last long; high rates are often followed by spiralling hyperinflations, and negative rates do not occur without anomalous market stresses. It is not an equity, which has a floor at zero and is at least expected to appreciate with inflation.

There is a symmetry to foreign exchange, which is lacking in other market rates. One is "long" or "short" of an equity; in foreign exchange to be long

of one currency is to be short of another. It is a rate of exchange and not an ownership of an asset. It has no floor or ceiling, no particular "stable region." As befits the largest global market, it is also the easiest and cheapest to trade in, with transactions often costing just a single basis point—1% of 1%—in bid-offer spread.

How and why has it grown to such a size? Partly, it is the nature of the beast and the way it is traded. Most foreign exchange transactions are done on a margined basis, with the principal amounts being notional only. Thus, for a simple forward trade of 1 month's duration, where a rate of exchange is locked in for 1 month ahead, no capital is exchanged at the start. At the end, the difference between the agreed rate and the market rate is paid out, scaled by the notional amount of the deal. This is usually at most a few percent of this notional amount. So one can see that it is unnecessary to actually own a sum of money equal to the notional amount—it is more of a scaling factor to the deal. Hence, the notional flows in the market can be very large relative to a smaller capital base.

Another reason for the size of the foreign exchange flows is that speculative trades, which have grown vastly in size and number over the last few years, are usually leveraged. The foreign exchange market is somewhat less volatile than the equity or commodity market, and so to generate comparable profits, profit seeking traders usually apply a multiplier to the notional amount. The last decade has seen the development of foreign exchange as an asset class, where structures suitable for investors are created around foreign exchange transactions. These often utilize large notional amounts to generate returns.

These additions increase an already considerable bulk of foreign exchange trades in the market. One critical activity made possible by the advent of floating exchange rates is hedging. Overseas investments can have their value drastically altered by fluctuations in the foreign exchange rates; hedges allow investors and corporates to immunize their portfolios and cashflows against these variations. Thus the growth of overseas investment has itself driven the volume of foreign exchange transactions higher; the investments, particularly less volatile fixed income instruments, will be significantly affected by foreign exchange movements unless they are hedged.

What are the instruments that make up this flow? The vast majority are spot and forward transactions, but the option market is also deep and liquid. This market came into its own in 1983 when Garman and Kolhagen published the formula for an option on a foreign exchange rate. Additionally, a vast variety of structures may be constructed, which allow investors or corporates to eliminate or transform risks, or gain exposure to specific areas and events.

Why do we need a Handbook of Exchange Rates? In part because it is so important, and in part because it is evolving so rapidly. In the last 5 years, we have seen the growth of foreign exchange as an asset class, which 10 years ago was the exclusive property of large trading floors and a few fund managers. Most large investors will now have a portion of their risk allocated to active strategies, which deliver fundlike returns derived from positioning themselves

in the foreign exchange market. Another significant change is the growth of correlation and volatility derivatives. The correlation of rates has become a traded quantity, allowing a remarkably subtle set of risks and rewards to be accessed. The fascinating dynamics of high frequency data are now largely understood via scaling laws, to the extent that co-location—the siting of trading hubs close to exchanges—is becoming an issue; the speed of light has become a limiting factor in foreign exchange trading.

Another fascinating development is strongly connected with the correlation properties of foreign exchange rates. In floating emerging markets, the majority of foreign exchange rates are closely connected with their equity markets for obvious reasons. So high is this correlation that one can replicate emerging market equity indices to good accuracy using only foreign exchange rates—with their greater liquidity and low trading costs. Other interesting correlations are those between the Japanese yen or Australian dollar to the world's equity markets. So strong is the negative (in the case of the Yen) or positive (the Australian dollar) correlation that currency positions are often used to hedge equity drawdowns. So the foreign exchange market is being used to proxy for other rates. Its liquidity and depth make this attractive, though market stresses could bring an end to some of these useful correlations.

The Handbook is designed to span this extensive subject, with experts in the different areas contributing to each section. In planning the book, we drew up a list of the key subjects deserving of a chapter and against each we wrote the name of the key people in that topic. In almost every case, to our delight, those people accepted our invitation to contribute. As a result, the chapters have been written by leading specialists in their fields, often with extensive experience in academia and/or professional practice. Each chapter then benefitted from the feedback of at least one anonymous referee and at least one coeditor, and most authors kindly also acted as referees.

The initial section "Overview" covers structure, regimes, and general underlying behaviors. Part 2 covers models and methods, focussing on the predictability—or lack of it—of foreign exchange rates. In Part 3, we go to the practitioner side of the subject to cover hedging, active management, high frequency trading, and products. Part 4 wraps up with a look at policy and a framework for analyzing currency crises. The chapters are mainly in the form of self-contained surveys, and trace the key developments in a well-defined topic with specific reference to the relevant research frontier. Some contributions also present new empirical findings, especially where competing paradigms are evaluated. So rapid has the evolution of this market been, that it would not be surprising if in a few years there are many new chapters to add! Alternatively, market stresses and political crises can influence foreign exchange rates to an enormous extent. It is easy to forget that our current regime of floating market determined rates is recent, and by no means the norm in a historical context. The foreign exchange market is a fascinating subject, which never stops evolving.

We owe a debt of gratitude to many people for helping us bring this project to a successful conclusion: the contributing authors, for the high quality of their chapters; the many anonymous referees who provided, without exception, valuable feedback to the authors; and Chiara Banti who collated the chapters and worked very hard to copy edit the first draft of the Handbook. Needless to say, without their help, we would never have completed this project.

Jessica James
Ian W. Marsh
Lucio Sarno

Contributors

SAEED AMEN, Nomura, London, UK

NAOHIKO BABA, Goldman Sachs Japan Co. Ltd., Tokyo, Japan

PHILIPPE BACCHETTA, Department of Economics, University of Lausanne, Lausanne, Switzerland; CEPR

CRAIG BURNSIDE, Department of Economics, Duke University, Durham, NC, USA; CEPR; NBER

GINO CENEDESE, Bank of England, London, UK

YIN-WONG CHEUNG, Department of Economics and Finance, City University of Hong Kong, Hong Kong

MENZIE CHINN, Robert M. La Follette School of Public Affairs; Department of Economics, University of Wisconsin-Madison, Madison, WI, USA; NBER

JAMES E. DALTON, CitiFX Intelligent Orders, Citigroup, London, UK

PAUL DE GRAUWE, Department of Economics, University of Leuven, Leuven, Belgium

PASQUALE DELLA CORTE, Imperial College, London, UK

ALEXANDRE DUPUIS, Olsen Ltd., Zurich, Switzerland; Centre for Computational Finance and Economic Agents (CCFEA), University of Essex, UK

MARTIN D. D. EVANS, Department of Economics, Georgetown University, Washington DC, USA; NBER

ROBERT FLOOD, University of Notre Dame, Notre Dame, IN, USA

JEFFREY A. FRANKEL, Kennedy School of Government, Harvard University, Cambridge, MA, USA; NBER

MARCEL FRATZSCHER, European Central Bank, Frankfurt/Main, Germany

KRISTJAN KASIKOV, CitiFX Quantitative Investor Solutions, Citigroup, London, UK

GEOFFREY KENDRICK, Nomura, London, UK

MICHAEL R. KING, Richard Ivey School of Business, University of Western Ontario, Canada

RICHARD M. LEVICH, Finance Department, Stern School of Business, New York University, New York, NY, USA

Hanno Lustig, UCLA Anderson School of Management, Los Angeles, CA, USA; NBER

Nancy Marion, Dartmouth College, Hanover, NH, USA

Nelson Mark, Department of Economics, University of Notre Dame, Notre Dame, IN, USA; NBER

Ian W. Marsh, Cass Business School, London, UK

Paul R. Masson, Rotman School of Management, University of Toronto, Toronto, Canada

Christopher J. Neely, Research Department, Federal Reserve Bank of St. Louis, St. Louis, MI, USA

Lawrence H. Officer, University of Illinois at Chicago, Chicago, IL, USA

Richard B. Olsen, Olsen Ltd., Zurich, Switzerland; Centre for Computational Finance and Economic Agents (CCFEA), University of Essex, UK

Carol Osler, Brandeis International Business School, Brandeis University, Waltham, MA, USA

Frank Packer, Bank for International Settlements, Basel, Switzerland

Evgenia Passari, Cass Business School, London, UK

Michael J. Paulus, Hongkong and Shanghai Banking Corporation (HSBC), Hong Kong

Momtchil Pojarliev, Hathersage Capital Management LLC, South Norwalk, CT, USA

Dagfinn Rime, Research Department, Norges Bank, Oslo, Norway; Norwegian University of Science and Technology

Pablo Rovira Kaltwasser, University of Leuven, Leuven, Belgium

Yuji Sakurai, UCLA Anderson School of Management, Los Angeles, CA, USA

Lucio Sarno, Cass Business School, London, UK; CEPR

Aysu Secmen, CitiFX Quantitative Investor Solutions, Citigroup, New York, USA

Thomas Stopler, Goldman Sachs, London, UK

Donggyu Sul, University of Texas, Dallas, TX, USA

Oleg Svirschi, Record Currency Management, London, UK

Ilias Tsiakas, Department of Economics and Finance, University of Guelph, Guelph, Ontario, Canada

Eric van Wincoop, Department of Economics, University of Virginia, VA, USA; NBER

Adrien Verdelhan, Department of Finance, MIT Sloan School of Management, Cambridge, MA, USA; NBER

Paul A. Weller, Tippie College of Business, University of Iowa, Iowa City, IA, USA

Juan Yepez Albornoz, Department of Economics, University of Notre Dame, Notre Dame, IN, USA