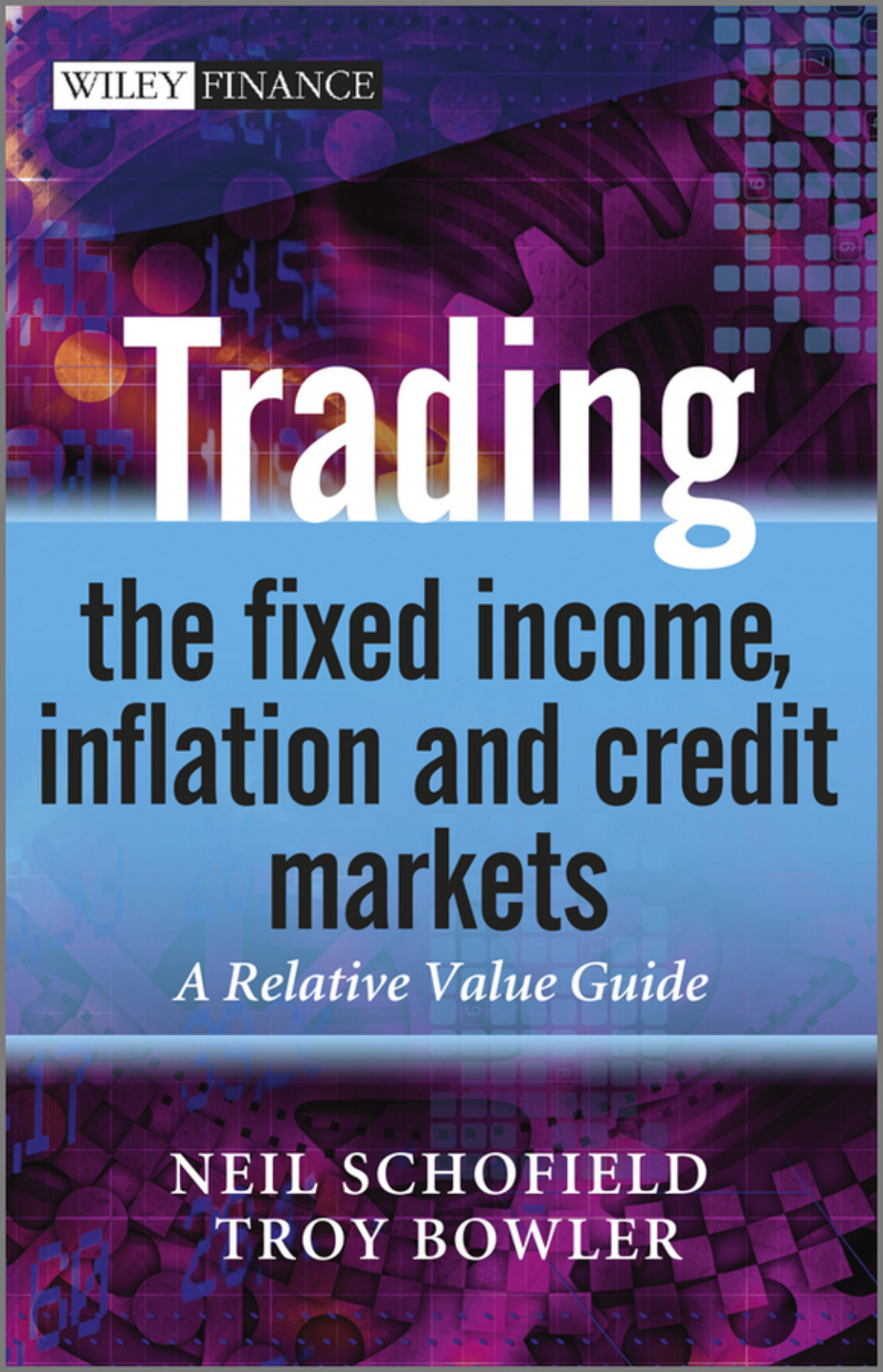
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Trading
the fixed income, inflation and credit markets
A Relative Value Guide
NEIL SCHOFIELD
TROY BOWLER

Trading the Fixed Income, Inflation and Credit Markets

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Trading the Fixed Income, Inflation and Credit Markets

A Relative Value Guide

Neil C. Schofield
Troy Bowler

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Dedicated to RBS
To Bren, Robert and Gillian
To Nicki

NCS

To my family and my friends;
who always support me

TB

Contents

Preface

If you have ever tried to read a finance textbook and bemoaned the fact that your brain starts to wander (or even wonder) after the first paragraph, then we think this book is for you. If you have ever been suckered into paying the best part of £100 for a finance textbook that you have opened only once, then again, we think this book is for you – clearly though for the right reason! If you have ever opened a finance textbook to be told "obviously" when it is patently far from it, then we also think this book is for you.

On the other hand, if you are looking for a heavy-duty academic text, then this book is definitely not for you. There are plenty of those available. Try, for example, *An Introduction to the Mathematics of Financial Derivatives* by Salih N. Neftci or the classic *Options, Futures and Other Derivatives* by John C. Hull. A slightly less academic but highly worthwhile read is *The Mathematics of Financial Derivatives: A Student Introduction* by Jeff Dewynne. Likewise, if you are looking for a cheaper version of one of the popular product handbooks that proliferate the market, put our book back on the shelf right now. It is not for you. We are not planning on discussing mortgage-backed bonds, Munis, REITs or 401Ks.

That is not to say that our book is not rigorous in its descriptions and its workings. It most certainly is. It is just that we want readers to come away from this book with a clear understanding of the intuition behind the theory, some practical examples to aid the understanding of that theory, some shortcuts that can be used to cut to the chase and some jargon-lite explanations of concepts such as PCA and Monte Carlo. As such, this book will be useful for students about to embark on a university course in finance and who want a book that is not dedicated to "squiggly d's" and stochastic calculus. It will also be useful for those people about to embark on a career in finance, whether on a well-structured graduate training course or not.

We have adopted a relative value approach to analysing the fixed income, credit and inflation market. The phrase "relative value" is perhaps most commonly interpreted in a literal sense; the value of one asset relative to another. From this notion the argument extends towards the definition of "value", which is often expressed as some notion that an asset can be considered cheap or expensive ("rich" in the market jargon). As any regular shopper will no doubt frequently report when they consider something to be a bargain, this notion is expressed with respect to some given benchmark or accepted norm.

This definition of relative value is a valid one, although we will argue that it is also somewhat limiting. Our definition of relative value is therefore "*what is the optimal way in which a particular view of the market can be expressed*". To grasp the significance of this

definition, consider the following simple example. Let us assume that we are an investor who is looking to earn a return in euros with a minimum degree of credit risk (i.e., the risk that the issuer of a security will be unable to repay its debts). If the investor chose to invest in AAA-rated EUR-denominated sovereign bonds, they would be able to pick between a variety of different countries. In theory, since the currency and the credit risk are identical, all of these bonds should return the same amount for a given yield. The investor may be able to identify one bond that they consider cheap relative to the universe of other assets and so purchase that asset. This type of transaction would conform to the traditional definition of relative value. Using the wider definition of relative value the investor would look at alternative structures that may afford the same exposure but offer a greater degree of return. So, for example, an investor may choose to purchase a bond future or enter into an interest rate swap transaction where they receive fixed or execute an option transaction that will show a profit if market rates move as expected. We will use this framework of spot–forward–swap–optionality as the basis of our trade design as we progress through the different asset classes.

Chapter 1 presents an overview of the different products that will be analysed in later chapters. It is not imperative to go through this chapter slavishly if you are confident of your product knowledge, but we include the chapter for the sake of completeness. *Chapter 2* introduces our relative value framework and considers the pricing relationships that exist between the spot, forward, swap and volatility markets. *Chapter 3* is essentially an extension of the pricing relationships developed in the previous chapter as it considers the market risk of the different instruments. *Chapter 4* considers how the relative value framework can be applied to express trading opinions within a fixed income context. *Chapter 5* takes a traditional "cheap/rich" approach to relative value within a sovereign bond context. *Chapter 6* looks at different ways to express views on expected yield curve movements. *Chapters 7 and 8* apply the relative value framework within a credit and inflation context, respectively. *Chapter 9* concludes the text on a slightly light-hearted note by considering some of our favourite trading axioms.

Finally, by the time that you have finished reading this book you will understand why, amongst other things, forward prices are not expected prices (Troy's pet hate!) and why most financial commentators need a little more humility. This book is the result of more than 50 years' combined working in various roles at the coal face of the capital markets rather than in the comfort of academia. We hope that it is worth the journey.

Acknowledgements

It's scary to think that Troy and I first met at Loughborough University many years ago; more than we care to remember. We went our separate ways and it wasn't until about 2002 that we bumped into each other at Barclays Capital. It was at Troy's instigation that we decided to embark on the project and I am personally grateful to him for his intellectual input into the text over the two to three years it took us to compile the material. His insight into all of these markets is remarkable and I am lucky to have been the scribe who documented his thoughts.

Troy has always been a big supporter of graduate education within Barclays Capital and the text was written with this audience in mind. The book is designed to both complement and supplement the existing classroom training that such a "bootcamp" course would deliver. However, we have tried to make the text accessible to any reader wishing to deepen their understanding of these complex financial markets.

I must also take the opportunity to extend a very big "thank you" to Stuart Urquhart of Barclays Capital. I first met Stuart at Barclays in about 2002, and ever since day one he has proved to be one of life's true gentlemen. Not only did he arrange for access to Barclays Capital Live for all of the data in the text, but he added value to some of the chapters with insightful suggestions and constructive observations. His professionalism and kindness are truly an example to us all. Thanks also to Dr Andy Bevan for help in shaping my thoughts on certain aspects of the yield curve.

I would also like to thank the late Paul Roth, who shaped my understanding on many aspects of derivatives. Sadly my late father, Professor Reg Schofield, passed away during the writing of the book and all his family and friends still miss him. He perhaps didn't realize it at the time, but his explanation in 2007 of yield curve modelling was a useful addition to the text – not bad for a Civil Engineer! As ever, Nicki never complained about me writing, even during (at least) two holidays.

Many thanks go to the team at John Wiley (Caitlin, Aimee and Pete in particular), who came to know me as Neil "*can I have another extension for delivery of the manuscript*" Schofield.

Although many people helped to shape the book, any mistakes are entirely our responsibility. I would always be interested to hear any comments about the text and so please feel free to contact me at neil@fmtuk.com or via my website (www.fmtuk.com).

P.S. Alan and Roger – two slices of white toast and a cuppa for me!

About the Authors

TROY BOWLER

Troy Bowler joined Barclays Capital in London in 2002 and is currently a Managing Director within Distribution, based in Singapore. Before joining Barclays Capital, he held positions at Deutsche Bank in London, where he was part of their highly-regarded global fixed income and relative-value research team, at PaineWebber and Bank of Tokyo Capital Markets (UK), where he was Chief Economist, and Charterhouse Investment Management Limited, where he managed money-market funds, including the #1 ranked GBP unit trust according to Micropal (acquired by McGraw-Hill Companies in 1997).

Although Troy's membership of the Institute of Investment Management and Research (IIMR), now known as CFA UK, has lapsed, he was a member of the Examination Committee in the mid-1990s, helping to revamp the IIMR's examinations. Previously, the examinations had focused almost exclusively on equity markets and the IIMR looked to widen the remit to encompass fixed income professionals. Those of you who went through the IIMR examinations prior to 2002, especially the "Economics & Applied Statistical Analysis" paper, may wish to thank or curse Troy in equal measure. He happily admits that he passed his examinations well before this.

Troy holds a BSc in Economics from Loughborough University and an MSc in Economics from London University.

NEIL C. SCHOFIELD

Neil Schofield is the principal of FMT Ltd, a UK-based company offering training services in the areas of treasury, derivatives, capital markets and risk management to financial institutions, Central Banks and corporations worldwide.

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Before joining Barclays Capital, he was a director at Chisholm-Roth Training for 4 years, where he was responsible for provision of training services for a number of blue-chip global investment banks. Clients included Citigroup, Deutsche Bank, Goldman Sachs and JP Morgan Chase.

He started his training career at Chase Manhattan Bank, where he was originally employed as an internal auditor. Over a period of 9 years, he conducted numerous internal and external

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Neil holds a BSc in Economics from Loughborough University and an MBA from Manchester Business School. He was elected as a Fellow of the IFS School of Finance (formerly the Chartered Institute of Bankers) in 1999.

Neil was appointed as a Visiting Fellow at the University of Reading ICMA centre in April 2007.

He is author of the book *Commodity Derivatives: Markets and Applications* published by John Wiley in October 2007.

1 Product Fundamentals

1.1 CHAPTER OVERVIEW

In this chapter we consider the features of a number of instruments that will be the focus of subsequent sections. The coverage is not intended to be comprehensive; the aim is to make sure that the reader is armed with sufficient terminology to be able to understand the more detailed concepts that will follow. Pricing and risk management will be the subject of Chapters 2 and 3, respectively.

This chapter starts with a discussion of the main "cash" (i.e., non-derivative) markets of fixed income, inflation and credit. The coverage then widens to incorporate the derivative building blocks, namely futures, forwards, swaps and options. Within this section the material occasionally leans towards the detail of specific products in certain asset classes that are considered key. However, the discussion relating to options is asset class neutral to keep the chapter size manageable.

Readers with a good knowledge of these subjects can skip this chapter but we would suggest a quick skim of the pages just in case a review is needed!

1.2 BOND FUNDAMENTALS

A key building block for the first part of the text will be bonds. A bond is an IOU that evidences the indebtedness of a borrower. Borrowers comprise mainly sovereign and corporate entities, although there have been issues made by individuals such as the pop star David Bowie.

1.2.1 Fixed income structures

Although bonds have many different forms we will initially focus on standard ("vanilla") structures. In return for borrowing a given sum of money, the issuer of the bond will pay a series of contractual interest payments to the owner of the instrument. When bonds were issued in physical form, the owner would detach a small coupon and present this to a bank appointed on behalf of the borrower as their eligibility to receive interest. As a result of this practice, interest payments on bonds have become termed coupons. At the maturity of the instrument the investor will be repaid the value stated on the face of the bond, but this may not be the sum that was originally paid to acquire the asset. This is because bonds are traded on a price basis, which is quoted as a percentage of the face value. Bonds are priced by present valuing all of the future cash flows, but this concept will be considered in Chapter 2. Suffice to say that with a limited amount of any bond in issue, the relative attractiveness of the fixed coupon will be the key determinant of how much an investor will pay to acquire the bond. If a bond has a fixed coupon of 5% but investors could earn a greater return on an equivalent investment (equivalent in terms of maturity and the risk of default), the

bond will have to be priced at less than its face value in order to make the investment attractive. If it were priced at say 95.00 and the investor held the instrument to maturity, they would be repaid 100% of the face value and would enjoy a capital gain of just over 5% over the period. The opposite would be true for a bond that has a relatively attractive coupon. Through the interaction of demand and supply, investors will seek to possess the bond, which will drive up its price. If held to maturity the investor will incur a capital loss but will have earned an above-market interest rate. The market uses the concept of a yield, which captures any capital gain or loss in addition to the receipt of a particular coupon.

1.2.2 Floating-rate notes

Floating-rate notes (FRNs) are interest-bearing securities that pay a variable coupon on a regular basis (usually quarterly). The coupon is usually a spread to a given margin relative to an interest rate index such as LIBOR (London Interbank Offered Rate) or Euribor. For example, the instrument may pay 3-month USD LIBOR + 0.15% (15 basis points). The instrument is economically equivalent to a series of consecutive fixed-term bank deposits, where the interest rate is reset on a periodic basis. The fixed percentage margin over the specified interest rate index is referred to as the quoted margin. The quoted margin is a function of the issuer's default risk relative to the interbank rate to which the interest payments are referenced. The better the credit rating the lower the quoted margin and vice versa.

FRN issuance is driven by the desire of the issuer to match their assets and liabilities. For example, banks will tend to be big issuers of FRNs (which will represent a liability) as the assets that the bond proceeds are used to purchase will tend to pay a variable rate of interest (e.g., mortgages). This ensures that if interest rates change, interest costs and income will move in tandem. The concept of banks being able to borrow on a LIBOR basis will become key to much of the analysis that follows. This is because investment opportunities are often analysed based on the return they generate relative to LIBOR. FRN investors will include many different entities:

- Bank treasuries with excess cash who are looking to match floating-rate liabilities.
- Central Banks, retail investors and credit-conscious fund managers will buy sovereign-issued FRNs.
- Money market funds and corporates can earn an enhanced yield compared to alternatives such as cash and commercial paper.

1.2.3 Inflation

Definitions

Although most people would argue that they understand the concept of inflation, both authors have found that in reality a number of market participants often struggle when trying to verbalize a definition. Inflation represents rising prices, deflation falling prices and disinflation is where price increases slow down.

Within the inflation world a nominal frame of reference looks at investments in terms of cash paid without taking into account the loss of purchasing power. So if an item costs €1 today, with 2% inflation it will cost €1.02 by the end of the year. Alternatively we could say that at the end of the year, €1 will only buy 0.98 of the item. How would this relate to bonds? Consider a 1-year bond that pays a principal of €100 plus one interest payment of €5 at its maturity. The real value of this final cash flow will depend on what happens

to prices over the period. If an investor expected inflation to be 3% then it will cost €103 in 1 year to buy something that costs €100 presently. However, the bond will pay a cash flow of €105 and so you expect to have €2 of extra purchasing power – a 1.94% increase in purchasing power.

The Fisher equation is used extensively by the market to express the relationship between the yields on nominal bonds and expected inflation. The equation expresses the relationships as:

$$(1+n) = (1+r)(1+f)(1+p)$$

where:

n = yield on nominal bond

r = real yield on inflation-linked bond

f = inflationary expectations

p = risk premium

However, the market has shortened the expression:

$$n = r + f + p$$

$$n = r + \text{bei}$$

where:

bei = breakeven inflation

In essence, the formula states that the yield on a nominal bond is made up of three components:

- A required real yield that investors demand over and above expectations of inflation.
- Inflationary expectations over a particular period of time ("breakeven inflation").
- A factor that captures the combination of a risk premium and a liquidity discount.
  - The risk premium is the compensation an investor earns for accepting undesirable inflation risk when holding nominal bonds. One interpretation is that it represents the risk premium demanded by nominal bond investors for unexpected inflation.
  - The liquidity discount represents the yield premium that investors demand to hold a less liquid inflation-linked bond.

However, the third component is generally considered to be difficult to disaggregate and so is generally ignored by the market.

The breakeven rate can be thought of as the average rate of inflation that will equate the returns on an inflation-linked bond and a comparator nominal bond issue of the same return. To illustrate how it should be interpreted, consider the following example. Suppose there are a nominal 5-year sovereign bond that is yielding 4.5% and an inflation-linked sovereign bond of the same maturity whose yield on a real basis is 1.5%. Using the principles of the Fisher equation this implies a breakeven inflation rate of 3.0%. An investor could use the value of breakeven inflation to assess which bond should be purchased:

- If the investor expects inflation to average less than 3.0% over the period, they should hold the nominal bond.

- If the investor expects inflation to average more than 3.0% over the period, they should hold the inflation-linked bond.
- If the investor expects inflation to average 3.0% over the period, they will be indifferent between the two assets.

Arguably the difficulty experienced by practitioners in trying to grasp the concept of inflation lies in defining the concept of a real yield. If one looked at the Fisher equation, a simple but somewhat unsatisfactory definition of real yields is simply the difference between nominal yields and inflation expectations. We present three other definitions:

- A real rate of interest reflects the amount earned or paid after taking into account the impact of inflation.
- It is the market clearing rate of return in excess of expected future inflation that ensures supply meets demand for a particular investment opportunity.
- The return for forgoing consumption today to consume more goods and services tomorrow.

Real yields should also:

- Reflect the growth in an economy's productivity.
- Represent the rate at which investments are rewarded. Investments compete for capital on the basis of the real yield they offer given their associated risk.

What can be even more confusing is when real rates of interest become negative, an example of which occurred in the US Treasury market in 2008. This happened when inflation expectations were higher than nominal interest rates. These negative real yields were attributable to:

- Slower economic growth prospects, which lowered rates of expected returns across investments.
- The US Federal Reserve was expected to cut interest rates such that inflation would be greater than nominal rates.
- A "flight to quality" by investors, which drove up the price of government securities, reducing their nominal returns.

So in general terms, negative real yields could occur if:

- An asset is not considered a productive use of capital.
- The asset is attractive but faces excess demand relative to its supply. As a result, its price rises and the nominal return falls.
- The existence of negative real yield can create an incentive to drive capital to other more potentially attractive investments.

Inflation-linked bonds

An inflation-linked bond is one whose value is linked to movements in a specific price index in order to maintain its purchasing power. An inflation index measures the way in which prices change. This is achieved by analysing and recording thousands of prices for a selection of goods and services on a monthly basis. Inflation figures for a particular month are then typically issued two to three weeks later. Some of the goods and services will carry a higher weighting, reflecting the fact that consumers will spend more money

on some items than others. The basket and the constituent weightings are revised on an annual basis. The most common inflation index used is the consumer price index (CPI) for the respective country of issue, although each country will typically calculate and quote a number of indices. In the USA the "Treasury Inflation Protected Securities" (TIPS; also sometimes referred to as the Treasury Inflation Indexed Securities – TIIS) reference their return to the consumer price all urban non-seasonally adjusted inflation index. In Europe a common index is the Harmonised Index of Consumer Prices (HICP) for all items excluding tobacco, while the UK mainly uses the Retail Price Index (RPI).

1.3 REPURCHASE AGREEMENTS

One important aspect of the fixed income world relates to how the purchase of a bond will be financed. It would be fair to say that most banks will not have large piles of cash lying around idle and so will look to manage their cash efficiently. The implication is that the cash required to purchase an asset will need to be borrowed and the proceeds from any sale will be reinvested. The most popular technique used in the financing of fixed income transactions is the repurchase agreement or "repo". A repo involves the simultaneous sale and future repurchase of an asset. The seller of the asset buys it back at the same price at which it was sold. On the second leg of the transaction the seller pays the buyer interest on the implicit loan that has been created. This interest is termed the repo rate.

The main cash flows associated with a typical repurchase agreement are illustrated in Figure 1.1.

A reverse repo is the opposite of a repo. From this perspective the transaction is viewed as the purchase of an asset for cash, with an agreement to resell at some future date. The market distinguishes between two different types of repo in relation to the asset that is transferred. A specific repo involves a bond that is specified by the two counterparties, whereas a general collateral ("GC") transaction involves a bond that meets some pre-agreed criteria.

Economically, the repo can be viewed as a collateralized loan rather than a pair of securities trades. Legally, however, the transaction is a sale and repurchase, which will

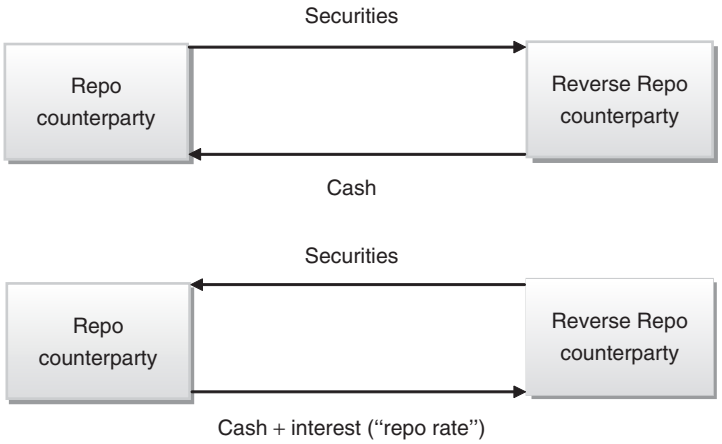

Figure 1.1 Repurchase agreements.

have important implications in the event of the default of one of the counterparties. If the securities had merely been pledged, then the default of the repo counterparty would result in the reverse repo counterparty becoming an unsecured creditor. However, the sale and repurchase structure means the reverse repo counterparty has the right of close out and set off – they get to keep the securities in lieu of the money lent. Similar principles would apply if the reverse repo counterparty were to fail.

Repos are quoted on a bid and offer basis. From a quoting institution's perspective a quote may be expressed as:

Bid	Offer
3.98%	3.92%
Buy securities	Sell securities
Earn interest	Pay interest

Although the convention of a high bid/low offer price may appear counter-intuitive, it allows for the market maker (i.e., the quoting institution) to make a profit through earning more interest than they would pay if they were able to execute offsetting trades simultaneously.

Appreciating that the transaction economically resembles a collateralized loan gives an insight into the popularity of the transaction. The interest that is payable on the second leg of the transaction will be lower than that of an unsecured borrowing and as a rule of thumb the rate that is agreed by the two counterparties is about 1/8th less than the LIBOR rate of the equivalent maturity.

It is important to appreciate that the legal title of the bonds is transferred to the reverse repo counterparty as part of the first leg of the transaction. This will allow them to sell on the bonds as part of an unrelated transaction if necessary. However, any economic benefit or risk is retained by the repo counterparty. This has a number of implications:

- If the bond issuer defaults over the period of the repo they will receive the security back but will still be forced to repay the price agreed in the first leg of the transaction.
- If the issuer of the bond being repo'd defaults, the repo counterparty will receive back the asset but will still be obliged to pay the original price agreed on the first leg of the transaction.
- If the bond pays a coupon during the period, this will have to be remitted back to the repo counterparty immediately.

Suppose that a bank is bullish on the prospects of the value of a particular bond and decides to use the repo mechanism to finance its purchase. The steps in the transaction are:

- Buy the bond for an agreed value and an agreed cash amount (an outright purchase).
- Sell the bond under repo and receive the market value with an agreement to repurchase the bond at a future date.
- The cash proceeds received from the first leg of the repo are used to settle the outright purchase.
- When the repo matures the bank retakes delivery of the bond and then sells it in the open market to any counterparty.
- The proceeds received from this sale are used to settle the outstanding principal and interest amount due under the repo.

It can be confusing as to why an investor would buy a bond outright and then sell it under repo to pay for it. However, the key to grasping the logic of this trade is to recall that all of the economic benefit of the transaction is retained by the repo seller (i.e., the outright buyer of the bond). So as long as the final sale generates sufficient cash to cover the initial purchase and the interest on the repo, the transaction will show a profit.

A similar procedure could be used if the market participant thought that a particular bond was going to fall in value:

- The target bond is purchased under a repo transaction.
- The bond is sold to a market participant in an outright sale.
- At the maturity of the repo the trader buys back the bond in the market to satisfy his commitment to redeliver the bond under the second leg of the repo.
- The proceeds of the repo (initial price plus interest received on the cash leg) are used to pay for the purchase of the bond.

As in the bullish scenario, as long as the cash received from selling the bond is greater than the cash paid to buy it, the transaction will be profitable.

Although this section is designed to give the reader an awareness of the key issues associated with a repurchase agreement, there is one particular aspect of the market that is worth highlighting. On occasion certain bonds will be in very high demand in the market and as a result the asset will "go on special" in the repo market. The excess demand for the bond may occur as a result of traders being very bearish in relation to a particular issue and there is significant demand to obtain the bond using the repo mechanism. Another example, which will be considered later, is that the bond futures contract may require a particular government bond to be delivered if it is held to its final maturity.

The impact of specialness in the repo market will result in repo rates going down. Intuitively, it would seem that the relative scarcity of an asset would cause rates to rise, but this is not the case. The participant who needs to take delivery of the asset will buy it under repo and deliver cash in return. Given the scarcity of the asset the cash that he has now lent out will only earn a very low rate of interest; this is the "cost" he must pay. Looked at from the repo seller's perspective, if they own the asset, they are able to profit from its scarcity by borrowing money at very low rates of interest. Depending on the level of demand for the asset, it is possible for the repo rate to turn negative; that is, the buyer of the bond in the repo transaction gets back less cash than they initially forwarded. This would occur if the penalty costs for failing to deliver are greater than the reduction in their repo proceeds.

1.4 CREDIT FUNDAMENTALS

One fundamental distinction made in the fixed income world is the importance of credit risk. This is defined as the risk that an entity will be unable to repay interest or principal due on monies that have been borrowed. The probability that an issuer will repay a particular debt is assessed by independent rating agencies, of which Standard and Poor's, Moody's and Fitch are examples. For example, Standard and Poor's defines a credit rating as an "independent opinion of the general creditworthiness of an obligor or an obligor's financial obligation based on relevant risk factors".[1] Each of the rating agencies applies different methods

to assess this creditworthiness and express it using a mixture of letters and numbers. For example, Standard and Poor's express credit ratings for both short and long-term instruments. For long-term credit ratings, the AAA designation reflects the strongest credit quality while D reflects the lowest. It is also possible to add a degree of granularity to the credit ratings by adding a plus or minus sign to show the relative standing with the major rating categories from AA to CCC.[2] Obligations rated as BBB– or better are termed by the market as "investment grade", while ratings lower than this threshold are termed "high yield". This is an important distinction, as some investors may have restrictions on the nature of the assets in which they can invest.

From a market perspective an investor who buys a bond with a certain element of credit risk is rewarded in the form of an enhanced return. That is, they will earn a certain percentage amount over and above the so-called default-free return. This enhanced return is referred to as a credit spread. A generalized approach to estimating this spread can be stated in the following relationship:

$$\text{Credit spread} = \text{Probability of entity defaulting} \times \text{loss incurred in the event of default}$$

However, there are a number of different ways in which this credit spread is measured, and this will be addressed in Chapter 3.

1.5 DERIVATIVE FUNDAMENTALS

A derivative is defined as an instrument that derives its value from the price of an underlying asset. The three main building block instruments that comprise the derivative world are forwards/futures, swaps and options. So, taking crude oil as an example, the market trades crude oil futures and forwards, crude oil swaps and crude oil options. Derivatives can be traded on an organized exchange or directly between counterparties on an over-the-counter (OTC) basis.

1.5.1 Futures

A future is an exchange-traded contract that fixes a price on the trade date for delivery of an asset at some future time period. An interest rate future fixes an interbank rate for some future time period – say the 3-month rate in 3 months' time. A bond future fixes the price of a bond for delivery at some future time period. An example of a bond future referenced to German sovereign Bunds is given in Table 1.1.

Table 1.1 Contract specifications for Euro Bund future

Trading unit	€100,000 nominal value, notional Bund, 6% coupon
Delivery months	March, June, Sept, Dec
Delivery day	The 10th calendar day of the respective delivery month (at seller's choice)
Quotation	Per €100 nominal (in decimals to 2 places)
Minimum price movement	0.01 (1 tick = €10)
Last trading day	11.00 a.m., two trading days prior to delivery date

Source: Eurex.

Although the detail of the Bund future will be considered later, there are a number of general features that are worth highlighting:

- Futures are generally traded in fixed amounts (€100,000 in this case), although there are exceptions to this such as futures on equity indices. The monetary value of this type of future changes in line with the value of the index.
- The contract is linked to a specific underlying asset so that both counterparties know exactly what will be delivered.
- Upon expiry of the contract the underlying can be delivered according to an agreed schedule of dates (in the case of the Bund it expires on the 10th calendar day of March, June, September and December).
- The underlying asset may be physically delivered (e.g., Bund futures) or cash settled, where the nature of the underlying asset makes it operationally impractical (e.g., FTSE 100 equity index).
- The smallest price movement is predefined by the exchange and is referred to as a "tick". This tick movement will have an associated monetary value. In the case of the Bund, since the contract size is €100,000 and the tick is defined as 0.01%, the tick value is €10.

Another feature of exchanges is the requirement of both counterparties to post collateral. Termed "margin", this is generally seen in two forms. Initial margin is posted at the outset of the trade, while variation margin is the mechanism whereby profits and losses are transferred between entities on a daily basis. To facilitate the settlement of exchange-traded contracts, a central clearing house will act as the counterparty to both sides of the transaction. So once a transaction is executed between two entities, the clearing house will become the buyer to every seller and the seller to every buyer. This feature removes the counterparty credit risk that would result if a transaction were executed on an OTC basis. However, it is clear that this argument is somewhat flawed in that each original party to the trade has merely transferred its credit exposure to the clearing house. However, the clearing house is often very heavily capitalized in order to mitigate this potential default risk.

1.5.2 Forwards

A forward contract is economically equivalent to a futures contract in that it will involve the fixing of a price at the point of execution for delivery at some future date. An entity trading an OTC forward will not be faced with the constraints of contract standardization that are a feature of exchange-traded contracts. Forwards allow the user greater flexibility in specifying deal parameters such as transaction size and maturity dates. Although something of a generalization, the majority of forward contracts will be cash settled. So, a cash-settled bond forward would fix the price of the bond for future delivery but the final settlement would not require the exchange of the asset for cash. Instead, the seller of the contract will pay a cash sum equal to the current market value of the bond and the buyer will pay the fixed price originally agreed upon. A forward deal is a contractual commitment which cannot be terminated unless both parties to the deal agree mutually to end the transaction.

Forward rate agreements

A forward rate agreement (FRA) is an OTC transaction that fixes a single interest rate for a single period at an agreed date in the future. The start of the period the rate will be fixed for and its length are negotiated between the contract buyer and seller. So an FRA transaction

that locks in the 3-month rate in 3 months' time is referred to as a 3/6 or 3s6s transaction. The first number indicates the effective date of the transaction, the final number the maturity and the difference between the two indicates the tenor of the interest rate that is being fixed. Interest rate tenors will typically reflect those most commonly traded in the cash markets and so will have a maximum maturity of 12 months. The effective and maturity dates for FRAs could extend as far as 5 years depending on the currency.

These instruments have never been adopted by the corporate community to hedge exposures and are arguably most often used by traders as a way of expressing a view on expected short-term interest rate movements. Schofield recalls a conversation with an FRA trader where the dealer pointed out that he created his quote based on where he thought the Central Bank rate would be at some future date (plus a few basis points to reflect the difference in credit risk).

These instruments are quoted on a bid and offer basis and so a hypothetical quotation could be:

3/6	3.11%–3.12%
6/9	3.15%–3.16%
9/12	3.25%–3.26%

The interpretation of the quotation from a market maker's perspective is:

Bid	Offer
Buy FRA	Sell FRA
Pay fixed rate	Receive fixed rate
Receive LIBOR	Pay LIBOR

From this quoting convention we can start to see that an FRA is a contract for difference, which involves an exchange of cash flows. On the trade date the parties to the deal agree a fixed contract rate for an agreed future period and then will make or receive compensation depending on the actual level at which LIBOR settles. As we will show in the next section, an FRA can be thought of as a single-period interest rate swap.

To illustrate the concept, consider the following example. Suppose that 3-month interbank rates are 3.00% and the market believes that Central Bank rates will increase over the next year. The trader sees the market quoting a 9/12 rate as 3.25%–3.26%. He believes that actual 3-month rates in 9 months' time will be lower than this and so decides to sell the FRA at the bid price of 3.25% (he is a market user not a market maker) on a notional of USD 10m. This will contract him to receive 3.25% and pay the prevailing LIBOR rate in 9 months' time. If market rates evolve as per his view (i.e., 3-month LIBOR is lower than 3.25%) he will end up being a net receiver of cash.

Let us say that 9 months later, the 3-month LIBOR rate fixes at 3.20%. The parties to the FRA agreement can calculate the settlement amount due. The market user who sold the contract expects to be a net receiver of 5 basis points per annum on a USD 10 million notional amount. However, there is something of a quirk in the settlement convention.

Normally, interest rate contracts will settle in arrears but in the FRA market the settlement takes place as soon as LIBOR fixes. This means that the recipient of the cash flow has use