



Understanding Repo Markets

Moorad Choudhry

Objectives of the Course

- Defining and describing the mechanics of Repo
- Understanding market fundamentals and applying knowledge gained to daily work in the repo markets
- Introducing trading theory and strategy

Agenda

- Introduction and Market Background
- Financial Arithmetic
- Uses and Economic Functions
- Mechanics of Repo
- Risks in trading Repo
- Legal, Accounting, Tax and Capital
- Repo netting
- Overseas and Central Bank Repo
- Case study - repo trades

Agenda (cont.)

- The UK Gilt Repo Market
- Trading and Hedging Strategy
- Electronic Repo Trading
- The Implied Repo Rate and Basis Trading
- The Yield Curve
- Using Bloomberg™ Screens
- Introduction to Equity repo



Introduction

Definition of a Repo

- The term “Repo” is from “Sale and *Repurchase* Agreement”
Repo is a money market instrument. There are two usually two parties to a repo transaction.
- One party “sells” bonds to the other while simultaneously agreeing to repurchase them or receive them back at a specified future date
- One party requires either the cash or the bonds and provides collateral to the other as well as compensation for the temporary use of the desired asset
- Although legal title to the collateral is transferred, the seller/lender retains both the economic benefits and the market risk of owning them
- If cash is involved the party receiving the cash will pay interest on this cash at the agreed repo rate

Repo Definition (cont.)

- Repo is therefore a secured loan
- Legally : a sale and repurchase of bonds
- Economically : a secured loan of cash
- The cash investor receives the repo rate
- Advantages for the cash investor :
 - secured investment
 - repo rate competitive with bank deposits
 - diversification away from bank risk



Market Background

Money Market Instruments

- Money market instruments have a maturity of less than one year
- Securities quoted on a yield basis
 - Money Market Deposits
 - Certificates of Deposit
 - (Repo)
- Securities quoted on a discount basis
 - Treasury Bills
 - Bills of exchange
 - Bankers acceptances
 - Commercial Paper

Bond Market Instruments

- Bonds are debt capital market instruments with a maturity of over one year
- Definition of a bond
 - plain vanilla or bullet bond
- Bond Issuer
- Term to maturity
- Principal and Coupon Rate
 - zero-coupon bonds; Floating-rate notes



Financial Arithmetic

Discounting and Present Value

- The principles of compound interest are used to show that £1 today is not the same as £1 in the future
- The effect of a (real) rate of interest
- Given a rate of 10%, we would select £1 today or £1.10 in one year
- The further into the future, the greater the compensation requirement for interest foregone because of the effect of compounding
- In compounding we seek to find a future value given a present value

Compounding, Discounting and Present Value (cont.)

- Compounding : a future value FV (given a present value, a time period n and interest rate)
- $FV = \text{Present Value} (1 + \text{Rate of Interest})^n$
- To analyse the potential economic benefit of future cash flows whose nominal value is known we employ the principle of discounting, the converse of compounding
- Discounting : value of sum receivable at a future date *today* (present value PV)
- $PV = \text{Future Value} / (1 + \text{Rate of Interest})^n$

Time value of money (cont.)

- So, present value analysis is a means by which future values can be converted into comparable present day terms using the discounting principle
- A future sum to be received which includes compound interest can be expressed in relative terms to £1 today
- The actual calculations to obtain the discount factors are rendered unnecessary by the discount function table

Fair pricing of bonds

- Vanilla Bond : pays fixed interest (coupon) annually or semi-annually , with return of principal at maturity
- *Fair price* of such a bond given by the discounted present value of the total cash flow stream, using market-determined discount rate (for this type of bond)

- The bond price / yield formula given here relates to annual coupon bond with complete years to maturity, an even number of coupon payment dates, no accrued interest

Price Equation

$$P = \frac{C}{(1+r)} + \frac{C}{(1+r)^2} + \dots + \frac{C}{(1+r)^{T-1}} + \frac{C}{(1+r)^T} + \frac{M}{(1+r)^T}$$
$$= \sum_{t=1}^T \frac{C}{(1+r)^t} + \frac{M}{(1+r)^T}$$

where

P = fair price of bond

C = coupon

M = redemption payment(par)

T = number of years to maturity

r = required rate of return on bond

Price / yield formula (semi-annual coupons)

$$P = \sum_{t=1}^{2T} \frac{C/2}{\left(1 + \frac{1}{2}r\right)^t} + \frac{M}{\left(1 + \frac{1}{2}r\right)^{2T}}$$

Estimate yield from two trial values for r , then solve using formula for linear interpolation

Assumes coupons are re-invested at the required rate r

Bond Yield

- *Yield to maturity* (YTM) is the most frequently used measure of return from holding a bond, and is given by “ r ” in the previous slide’s equation.
- YTM is equivalent to the *internal rate of return* on the bond, the rate that equates the value of the discounted cash flows on the bond to its current price.
- Solution cannot be found analytically so needs to be done through numerical iteration. The price/yield formula assumes re-investment of coupons at the same yield level through life of the bond.

Yield Curve

■ Accessing capital markets

The pricing of debt instruments revolves around the yield curve. This curve, or *term structure of interest rates*, describes relationship between yield and maturity on stock differing only in term to maturity

■ Types of Yield Curve

Redemption yield curve; Coupon yield curve; Par yield curve; Spot (or Zero-coupon) yield curve; Forward yield curve

■ Shape of the Yield Curve

Expectations of market participants of future course of interest rates; Liquidity preference theory; Segmentation theory

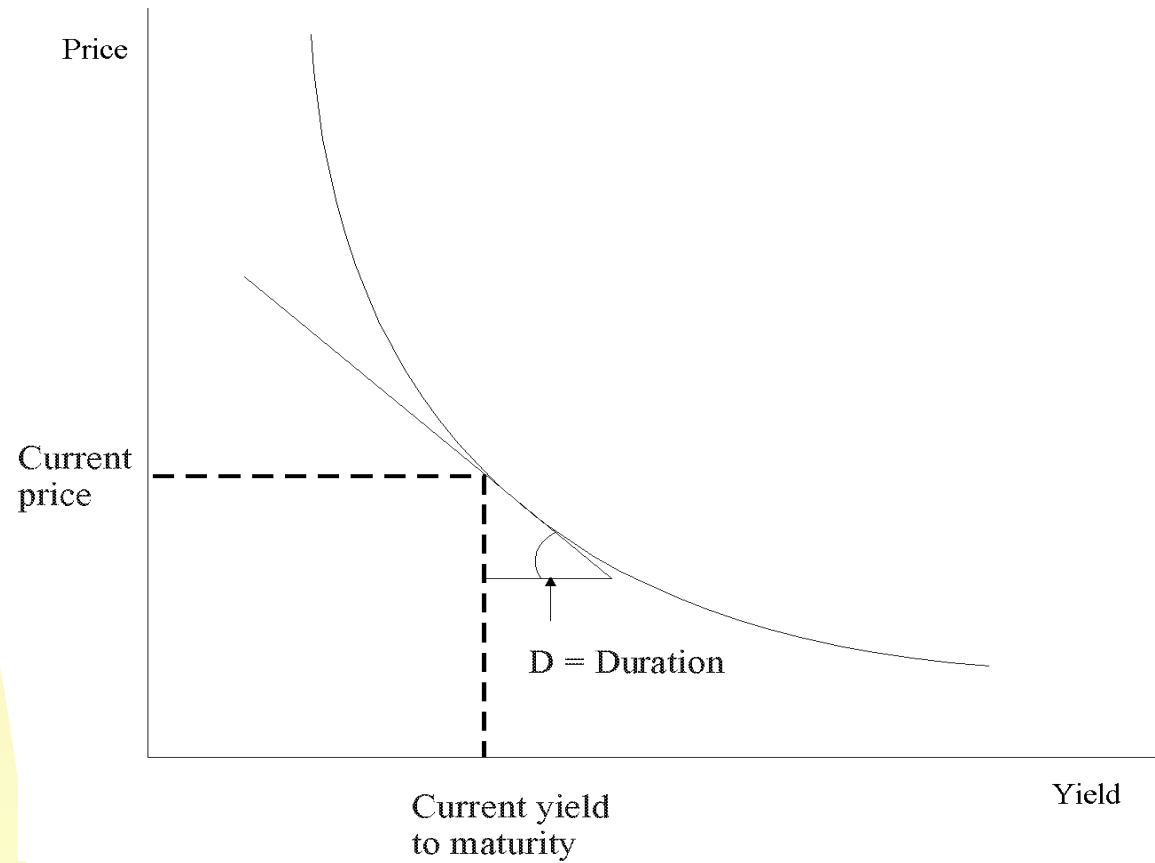
Price / Yield Relationship

- As the price of a bond is the sum of its discounted cash flows, a rise in rates results in a fall in price, and vice-versa
- Price equation shows the relationship between bond price and interest rate.
- Sensitivity of the bond to changes in interest rate is measured by *Duration* and *Modified Duration*. Duration is the weighted average maturity of a bond using its discounted cash flows as weights.

How Interest Rate Movements Affect Bond Prices

- At issue, a bond's coupon reflects current interest rates
- The coupon is fixed for the life of the bond and cannot be changed even as interest rates change
- It is therefore the price of the bond that changes to reflect varying market interest rates
- A rise in interest rates causes the bond's price to fall
- A fall in interest rates causes the bond's price to rise

Price / Yield relationship profile



Accrued Interest

- Virtually all bond issuers pay coupon interest once or twice a year
- An investor selling a bond between two coupon payments will receive from the purchaser the interest that has accrued since the last payment
- To the bond's "clean" market price is added the accrued interest, resulting in the "dirty" price which reflects the actual cash proceeds of the sale. The dirty price is the bond market value.

Accrual Conventions

C = coupon or stated rate:

act/365 accrued = C * days/365

act/360: accrued = C * days/360

act/act: accrued = C * days/actual no. of
days in period

30/360: accrued = C * '360 days'/360

(assumes each month
has 30 days)

What Determines Longer Term Interest Rates?

- Interest rate is the cost of borrowing money
- Many rates, depending on class of borrower and term
- Three key factors
 - Credit risk
 - Liquidity risk
 - Market risk

Functions and Uses of Repo

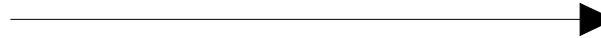
Classic Repo

First Leg

Bank A



sells 100 worth of stock



Bank B



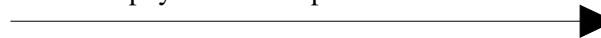
pays 100 cash for stock

Second leg

Bank A



pays 100 cash plus interest



Bank B



sells 100 worth of stock

Classic Repo Example

- On 6 September 1999 Bank A agrees to sell £1m nominal of a UK gilt, the 8% Treasury 2000, which is trading at a dirty price of 104.30.
- Trade value date is 7 September, term 30 days, matures 7 October and agreed repo rate is 6.75%.
- The first leg of the trade Bank A passes over the stock and receives £1.043m
- On 7 October Bank B returns the gilt and Bank A pays over the original monies plus repo interest of £5786.50.

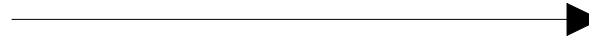
Classic Repo Example

First Leg

Bank A



sells £1m nominal UKT 8% 2000



Bank B



pays £1.043m

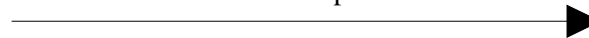


Second leg

Bank A



returns £1.043m plus £5786.5 interest



Bank B



returns £1m nominal UKT 8% 2000



Classic Repo (cont.)

- In a classic repo the sale and repurchase prices are the same, although settlement values will differ because of addition of repo interest on termination
- A sale and repurchase is a “repo”, whereas a purchase and sell back is a “reverse repo”. Of course the counterparty is either one or the other, opposite to your position!
- If a coupon is paid during the term of the repo it will be handed over to the seller.
- A classic repo is subject to a legal contract signed in advance by both parties

The Sell / Buy Back

- A sell / buy back is a spot sale and forward repurchase of bonds transacted simultaneously. The repo rate is not explicit but is implied in the forward price.
- Therefore the end clean price in the trade is different to the start clean price. This simply reflects repo interest and has nothing to do with the actual market price at the time.
- Coupon payments during the term of the trade are paid to the buyer, and may be passed over at the time or handed over to the seller through incorporation into the forward price (in which case a payment is not received immediately).

The Sell / Buy Back (cont.)

- Generally sell / buy backs are not subject to a legal agreement, so in effect the seller has no legal right to any coupon and there is no provision for *variation margin*.
- The forward bond price is calculated by converting the termination money, that is, dividing the termination money by the nominal value.
- The interest accrued on the bond *during the term of the trade* is subtracted from the forward price to obtain a forward clean price
- Example 5.2 in your text book.

The Sell / Buy Back (cont.)

- If there is a coupon payment during the trade, and it is not paid over until termination, a compensating payment is made of interest on the amount at the repo rate
- When calculating forward price where a coupon will be paid during the term, subtract coupon payment from forward price
- That is – coupon netted out with interest payment, all factored into forward price
- Sell / buy backs are not possible with open (no fixed term trades) as no forward price can be calculated

Stock Lending

- Institutional investors such as pension funds and insurance companies may prefer to enhance income from portfolios by lending bonds, for a fee, rather than through repo
- No requirement for dealing, monitoring and settlement systems as required in repo, and no exposure to interest rate risk
- Less transparent and readily realisable value from “special” stock

Margin

- An initial *margin* is given to the supplier of cash in the transaction. The market value of the collateral is reduced (or given a “haircut”) by the amount of margin when determining the value of cash lent out
- Two methods used to calculate the margin, assume a 2% level :
 - dirty price of bonds x 0.98
 - dirty price of bonds / 1.02Bloomberg uses the second method

Margin (cont.)

- Size of margin required in any transaction is a function of :
 - credit quality of counterparty
 - term of the repo
 - duration (price volatility) of collateral
 - existence of any legal agreement
 - quality of collateral
- A provision for *variation margin* is contained in repo agreements, to allow for the level of collateral to be say, increased if its market value has fallen significantly during the term of the trade

Margin

6.2 see example

- 30 day repo, at 5 9/32%, margin 2.5%.
Principal £9.5m, clean price collateral 95-00, accrued (54 days)
£88,767.12, consideration £9,588,767.12.
- Consideration is divided by 1.025, gives £9,354,894.75,
rounded to £9,355,000. Repo interest is £40,607.75.
- Price of collateral drops to 92-00 after 15 days, market
value now 9.2m + accrued (69 days), which is
£9,313,424.65. Repo desk has lent £9.355m!
- To restore original margin of 2.5%, desk calls for
adjustment calculated as follows :

$$\frac{[(\text{original consideration} + \text{repo interest accrued}) \times (1 + \text{initial margin})] - (\text{new all-in price} \times \text{nominal amount})}{}$$

**Margin call is $[(9.355\text{m} + 20,303) \times 1.025] - (0.93134 \times 10\text{m})$
= £296,261.82**

Other Repo Types

- Hold-in-custody repo
- Borrow vs Letter of Credit
- Cross-currency repo
- Tri-party Repo

Tri-Party Repo

- Market participants such as cash rich investors may prefer tri-party repo because it eases admin (lower admin burden than “delivery” repo, but less risky than HIC repo)
- Collateral is held in an independent third-party account; service provided by Euroclear and Clearstream Banking
- The tri-party agent is also custodian, manages exchange of collateral and cash internally
- Tri-party agreement signed by all three parties
- Tri-party repo rate is usually higher than the delivery repo rate, but lower than HIC repo

Using Repo

- **Funding Positions**

In normal course of business, long/short of bonds is short/long of cash. Can finance this in interbank or repo market

Covering short positions

General collateral (GC) repo rate vs interbank

- **Investment option**

- **Yield enhancement**

Credit intermediation between markets (secured and unsecured, stock lending, etc)

Collateral

- **General collateral (“GC”)**

Collateral that is not a specified security but of a defined homogenous credit quality, for example UK gilts or AA-rated sterling Eurobonds. A repo in GC does not specify any particular security, but the repo buyer must be informed what stock is being passed over fairly shortly after the trade is agreed

- **Specific repo**

Repo in a specific security, specified at time of trade. Equity repo is almost by definition always specific repo. A specific is not necessarily a “special”

- **Special repo**



Repo Market Players

Repo Market Players

- **Investors**

Cash-rich institutions; banks and building societies

- **Borrowers**

- Traders; financing bond positions, etc

- **Other institutions**

Flexibility and ease of trading makes this a market for almost any type of firm involved in borrowing or lending collateralised cash



Repo Dealing Risks

Dealing Risks

- **Counterparty / Credit Risk**

Counterparty risk is risk of default due to financial difficulty or withdrawal from business

Banks internally rate all counterparties and assign exposure limits to each, by firm and sector

- **Collateral risk / Issuer risk**

Quality of collateral held suffering due to decline in fortunes of issuer; lower grade collateral trades at a higher spread to government repo rate

- **Market Risk**

Risk exposure from changes in market levels, interest rates, asset values, etc. One reason for continuing popularity in stock lending!

Risks (cont.)

- Operational Risk
- Legal Risk
- Stock specific risk
The risk that a specific bond goes special
- FX risk
Cross-currency repo, or a stock loan collateralised with assets denominated in a different currency

Credit Risk : Ratings (Investment Grade)

	<u>S&P</u>	<u>Moody's</u>
Top quality	AAA	Aaa
High quality	AA+	Aa1
	AA	Aa2
	AA-	Aa3
Upper medium	A+	A1
	A	A2
	A-	A3
Medium	<u>BBB+</u>	<u>Baa1</u>
	BBB	Baa2
	BBB-	Baa3

Dealing with risk

- Formal binding legal agreements
- Default arrangements; netting
- Margining
 - Initial margining
 - Mark-to-market
 - Daily or regular variation margin



Legal, Accounting, Tax and Capital Issues

Legal Issues

- PSA / ISMA Agreement

Introduced November 1992; updated 1995 and 2000

Market standard agreement used as legal basis for repo in non-USD markets

- Main features :

- trades structured as outright sales and purchases

- full ownership conferred of securities transferred

- obligation to return “equivalent” securities

- provision for initial and variation margin

- coupon paid over to seller at time of payment

- legal title to collateral in event of default

- Gilt Repo Agreement

Accounting and Tax

- On-balance sheet. An accounting entry appears as secured loan and not a “sell” transaction

Bonds given as collateral remain on the balance sheet; corresponding liability is repo cash (opposite for buyer)

P&L account, repo interest treated as payment of interest on accruals basis

- Tax treatment differs according to jurisdiction

Principal issue is whether “sale” of securities triggers taxable event and/or result in transfer taxes

In UK return leg of repo treated as interest, taxed as income. Coupon payments treated as benefit to seller, taxable date is dividend date

Capital Treatment

- BIS Capital Accord, sets minimum ratio of capital to *weighted risk assets* of 8%. Assets on balance sheet assigned weighting from 0% (“riskless”) to 100%.
- Repo transaction attracts a charge on bank’s *trading book*
- Capital allocation is :
$$\max \{[(C_{mv} - S_{mv}) \times 8\% \times RW], 0\}$$
- By definition repo attracts lower charge than unsecured transactions. Trades conducted under legal documentation given favourable treatment; sell/buy backs attract a full charge.

Repo Netting

Repo Netting

- Some markets have introduced central clearing with multi-lateral netting ability
- Repo netting means market participants can net long and short repo positions, reducing impact on balance sheet and also freeing up credit lines. Benefit of settlement netting and more uniformity in risk management procedures
- This system is already well established in US market, provided by Government Securities Clearing Corporation
- Netting replaces a large number of bilateral credit exposures with a set of single exposures to a central counterparty

Repo Netting (cont.)

RepoClear members as at 10/01 included JPMorgan Chase, Deutsche Bank, RBS NatWest, Barclays Capital, CSFB and Morgan Stanley

- Developing market, although market should eventually favour one system
- *RepoClear* developed primarily by London Clearing House (LCH).
Steering committee made up of a number of banks. Initially for bund repo, followed by other European bonds including gilts. Trades capture by TRAX. Risk management by margining and a default fund. Also plan for cross-margining with swaps and futures and eventual cash bond clearing. Introduced Aug 1999 for Bund repo, other currencies to follow. *SwapClear* introduced Aug 1999
- *GSCC/Euroclear* originally planned centralised netting for euro repo and cash trades in 2000...
- *Cleernet* set up Nov'98 for French government bonds and repo, plan other euro bonds

Repo Netting (cont.)

- Mark-to-market on *RepoClear* uses Reuters prices, therefore illiquid bonds not repo-ed over it
- GSCC/Euroclear have joined LCH as a joint venture to further develop RepoClear
- Default fund £375m as at Oct 2001, plan to increase this
- See www.repodealer.com for latest members and details on:
 - ---membership criteria
 - ---size of default fund (at least £250m)
 - ---member banks

Overseas and Central Bank Repo

Central Bank Operations

- Central banks are an important customer base for repo business
- In addition, many central banks use repo as a tool of monetary policy to control liquidity in domestic money market
- A central bank “repo” operation is actually a reverse repo, buying in eligible securities (typically domestic government debt) vs. lending cash to a list of eligible counterparties
- Net effect is a short-term injection of liquidity into the money market

Central Bank Operations

- Duration of transaction varies, usually 2w and 4w trades
- Trade can be at fixed rate determined by central bank, or (less usual) variable rate resulting from auction amongst eligible participants
- In addition to achieving objective of controlling market liquidity, central bank repo operations can also send a signal to market of intended short-term rates
- Central banks use repo because of security (quality collateral) and liquidity of market

USA

- The original repo market, the largest and most liquid (\$1 trillion outstanding, quoted 10 years ago! Approx 2-3 times this)
- Market uses standard PSA master repurchase agreement
- Fed “wire” mechanism allows same-day domestic settlement
- Government bills, notes and bonds most actively traded
- Market in federal agency debentures and mortgage-backed securities

Germany

- One of the most important, and efficient, markets in Europe, due to benchmark status of Bunds and active derivatives market
- Market evolved offshore in London, due to competitive factors, main one was Bundesbank's domestic bank minimum reserve requirements (scrapped in 1996)
- Market since also developing in Frankfurt

France

- With Germany, one of the most efficient markets in Europe
- The domestic market is more liquid than the international cross-border market (primarily based in London)
- A significant proportion of business is done on a floating (rather than fixed) rate basis, with term trades done as a spread to EONIA - the european overnight interest rate (replaced TMP, the French overnight money market rate)
- Has own legal agreement, the *pension livree*

Italy

- One of the largest government bond markets in the world, reflected in the repo market
- Historically BTPs, CTOs and CCTs paid coupons net of tax at (at 12.5%). Foreign institutions entitled to reclaim this tax had to do so via a domestic custodian
- All trades settled domestically for this reason, repo rates quoted on both a net and gross basis
- From January 1997 bonds pay coupons gross to non-residents, removing above restrictions
- Note that in the domestic market a “buy/sell back” is called a “repo”

Switzerland

- Historically no domestic swiss franc repo market due to the imposition of stamp duty on such transactions; this was abolished in 1997
- Trading has taken place offshore (mainly London)

Other markets

- Active government bond repo trading in Spain, Netherlands, Belgium, Denmark, Sweden, Austria and Eire
- In all these cases there is a domestic market interacting with a cross-border one based in London

More examples

- Walk through of gilt repo examples from text book
- Observe margin, etc
- Para 12.10



Case Studies

The UK Gilt Repo Market

Introduction

- Background

UK Gilt Repo market began on 2 January 1996

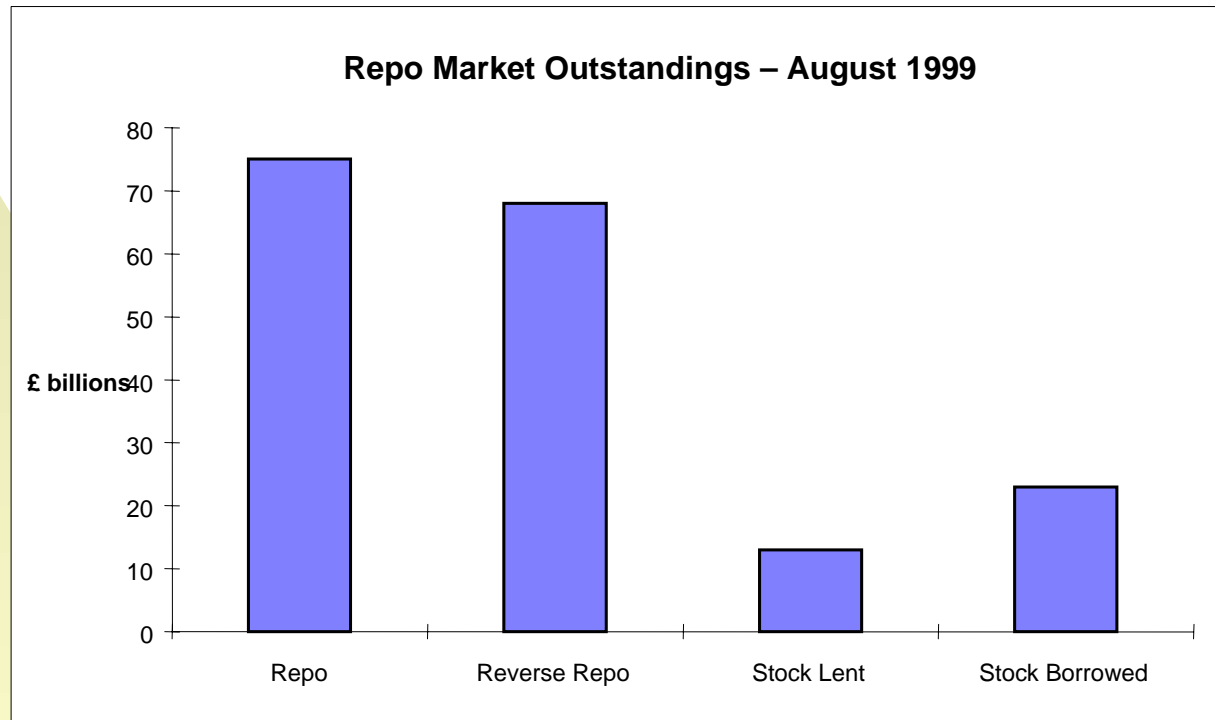
Repo allowed all market participants to borrow or lend gilts

Legal agreement based on PSA/ISMA

- Market Growth

Market grew to £50 bln of repos and stock loans outstanding in first two months

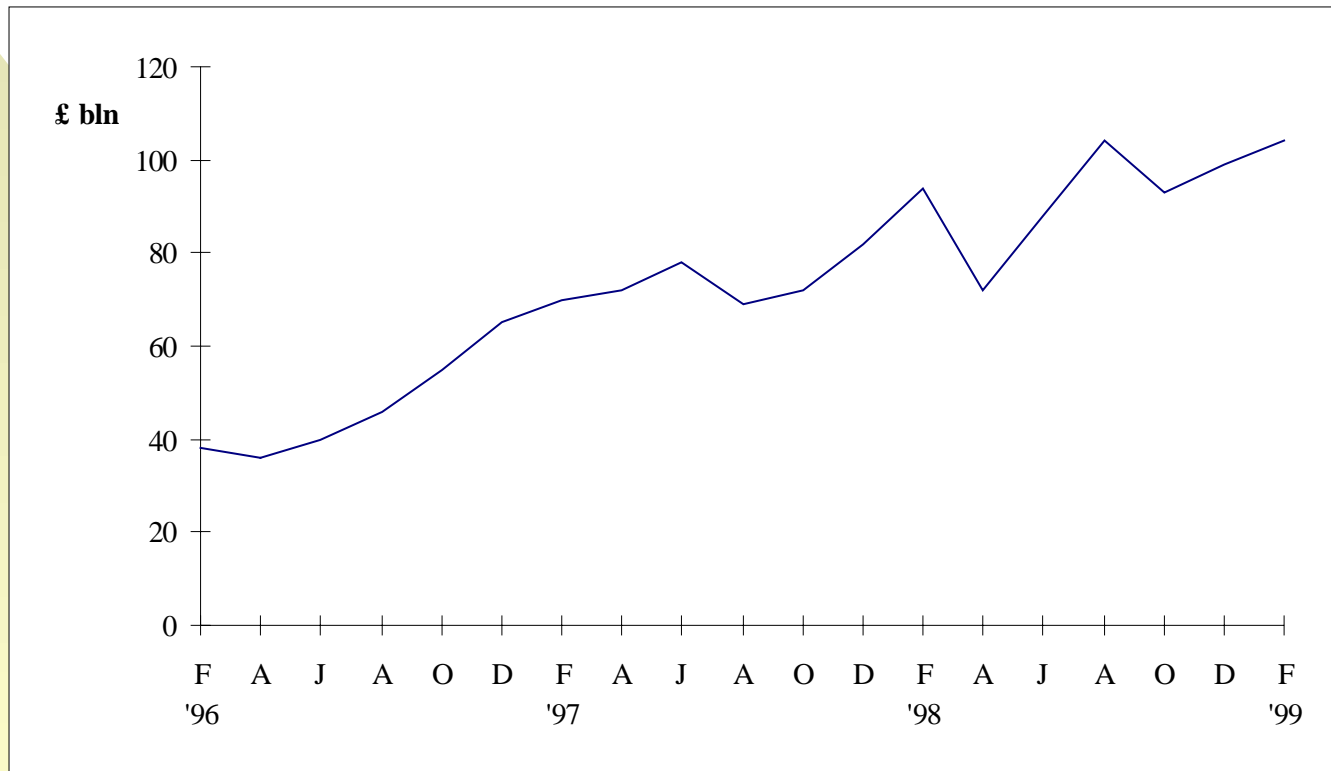
Further growth to £95 bln by Feb '97. Around £105 bln in Feb 2002



Source : Bank of England

Average turnover in gilt repo at November 1999 about £16 bln,
down from about £20 bln in May 1999

Repo growth (volume outstanding) Feb 96- Feb 99



Source: BoE

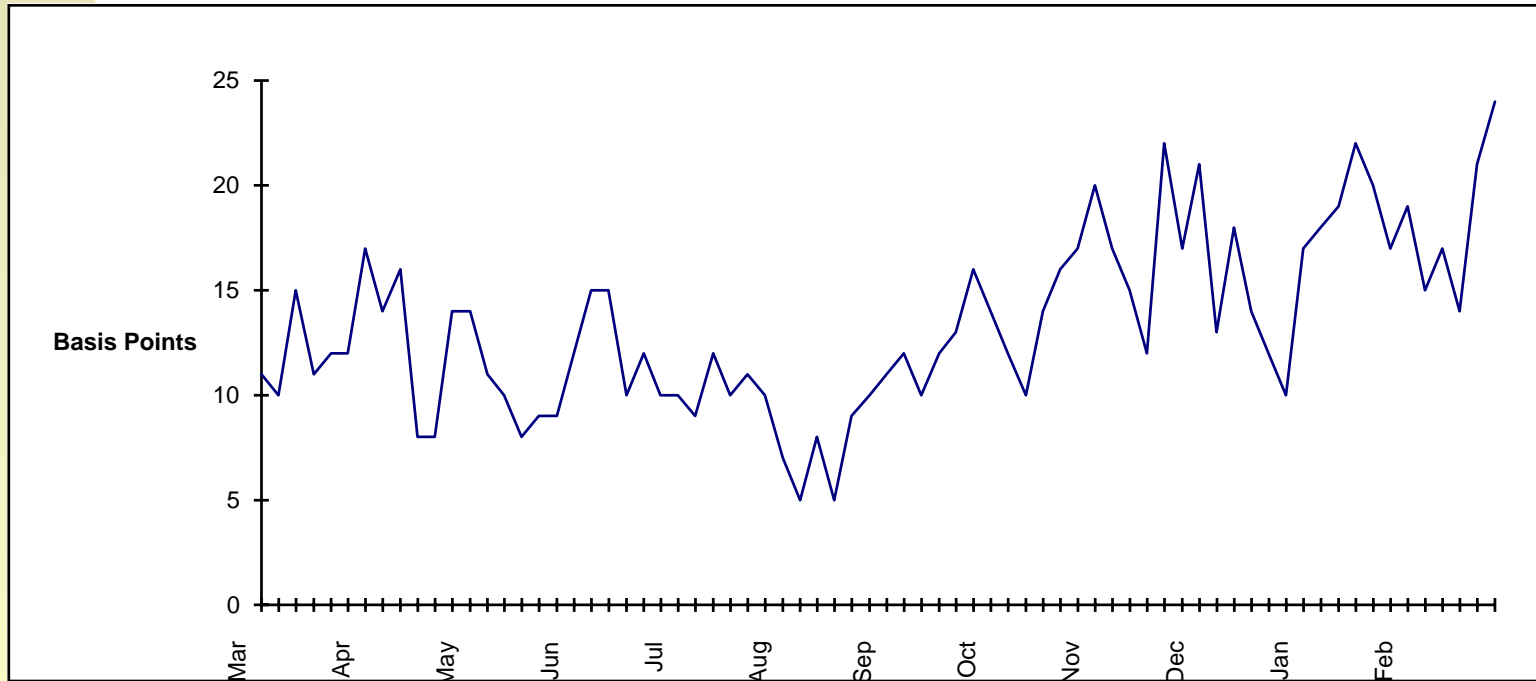
Gilt Repo and other sterling money markets

- Gilt repo has developed alongside growth in the existing unsecured money market.

Market participants estimate that gilt repo now accounts for about 50% of all overnight transactions in the sterling money markets

- The repo general collateral (GC) rate tends to trade below the interbank rate, on average about 10-15 bps, reflecting status as government credit
The following slide shows spread of 3m GC rates below the interbank rate
- Introduction of repo has led to reduction in volatility of overnight unsecured rates (BoE)

Three-Month Interbank rate minus Three-Month Gilt Repo GC Rate 1997/98



Middle rates at 10.15am

Source : Bank of England, Bloomberg, Reuters

Market Structure

■ Repo Market Making

Some firms have provided what is in effect a market making function in repo. Typical of these are former SEMBs and banks running large matched books

Around 20 firms quote two-way repo rates on request

Examples include Gerrard & King, Lazards, NatWest GFM and Cater Allen

■ Brokers

A number of sterling broking houses are active in repo. Counterparties require signed legal documentation in place, along with credit lines, before trading can take place

Brokerage usually 1 basis point of total nominal amount for GC, 2 bps for specific and special repo

Firms include Garban ICAP, Tullett & Tokyo Liberty, Tradition

Patterns of Trading

- **Maturities**

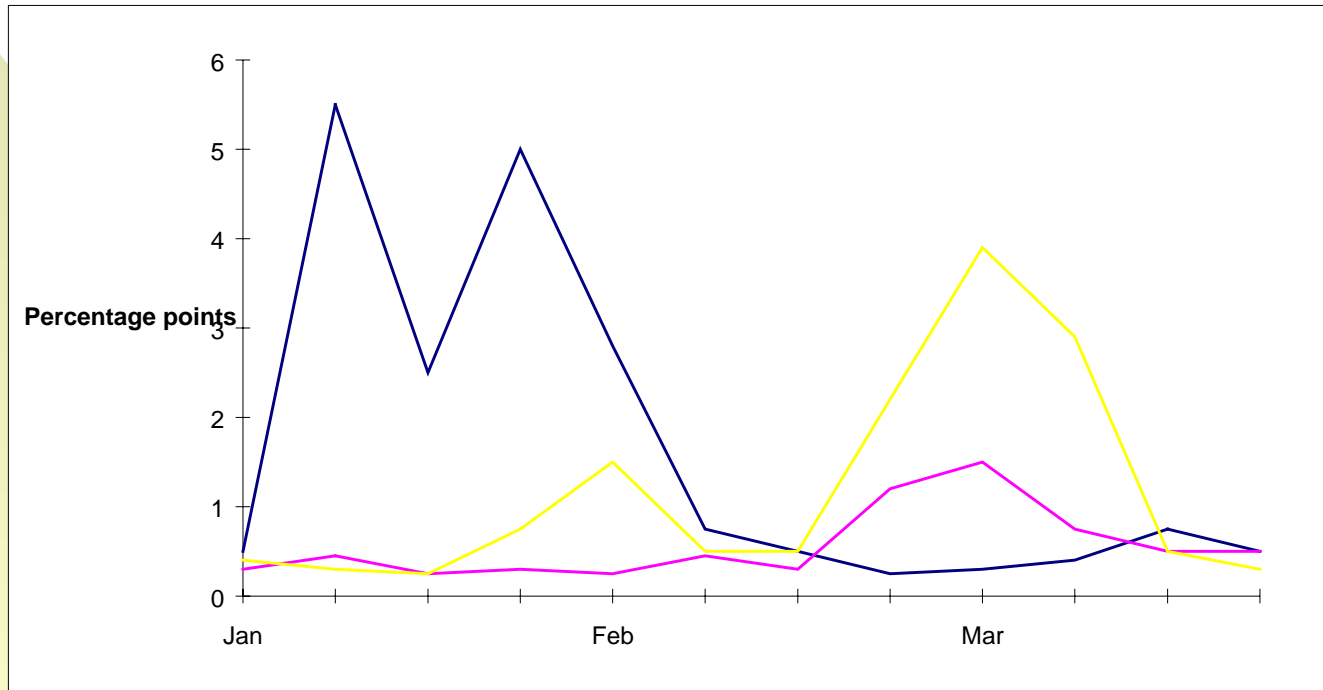
Activity is concentrated at the very short end of the yield curve, with around 90% of trading at overnight to 1w maturity (BoE)

Trades of up to 3m are common, 6m not unusual. Quote spread for up to 3m is usually around 5 bps for GC

- **Specials**

The chart on the next slide shows rates for some stocks that went special in early 1997 - over the last six months special rates have been lower; eg., 30bps through 1w GC for the 6H 03 recently

Selected Specials Rates 1997



Source : Bank of England

6 99, 7T 06, 7H 06

Negative rates for 6 99 start of 1998

Open Market Operations

- Gilt repo introduced into open market operations by BoE in April 1997
- Expanded list of eligible counterparties, providing they meet BoE requirements
- Maintain active presence in market
 - Participate regularly in Bank's operations
 - Provide useful information on market conditions and movements
- No formal underwriting commitment

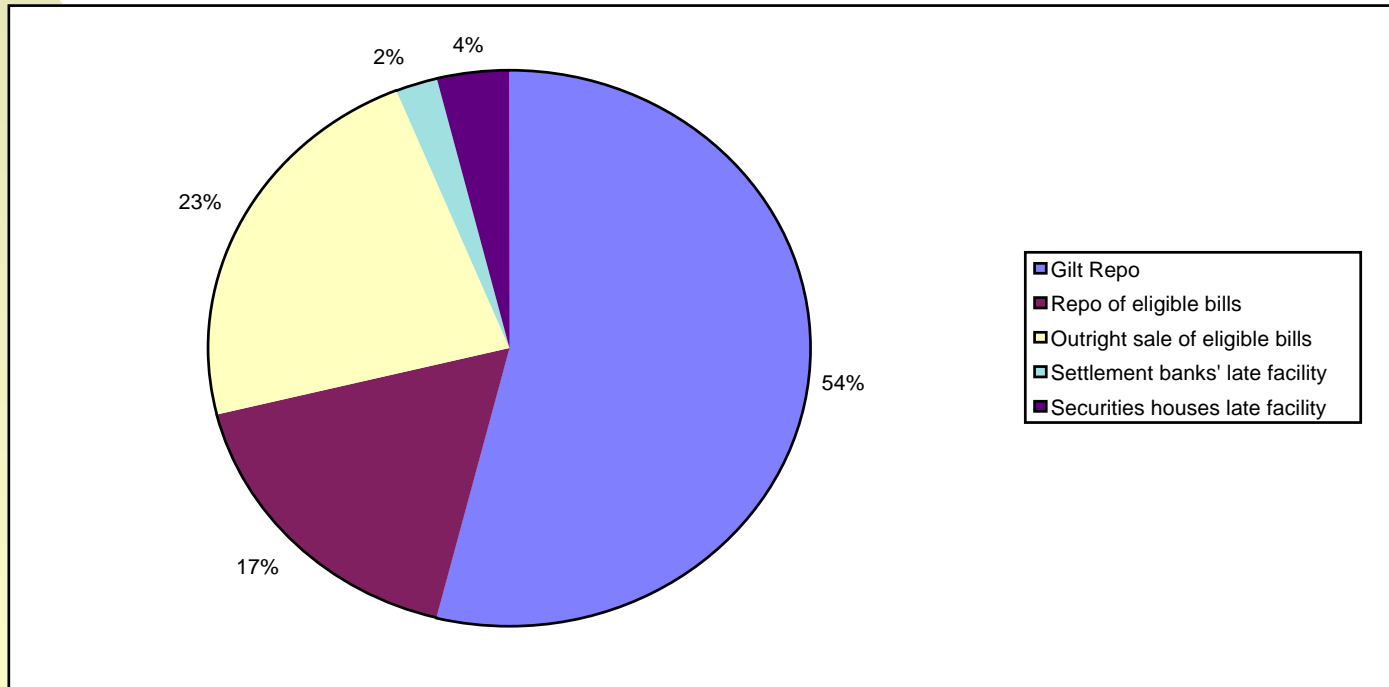
Open Market Operations (cont.)

- The chart on the next slide shows how the Bank of England's daily refinancing was provided for the period Sep - Dec 1999. About 70% was by repo of gilts and eligible bills

		£ millions
1997	Year	900
1998	Year	1200
1999	Year	1400
2000	Q1	1400
	Q2	2200
	Jul-Aug	1200

(Source:BoE)

Percentage shares, Sep-Dec 1999



Source : Bank of England

CREST/CGO

- Crest/CGO is the office running the settlement system for gilts (and certain other securities). Originally a BoE department, merged with Crest in July 2000
- Delivery by Value (DBV)

A mechanism whereby a CGO member may borrow from or lend funds to another CGO member against overnight gilt collateral

The CGO system automatically selects and delivers securities to a specified aggregate value on the basis of the previous night's CGO reference prices. Givers and takers of collateral can specify the classes of security included in the DBV

CREST / CGO (cont.)

- DBV Repo

A repo transaction in which the delivery of the securities is by the DBV mechanism in CGO

A series of DBV repos may be constructed to form an “open” or “term” repo

- Gilt Reference Prices (previously “CGO reference prices”) - supplied by DMO

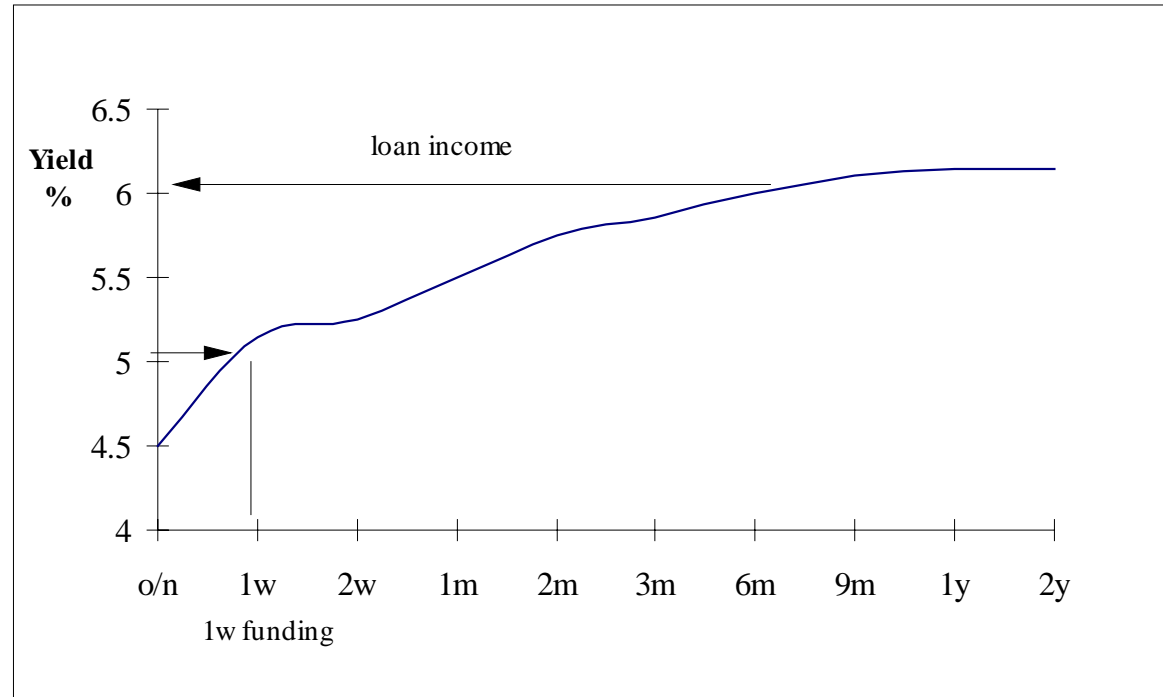
Daily prices of gilt and other securities held in CGO, used by CGO in processes including revaluing stock loan transactions, calculating total consideration and DBV assembly

Impact of Gilt Repo

- The ability of all market participants to short gilts and to take and finance or cover their desired positions has improved the efficiency and liquidity of the market, including:
 - Reduced range of cash gilt quote spread???? Ultra-long end not as liquid, MFR requirements etc**
 - Wider range of funding and money placement options**
 - Reduction in volatility of overnight interest rates**
 - Benefit to other sterling markets, such as sterling bond market (and hedging)**
- These developments help overseas investors to formulate a positive perception of the gilts market, helping increase the willingness of overseas and domestic investors to hold gilts

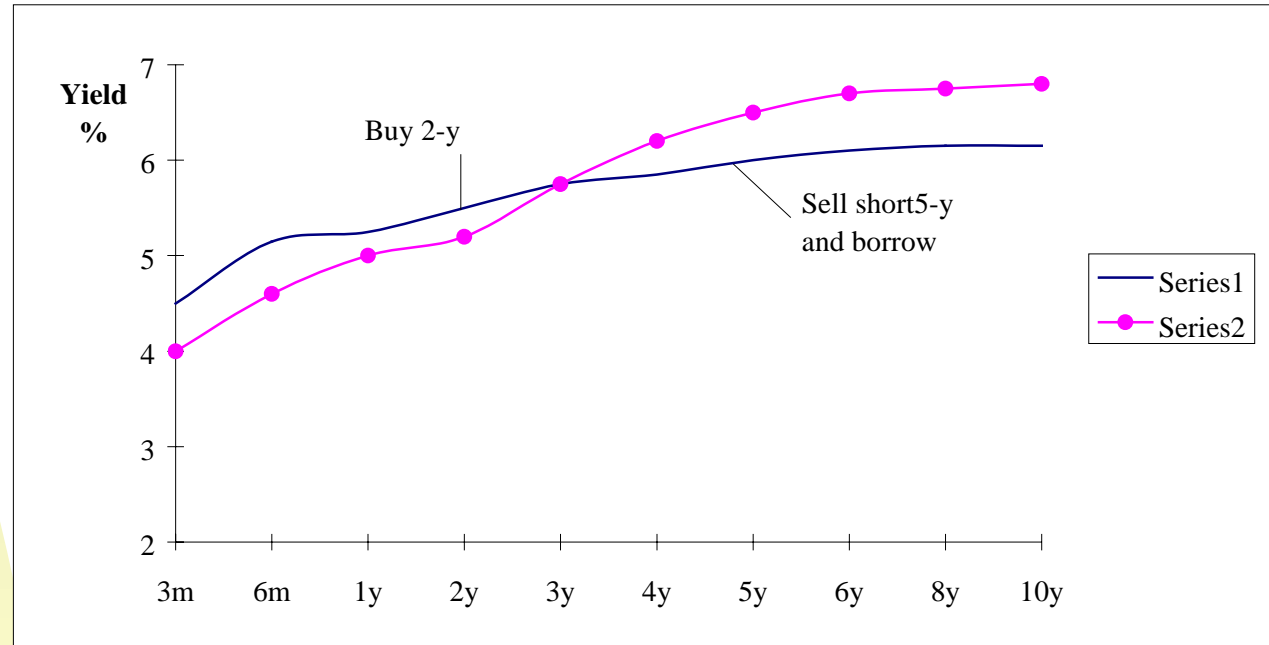
Trading and Hedging Strategies

Positive Yield Curve Environment



- Creating a “tail”, funding short
- Interest rate gap exposure
- Issues in inverted (negative) yield curve environment ?

Yield Curve Arbitrage



-- Expect yield curve steepening; spread trade 2-yr vs 5-yr

-- "series 1" is shape of curve at start of trade, "series 2" shape of curve at point profit taken and trade unwound

Credit Intermediation

- Government bond repo will usually trade lower than other money market instruments; this allows trading of spreads between markets of different credits.
- Examples
 - Repo dealer lends GC currently trading at Libor-25 and invests cash in CDs trading at Libor-12.5
 - Securities house borrows specific collateral in stock lending market, on-lends stock in repo; cash then lent in interbank at higher rate, eg., to buy CDs
 - Trading repo at GC, uses cash to reverse in emerging market collateral at spread of say, 400 bps higher

Matched Book Trading

- Principals with large volumes of repos and reverse repos are said to be running “matched books” - essentially market-making in repo
- Term “matched book” is a misnomer - books are deliberately mismatched; traders take positions according to their view of :
 - short term interest rates
 - anticipated supply and demand in underlying stock
- The examples of position gap and interest rate tails are matched book trades

Specials Trading

- A repo market allows demand for borrowing / lending stocks to be cleared by the price mechanism
- Reasons for stocks going “special” :
 - government bond auctions
 - outright short selling
 - hedging; bond underwriting
 - derivatives trading, such as basis trading
 - small size issues leading to low liquidity
 - buy-back or cancellation of debt
- Link between dearness in cash market and special status flows both ways

Specials Analysis

Relationship between cash prices and repo rates on specials :

- there is a positive correlation between changes in a stock trading expensive to the yield curve and changes in the degree to which it trades special.
- Theory predicts this : traders maintain short positions for paper with high funding costs only if the anticipated fall in the price of the bond is large enough to give a profit
(also implies longer duration stocks should be less expensive for a given specials premium, as prices are more sensitive to yield changes, so any rise in yield gives trader running a short position a higher profit to offset cost of repo)

Specials Analysis (cont.)

Explanation of cause and effect :

- when stock *perceived* as expensive, eg., after auction announcement; creates a greater demand for short positions, and hence greater demand for the paper in repo (to cover shorts)
- at other times stock might go tight in the market; tends to be bid higher in the *cash* market as traders closed out existing shorts (now too dear to run); at same time traders and investors try to buy the stock outright since it is now cheap to finance by repo-ing out

Specials Analysis (cont.)

- The link between dearness in the cash market and specialness in the repo market flows both ways, either preceding change in the other
- In both cases stock remains expensive until existing holders take profits by selling their stock or making it available for repo / lending
- Central bank may intervene (if a government bond)

Specials Analysis (cont.)

RBS Trust May 1999

Investec Bank Sep 2000

- Repo of gilt strips: these stocks are “special” on an almost permanent basis
- For example in stock loan market, 8% 2021 lent out on an open basis (no fixed term) at approx. 10bps. The 2021 principal strip lent out at 50-100bps!
- It is also rare to find repo in coupon strips - reflecting low demand for this type of paper at present

Repo Hedging Tools

- Futures strip : a forward interest rate gap hedged using a strip of interest rate futures, eg., the short sterling contract on LIFFE
- Forward Rate Agreements
Off-balance sheet instrument, priced off exchange-traded futures, can fix to match exact dates of interest rate gap
- Interest Rate Swaps

Electronic Repo Trading

Electronic repo trading

- “GiltKING” is a fully automated electronic trading system in gilt repo, introduced by King & Shaxson in September 1998.
- Live prices and size of bargain displayed on screen, which can be traded on touch of mouse button
- Garban ICAP and other brokers provide a more conventional screen broking service, displaying live prices; dealing still conducted over telephone

GiltKING live page

Overnight									
⁷ 62 17	⁷ 61 12	⁷ 60 50	GC	⁷ 60 121	⁷ 55 50	⁷ 52 20			
⁷ 60 50	⁷ 59 50	⁷ 57 50	DBV	⁷ 56 15	⁷ 50 97	⁷ 48 75			
		⁷ 52 45	6 99	⁷ 50 50					
			8 00	⁷ 45 76					
	⁷ 51 25	⁷ 49 30A	7 01	⁷ 46 25	⁷ 42 18				
			7 02	⁷ 47 60					
	⁷ 44 10	⁷ 41 15	8 03						
		⁷ 43 19	6H 03	⁷ 38 76					
	⁷ 45 25	⁷ 41 23	6T 04						
		⁷ 35 30	8H 05	⁷ 29 160	⁷ 27 80	⁷ 25 25			
⁷ 23 50		⁷ 21 20	7H 06	⁷ 11 30					
		⁷ 10 75	7Q 07						
8H 05									
		⁷ 35 30	ON	⁷ 29 160	⁷ 27 80	⁷ 25 25			
		⁷ 37 45	TN						
		⁷ 55 20	1W	⁷ 45 15					
		⁷ 45 20	1M						
			2M						
	⁷ 42 25	⁷ 37 20	3M	⁷ 35 20					
			6M						
			9M						
			1Y						

The Implied Repo Rate and Basis Trading

Basis Trading

- The simultaneous trading of cash bonds and the related bond futures contract, for which an open repo market is essential. Also known as *cash and carry* trading.
 - The definition of the long gilt contract on LIFFE calls for delivery of a gilt of notional 7% coupon and between 8.75 - 13 years maturity
 - The *conversion factor* for each bond is intended to compensate for coupon and timing differences of deliverable bonds
- The conversion factor gives the price of a bond such that its YTM on delivery day equals notional coupon

Bloomberg Screen - page DLV

Futures price: 114.55

	Price	Source	Yield	C.Factor	Gross Basis	Implied Repo %	Actual Repo %	Net Basis
							7.26	
UKT9 10/13/08	130.7188	BGN	5.035	1.1407155	0.05	6.64	7.26	0.131
UKT7 1/4 12/07/07	116.3750	BGN	4.988	1.0165266	-0.068	6.51	7.26	0.144
UKT8 09/25/09	125.4375	BGN	4.950	1.0750106	2.295	-4.86	7.26	2.474
UKT9 07/12/11	136.1563	BGN	5.095	1.1655465	2.643	-5.34	7.26	2.831
UKT6 1/4 11/25/10	110.7500	BGN	5.049	0.9400748	3.064	-11.38	7.26	3.362
UKT5 3/4 12/07/09	106.6250	BGN	4.966	0.9051249	2.943	-11.61	7.26	3.273

Cheapest-to-Deliver Bond

- As bonds trade at different levels, those in the delivery basket will not be equivalent at time of delivery; the bond that maximises the expression below will be the “cheapest to deliver” :
- $\text{Gross basis} = P_{\text{bond}} - (P_{\text{fut}} \times \text{CF})$
- Two measures of determining CTD, net basis and implied repo rate

Gross and Net Basis

- Basis trading arises from the difference between the current clean price of a bond and the clean price at which the bond is bought through the purchase of a futures contract; the difference between these two prices is the gross basis.
- Gross basis is essentially the difference between the running yield on the bond and the current repo (money market) rate.
- Net basis is gross basis adjusted for net carry; the actual coupon income and re-investment minus borrowing cost, which is at the security's actual repo (money market) rate. Bond with lowest net basis is CTD.
- A positive net basis represents the *loss* to a long cash / short futures position, and the expected profit for the short cash / long futures position.

Reverse cash-and-carry; real world trading

- Generally a cash-and-carry strategy will produce a negative result; bid-offer spreads will also erode any theoretical advantage.
- Does this mean the reverse cash-and-carry will produce a profit? In theory yes, trader earns repo rate on short sale proceeds, indicated when implied repo rate is lower than actual repo rate.
- However the short future initiates the delivery process, and chooses time of delivery and which bond.
- Finally, *basis risk* - the risk that price changes in one instrument are not matched exactly by changes in the other - can also produce negative results

The Implied Repo Rate

- IRR: annualised % difference between the dirty price of the CTD bond and the dirty price of the future
- Represents the profit (or loss) that could be locked in by buying the CTD bond and selling it forward (or by selling it short and buying it forward)
- If a profit, this should be offset by the cost of financing the CTD bond.
- If a loss, it should be offset by the return earned on the cash proceeds of the short sale.

Calculating the Implied Repo Rate

$$\text{IRR} = \frac{\text{Dirty futures price} - \text{Dirty cash price}}{\text{Dirty cash price}} \times \frac{365}{\text{Days to expiry}} \times 100$$

Dirty futures price = cash inflow

Dirty cash price = cash outflow

The rate implied by a cash-and-carry strategy is called the repo rate because it is equivalent to a repo agreement with the futures market.

Summary: Cash and Carry Strategy

- Buy the cash bond and sell it forward at the futures price (i.e. sell the futures) in the hope of making a profit
- A profit will be realised only if the capital gain earned by selling the bond forward at a higher price exceeds the cost of financing the bond, i.e. the actual repo rate.
- This will be the case when the implied repo rate is higher than the actual repo rate

Summary: Reverse Cash and Carry Strategy

- Buy the futures and simultaneously sell the underlying CTD bond
- Earn the actual repo rate on the proceeds from the sale of the cash bond
- Profit realised when the cash inflow from selling the bond and investing the proceeds is greater than the outflow from buying the bond forward (on settlement of the futures contract)
- Potential profit from such a trade is indicated when the implied repo rate is *lower* than the actual repo rate



Forward Rates

Zero-Coupon Rates

- Zero-coupon (or spot), par and forward rates are closely linked.
- The yield on a zero coupon bond can be viewed as true yield, as no reinvestment is involved and there are no interim cash flows vulnerable to change in rates
- Spot and forward rates can be derived from a conventional cash market curve, using the equation below for the spot rate r_s

$$FV = PV \times (1+r_s)^n$$

$$r_s = \sqrt[n]{FV/PV} - 1$$

Forward Rates Example

- Consider following spot yields

1 yr	10%
2 yr	12%
- Problem : Desk wants to lock in today the cost of borrowing 1-yr funds in 1 year's time
- Solution :
raise 1-yr funds @ 10% yield
Invest proceeds for 2 years @ 12%

Forward Rates

Breakeven principle: forward rates must be arbitrage-free, giving the same holding period return from fixed rate / reinvestment strategies

For example

[R is the forward rate starting 1 period from now]

[y_2 is the 2-period interest rate]

$$(1 + y_2)^2 = (1 + y_1) \cdot (1 + R)$$

$$R = \frac{(1 + y_2)^2}{(1 + y_1)} - 1$$

Forward Rates (example cont.)

- Breakeven calculation :

Total funding cost = Total Return on Investments

$$(1+0.12)^2 = (1+0.1) \times (1+R)$$

$$(1+R) = (1+0.12)^2 / (1+0.1)$$

$$(1+R) = 1.14036$$

$$r = 14.04\% \text{ [1yr fwd-fwd rate breakeven]}$$

- Benefits of positive carry are passed on to forward price

Implied Spot and Forward Rates

- Rates from a government bond yield curve describe risk-free rates of return *today*. They also *imply* risk-free rates of return for future time periods - *implied forward rates*
- Section 17.3 text book - constructing spot and forward yield curves
- Coupon, Zero and Forward rates are related.
- Example 17.3 text book - forward rate calculation for a money market maturity. Different formula due to no compounding

Forward rates in discrete time

$$P(t, T) = \frac{1}{r(t, T)^{(T-t)}}$$

$$r(t, T) = \left[\frac{1}{P(t, T)} \right]^{\frac{1}{(T-t)}}$$

Forward rate at time t for period $[T, T + 1]$ is $f(t, T)$

$$f(t, T) = \frac{P(t, T)}{P(t, T + 1)}$$

Bond price in terms of the forward rates

$$P(t, T) = \frac{1}{\prod_{j=t}^{T-1} f(t, j)}$$

The forward rate can also be defined in terms of the spot rate and in terms of spot rate discount factors.

Forward Rates : Exercise

A top-rated customer asks you to fix a yield at which he can issue a 2-year zero-coupon USD Eurobond in 3 years time. Currently zero-coupon cash rates derived from the Treasury yield curve are :

1 Yr	6.25%
2 Yr	6.75%
3 Yr	7.00%
4 Yr	7.125%
5 Yr	7.25%

Assuming no spreads in rate quotes (!), what is the break-even rate from which you can quote to the customer ?



Bloomberg Screens

Main repo screens

- **Use BSR for repo buy/sell back analysis**
Calculates forward price (or original) and settlement amounts, at selected haircut
- **Use screen RRRA for repo/reverse repo analysis**
Calculates rates, forward price, settlement and nominal for given investment
This is a later screen and often more useful!
- **Use screen YA for bond yield analysis**



Introduction to Repo Structures

Example repo structures

- Callable repo
- Total Return Swap

Callable Repo

- If lender of cash on a term fixed rate repo negotiates the right to terminate early, or take back a portion of the cash.
- Lender has an interest rate option
- Benefits if repo rates rise
- Can terminate repo, take back cash and reinvest at higher rates
- ‘Callable’ repo will therefore offer lower fixed rates than conventional repo

Total Return Swap

- Also known as Total Rate of Return Swap, economically identical to a repo; main difference is transaction typically governed by ISDA swap agreement
- This may alter way in which trade is reflected on balance sheet
- Transaction works as follows :
 - i) Institution sells security at market price
 - ii) Institution executes a swap transaction for a fixed term, exchanging the total return on the security for an agreed rate on the relevant cash amount
 - iii) On maturity of the swap, Institution repurchases security at the market price
- In theory, each leg can be executed separately with different parties; in reality trade is bundled together and so economically identical to a repo

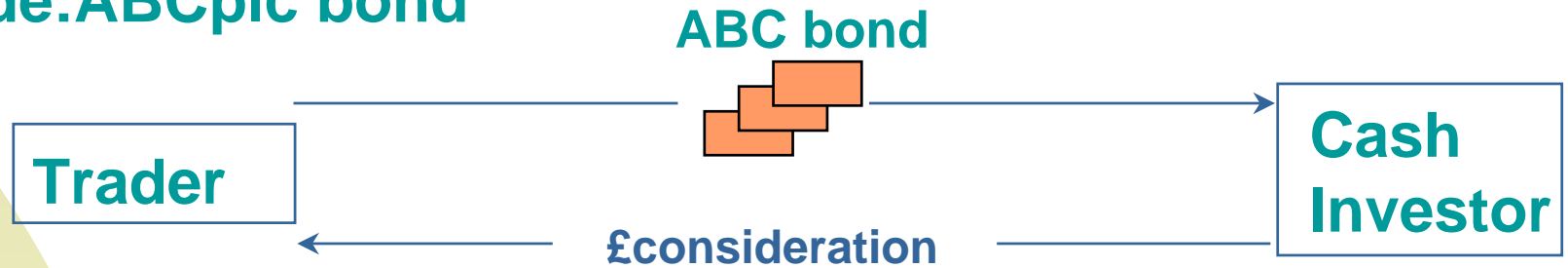
Total return swap (cont.)

- The bond trader will receive the “total return” on the bonds, which means that
 - if bond rises in value, trader pays the difference in value to the counterparty
 - if the bonds fall in value, the trader will receive the difference from the counterparty
- As part of the swap, trader pays Libor +/- swap on the cash proceeds
- The cash investor counterparty has full title and can sell securities in the open market at termination
- Dealer has no legal obligation to repurchase the bonds
- The trade will take bonds off dealer’s balance sheet, which may be desired if a year-end is approaching, for (say) credit rating analysis

Sale + Total Return Swap

Start of trade: ABC plc bond

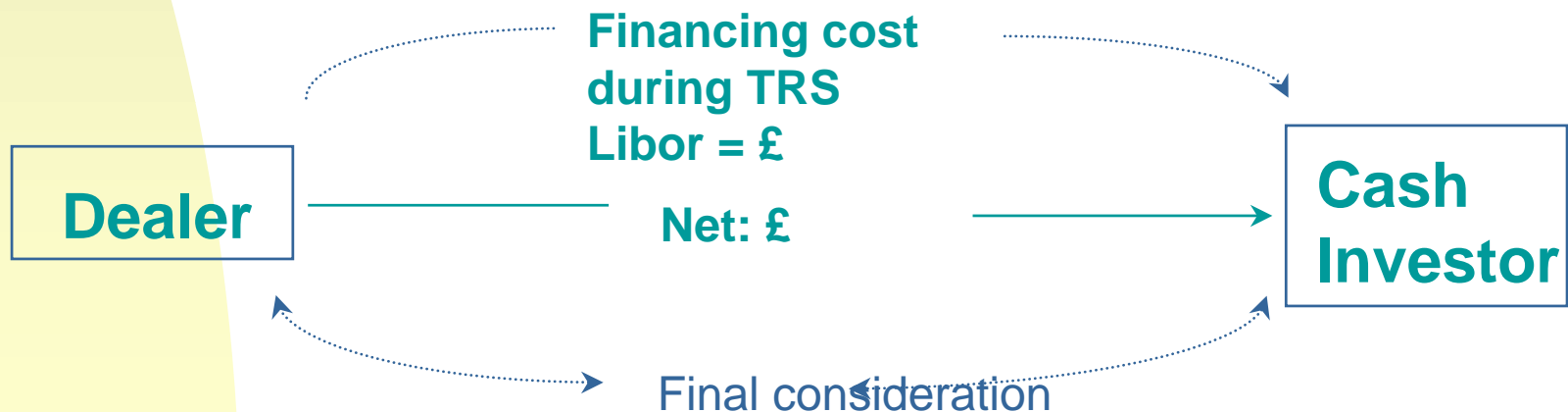
Sale of bonds...



Termination: rise in price

Settlement (unwind) of OTC swap agreement

Bonds bought back



Bond price appreciation, so trader pays difference

Total Return Swap (cont.)

- The TRS trade is common in equity repo, as a fixed term trade
- It is often used as a form of hedge, as well as for financing the underlying position
- Hedge transaction: pay Libor on funds received; on termination of the trade receive difference in market value if price has dropped
- This is “selling the swap”, opposite is buying the swap

Introduction to Equity Repo

Equity Repo

- Equity repo developed later than bond repo; logical development since repo is a collateralised loan and equity can be a type of collateral
- From early 1990's investment houses and market makers developed repo as a means of funding their equity books
- The main difference compared to bond repo is the uncertainty of cash flows of equity asset

Equity repo (cont.)

- Another issue is how corporate actions affect trades, eg, rights issue will affect sellers portfolio
- Dividends are paid net of withholding tax
- No standard documentation in place yet for equity repo - but the PSA/ISMA has recently been updated to also refer to net paying securities (previously only referred to gross paying securities and so could not be applied in context of equities)
- Equity prices display greater volatility and they are less liquid than government bonds, resulting in higher margins for repo

Equity repo (cont.)

For example:

**Banque Paribas
quoting a repo bid
rate, against which
they will take any
FTSE-100 security
(TCAM)**

- There is no equivalent of “GC” in equity repo, because usually a specific stock is specified
- However banks may quote a rate applicable to a certain class of equity, eg., FTSE-100 or CAC-40 stocks. This then becomes a de facto GC rate
- Trades are often done against collateral made up as a basket of stocks and not just one stock. If a stock falls out of the index basket (eg., replaced in FTSE-100 by another) there is a stock substitution and it is replaced by an acceptable security

Equity repo example

Assume no haircut,
and not dealt over a
dividend date

- 1 March: price of XYZ plc shares is £5.50. A repo trader sells 100,000 shares to cash investor, to repurchase in 30 days at the original price plus repo interest. Repo rate 6%.
- 31 March: price of XYZ plc shares now £7. Trader repurchases shares at original price of £550,000 plus repo interest of £2712.33.
- Shares have remained on trader's balance sheet; the rise in share price makes no difference to repo transaction cash flows. Had shares *fallen* in price, repo buyer could have asked for more shares (a margin call)



Emerging Market Repo

Emerging Market Repo

- As markets develop, increasing interest in capital markets, including repo
- Attraction of higher yields, just as yields are dropping in developed markets, brought on by eg., Fed performance, EMU convergence, low inflation
- Size of debt markets growing steadily, eg., \$100bln in Argentina, \$220 bln in Brazil, \$60 bln in Russia
- Volatility can be quite high, eg. 1998 bond markets correction

Emerging Market Repo

- Widening spreads reflect highly volatile markets and investor loss of confidence in emerging markets in 1998
- Higher level of risk :
 - Counterparty risk
 - Market risk, price volatility
 - Settlement risk (often domestic market)
 - Much higher margins required

To conclude

- Re-visit objectives
- Summarise: cash bond market, and repo market. Repo is a money market deposit and funding instrument
- Delegate assessment
- Follow-up queries :
moorad.choudhry@chase.com

