repo workshop
repo, bonds & derivatives
Manila, January 2018

Richard Comotto
ICMA Centre
University of Reading
United Kingdom
structure & operation of the repo market

topics
• role of repo
• repo & bonds
• repo & derivatives
role of repo

- **securities market liquidity** *(securities-driven repo)*
  - enhancing settlement efficiency --- covers accidental shorts; equilibrates temporary supply & demand imbalances; facilitates faster settlement times; prevents market squeezes
  - enabling market-making in secondary market --- efficiently finances trading inventory; covers short positions arising from deliveries without inventory
  - financing leveraged investors *(including traditional investors)* --- supports arbitrage & boosts market liquidity
  - covering short investors --- supports arbitrage; helps prevent asset bubbles
  - catalyzing price discovery --- repo rate key to discussing relative value through forward price; boosts secondary market liquidity; enables arbitrage of anomalies to produce consistent yield curve; integrates money & capital markets to produce continuous yield curve
  - hedging primary issuance
  - supporting corporate bond investors --- allows ‘spreading’ of corporate against government bonds
  - hedging & pricing derivatives
role of repo

- **liquidity management** *(cash-driven repo)*
  - *efficient source of liquidity* for intermediaries & investors --- mitigation of credit & liquidity risk produces cheaper funding; diversification of risk attracts lenders & produces deeper funding; allows temporary liquidation of longer-term assets without disrupting investment strategy; provides leverage to traditional & alternative investors; funds cross-border investment in bonds without currency risk
  - *resilient source of liquidity* for both intermediaries & investors --- mitigates liquidity risk through collateral re-use; reduced liquidity risk encourages term lending & roll-overs; reduced liquidity risk attracts diversity of lenders, which broadens market; means of temporarily liquidating longer-term investments with less market impact in crisis
  - *secure home for short-term investment* --- particularly for risk-averse uninsured investors with no central bank access; flexible tenors
role of repo

• central bank open market operations
  • secure & efficient market for intervention
  • source of benchmarks --- indicators of monetary & macro-prudential conditions; operational target for monetary policy

• collateral management
  • collateral transformation --- allows mobilisation, trading & pricing of collateral, including transformation into cash for CCP variation margins
systemic cash flows

- **short-term cash investors**
- **commercial banks**
- **repo dealers**
- **primary dealers & syndicates**
- **issuers**
- **long-term investors**
- **asset managers**
- **prime brokers**
- **leveraged investors**

**cash supply**

- funding management = borrowing cash
- risk management = covering short hedges or short risk positions
- market-making = quoting immediately-dealable prices in reasonable amount
- trading = buying and selling securities for profit
- primary distribution = selling new securities to investors

**collateral supply**

- liquidity management = lending cash
- yield enhancement = lending out special collateral
- portfolio management = investment in securities
- underwriting = buying from new issuers at a fixed price in order to sell to investors

- primary distribution
- risk management
- trading
- trading & portfolio management
- trading
- portfolio management
- liquidity management
- funding & liquidity management, yield enhancement
- risk & funding management
- risk, liquidity & funding management
- risk management

- non-bank treasuries, money market investors
- market-makers, other securities dealers
- primary distribution
- leveraged investors

- primary distribution
- risk & funding management
- risk & funding management
- risk & funding management
- risk & funding management
- risk & funding management
repo market cash flows

- Securities lending & borrowing
- Liquidity management
  - Non-bank financials (incl. MMMF)
  - Commercial banks
  - CCPs (treasury)
  - Derivatives dealers
- Tri-party agents
- Repo desk
- Prime brokers
- Beneficial owners, asset managers & agents
- Leveraged investors & proprietary traders
- Cash reinvestment agents
- Central bank
- Interdealer
- Market makers & primary dealers

Cash flows only

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repo & bonds

- market-making
- hedging new issuance
  - new issuance
  - auctions
  - forward markets
- efficient pricing of securities
  - cost of carry
  - forward price/yield
- enhancing securities settlement efficiency
- balancing bond market supply & demand
- collateral transformation
market-making

- market-makers are essential to secondary market liquidity
- market-maker provides immediately dealable quotes in minimum size, whether or not he has a matching customer or inventory
- by providing immediately dealable quotes, market-makers create liquidity --- which reduces risk to investors & cost to issuers
- but providing immediately dealable quotes exposes market-maker to market & funding liquidity risks --- repo allows market-maker to hedge intervals between buying & selling
market-making

repo dealer

benchmark security

purchase

cash

repurchase

cash

repo dealer

non-benchmark security

purchase

cash

repurchase

cash

benchmark security

non-benchmark security

purchase

cash

repurchase

cash

repo dealer

counter party 1

investor 1

purchase from customer

purchase to close reverse repo

eventual sale to another customer

borrowing benchmark bond
to short hedge non-benchmark bond

borrowing cash
to fund non-benchmark bond
market-making

- market-maker may not be able to lay off his customer deal immediately or may not wish to do so immediately because of price expectations
- repo of non-benchmark bond purchased from customers provides funding to market-maker for purchase
- reverse repo of benchmark bond (with similar maturity) allows market-maker to short hedge market risk
hedging new issuance

- securities dealers also need repo to hedge primary market issuance of non-government securities
- principles are same as for market-making
hedging new issuance

repo dealer ➔ repo dealer

repo dealer ➔ market maker ➔ repo dealer

repo dealer ➔ market maker ➔ repo dealer

counter party 1 ➔ issuer ➔ counter party 1

counter party 1 ➔ issuer ➔ counter party 1

borrowing benchmark bond to short hedge new issue
borrowing cash to fund new issue

purchase to close reverse repo

eventual sale to investor

purchase from issuer

short sale

benchmark security

cash ➔ cash ➔ cash ➔ cash

purchase ➔ repurchase ➔ purchase ➔ repurchase

new issue ➔ cash ➔ cash ➔ cash ➔ cash

new issue ➔ cash ➔ cash ➔ cash ➔ cash

benchmark security ➔ benchmark security ➔ benchmark security ➔ benchmark security

issuer ➔ market maker ➔ issuer ➔ market maker

investor ➔ counter party 2 ➔ investor ➔ counter party 2

counter party 2 ➔ investor ➔ counter party 2 ➔ investor

cash ➔ cash ➔ cash ➔ cash

cash ➔ cash ➔ cash ➔ cash

cash ➔ cash ➔ cash ➔ cash
hedging new issuance

- market-makers need repo to offer forward (grey) market to investors ahead of an auction of government securities
- forward market:
  - allows investors to reduce risk by fixing price of purchase & ensuring access to new issue
  - spreads supply & demand away from auction day
  - provides information to help pricing at auction
hedging new issuance

fund long position in benchmark bond with repo to auction: on auction day, bid for new bond to deliver to investor & sell off benchmark bond

hedge with existing benchmark bond of similar maturity

sell future new bond to investor

WI/grey/forward market
efficient pricing of securities

- efficient pricing of bonds depends on an accurate & smooth yield curve
- an accurate & smooth yield curve depends on the ability of dealers to buy up cheap bonds & sell off expensive bonds — this requires repo
efficient pricing of securities
efficient pricing of securities

• should we buy the cheap bond?
• should we sell the expensive bond?
• is there real relative value?
efficient pricing of securities

• should we buy the cheap bond?
• what is cost of running the long position?
• cost of long position --- pay repo, earn coupon
• if coupon < repo, pay negative carry
• dealers reluctant to take long positions
• is this why bond is cheap?
efficient pricing of securities

if we add in cost of repo funding, will the value of this ‘cheap’ bond rise & its yield fall into line with equivalent adjusted value of comparables?

if it does, then there is no relative value!
efficient pricing of securities

• should we sell the expensive bond?
• what is cost of running the short position?
• cost of short position --- earn repo, pay coupon
• if coupon > repo, pay positive carry
• dealers reluctant to take short positions
• is this why bond is expensive?
if we add in cost of repo funding, will the value of this ‘expensive’ bond fall & its yield rise into line with the equivalent adjusted value of comparables?

if it does, then there is no relative value!

efficient pricing of securities
efficient pricing of securities

- build cost of carry into price/yield of bond
- calculate the forward (break-even) price/yield
efficient pricing of securities

assume no change in clean price
positive carry will generate overall profit
holder can afford to sell at loss = carry

current clean price

profit

loss

buy holding period sell

offsetting price fall = carry
forward (break-even) price

positive carry
efficient pricing of securities

forward price = current clean price - cost of carry

profit

current clean price

loss

buy holding period sell

positive carry

offsetting price fall = carry

forward (break-even) price
efficient pricing of securities

buy EUR25 million nominal 4.5% 04/07/09
price 94.55, yield 5.28956%
83 days accrued interest
fund with repo for 30 days at 4.25%

what is forward price/yield in one month?
efficient pricing of securities

buy 25 million nominal 4.5% 04/07/2019
price 94.55, yield 5.28956%
83 days accrued interest (market value = 23,893,322)
fund with repo for 30 days at 4.25%

in 1 month:

accrued interest = \( \frac{25,000,000 \times 4.5 \times 30}{100 \times 365} = 92,466 \)

repo interest = \( \frac{23,893,322 \times 4.25 \times 30}{100 \times 360} = 84,622 \)

carry = 92,466 - 84,622 = 7,844

break-even value = 23,637,500 - 7,844 = 23,629,656

forward price = \( \frac{23,629,656}{25,000,000} \times 100 = 94.518626 \)

forward yield = 5.300% (+1bp)
efficient pricing of securities

long 3-year bond position at 94.55/5.29%

forward $2^{11/12}$-year bond position at 94.52/5.30%

repo 4.25%
efficient pricing of securities

**COST OF CARRY ANALYSIS**

<table>
<thead>
<tr>
<th>Settlement Date</th>
<th>9/25/00</th>
<th>Fix (1=Price or 2=Yield)</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>94.5500000</td>
<td>Accrued Interest</td>
<td>1.0233</td>
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<tr>
<td>Yield</td>
<td>5.28956</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workout Date</td>
<td>7/4/09</td>
<td>-Value</td>
<td>100,000</td>
</tr>
<tr>
<td>Choose:</td>
<td>Business or Calendar Days</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COST OF CARRY**

<table>
<thead>
<tr>
<th>Repo Rate</th>
<th>4.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repo</td>
<td>B.P.</td>
</tr>
<tr>
<td>Termination Date</td>
<td>Equiv Spread</td>
</tr>
<tr>
<td>Next Day (9/26/00)</td>
<td>5.084 83.4 0.0022</td>
</tr>
<tr>
<td>30 Days (10/25/00)</td>
<td>5.095 84.5 0.0673</td>
</tr>
</tbody>
</table>

**BOND BORROW**

<table>
<thead>
<tr>
<th>1 = Regular</th>
<th>2 = FED.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Termination Date</td>
<td>B.P. Price Net P &amp; L For Breakeven</td>
</tr>
<tr>
<td>Next Day (9/26/00)</td>
<td>Spread Pick Up 1000 (M)Face Price / Yield</td>
</tr>
<tr>
<td>30 Days (10/25/00)</td>
<td>150.0 -0.0040 -39.82 94.555151/5.28896</td>
</tr>
<tr>
<td>150.0 -0.1195 -1194.67 94.705359/5.27147</td>
<td></td>
</tr>
</tbody>
</table>

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efficient pricing of securities

- but cost of carry based on coupon ignores pull-to-par
- pull-to-par means a bond price will converge to par by maturity
- discount bonds will make capital gains --- increasing carry
- premium bonds will make capital losses --- decreasing carry
- pull-to-par capital gains/losses need to be factored into carry when estimating forward break-even price/yield
- pull-to-par is measured by coupon-YTM differential over holding period (YTM converges to coupon by maturity)
- to adjust carry & forward break-even price for pull-to-par, replace coupon with YTM

\[ \text{carry} = \text{YTM} - \text{repo rate} \]

\[ \text{carry} = 5.28956\% \ (A/A) - 4.25\% \ (A/360) \]
\[ = 5.28956\% \ (A/A) - 4.309\% \ (A/A) = 0.9805\% \]
enhancing securities settlement efficiency

• market-makers & other securities dealers can fail on onward deliveries if inward deliveries are late, often because of lack of supply
• repo market provides temporary supply of securities to borrow in order to fulfil delivery commitments
• securities markets without parallel repo market suffer from lower settlement efficiency --- risk to investors increases the cost of issuance
balancing bond market supply & demand

- excess demand or supply will cause price to jump --- such volatility will increase risk to investors & cost of issuance
- if supply cannot meet demand for a bond, dealers will try to borrow that bond, which will go on special in the repo market --- offer of cheap cash (yield enhancement) will encourage more investors to lend the bond
collateral transformation

- growing demand for collateralisation of financial transactions & use of central counterparties (CCP)
- growing demand for HQLA
- different counterparties require different types of collateral: repo allows collateral-providers to exchange collateral in supply for collateral in demand
- collateral transformation usually involves repoing out asset & reversing in another --- often called a collateral swap or collateral upgrade/downgrade trade
repo & interest rate swaps

Swap dealers typically seek to hedge an IRS position with an opposite IRS position.

\[
\text{swap rate} = \text{government bond yield} + \text{swap spread}
\]

\[
6\text{-mo LIBOR}
\]

hedge funded with repo

interest rate swap
But if an opposite IRS was not immediately available, classic temporary hedge (warehouse) for long IRS position (paying fixed) was long government bond financed by repo.

\[
\text{swap rate} = \text{government bond yield} + \text{swap spread}
\]

\[
\text{IRS1} \quad \text{6-mo LIBOR}
\]
As soon as an opposite IRS became available, bond is sold & repo closed out.

**repo & interest rate swaps**

- **government bond yield**
- **IRS2**
- **ON repo rate**
- **swap dealer**
- **swap rate = government bond yield + swap spread**
- **IRS1**
- **6-mo LIBOR**
repo & interest rate swaps

If swap rate had fallen because of lower government bond yield, IRS positions would suffer an income loss. However, warehouse bond would be sold off for offsetting capital gain.

\[
\text{swap rate (3.5\%) = government bond yield (2.9\%) + swap spread (0.6\%)}
\]

\[
\text{swap rate (3.6\%) = government bond yield (3.0\%) + swap spread (0.6\%)}
\]
repo & interest rate swaps

- Swap curve
- Government bond curve

Percentage levels:
- 3.6%
- 3.5%
- 3.0%
- 2.9%

Delta change: 0.6%
But if fall in swap rate was due to narrower swap spread and government bond yield had not fallen, there would be no capital gain on warehouse bond to offset income loss on IRS positions.

This **swap spread risk** is problem for hedgers but can be used to anticipate changes in the swap spread, which is driven by bank credit & liquidity risk --- **swap spread trading**
repo & interest rate swaps

3.6%
3.5%
3.0%

0.5%

swap curve
government bond curve
repo & interest rate swaps

Classic warehouse provides no-arbitrage pricing model for IRS --- NPV(swap spread) = NPV(expected LIBOR-repo spread).

No-arbitrage pricing model demonstrates links between IRS, cash bonds & repo.
repo & interest rate swaps

What happens to swap rate if government bond goes special?

\[
\text{swap rate} = \text{government bond yield} + \text{swap spread}
\]

\[
\text{profit} = \text{expected LIBOR-repo spread}
\]

\[
\text{loss} = \text{swap spread}
\]
What happens to swap rate if government bond goes special?

1. repo rate falls below GC.
2. expected profit on floating side increases, ie NPV (expected LIBOR-repo spread) increases.
3. loss on fixed side has to be increased, ie dealer increases NPV (swap spread) by increasing swap spread (S)!
repo & interest rate rate swaps

- Schatz benchmark swap spread (lhs)
- RFR German repo rate (rhs)
And happens to swap rate if money market yield curve steepens?

1. 6-mo LIBOR rises relative to ON repo rate, so expected profit on floating side increases, ie NPV (expected LIBOR-repo spread) increases

2. Loss on fixed side has to be increased, ie dealer increases NPV (swap spread) by increasing swap spread (S)!

profit = expected LIBOR-repo spread
repo & interest rate swaps

Schatz benchmark swap spread (lhs)
2nd/6th Euribor contract slope (rhs)