The EURIBOR future will change in value by €25 for every basis point change in the forward rate. From Chapter 4, the Bund that was cheapest to deliver (the 3.75% of January 2019) had a DV01 of 8.03 (per 10,000 nominal). This DV01 is divided by the Bund's conversion factor (0.852328) to return an adjusted DV01 value of 9.421256 (8.03/0.852328). Since the Bund future has a notional contract size of €100,000, this DV01 figure would equate to a monetary value of €94.21. Hence the number of EURIBOR futures per Bund future is 3.77 (€94.21/€25); since the EURIBOR future has a lower DV01, the trader should execute a greater number of these relative to the Bund futures. So, if we assume that the trader buys 100 June Bund futures, he should sell 377 EURIBOR futures to ensure the position is DV01 neutral.

Suppose that 1 week later the curve has flattened as expected and short-term rates have risen relative to long-term rates. The new prices observed in the market are:

June EURIBOR future	99.51
June Bund future	120.88

The profit and loss on the position are therefore:

$$\text{Profit on EURIBOR future is 377 contracts} \times \text{24 basis points} \times €25 = €226{,}200$$

$$\text{Loss on Bund future is 100 contracts} \times \text{60 ticks} \times €10 = €60{,}000$$

$$\text{Overall profit on the transaction is therefore } €166{,}200$$

6.3.2 Fed Funds futures vs. interest rate swaps

In the last example, the trader was taking a view between short-term interbank futures and long-term government rates. In a similar vein, a trader could take a view between short-term government rates and long-term interbank rates. One way of expressing this particular view would be to execute a DV01-neutral trade between US Fed Fund futures and a forward-starting interest rate swap with an effective date to match the maturity of the futures. For example, if the trader believed that the curve would steepen, resulting in an increase in the yield spread between the two instruments, then they should pay fixed on the forward-starting swap and buy the short-dated futures contract.

6.3.3 Bonds and swaps

In this section we illustrate how views on expected yield curve movements could be expressed using bonds. Steepening trades can also be constructed using interest rate swaps and an example of this is shown in Section 3.5.3.

We start with a single transaction and then gradually increase the complexity. We make a number of simplifying assumptions for ease of illustration:

- Investment horizon = 92 days.
- All of the bonds will pay coupons annually, and we will assume that the current settlement date is also a coupon payment date so there is no accrued interest.
- All of the bonds are currently trading at par.

- The bond day basis will be actual/actual.
- A money-market day basis of actual/360.
- 3-month (92-day) repo rate is 0.25%.

We will analyse each transaction in terms of:

- Sources of profitability.
- Carry.
- Roll down.

5-year "bullet" trade

In this transaction the trader buys €10m of the 5-year bond and finances it for 92 days in the repo market. The details of the bond are:

- Price = 100.00
- Coupon and yield = 2.77%
- DV01 = 0.046099

The first step is to calculate the carry on the position.

Coupon income

$$€10{,}000{,}000 \times 2.77\% \times 92/365 = +€69{,}819$$

Repo expense

$$€10{,}000{,}000 \times 0.25\% \times 92/360 = -€6{,}389$$

Over the 3-month horizon the position carries positively to the tune of €63,430. We could use this information to calculate the 3-month forward price of the bond, which would allow us to calculate the breakeven on the position. Since the position carries positively, this acts as a buffer against a potential fall in price/rise in yield. As a result, we can derive the forward breakeven price as the spot price less this positive carry element:

$$€10{,}000{,}000 - €63{,}430 = 9{,}936{,}570 \text{ or } 99.3657$$

This price implies a yield to maturity (for settlement in 3 months' time) of 2.91%, a difference of 14 basis points from the current yield. So, if the trader were able to sell the bond in 3 months' time at 99.3657, then his overall profitability on the transaction would be zero. From this it follows that he will make a loss at any yield greater than 2.91% or any price less than 99.3657. As a result, this strategy (sometimes referred to as "riding the curve") is based on the trader's view of how yields will actually evolve relative to the implied forward yield of 2.91%.

Sadr (2009) points out that carry on a bond position can be expressed in either price or yield terms. Price carry is:

$$\text{Spot clean price} - \text{forward clean price}$$

Yield carry is:

$$\text{Forward yield} - \text{spot yield}$$

"*If the yield carry is positive, then one can buy the bond spot, finance it in repo to the forward date, and as long as its actual yield on the forward date is lower than the forward yield, one can close out the position by selling the bond for a net profit.*"

He also presents a very useful shortcut method of estimating the approximate yield carry:

$$\left(\text{Spot yield} - \text{repo rate} \times \frac{365}{360}\right) \times \frac{\Delta T}{\text{DV01} - \Delta T}$$

where ΔT is defined as the length of the holding period in years. In his text, Sadr grosses up the DV01 by a factor of 100, which is common practice in the market. So if we were to apply this formula to our previous example, the yield carry approximation is:

$$\left(2.77\% - 0.25\% \times \frac{365}{360}\right) \times \frac{0.25}{4.6099 - 0.25} = 0.1443\%$$

which is close to our earlier calculation of 14 basis points.

To calculate the 3-month roll down on the position, the bond is repriced using the current yield of bonds with a residual maturity of 4.75 years. Let us assume that the 4-year rate is 2.35%, which is 42 basis points lower than the 5-year rate. From this we will assume that bonds with a maturity of 4.75 years are currently trading about 10.5 basis points (42 bp/4) below the 5-year rate. If we were to price this bond with a residual maturity of 4.75 years at a yield of 2.665%, we would derive a price of 100.455674. This would mean that the holder of the bond would now enjoy a roll-down profit of €45,567.

As a result, we can see that the position carries positively and also enjoys positive roll down.

2s10s Steepening trade

As the name suggests, this transaction is designed to profit from a steepening of the yield curve and is constructed as a combination of long and short positions in different maturities. By convention, the trade is also constructed to be duration neutral in order to protect the investor against parallel yield curve movements. The nominal positions of each bond are selected according to the ratio of the bonds' DV01s. The shorter-dated bond will have a lower DV01, so the position will be larger in nominal terms than the longer-dated bond.

Long position in 2-year bond

- Price = 100.00
- Coupon and yield = 1.2%
- DV01 = 0.019646
- Nominal = €10 m

Short position in 10-year bond

- Price = 100.00
- Coupon and yield = 3.85%
- DV01 = 0.081718
- Nominal = €2.4m

The nominal amount of the 10-year position has been rounded, since it may be difficult for a trader to execute a deal in an "odd size" in the market.

As a result, both positions have about the same DV01 exposure:

$$\frac{10{,}000{,}000}{100} \times 0.019646 = €1{,}965$$

$$\frac{2{,}400{,}000}{100} \times 0.081718 = €1{,}961$$

As before, the first step is to calculate the carry on the entire position.

2-year position
Coupon income

$$€10\,\text{m} \times 1.2\% \times 92/365 = +€30{,}247$$

Repo expense

$$€10\,\text{m} \times 0.25\% \times 92/360 = -€6{,}389$$

Net carry on 2-year is $+€23{,}858$

10-year position
Coupon expense

$$€2{,}400{,}000 \times 3.85\% \times 92/365 = -€23{,}290$$

Repo income

$$€2{,}400{,}000 \times 0.25\% \times 92/360 = +€1{,}533$$

Net carry on 10-year is $-€21{,}757$

The combined position carries positively over the 3-month period to a total value of $+€2{,}101$.

Since the yield curve is upward sloping, the roll down on the position can be calculated by revaluing the instruments at lower yields and shorter residual maturities.

If 1-year yields are 0.55% and 2-year yields 1.20%, then again we will assume that over the course of 12 months the 2-year position would roll down by a total of 0.65%. Therefore, over a quarter of a year we may roughly expect the roll down to be about 0.16%. As a result, we can recalculate the price of the bond with a maturity of 1.75 years and a yield that was 0.16% lower (i.e., 1.04%). This returns a bond price of 100.274557, so the long 2-year position shows a profit of $+€27{,}455$.

At the 10-year maturity the curve is not as steep and so following a similar procedure as before, we assume a roll down of 0.035%. As a result, the price of a 9.75-year bond at a yield of 3.815% is 100.266987. Having shorted €2.4m at a price of 100.00, the new higher price of the bond generates a loss of €6,408. The roll down on the combined position is therefore $+€21{,}047$.

As a result, we can say this position enjoys both positive carry and roll down. If the curve moves in a parallel fashion the profit on the one side of the trade equals the loss on the other, as both legs possess the same DV01; the overall profit is therefore zero. However, the trade will make a profit if the yield curve steepens irrespective of whether overall rates rise or fall. If the curve steepens while rates increase, the loss on the 2-year position is less than the profit on the 10-year position, since both bonds have about the same DV01.

Therefore, the net profit will be approximately €1,963 for every basis point of steepening. If the curve were to steepen while rates decrease, then the profit on the 2-year position will be more than the loss on the 10-year, since both sides have the same DV01. Again, the net profit will be approximately €1,963 for every basis point of steepening. If the curve were to flatten, the trade would make a loss.

It is also worth mentioning that the market will often express roll down and carry in terms of basis points with respect to the cash-equivalent value of the DV01. This is useful when the nominal amounts are different but the risk in DV01 terms is the same. So, if a trader expected a position to display a total of 15 basis points of roll down and carry and had constructed the steepener with a risk of €100,000 per basis point, this would equate to a roll down and carry of €1,500,000.

A flattening trade can be constructed using the same principles, with the position showing a profit if the curve were to flatten.

6.3.4 Conditional curve trades

An unconditional curve trade involves the use of swaps to express views on the evolution of the yield curve slope. If swaptions are used for the same purpose, the trades are referred to as conditional curve trades.

Before we consider how these trades are constructed, let us consider some of the conventions of quoting swaptions. Generally speaking, swaptions can be quoted as:

- Percentage ("lognormal") volatility.
- Normalized volatility (i.e., underlying yield multiplied by lognormal volatility).
- Basis points upfront.
- Cash amount upfront.

A snapshot of USD lognormal volatilities is shown in Figure 6.2.

The matrix highlights two different trading opportunities. Reading down each column shows there is a term structure of option volatility. As with any term structure, transactions could be constructed to express views on its expected evolution. Reading along each line

	3m	6m	1y	2y	3y	4y	5y	6y	7y	8y	9y	10y	15y	20y	25y	30y
1m	88.5	96.4	100.2	75.3	72.6	57.8	51.3	43.4	37.3	34.3	31.9	29.8	25.0	23.6	22.9	22.4
3m	70.3	77.4	74.9	68.5	66.5	54.0	48.7	42.1	37.1	34.5	32.3	30.5	25.9	24.4	23.8	23.3
6m	80.1	87.8	81.0	72.7	64.7	52.8	47.5	41.6	37.1	34.6	32.6	30.9	26.3	24.8	24.2	23.7
12m	96.0	97.0	83.4	67.9	55.8	46.5	41.9	37.9	34.7	33.0	31.5	30.2	26.3	24.9	24.4	24.0
2y	74.5	69.9	62.3	50.1	41.9	37.2	34.3	32.3	30.5	29.4	28.4	27.5	24.6	23.5	23.2	22.8
3y	47.5	44.8	40.9	36.3	32.9	30.7	29.3	28.2	27.2	26.6	26.1	25.5	23.3	22.5	22.2	22.0
4y	34.8	33.6	31.4	29.5	27.9	26.9	26.1	25.4	24.9	24.5	24.1	23.8	21.9	21.3	21.1	20.9
5y	29.9	29.1	27.6	26.3	25.4	24.8	24.3	23.9	23.4	23.1	22.9	22.6	20.9	20.4	20.2	20.0
7y	24.7	24.2	23.4	22.8	22.4	22.1	21.8	21.6	21.3	21.2	21.1	21.0	19.6	19.2	19.1	19.0
10y	21.3	21.0	20.6	20.1	19.8	19.6	19.5	19.5	19.4	19.4	19.3	19.3	18.0	17.5	17.6	17.6
15y	19.2	19.0	18.5	18.1	18.1	18.0	17.9	17.9	17.9	17.9	17.8	17.8	16.6	16.2	16.4	16.5
20y	18.0	17.8	17.5	16.9	16.7	16.6	16.5	16.5	16.5	16.5	16.6	16.6	15.6	15.5	15.7	15.9
25y	18.0	17.8	17.5	16.8	16.6	16.5	16.5	16.6	16.6	16.7	16.8	16.9	16.3	16.4	16.6	16.7
30y	18.1	17.9	17.4	16.6	16.5	16.5	16.5	16.6	16.8	17.0	17.2	17.3	17.1	17.2	17.3	17.4

Figure 6.2 Lognormal volatilities for USD swaptions. Option maturities are read horizontally, swap tenors are read vertically, so the implied volatility of a 1-year option into a 5-year swap is 37.4%. *Source:* Barclays Capital Live. Reproduced with permission.