

## **Basis Concepts**

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### **Exhibit 2.1**

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#### **Basis Concepts**

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- **Definition**

- **What drives the basis?**

  - Carry (coupon income, RP expense)

  - Strategic delivery options

  - Option-adjusted basis

- **Fair value of a futures contract**

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## Basis Concepts

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### Exhibit 2.2

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#### Basis Definition

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$$\text{Basis} = \text{Spot Price} - (\text{Conversion Factor} \times \text{Futures Price})$$

Example: 8-3/4s of 5/15/17 on 3/8/95

Spot price = 110-03/32nds (110.09375)

Futures price = 102-01/32nds (102.03125)

Conversion factor = 1.0771

Basis = 110.09375 - (1.0771 x 102.03125)

= 110.09375 - 109.89786

= .19589 price points

(or .19589 x 32 = 6.3/32nds)

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Basis measures the spread between the spot and futures prices

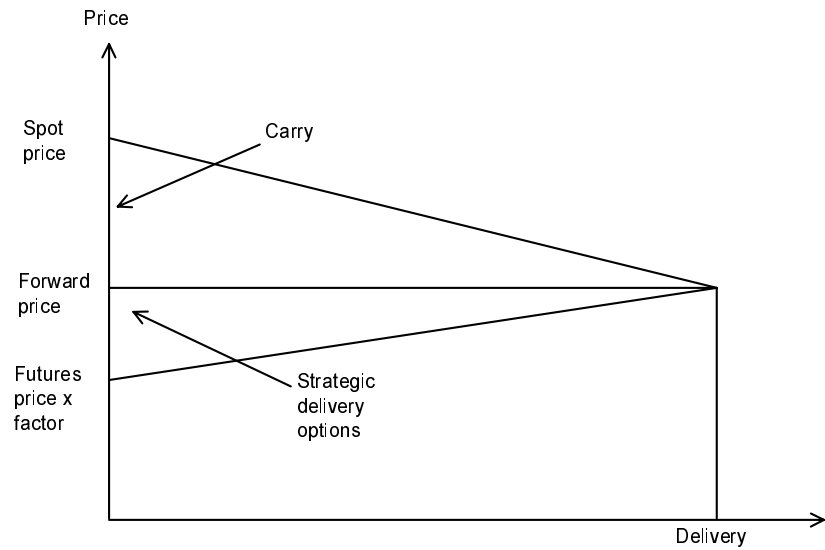
## Basis Concepts

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### Exhibit 2.3

#### What Drives the Basis?

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$$\text{Basis} = \text{Spot price} - (\text{Conversion factor} \times \text{Futures price})$$

$$\text{Basis} = \text{Carry} + \text{Value of strategic delivery options}$$

$$\text{Futures price} = \frac{\text{Spot price} - \text{Basis}}{\text{Conversion factor}}$$

$$\text{Futures price} = \frac{\text{Spot price} - \text{Carry} - \text{Delivery option value}}{\text{Conversion factor}}$$

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## **Basis Concepts**

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### **Exhibit 2.4**

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#### **Carry and Forward Pricing**

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*Carry = Coupon Income - RP Financing*

*Forward price = Spot Price - Carry*

*Futures price with a single deliverable bond = Forward price / Factor*

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### Exhibit 2.5

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#### Calculating Carry

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■ **Objective**

On 3/8/95, determine the price at which you would be willing to sell the 8-3/4s of 5/15/17 for delivery on 3/31/95

■ **Market data**

Spot price = 110-03/32nds

Full price = \$112.8493

Term RP rate = 6.00%

22 days from settlement (on 3/9) to delivery

■ **Coupon income**

$(\text{Coupon} / 2) \times (\text{Days to delivery} / \text{Days in coupon period})$

$$(8.75 / 2) \times (22 / 181) = 0.532$$

■ **RP financing expense**

$\text{Full price} \times \text{RP rate} \times (\text{Days to delivery} / 360)$

$$112.8493 \times .0600 \times (22 / 360) = .414$$

■ **Net carry**

Coupon income - Financing expense

$$0.532 - 0.414 = .118 \text{ (in price points)}$$

$$0.118 \times 32 = 3.78/32\text{nds (about } 4/32\text{nds)}$$

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## Basis Concepts

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### Exhibit 2.6

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#### Forward Price = Spot Price - Carry

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##### ■ Market data

Spot price = 110 - 03/32nds

Carry = 3.78/32nds

##### ■ Forward price

Spot price - Carry = 110 - 03/32nds - 3.78/32nds = 109.97575

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- The forward price is the price at which you can buy the bond in the spot market, finance the position at the RP, and just break even on the transaction.
- In this case, you can buy the bond at 110-3/32nds, sell it forward at 109-31/32nds (for a capital loss of 4/32nds), and finance the position at 5.85% (for a net gain in carry of 4/32nds). The capital loss on the spot/forward trade is just offset by net carry.

## Basis Concepts

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### Exhibit 2.7

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#### Futures Price with One Deliverable Bond

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$$\begin{aligned}\text{Futures price} &= \text{Forward price} / \text{Factor} \\ &= 109.975 / 1.0771 \\ &= 102.1036 \text{ (or } 102\text{-}03/32\text{nds)}\end{aligned}$$

Basis if there were only one deliverable bond

$$\begin{aligned}\text{Basis} &= 110.09375 - (1.0771 \times 102.1036) \\ &= 110.09375 - 109.96879 \\ &= 0.12496 \text{ price points (or } 0.12496 \times 32 = 4/32\text{nds)}\end{aligned}$$

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- Notice that if the 8-3/4s were the only deliverable bond, and if the futures price were equal to the converted forward price of the 8-3/4s, the bond's basis would simply be equal to carry.
- As it is, the basis of the 8-3/4s on 3/8/95 was 6.3/32nds. The difference will be explained by the short's strategic delivery options.

## Basis Concepts

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### Exhibit 2.8

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#### Calculating a Bond's Implied RP Rate

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$$\text{Implied RP rate} = \left[ \frac{\text{Invoice price}}{\text{Purchase price}} - 1 \right] \times \frac{360}{\text{Days}}$$

#### where

*Invoice price* = (Conversion factor × Futures price) + Accrued interest at delivery

*Purchase price* = Today's full price

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- The implied RP or repo rate is the hypothetical return you would earn if you were to buy the cash bond, sell futures short against it, and then deliver the bond into the futures contract.
- The invoice price includes accrued interest at the hypothetical delivery date.
- The purchase price is today's spot price plus today's accrued interest.
- See Burghardt, et. al., *The Treasury Bond Basis* for the calculation of implied RP rates if a coupon falls between today and futures delivery.



## Basis Concepts

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### Exhibit 2.9

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#### Implied RP Example

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##### ■ Data for 8-3/4s of 5/15/17 on 3/8/95

Full price for settlement on 3/9/95 = 112.8493 (includes 2.7555 accrued interest)

Futures price = 102-03/32nds

Conversion factor = 1.0771

##### ■ Implied RP for delivery on 3/31/95

Invoice price = (Futures x Factor) + Accrued interest at delivery

$$= ( 102.09375 \times 1.0771 ) + 3.2877$$

$$= 113.2529$$

Implied RP = [ (Invoice price / Purchase price) - 1 ] x [ 360 / 22 ]

$$= [ (113.2529 / 112.8493) - 1 ] \times [ 16.3636 ]$$

$$= .0585 \text{ (or 5.85\%)}$$

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Notice that the implied RP rate in this example is the same as the market RP that was used to calculate carry.

### **Exhibit 2.10**

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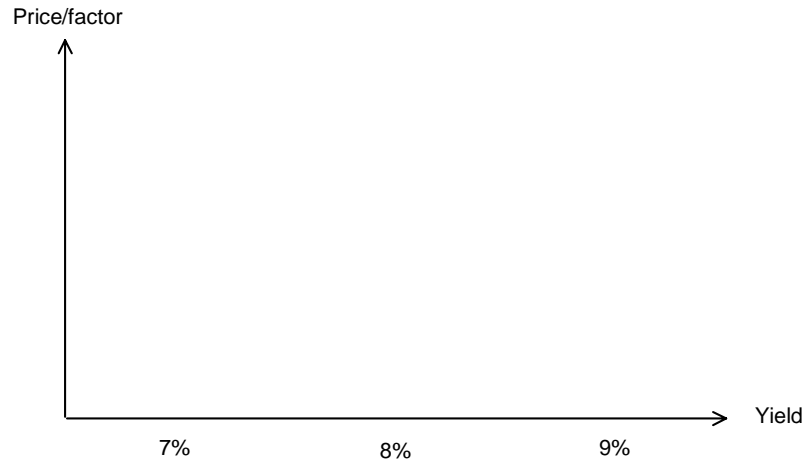
#### **If There is More Than One Deliverable Bond**

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- The short decides which bond to deliver and when
  - Which is the cheapest bond to deliver?
  - Shifts in the cheapest to deliver (very important)
    - changes in yield levels
    - changes in yield spreads
  - Shifts in the best time to deliver (not very important)
  - What is the fair value of the futures price?
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## Exhibit 2.11

### Finding the Cheapest Bond to Deliver



#### Selected Deliverable Bonds

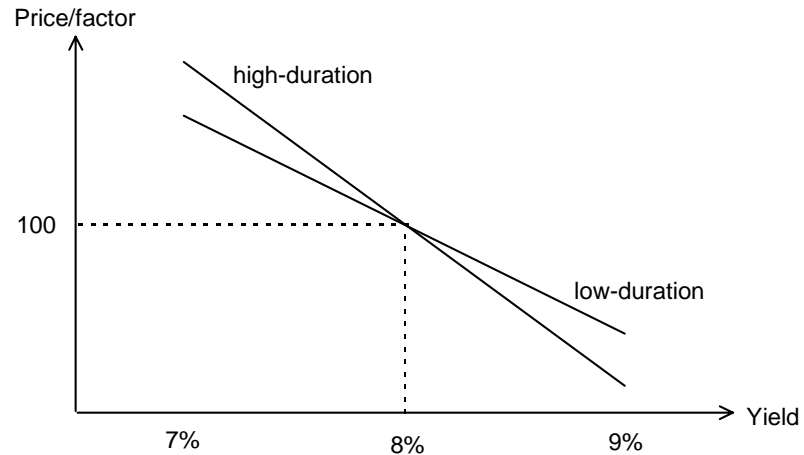
Coupon	Price	Factor	Yield	DV01	Modified duration	Implied RP rate	
11.25	135-04+	1.3197	7.757	127.03	9.35	2.33	
<b>8.75</b>	<b>110-03</b>	<b>1.0771</b>	<b>7.785</b>	<b>113.00</b>	<b>10.01</b>	<b>4.87</b>	<b>CTD</b>
8.875	111-23+	1.0922	7.786	117.72	10.49	3.55	
7.875	101-02	0.9863	7.778	111.76	11.01	0.80	
6.25	83-12+	0.8050	7.697	99.20	11.84	-17.10	
7.625	99-29	0.9575	7.632	117.03	11.66	-28.50	

Overnight RP rate = 5.85%

- The bond with the highest implied RP rate is the cheapest to deliver.
- Notice that the highest implied RP rate is lower than the market RP rate.
- The 8-3/4s may not always be the cheapest bond to deliver

**Exhibit 2.12**

## Shifts in the Cheapest to Deliver



### Selected Deliverable Bonds

Coupon	Price	Factor	Yield	DV01	Modified duration	Implied RP rate
11.25	135-04+	1.3197	7.757	127.03	9.35	2.33
8.75	110-03	1.0771	7.785	113.00	10.01	4.87
8.875	111-23+	1.0922	7.786	117.72	10.49	3.55
7.875	101-02	0.9863	7.778	111.76	11.01	0.80
6.25	83-12+	0.8050	7.697	99.20	11.84	-17.10
7.625	99-29	0.9575	7.632	117.03	11.66	-28.50

Overnight RP rate = 5.85%

- Low-duration bonds tend to be cheapest to deliver when yields are low.
- High-duration bonds tend to be cheapest to deliver when yields are high.
- At expiration, the cheapest to deliver bond is the bond with the lowest converted price — that is, the bond with the lowest price/conversion factor.
- Before expiration, the most reliable guide to cheapness is the bond's implied RP rate.
- The implied RP is the financing rate one could pay and still break even buying the bond in the spot market and delivering it at the futures invoice price.

**Exhibit 2.13**

**CTD Scenario Analysis**

<HELP> for explanation.

DG16 Comdty **CMS**

**VIEW** B  
 B-Basis, C-basis Chg  
 H-Horizon bond price  
 U-BPV  
 S-CTD B.P. Spread  
 P-P&L 32nds

**CTD Scenario Analysis** Pg1 of 3

CTD Basis **0.** 32nds Stl **4/ 1/99** Dlv **6/30/99**

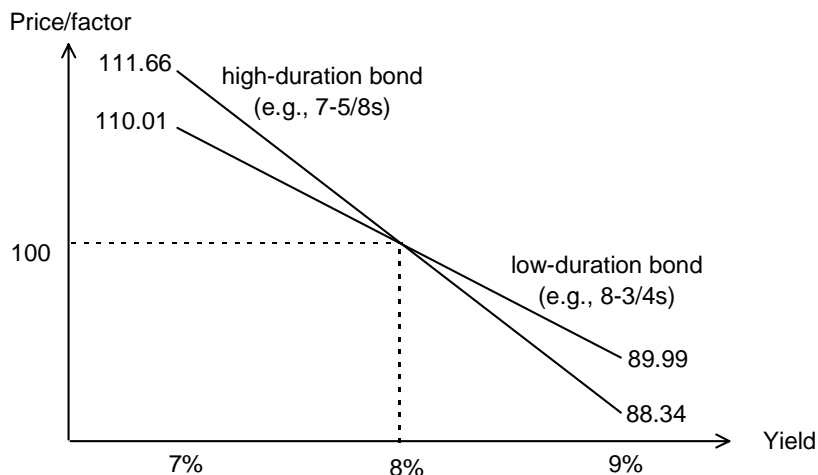
PARALLEL YIELD SHIFTS (BP)				
<b>-100</b>	<b>-50</b>	<b>0</b>	<b>70</b>	<b>200</b>
Price: 132-14+	126-16	120-29+	113-21	100-26+
Chng: +11-29+	+5-31	+ 12+	-6-28	-19-22+
Risk: 12.28	11.52	10.82	10.20	10.02

<b>USM9</b>		<b>120-17</b>		Price	Src	Yield	Basis	Basis at Contract Horizon (32nds)				
1)T	11 1/4	02/15/15	<b>156-00+</b>	BGN	<b>5.802</b>	<b>33.2</b>	<b>33.2</b>	<b>.0</b>	<b>.0</b>	<b>.0</b>	<b>.1</b>	<b>37.4</b>
2)T	10 5/8	08/15/15	<b>150-00</b>	BGN	<b>5.840</b>	<b>38.1</b>	23.1	15.2	8.2	<b>.0</b>	23.9	
3)T	9 7/8	11/15/15	<b>142-11+</b>	BGN	<b>5.853</b>	<b>48.2</b>	47.9	34.0	21.8	7.0	19.4	
4)T	9 1/4	02/15/16	<b>135-29+</b>	BGN	<b>5.867</b>	<b>55.1</b>	67.1	48.2	31.4	11.1	13.8	
5)T	8 7/8	08/15/17	<b>133-06+</b>	BGN	<b>5.892</b>	<b>86.5</b>	131.5	96.1	65.1	28.1	6.9	
6)T	8 3/4	05/15/17	<b>131-21</b>	BGN	<b>5.885</b>	<b>85.2</b>	127.2	93.7	64.2	29.0	9.5	
7)T	7 1/4	05/15/16	<b>114-22+</b>	BGN	<b>5.876</b>	<b>78.5</b>	119.7	89.7	63.0	30.5	9.6	
8)T	9 1/8	05/15/18	<b>136-20+</b>	BGN	<b>5.902</b>	<b>98.6</b>	154.8	113.1	76.6	33.4	4.8	
9)T	7 1/2	11/15/16	<b>117-17+</b>	BGN	<b>5.886</b>	<b>83.9</b>	130.5	97.2	67.6	31.8	7.4	
10)T	9	11/15/18	<b>135-20+</b>	BGN	<b>5.907</b>	<b>108.6</b>	175.1	128.2	87.4	39.1	3.3	
11)T	8 7/8	02/15/19	<b>134-14</b>	BGN	<b>5.907</b>	<b>114.5</b>	186.5	136.9	93.7	42.7	2.8	
12)T	8 1/8	08/15/19	<b>125-30+</b>	BGN	<b>5.915</b>	<b>125.7</b>	212.0	156.4	107.9	50.6	<b>.0</b>	
13)T	8 3/4	05/15/20	<b>133-29+</b>	BGN	<b>5.915</b>	<b>138.8</b>	233.6	172.3	119.1	56.7	1.4	
14)T	8 1/2	02/15/20	<b>130-28</b>	BGN	<b>5.906</b>	<b>138.1</b>	230.9	171.1	119.2	58.0	3.5	
15)T	8 3/4	08/15/20	<b>134-04+</b>	BGN	<b>5.914</b>	<b>143.5</b>	242.6	179.0	123.9	59.2	1.1	
16)T	7 7/8	02/15/21	<b>123-27+</b>	BGN	<b>5.916</b>	<b>155.5</b>	267.7	198.8	139.0	68.9	.7	

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 Princeton: 609-279-3000 Singapore: 226-3000 Sydney: 2-9777-8686 Tokyo: 3-3201-8900 Sao Paulo: 11-3048-4500  
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**Exhibit 2.14**

**The Disadvantage to Being Long Futures**



**Selected Deliverable Bonds**

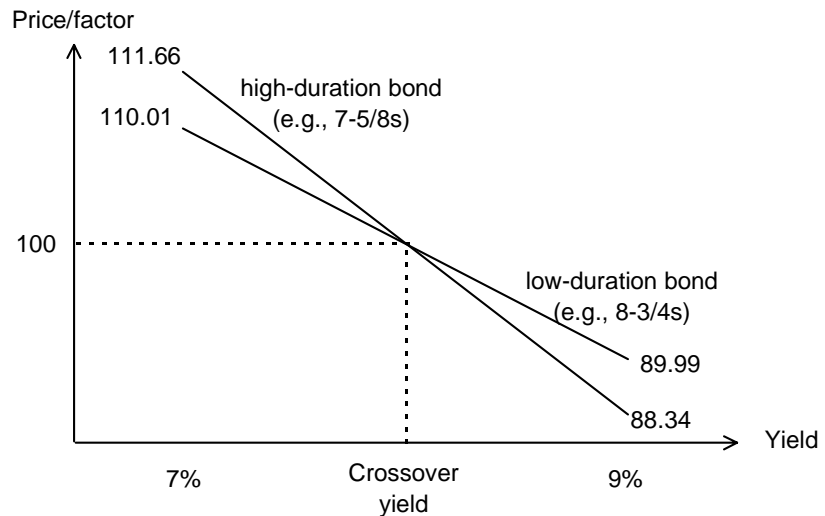
Coupon	Price	Factor	Yield	DV01	Modified duration	Implied RP rate
11.25	135-04+	1.3197	7.757	127.03	9.35	2.33
8.75	110-03	1.0771	7.785	113.00	10.01	4.87
8.875	111-23+	1.0922	7.786	117.72	10.49	3.55
7.875	101-02	0.9863	7.778	111.76	11.01	0.80
6.25	83-12+	0.8050	7.697	99.20	11.84	-17.10
7.625	99-29	0.9575	7.632	117.03	11.66	-28.50

Overnight RP rate = 5.85%

- With a modified duration of 10.01 percent, the converted price of the 8-3/4s would increase to approximately 110.01 if its yield were to fall to 7 percent. The price of the 7-5/8s, on the other hand, with a modified duration of 11.66 percent, would increase to 111.66.
- If yields were to rise to 9 percent, the price of the 8-3/4s would fall to just below 90. The price of the 7-5/8s would fall to approximately 88.34.

**Exhibit 2.15**

## Value of the Short's Right to Switch Deliverable Bond



### Selected Deliverable Bonds

Coupon	Price	Factor	Yield	DV01	Modified duration	Implied RP rate
11.25	135-04+	1.3197	7.757	127.03	9.35	2.33
8.75	110-03	1.0771	7.785	113.00	10.01	4.87
8.875	111-23+	1.0922	7.786	117.72	10.49	3.55
7.875	101-02	0.9863	7.778	111.76	11.01	0.80
6.25	83-12+	0.8050	7.697	99.20	11.84	-17.10
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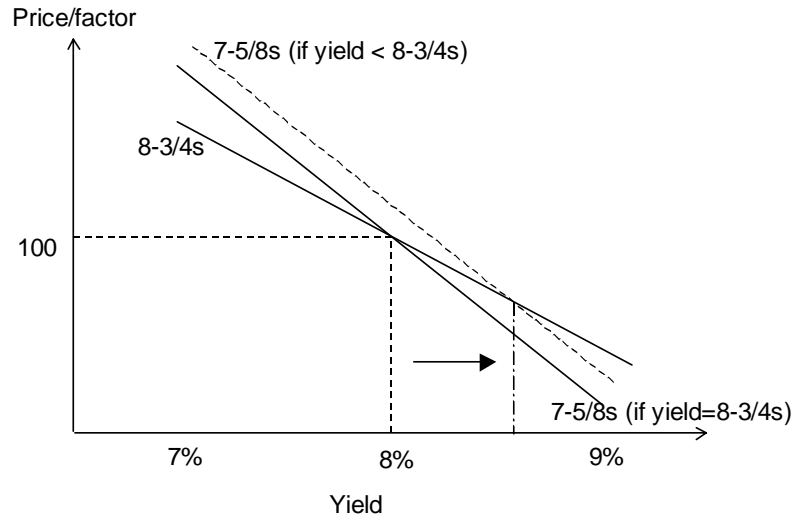
Overnight RP rate = 5.85%

- In a bull market with yields falling, say, from 9 percent to 7 percent, one would make approximately 23.32 points with a long position in the 7-5/8s. With a long futures contract, on the other hand, one would make at most 21.67 [= 110.01 - 88.34]. The smaller gain on the futures would be caused by a shift in the cheapest to deliver.
- The right to swap out of the 7-5/8s and into the 8-3/4s if yields fall below the crossover point is a potentially valuable option for whoever is short the futures contract.
- The value of the short's option to switch deliverable bonds depends on three things — how close the yield is to a crossover point, how volatile bond yields are, and how much time remains to the expiration of trading in the futures contract.

# Basis Concepts

**Exhibit 2.16**

**Crossover point usually not 8%**



**Selected Deliverable Bonds**

Coupon	Price	Factor	Yield	DV01	Modified duration	Implied RP rate
11.25	135-04+	1.3197	7.757	127.03	9.35	2.33
8.75	110-03	1.0771	7.785	113.00	10.01	4.87
8.875	111-23+	1.0922	7.786	117.72	10.49	3.55
7.875	101-02	0.9863	7.778	111.76	11.01	0.80
6.25	83-12+	0.8050	7.697	99.20	11.84	-17.10
7.625	99-29	0.9575	7.632	117.03	11.66	-28.50

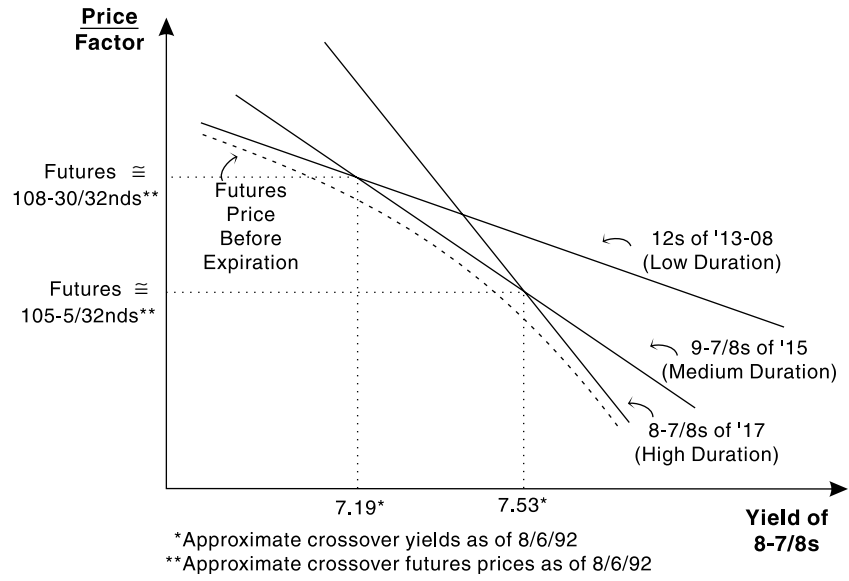
Overnight RP rate = 5.85%



# Basis Concepts

## Exhibit 2.17

### Cash/Futures Price Relationships

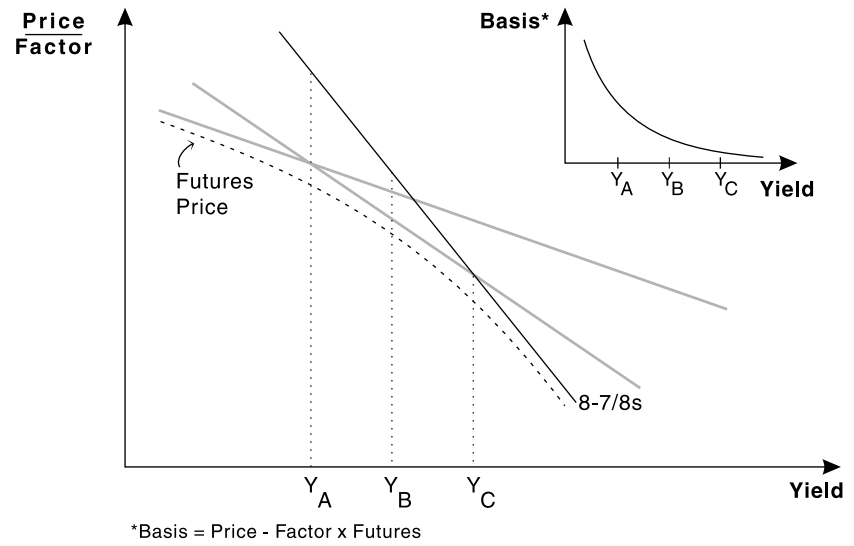


Source: Burghardt, et.al., *The Treasury Bond Basis*, Irwin, 1994.

**Exhibit 2.18**

## Basis of 8-7/8s is Like a Call Option on Bond Futures

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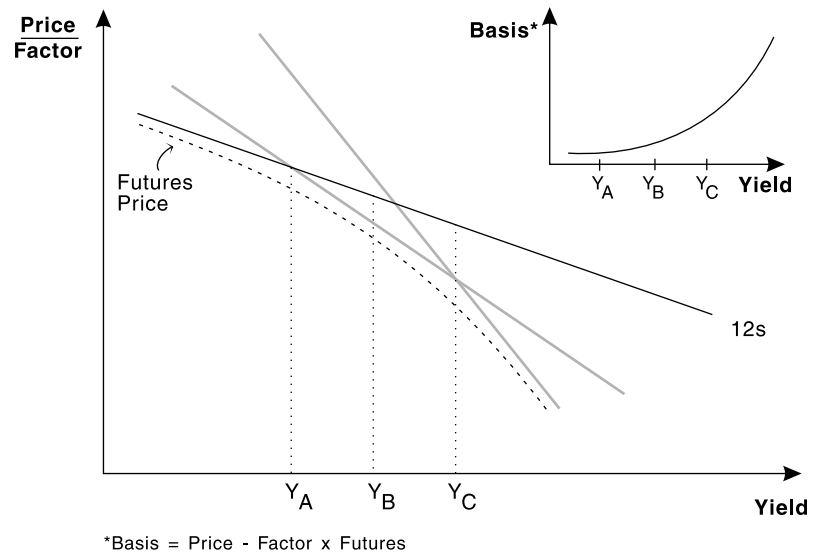
Source: Burghardt, et.al., *The Treasury Bond Basis*, Irwin, 1994.

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## Exhibit 2.19

### Basis of 12s is Like a Put Option on Bond Futures

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Source: Burghardt, et.al., *The Treasury Bond Basis*, Irwin, 1994.

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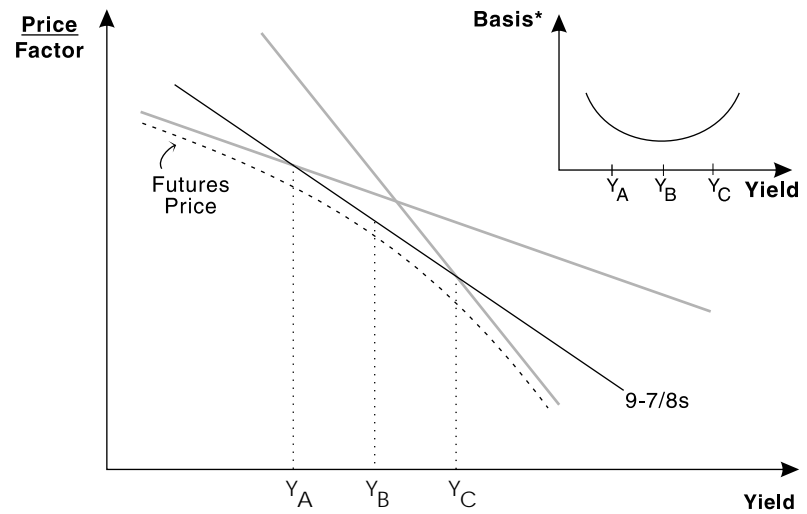
# Basis Concepts

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## Exhibit 2.20

### Basis of 9-7/8s is Like a Straddle on Bond Futures

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\*Basis = Price - Factor x Futures

Source: Burghardt, et.al., *The Treasury Bond Basis*, Irwin, 1994.

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### Exhibit 2.21

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#### The Market Value of the Strategic Delivery Options

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■ Basis net of carry of the 8-3/4s

Basis = 6.3/32nds

Carry at an RP rate of 6.00% = 3.8/32nds

Basis net of carry = 2.5/32nds [= 6.3/32nds - 3.8/32nds]

The short is paying 2.5/32nds for the delivery options in the March futures contract.

■ Market and implied RP rates

The market RP rate was 6.00%

The implied RP rate for the 8-3/4s is 4.87%

The short is giving up 113 basis points for 22 days in exchange for the delivery options

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- There are two ways of measuring the value that the market places on the short's strategic delivery options.
- One is basis net of carry, which is approximately the amount by which the futures price is below the forward price.
- The other is the difference between the market RP rate, which could be earned in the money market, and the CTD's implied RP rate, which is the hypothetical return to cash/futures arbitrage with the cheapest to deliver bond.

## Basis Concepts

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### Exhibit 2.22

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#### Reckoning the Fair Value of a Futures Contract

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##### Option-Adjusted Basis Report

(March '95 contract, all units in 32nds)

Issue	Market basis	Carry	Carry delta	Theoretical option value	Theoretical basis	Option-adjusted basis net of carry
Coupon Maturity	1	2	3	4	5=2+4	6=1-5
11.25 2/15/15	15.68	5.94	0.3	9.56	15.50	0.18
8.75 5/15/17	6.27	3.78	0.2	2.59	6.37	-0.10
8.875 2/15/19	9.47	4.09	0.2	5.48	9.57	-0.10
7.875 2/15/21	13.73	3.40	0.2	10.53	13.93	-0.20
6.25 8/15/23	40.17	2.33	0.2	32.12	40.45	-0.28
7.625 2/15/25	70.76	3.05	0.2	67.94	70.99	-0.23

Assume a 6.00% RP rate and a 13.0 percent yield volatility

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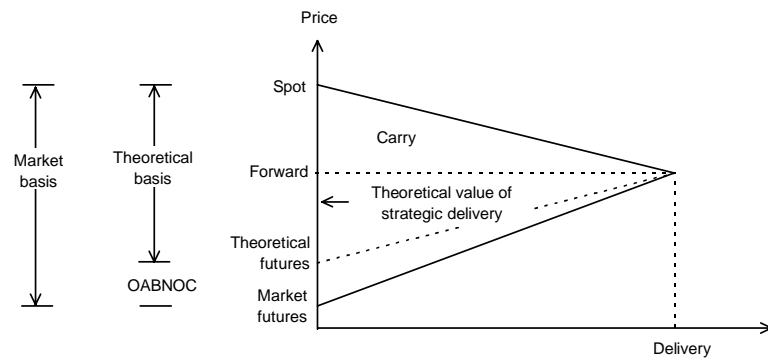
- The theoretical basis = carry + theoretical option value
- Carry delta is the effect of a 10 basis point change in the RP rate on the value of carry
- If the option-adjusted basis is positive, the market basis is greater than the theoretical basis, and futures are cheap.
- Futures are fairly priced if the option-adjusted basis is zero.

### Exhibit 2.23

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#### Are Futures Rich or Cheap?

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- In the example above, the market futures price is lower than the theoretical futures price. As a result, the market basis is larger than the theoretical basis, and the “option-adjusted basis net of carry” is positive. We conclude, then, that futures are cheap if the option-adjusted basis net of carry is positive.
- If the futures price is above its theoretical value, we would find that the option-adjusted basis is negative and would conclude that futures are rich.

### **Exhibit 2.24**

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#### **BASIS CONCEPTS**

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- Definition of the basis
- What drives the basis?  
Carry (coupon income, RP expense)  
Embedded delivery options
- Changes in the cheapest to deliver
- Fair value of a futures contract
- P/L of a basis position