Fundamentals of the bond market

RBC Dominion Securities

Bonds are an important component of any balanced portfolio. To most they represent a conservative investment vehicle. However, investors purchase bonds for a variety of reasons, including regular income, reducing portfolio volatility, and potential for capital gains. This publication describes bonds and the factors determining bond prices.

The basics

A bond is an obligation or loan made by an investor to an issuer (e.g. a government or a company). The issuer promises:

- To repay the principal (or face value) of the bond on a fixed maturity date; and
- To make regularly scheduled interest payments (usually every six months).

The major issuers of bonds are governments and corporations. Investors in the bond market range from individuals to many different types of institutions, including banks, life insurance companies, pension funds and mutual funds.

Why invest in bonds?

Bonds offer investors a number of benefits. A few of the more popular ones are outlined below:

Income

Bonds typically pay semi-annual interest. They provide the investor with regular and predictable income. This is a contractual obligation and must be paid unless the issuer is under bankruptcy protection.

Portfolio diversification

A balanced portfolio generally includes a combination of cash, equities (stocks) and bonds. For many, a properly structured portfolio will include a significant proportion of bonds. Even for investors who do not need safety or current income, bonds provide an important element of diversification and risk management. Table 1 below summarizes the benefits of holding bonds in a portfolio over the past 50 years. As you can see, the return of a portfolio with both stocks and bonds is a little lower than a pure equity portfolio, but the volatility – measured by standard deviation of annual returns – is dramatically lower as are the absolute declines in portfolio value in bear markets.

Preservation of capital

Although the day-to-day value of a bond will fluctuate according to market conditions, high quality bonds can be expected to mature at par (100). Therefore, an investor knows the exact amount to be received at maturity. If a capital return is required prior to maturity, interim fluctuations will be an important consideration.

Predictability

The regular interest payments provide investors with predictability in their portfolios.

Liquidity

If funds are needed before the maturity date, the bond can be sold through an investment dealer. The price received upon sale of the security will, of course, depend on the prevailing level of interest rates and the credit profile of the issuer.

Table 1: The Benefits of Diversification

The Benefits of Diversification (1953 - 2003)				
	100% Equities Portfolio	100% Bonds Portfolio	Simple Average 50/50 Portfolio	Rebalanced Annually 50/50 Portfolio
Average Annual Return	10.14%	7.13%	8.64%	9.04%
Volatility	16.42%	10.29%	13.36%	9.82%
Largest Loss	(25.93%)	(10.46%)	(18.20%)	(13.81%)
Average Loss	(8.62%)	(3.67%)		(5.05%)
# of Losses	14	12		10
# of Losses › 10%	6	1		1

Bond pricing

The face value of a bond is the amount the issuer will pay at maturity. The market price of a bond is quoted as a percentage of its face value. For example, a bond with a market price of 94 is priced at 94% of its face value. Market price should not be confused with face value. A bond with a face value of $100 and a market price of 94 would cost an investor $94 (not including accrued interest).

When a bond is purchased for the full face amount, it is purchased at par (i.e. 100). If the price is less than par (e.g. 94), the bond is purchased at a "discount", and if the price is greater than par (e.g. 105) the bond is purchased at a "premium".

The price of a bond is determined by the current rate of return – or yield – demanded by investors. In turn, the general levels of interest rates determine the yield. Other factors specific to a particular issuer or bond, such as liquidity, credit quality, or term, also affect the yield.

Bond interest

The rate of interest paid to the investor is based on the coupon rate. This coupon rate is set at the time of issue and is determined by a number of factors, including:

- The interest rate environment at the time of the issue
- The credit quality of the issue
- The term to maturity (e.g. short, medium or long)

Table 2: $100,000 Canada 5.25% June 1, 2013

Issuer:	The entity borrowing funds (governments and corporations).	Government of Canada
Coupon Rate:	The fixed rate of interest, payable as a percent of the bond's face value. This rate does not change throughout the life of the bond.	5.25%
Coupon Payments:	Bonds typically pay interest on a semi-annual basis.	The investor would receive two $2,625 payments (June 1 and December 1).
Maturity Date:	The date when the principal must be repaid.	June 1, 2013
Principal/Face Value:	The amount to be repaid upon maturity.	$100,000

Yield to maturity

The yield to maturity of a bond is the rate of return earned by investing in the bond. It assumes the bond is held until maturity and that all coupon payments are reinvested at the original yield. Bond yields constantly adjust to changing market conditions and should not be confused with the coupon rate, which does not change.

The yield to maturity encompasses two factors:

1. The coupon income that is fixed and is paid every six months until maturity.
2. The capital gain or loss, which is the difference between the market price and face value (100). In calculating a yield, this gain or loss is spread out (or amortized) over the years remaining until maturity.

Example 1 (right) illustrates the concept of yield.

Price changes due to market interest rates

Bond prices move in the opposite direction to interest rates. That is, as interest rates rise, the price of a bond falls, and as interest rates decline, the price of a bond rises.

This concept is best illustrated by an example. Suppose an investor purchased a new 4.5% coupon bond one year ago. Assume that since that time, the general level of interest rates has fallen and that a similar bond issued today would have a coupon of 3.75%. Therefore, the 4.5% coupon bond is obviously a valuable asset since it pays a coupon greater than the market rate.

To entice the investor to sell the 4.5% bond, a second investor would have to pay a higher price than what it was originally purchased for. This price must be high enough such that the second investor would earn the going yield of 3.75%. Thus, prices of bonds rise when the general level of interest rates falls. Of course, the process also works in reverse in a rising interest rate environment. The 4.5% bond would be less valuable if current interest rates are 5.5%. Its price would have to fall enough to make the yield to the purchaser 5.5%.

Appendix II contains a table showing how interest rate changes affect four different Government of Canada bonds.

Example 1

Calculating an approximate bond yield

Issue: US Treasury 5.38% February 15, 2031
Coupon: 5.38%
Market Price: 110.03 (as of March 16, 2004)
Capital Gain / Loss: 100 - 110.03 = (10.03)
Years to Maturity: 27 years
Capital Loss Per Year: 10.03 ÷ 27 = 0.37

In this example, the annual pre-tax return is:

5.38 (annual income)
-0.37 (capital loss per year)
= 5.01

Dividing this by the average bond purchase price (105.015) and the redemption value (100), we arrive at an approximate yield of 4.77%.

The actual semi-annual yield to maturity is calculated by discounting to the present time all the future cash flows (i.e. coupon payments and principal repayment) at a certain yield so that when these discounted cash flows are summed, they add up to the current market price. The actual semi-annual yield for this bond is 4.72%, which is close to the approximation calculated above. For a full example of a yield to maturity calculation, see Appendix I.

Coupon income is what the bond pays relative to its par value.
Yield is what the bond returns relative to market price.

Table 3: The Effect of the Term to Maturity on Bond Prices

Example: Bonds with 4.0% Coupon				
		Term to Maturity		
		2 Year	10 Year	30 Year
Market Interest Rate	3.00%	101.92 + 1.92%	108.58 + 8.58%	119.69 + 19.69%
	4.00%	100	100	100
	5.00%	98.12 (1.88%)	92.21 (7.79%)	84.55 (15.45%)

Term to maturity affects how much bond prices fluctuate...

When interest rates change, long-term bonds will change in price by a greater amount than short-term bonds assuming that both have the same coupon and credit profile. If interest rates decline, investors will be willing to pay much more for an attractive rate that is locked in for an extended period (say 20 years) than for the same rate guaranteed for a short period (say two years). The opposite is also true. That is, if rates increase, the prices of longer bonds would fall by more than shorter bonds as investors in long bonds would face an unattractive rate for an extended period of time.

Table 3 (above) illustrates the effect of term to maturity on the price of a bond. Long-term bonds will be more sensitive to changes in market yields than short-term bonds. We can see that if market interest rates move from 4% to 3%, a two-year bond with a 4% coupon will subsequently rise $1.92 (1.92%) in price. In this same environment, a 30-year bond with a 4% coupon will rise $19.69 (19.69%) in price. The opposite to this is also true – that is, in a rising interest rate environment, prices on longer term bonds will decline to a much larger degree than prices on shorter maturities.

...But term to maturity doesn't tell the whole story

The coupon rate also affects the degree to which bond prices change with interest rates. Table 4 (facing page, top) shows the extent of bond price movements for a number of bonds that all have a 10-year term to maturity. As you can see, for a given change in interest rates, the resulting change in price was different for each bond. For example, if rates were to rise by 1%, the bond that pays no interest until maturity would see its price decrease by 9.31% while the bond that pays a 10.0% coupon bond decreased by 6.67%. This shows that higher coupon bonds change in price less on a percentage basis than lower coupon bonds. For any term to maturity, strip coupons (i.e. bonds that pay no interest until maturity) will have greater price volatility for a given change in interest rates than other bonds.

This analysis implies that term to maturity alone is not an adequate measure of interest rate risk. Bond managers use a term called "modified duration" that is effectively the term to maturity adjusted for the impact of coupon rates. Interestingly, modified duration is also an estimate of the percent price change for a 1% change in interest rates. For example, the modified duration of the 10% coupon, 4% yield bond in Table 4 is 7.06 years, while the actual price change is 7.4% for a 1% decrease in rates and (6.76)% for a 1% increase in rates.

Table 4: The Effect of the Coupon Rate on Bond Prices

Example: Bonds with 10-Year Maturities				
		Coupon Rate		
		0.0%	5.0%	10.0%
Market Interest Rate	3.00%	$74.26 + 10.3%	$117.16 + 8.31%	$160.05 + 7.4%
	4.00%	$67.32	$108.17	$149.02
	5.00%	$61.05 (9.31%)	$100 (7.55%)	$138.95 (6.76%)

THE YIELD CURVE – RATES DIFFER BETWEEN MATURITIES

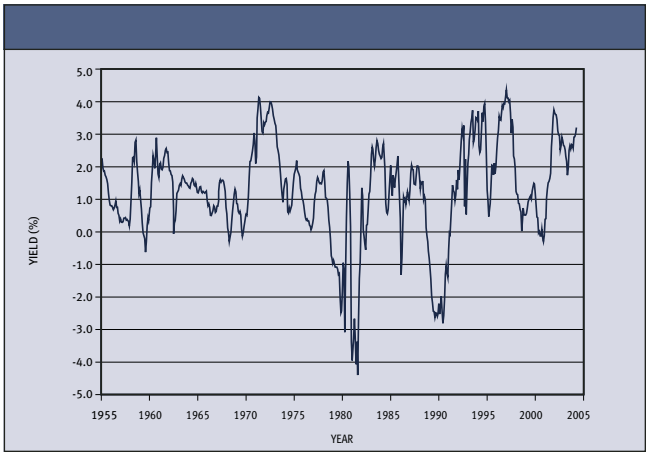
Yields for Government of Canada bonds reflect the general level of interest rates at a particular point in time. Graphing these yields across all available terms (e.g. 1 to 30 years) generates a curve, typically referred to as a yield curve. The yield curve compares the prevailing rates of interest over varying terms to maturity. See Figure 2 for an example of the Canada yield curve.

Historically, long-term rates have been higher than short-term rates the majority of time. Figure 1 (right) shows the spread between the Government of Canada 30-year bond and the 90-day Treasury bill. As you can see, the spread has been positive the majority of the time over the past 50 years. This reflects a number of factors: that many investors require a premium for accepting the higher price volatility of a longer term bond, and that many investors have short-term liquidity needs so they prefer to invest in short-term securities.

The yield curve also embodies investors' expectations about the future direction of interest rates. In times when interest rates are expected to rise, investors tend to favour short-term bonds. Competition amongst investors for short-term securities will push down short-term yields while large scale selling of long-term securities would cause their yields to rise. Conversely, in a strong economy where inflation is high, the yield curve may become inverted or downward sloping with short-term rates higher than long-term rates.

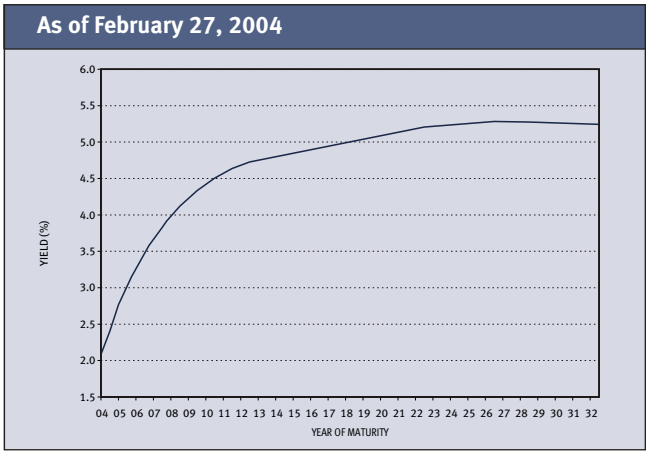
This may happen when short-term rates are very high due to high current inflation. Investors expect future inflation rates to be much lower, so they are willing to take a lower return in the future than they can currently get.

Figure 1: 30-Year Canada Bond Minus 90-Day T-Bill



Source: Trend & Cycle

Figure 2: Canadian Yield Curve



Source: RBC Capital Markets

Accrued interest

Bond interest is typically paid on a semi-annual basis. Interest is earned by the seller of the bond from the last interest payment date, up to the settlement date. This is referred to as the accrued interest of the bond. The seller of the bond receives the accrued interest, and the purchaser of the bond pays the accrued interest. The buyer is subsequently reimbursed for the accrued interest they paid when they receive the coupon at the next coupon payment date.

The example (right) illustrates how accrued interest is calculated.

Example 3:

Let's consider the Canada 5.25% June 1, 2013 from Table 2 assuming the following details:

Purchase Date: February 11, 2004
Settlement Date: February 16, 2004
Par Value: $100,000
Purchase Price: 105.80

Regular interest payments for this bond are June 1 and December 1. Therefore, interest accrues from December 1 (the last semi-annual interest date) to February 16 (the settlement date). The total number of days interest has accrued is 77:

December 1 to 31	**30 days**
January 1 to 31	**31 days**
February 1 to 16	**16 days**

Note that this calculation includes February 16 (the settlement date) but does not include December 1 (the last interest payment date).

Based on the example above, the accrued interest on a par value of $100,000 equals $1,107.53. The calculation is as follows:

The $1,107.53 of accrued interest is added to the total cost of the bond:

(1.058 X $100,000) + $1,107.53

Total Cost = $106,907.53

*Accrued interest in any six-month period cannot exceed half the annual coupon.

Risks affecting bond prices

Although a bond is considered a conservative investment, there are a few risks associated with fixed-income investing. These include:

Interest rate risk

As previously discussed, the movement of interest rates has an inverse effect on bond prices. In some circumstances this may create losses if the bond is sold before maturity.

Purchasing power risk

Inflation erodes the purchasing power of a fixed-income security and hence becomes one factor investors should consider. The coupon payments and principal received from a bond are not indexed to inflation so they will be able to buy less in a high inflation environment.

Marketability or liquidity risk

This concerns the ability of the investor to easily dispose of a bond in a timely and efficient manner. Generally, liquidity is affected by a number of factors including: size of issue, credit quality, term to maturity, composition of investors who hold the security (i.e. is it widely traded or closely held), and other unique or special features. On this scale, government bonds typically rate the highest. At the opposite end of the scale would be some corporate and strip coupons.

Credit risk

Credit risk refers to the issuer's ability to make timely interest and maturity payments. Even perceptions of a poor credit risk will adversely affect the market price of bonds. Generally, a portfolio containing six to eight high quality investment grade (rated A- or higher) bonds would be viewed as reasonably diversified. With lower quality, or below-investment grade bonds, a portfolio should contain about 20 names to achieve reasonable diversification effects. Many below-investment grade bonds should be considered part of the equity component of a diversified portfolio.

Call risk

Some bonds have a call feature where the issuer can redeem the bonds at a fixed price at a date before maturity. In a declining interest rate environment, the probability that a callable bond will be redeemed increases. Issuers will redeem the bond if they feel that they can reissue another bond at a lower coupon rate.

Reinvestment risk

If the intention of the investor is to accumulate wealth (i.e. save and re-invest the bond's coupons) rather than generating current income, then reinvestment risk becomes an issue. Future coupons must be reinvested at prevailing market rates, so changes in this reinvestment rate will positively or negatively affect the ultimate compounded yield to maturity.

Rating agencies

Investors must have a means of gauging the bond issuer's credit worthiness. Independent rating agencies carefully evaluate the strength of issuers and the collateral and covenants associated with the security. They assign a rating to reflect the credit quality of the debt. The two major bond-rating agencies in Canada are the Dominion Bond Rating Service (DBRS) and Standard and Poor's (S&P). In the U.S., the two major rating agencies are S&P and Moody's.

Tax implications of fixed-income securities*

Coupon payments (for investments made in 1990 and later)

Coupon payments, which are classified as interest income, must be reported on an annual basis, based on the anniversary date of the investment.

Discounts and premiums

When bonds are purchased at either a discount or a premium and they mature at par, the amount of any realized gain or loss may be treated as a capital gain or capital loss for tax purposes.This is also true when the bonds are sold prior to maturity.

Strip bonds

Though holders receive no interest income from coupon or residual bonds, they are taxed on the interest earned each year. The amount of interest taxed is calculated by taking the difference between the current price and the purchase price under the assumption that the yield to maturity has remained the same. For this reason, strip coupons are generally recommended only for non-taxable accounts.

**Note: Individuals should consult with their personal tax advisors before taking any action based on the information in this guide.*

Appendix I

Yield to Maturity Calculation

Bond: Government of Canada 3% maturing December 1, 2005
Settlement Date: December 1, 2003
Market Price: $100.085
Coupon Frequency: 2 per year

This bond pays $1.50 on June 1, 2004, December 1, 2004, June 1, 2005, and December 1, 2005. It pays $100 principal on December 1, 2005.

Bond prices are essentially the present value of all future cash flows from the bond. The general equation for calculating a present value is:

$$PV = \sum FV_n \left[\frac{1}{1+i}\right]^n$$

where i = semi-annual yield
n = number of compounding periods
PV = present value
FV = future value

We input the figures we have for this bond and calculate the unknown using trial and error:

$$100.085 = \frac{1.5}{(1+i)} + \frac{1.5}{(1+i)^2} + \frac{1.5}{(1+i)^3} + \frac{1.5}{(1+i)^4} + \frac{100}{(1+i)^4}$$

By trial and error, we find that i=1.48%.

To get the annualized semi-annual yield, we multiply 1.48 by 2 and get 2.96%.

We can also arrive at the yield by using a financial calculator:

Input in the calculator:

N=4
PMT=1.5
PV=100.085
FV=100

Calculate for i.

Appendix II

Effects of Interest Rate Movements

Bond Price-Yield Table								
	2yr CANADA 5.75% 1-Sep-06		5yr CANADA 4.25% 1-Sep-08		10yr CANADA 5.25% 1-Jun-13		30yr CANADA 5.75% 1-Jun-29	
Yield Change	Price	Yield	Price	Yield	Price	Yield	Price	Yield
-2.000%	112.600	0.660	112.341	1.410	123.983	2.350	147.756	3.030
-1.875%	112.268	0.785	111.762	1.535	122.816	2.475	144.933	3.155
-1.750%	111.937	0.910	111.186	1.660	121.662	2.600	142.183	3.280
-1.625%	111.607	1.035	110.613	1.785	120.521	2.725	139.503	3.405
-1.500%	111.278	1.160	110.044	1.910	119.392	2.850	136.891	3.530
-1.375%	110.951	1.285	109.479	2.035	118.276	2.975	134.346	3.655
-1.250%	110.624	1.410	108.917	2.160	117.173	3.100	131.865	3.780
-1.125%	110.299	1.535	108.358	2.285	116.081	3.225	129.447	3.905
-1.000%	109.975	1.660	107.802	2.410	115.002	3.350	127.089	4.030
-0.875%	109.653	1.785	107.250	2.535	113.935	3.475	124.791	4.155
-0.750%	109.331	1.910	106.702	2.660	112.880	3.600	122.550	4.280
-0.625%	109.011	2.035	106.156	2.785	111.836	3.725	120.364	4.405
-0.500%	108.691	2.160	105.614	2.910	110.804	3.850	118.234	4.530
-0.375%	108.373	2.285	105.075	3.035	109.783	3.975	116.155	4.655
-0.250%	108.056	2.410	104.539	3.160	108.774	4.100	114.128	4.780
-0.125%	107.741	2.535	104.006	3.285	107.775	4.225	112.151	4.905
0.000%	**107.426**	**2.660**	**103.477**	**3.410**	**106.788**	**4.350**	**110.222**	**5.030**
+0.125%	107.113	2.785	102.951	3.535	105.811	4.475	108.341	5.155
+0.250%	106.800	2.910	102.428	3.660	104.846	4.600	106.505	5.280
+0.375%	106.489	3.035	101.907	3.785	103.890	4.725	104.713	5.405
+0.500%	106.179	3.160	101.391	3.910	102.946	4.850	102.965	5.530
+0.625%	105.870	3.285	100.877	4.035	102.011	4.975	101.259	5.655
+0.750%	105.562	3.410	100.366	4.160	101.087	5.100	99.594	5.780
+0.875%	105.256	3.535	99.858	4.285	100.173	5.225	97.968	5.905
+1.000%	104.950	3.660	99.353	4.410	99.269	5.350	96.382	6.030
+1.125%	104.645	3.785	98.852	4.535	98.375	5.475	94.833	6.155
+1.250%	104.342	3.910	98.353	4.660	97.490	5.600	93.320	6.280
+1.375%	104.040	4.035	97.857	4.785	96.616	5.725	91.844	6.405
+1.500%	103.739	4.160	97.364	4.910	95.750	5.850	90.401	6.530
+1.625%	103.438	4.285	96.874	5.035	94.894	5.975	88.993	6.655
+1.750%	103.139	4.410	96.387	5.160	94.048	6.100	87.617	6.780
+1.875%	102.841	4.535	95.903	5.285	93.210	6.225	86.274	6.905
+2.000%	102.544	4.660	95.421	5.410	92.382	6.350	84.961	7.030

The information contained herein has been obtained from sources believed to be reliable at the time obtained but neither RBC Dominion Securities Inc. nor its employees, agents, or information suppliers can guarantee its accuracy or completeness. This report is not and under no circumstances is to be construed as an offer to sell or the solicitation of an offer to buy any securities. This report is furnished on the basis and understanding that neither RBC Dominion Securities Inc. nor its employees, agents, or information suppliers is to be under any responsibility or liability whatsoever in respect thereof. The inventories of RBC Dominion Securities Inc. may from time to time include securities mentioned herein. RBC Dominion Securities Inc. and Royal Bank of Canada are separate corporate entities which are affiliated. *Member CIPF. ®Registered trademark of Royal Bank of Canada. Used under licence. © Copyright 2004. All rights reserved.*

BOND (11/04)