

Economics 435
The Financial System
(2/12/14)

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Future Value and Present Value

- If the present value is \$100 and the interest rate is 5%, then the *future value* one year from now is:

$$\$100 + \$100(0.05) = \$105$$

- This also shows that the higher the interest rate, the higher the future value.
- In general:

$$FV = PV + PV(i) = PV(1 + i)$$

- And:

$$PV = \frac{FV}{(1 + i)}$$

Future Value and Compound Interest

- What if you leave your \$100 in the bank for two years at 5% yearly interest rate?
- The future value is:

$$\$100 + \$100(0.05) + \$100(0.05) + \$5(0.05) = \$110.25$$

$$\$100(1.05)(1.05) = \$100(1.05)^2$$

- In general

$$FV_n = PV(1 + i)^n$$

$$PV = \frac{FV}{(1 + i)^n}$$

Complications

- What if payments, X_t , occur all the way along until the end?
- What if the interest rate, i_t , is not constant?

$$PV_t = \left[\frac{X_{t+1}}{(1+i_t)} + \frac{X_{t+2}}{(1+i_t) \times (1+i_{t+1})} + \dots + \frac{X_{t+n}}{(1+i_t) \times (1+i_{t+1}) \dots (1+i_{t+n-1})} \right]$$

- But at time t , one doesn't know $t+n$ information ... so:

$$PV_t = \left[\mathcal{E}_t \frac{X_{t+1}}{(1+i_t)} + \mathcal{E}_t \frac{X_{t+2}}{(1+i_t) \times (1+i_{t+1})} + \dots + \mathcal{E}_t \frac{X_{t+n}}{(1+i_t) \times (1+i_{t+1}) \dots (1+i_{t+n-1})} \right]$$

Bond Basics

- The most common type of bond is a **coupon bond**.
 - Issuer is required to make annual payments, called **coupon payments**.
 - The annual interest the borrower pays (i_c), is the **coupon rate**.
 - The date on which the payments stop and the loan is repaid (n), is the **maturity date** or term to maturity.
 - The final payment is the **principal, face value,** or **par value** of the bond.

Bond Prices

1. Zero-coupon or discount bond

- Promise a single payment on a future date
- Example: Treasury bill

2. Fixed-payment loan

- Sequence of fixed payments
- Example: Mortgage or car loan

3. Coupon bond

- periodic interest payments + principal repayment at maturity
- Example: U.S. Treasury Bonds and most corporate bonds

4. Consol

- periodic interest payments forever, principal never repaid
- Example: U.K. government has some outstanding

Zero-Coupon Bonds

- **U.S. Treasury bills (T-bills)** are the most straightforward type of bond.
 - Each T-bill represents a promise by the U.S. government to pay \$100 on a fixed future date.
 - No coupon payments - **zero-coupon bonds**
 - Also called **pure discount bonds** (or discount bonds) since the price is less than face value - they sell at a discount.
- Price of \$100 face value zero-coupon bond

$$= \frac{\$100}{(1 + i)^n}$$

Zero-Coupon Bonds

Assume $i = 5\%$

Price of a One-Year Treasury Bill

$$= \frac{100}{(1 + 0.05)} = \$95.24$$

Price of a Six-Month Treasury Bill

$$= \frac{100}{(1 + 0.05)^{1/2}} = \$97.59$$

Zero-Coupon Bonds

- For a zero-coupon bond, the relationship between the price and the interest rate is the same as we saw on present value calculations.
- When the price moves, the interest rate moves with it, in the opposite direction.
- We can compute the interest rate from the price using the present value formula.

The price of a one-year T-bill is \$95.

$$i = (\$100/\$95) - 1 = 0.0526 = 5.26\%$$

Fixed-Payment Loans

- Home mortgages and car loans are fixed-payment loans.
 - They promise a fixed number of equal payments at regular intervals.
 - Amortized loans - the borrower pays off part of the principal along with the interest for the life of the loan.

- Value of a Fixed Payment Loan =

$$\frac{\textit{FixedPayment}}{(1+i)} + \frac{\textit{FixedPayment}}{(1+i)^2} + \dots + \frac{\textit{FixedPayment}}{(1+i)^n}$$

- The sum of the present value of the payments.

Coupon Bonds

- The issuer of a coupon bond promises to make a series of periodic interest payments (coupon payments), plus a principal payment at maturity.

Price of Coupon Bond =

$$P_{CB} = \left[\frac{\textit{CouponPayment}}{(1+i)^1} + \frac{\textit{CouponPayment}}{(1+i)^2} + \dots + \frac{\textit{CouponPayment}}{(1+i)^n} \right] + \frac{\textit{FaceValue}}{(1+i)^n}$$

Consols

- **Consols** or **perpetuities**, are like coupon bonds whose payments last forever.
- The borrower pays only interest, never repaying the principal.
- The U.S. government sold consols once in 1900, but the Treasury has bought them all back.
- The price of a consol is the present value of all future interest payments.

$$P_{\text{Consol}} = \frac{\text{Yearly Coupon Payment}}{i}$$

Bond Yields

- We know how to calculate bond prices given an interest rate.
- We also need to be able to go in the other direction.
 - Calculate the return to an investment, implicit in the bond's price.
- We will combine information about the promised payments with the price to obtain the *yield*:
 - A measure of the cost of borrowing and the reward for lending.
 - We will use the terms *yield* and *interest rate* interchangeably.

Yield to Maturity

- The most useful measure of the return on holding a bond is called the **yield to maturity**:
 - The yield bondholders receive if they hold the bond to its maturity when the final principal payment is made.

$$\text{Price of 1yr 5\% Coupon Bond} = \frac{\$5}{(1+i)} + \frac{\$100}{(1+i)}$$

- The value of i that solves the equation is the yield to maturity.

Current Yield

Example:

1 year, 5% coupon bond selling for \$99

$$\text{Current Yield} = \frac{5}{99} = 0.0505, \text{ or } 5.05\%$$

Yield to maturity for this bond is 6.06 percent found as the solution to:

$$\frac{\$5}{(1+i)} + \frac{\$100}{(1+i)} = \$99$$

Holding Period Returns


- The *one-year holding period return* is the sum of the yearly coupon payment divided by the price paid for the bond and the change in the price divided by the price paid.

$$= \frac{\text{Yearly Coupon Payment}}{\text{Price Paid}} + \frac{\text{Change in Price of the Bond}}{\text{Price of the Bond}}$$

$$= \text{Current Yield} + \text{Capital Gain (as a \%)}$$

Data on “Treasury Notes and Bonds”

http://online.wsj.com/mdc/public/page/2_3020-treasury.html

TREASURY NOTES & BONDS					
GO TO: Bills					
Friday, February 07, 2014		Find Historical Data  WHAT'S THIS?			
Treasury note and bond data are representative over-the-counter quotations as of 3pm Eastern time. For notes and bonds callable prior to maturity, yields are computed to the earliest call date for issues quoted above par and to the maturity date for issues below par.					
Maturity	Coupon	Bid	Asked	Chg	Asked yield
2/15/2014	1.250	100.0156	100.0234	-0.0078	-0.471
2/15/2014	4.000	100.0469	100.0547	-0.0391	-0.025
2/28/2014	0.250	100.0000	100.0078	-0.0078	0.093
2/28/2014	1.875	100.0859	100.0938	-0.0156	-0.010
3/15/2014	1.250	100.0938	100.1094	-0.0156	0.050
3/31/2014	0.250	100.0000	100.0156	-0.0078	0.134
3/31/2014	1.750	100.1875	100.2188	-0.0391	0.124
4/15/2014	1.250	100.1953	100.2031	-0.0078	0.094
4/30/2014	0.250	100.0156	100.0313	-0.0156	0.107
4/30/2014	1.875	100.3750	100.3906	-0.0234	0.084
5/15/2014	1.000	100.2266	100.2344	-0.0078	0.097
5/15/2014	4.750	101.1875	101.2109	-0.0547	0.085
5/31/2014	0.250	100.0391	100.0469	unch.	0.095
5/31/2014	2.250	100.6406	100.6563	-0.0234	0.078

2/15/2023	7.125	137.7500	137.8203	0.2891	2.428
5/15/2023	1.750	92.8047	92.8672	0.2578	2.622
8/15/2023	2.500	98.7891	98.8516	0.2656	2.637
8/15/2023	6.250	131.3281	131.3906	0.2500	2.519
11/15/2023	2.750	100.6094	100.6719	0.2266	2.671
11/15/2024	7.500	144.7656	144.8359	0.2891	2.676

5/15/2040	4.375	113.5547	113.6328	0.1328	3.570
8/15/2040	3.875	104.7031	104.7813	0.1328	3.594
11/15/2040	4.250	111.3281	111.4063	0.1563	3.583
2/15/2041	4.750	120.3125	120.3516	0.1953	3.570
5/15/2041	4.375	113.5469	113.5938	0.2031	3.589
8/15/2041	3.750	102.2344	102.2656	0.1875	3.619
11/15/2041	3.125	90.8125	90.8281	0.1641	3.653
2/15/2042	3.125	90.6719	90.6875	0.1719	3.659
5/15/2042	3.000	88.2578	88.2891	0.1719	3.669
8/15/2042	2.750	83.5391	83.5859	0.1797	3.685
11/15/2042	2.750	83.3594	83.4375	0.1563	3.689
2/15/2043	3.125	90.1484	90.2109	0.1875	3.677
5/15/2043	2.875	85.4063	85.4688	0.1719	3.691
8/15/2043	3.625	99.2109	99.2734	0.1953	3.665
11/15/2043	3.750	101.5078	101.5703	0.1641	3.663

Data on Treasury Bills

TREASURY BILLS

GO TO: [Notes and Bonds](#)

Friday, February 07, 2014

Treasury bill bid and ask data are representative over-the-counter quotations as of 3pm Eastern time quoted as a discount to face value. Treasury bill yields are to maturity and based on the asked quote.

Maturity	Bid	Asked	Chg	Asked yield
2/13/2014	0.045	0.035	0.040	0.035
2/20/2014	0.040	0.030	0.035	0.030
2/27/2014	0.045	0.025	0.060	0.025
3/6/2014	0.095	0.080	0.035	0.081
3/13/2014	0.100	0.085	0.060	0.086
3/20/2014	0.095	0.075	0.035	0.076
3/27/2014	0.100	0.065	0.040	0.066
10/16/2014	0.075	0.065	-0.005	0.066
11/13/2014	0.090	0.080	0.005	0.081
12/11/2014	0.090	0.085	unch.	0.086
1/8/2015	0.100	0.095	unch.	0.096
2/5/2015	0.115	0.110	-0.005	0.112

“On the run”

Data on Treasurys

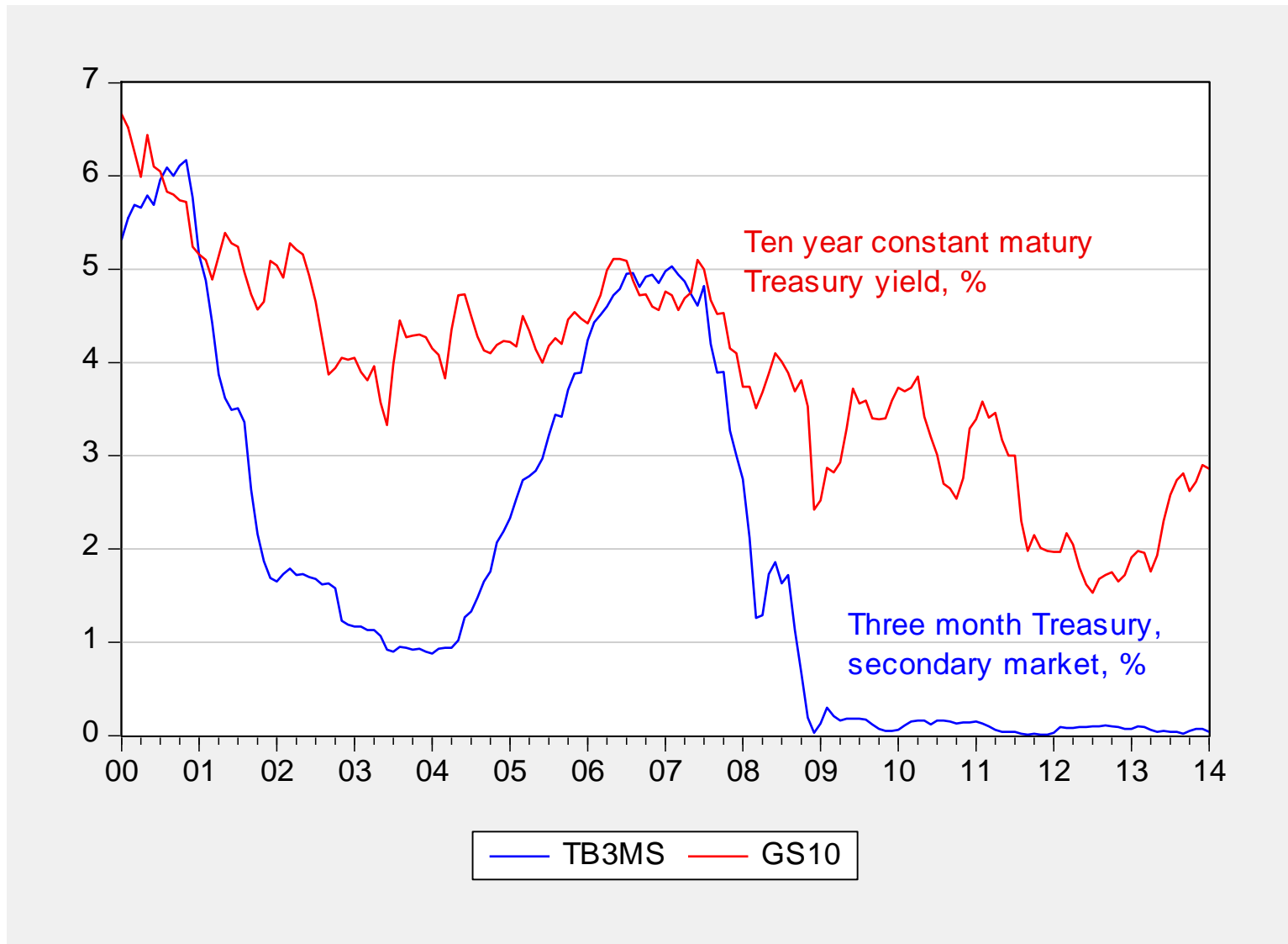
<http://finance.yahoo.com/bonds>

US Treasury Bonds Rates

Maturity	Yield	Yesterday	Last Week	Last Month
3 Month	0.07	0.05	0.03	0.03
6 Month	0.05	0.05	0.05	0.06
2 Year	0.30	0.31	0.29	0.43
3 Year	0.63	0.66	0.67	0.83
5 Year	1.47	1.52	1.47	1.76
10 Year	2.69	2.70	2.65	3.00
30 Year	3.68	3.67	3.60	3.89

See also: <http://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield>

Secondary Market, Constant Maturity



Real and Nominal Interest Rates


- The nominal interest rate you agree on (i) must be based on *expected inflation* (π^e) over the term of the loan plus the real interest rate you agree on (r).

$$i = r + \pi^e$$

- This is called the *Fisher Equation*.
- The higher expected inflation, the higher the nominal interest rate.

Data on Treasury Inflation Protected Securities (TIPS)

http://online.wsj.com/mdc/public/page/2_3020-tips.html

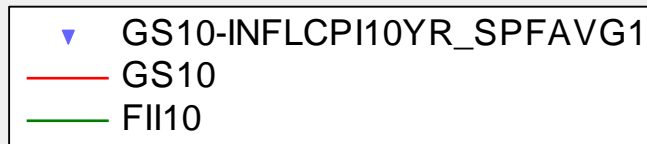
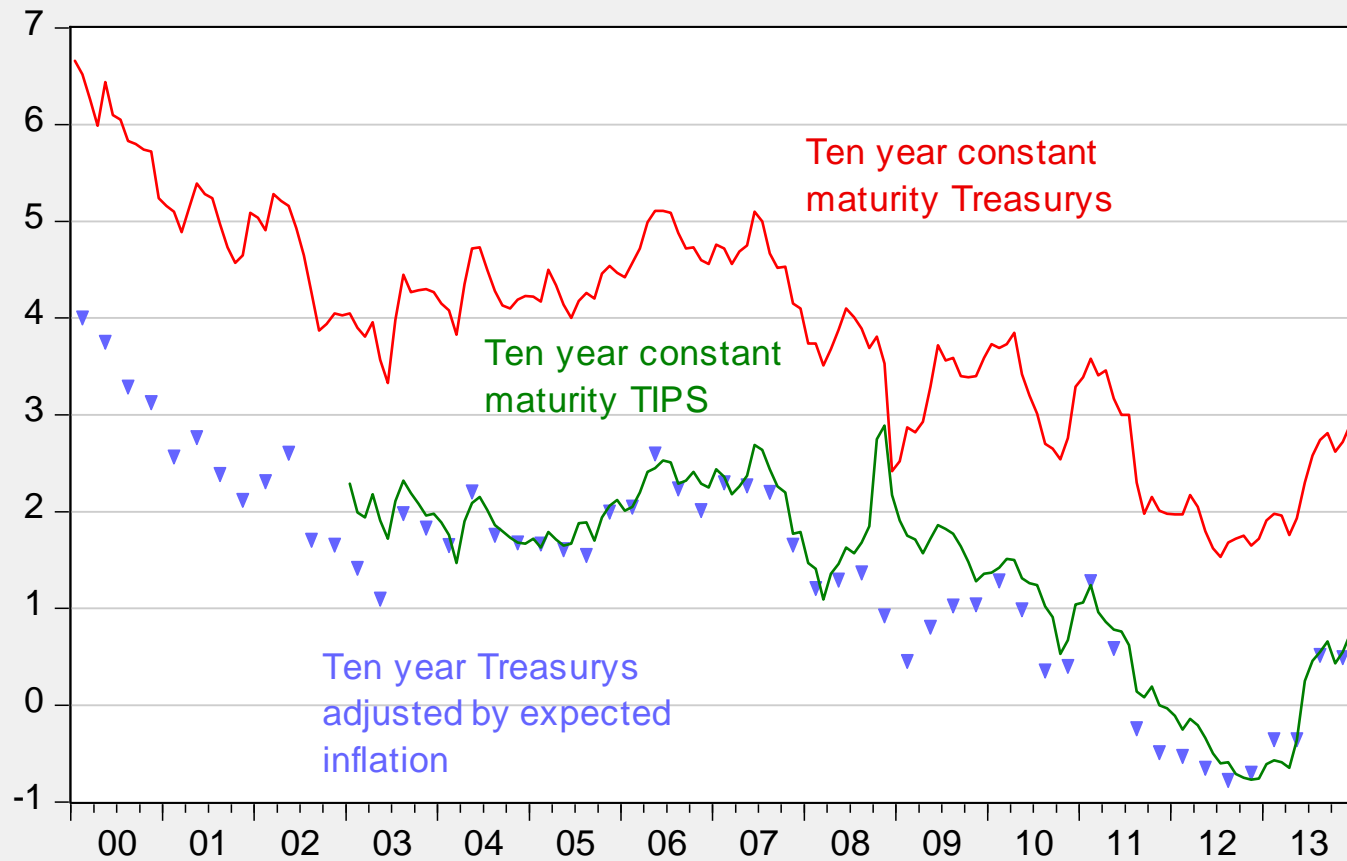
Treasury Inflation-Protected Securities						
Monday, February 11, 2013 Find Historical Data  WHAT'S THIS?						
<p>Treasury Inflation-Protected Securities, or TIPS, are securities whose principal is tied to the Consumer Price Index (CPI) . The principal increases with inflation and decreases with deflation. When the security matures, the U.S. Treasury pays the original or adjusted principal, whichever is greater. TIPS pay interest every six months. Figures after periods in bid and ask quotes represent 32nds; 101.26 means 101 26/32, or 101.8125% of 100% face value; 99.01 means 99 1/32, or 99.03125% of face value.</p>						
Maturity	Coupon	Bid	Asked	Chg	Yield*	Accrued principal
2013 Apr 15	0.625	100.15	100.15	unch.	-2.157	1088
2013 Jul 15	1.875	102.15	102.15	unch.	-3.849	1252
2014 Jan 15	2.000	103.25	103.26	unch.	-2.053	1244
2014 Apr 15	1.250	103.23	103.23	unch.	-1.884	1086
2014 Jul 15	2.000	106.07	106.07	unch.	-2.282	1220
2015 Jan 15	1.625	107.02	107.03	unch.	-1.970	1204
2015 Apr 15	0.500	105.08	105.08	unch.	-1.866	1061
2015 Jul 15	1.875	109.32	110.01	- 1	-2.137	1182
2016 Jan 15	2.000	111.21	111.23	- 1	-1.877	1158

2022 Jul 15	0.125	108.09	108.14	+ 4	-0.737	1000
2023 Jan 15	0.125	107.10	107.15	+ 4	-0.604	n.a.
2025 Jan 15	2.375	133.17	133.23	+ 3	-0.387	1220

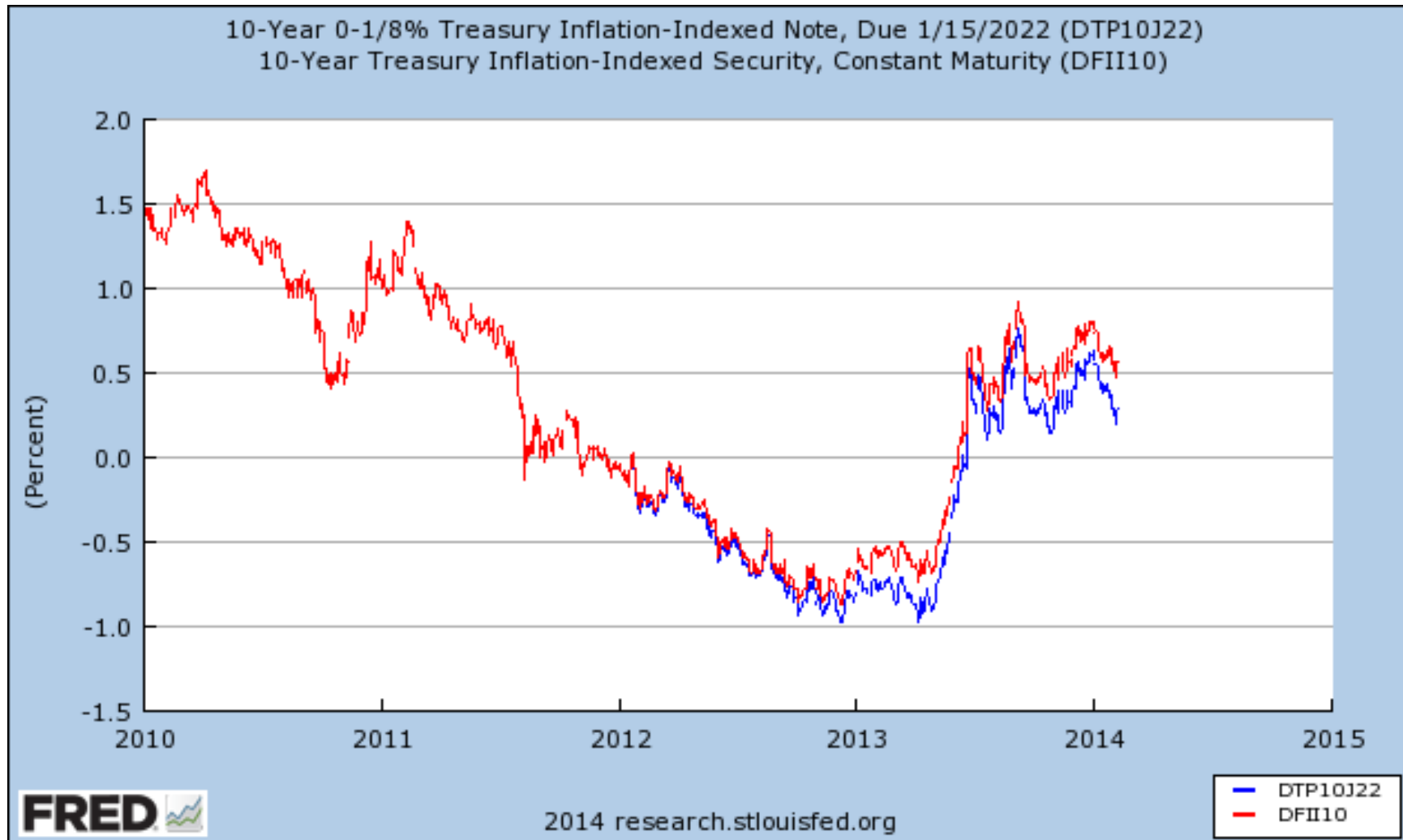
2029 Apr 15	3.875	162.12	162.22	+ 5	-0.001	1398
2032 Apr 15	3.375	160.25	161.04	+ 5	0.141	1295
2040 Feb 15	2.125	142.16	142.30	+ 17	0.438	1064
2041 Feb 15	2.125	143.13	143.28	+ 18	0.455	1050
2042 Feb 15	0.750	105.28	106.09	+ 16	0.516	1017

*-Yld. to maturity on accrued principal.

Nominal vs. Real



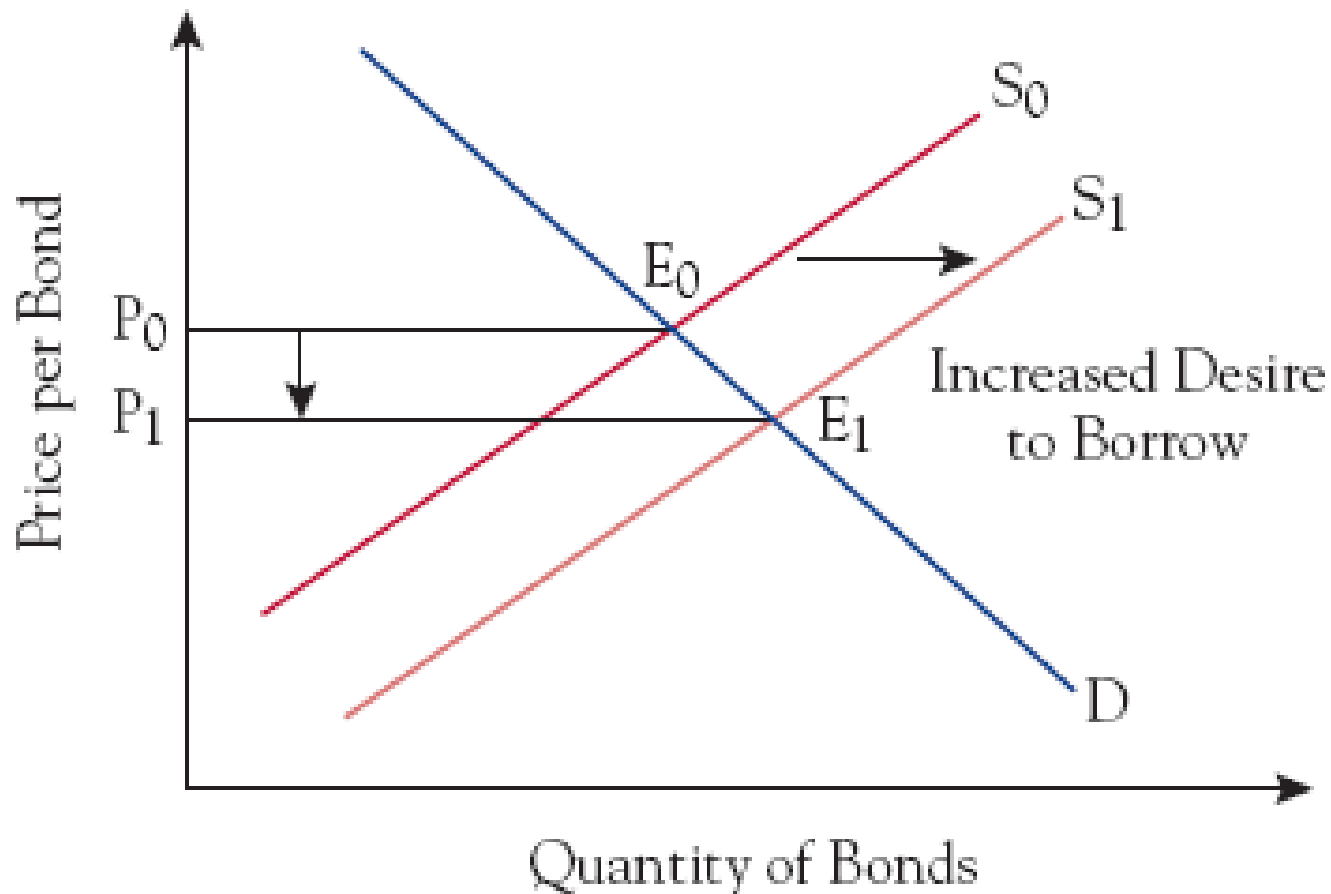
Constant Maturity vs. On the Run



Factors That Shift Bond Supply

Figure 6.2

A Shift in the Supply of Bonds



Factors That Shift Bond Demand

Figure 6.3

A Shift in the Demand for Bonds

