Public Affairs 974-1
Monetary and Financial Policy in the Wake of the Financial Crisis
(10/4/12)

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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?

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

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

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

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 =

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

- 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 =

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

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

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.

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

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.

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

= Current Yield + Capital Gain (as a %)

Data on “Treasury Notes and Bonds”

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

U.S. Treasury Quotes

TREASURY NOTES & BONDS

GO TO: Bills

Wednesday, September 26, 2012 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
9/30/2012	0.375	100.0000	100.0078	0.0000	-0.576
9/30/2012	4.250	100.0234	100.0469	-0.0156	-1.433
10/15/2012	1.375	100.0625	100.0703	0.0000	-0.054
10/31/2012	0.375	100.0234	100.0313	0.0000	0.037
10/31/2012	3.875	100.3438	100.3516	-0.0156	-0.097
11/15/2012	1.375	100.1641	100.1719	-0.0078	0.084
11/15/2012	4.000	100.5156	100.5234	-0.0078	0.068
11/30/2012	0.500	100.0703	100.0781	0.0000	0.053
11/30/2012	3.375	100.5703	100.5781	-0.0078	0.068
12/15/2012	1.125	100.2109	100.2188	0.0039	0.111
11/15/2019	3.375	116.1016	116.1484	0.4063	1.022
2/15/2020	3.625	118.0625	118.1094	0.4375	1.068
2/15/2020	8.500	152.9453	152.9922	0.4531	1.028
5/15/2020	3.500	117.3359	117.3828	0.4609	1.118
2/15/2039	3.500	115.5391	115.6172	1.4219	2.671
5/15/2039	4.250	130.4297	130.5078	1.5469	2.646
8/15/2039	4.500	135.5234	135.6016	1.6016	2.642
11/15/2039	4.375	133.0703	133.1484	1.5625	2.653
2/15/2040	4.625	138.2188	138.2969	1.6406	2.649
5/15/2040	4.375	133.2266	133.3047	1.6172	2.664
8/15/2040	3.875	123.0781	123.1250	1.5625	2.691
11/15/2040	4.250	130.7969	130.8438	1.6250	2.681
2/15/2041	4.750	141.1563	141.2031	1.6563	2.670
5/15/2041	4.375	133.4766	133.5078	1.6250	2.689
8/15/2041	3.750	120.4688	120.5000	1.5313	2.721
11/15/2041	3.125	107.3672	107.3828	1.4922	2.755
2/15/2042	3.125	107.2109	107.2266	1.4375	2.764

Data on Treasury Bills

TREASURY BILLS

GO TO: Notes and Bonds

Wednesday, September 26, 2012

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
9/27/2012	n.a.	n.a.	n.a.	n.a.
10/4/2012	-0.020	-0.030	-0.0350	-0.0300
10/11/2012	0.010	0.000	0.0000	0.0000
10/18/2012	0.015	0.005	0.0000	0.0050
10/25/2012	0.050	0.045	0.0300	0.0460
11/1/2012	0.035	0.025	0.0200	0.0250
11/8/2012	0.045	0.010	0.0000	0.0100
6/27/2013	0.155	0.150	-0.0050	0.1520
8/22/2013	0.170	0.160	0.0000	0.1620
9/19/2013	0.165	0.160	-0.0050	0.1620

"On the run"

Data on Treasuries

http://www.bloomberg.com/markets/rates-bonds/government-bonds/us/

Rates & Bonds | Government Bonds | Corporate Bonds | Key Rates

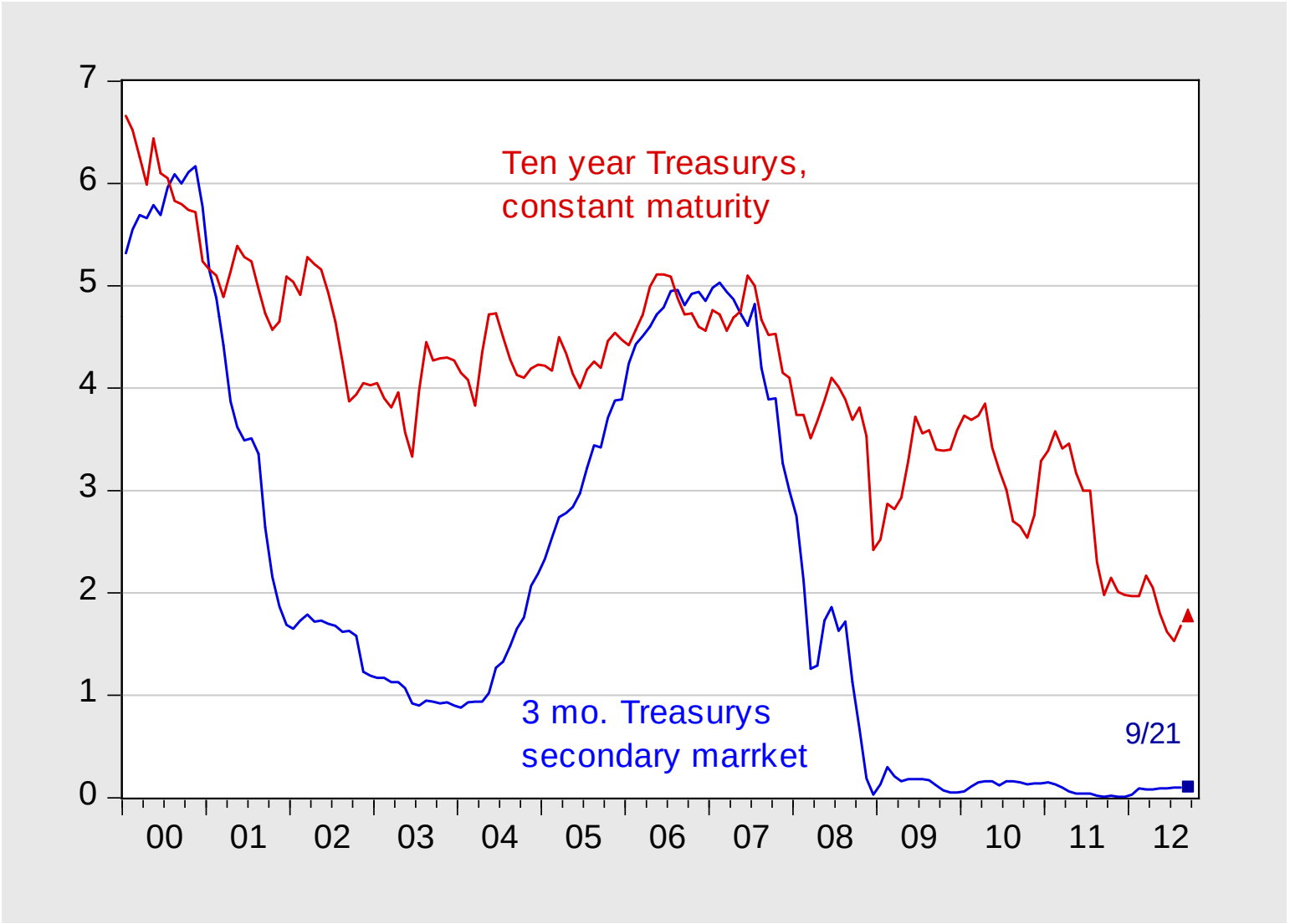
Government Bonds

U.S. UK Germany Japan Hong Kong Australia Brazil

U.S. Treasuries

	COUPON	MATURITY	PRICE/YIELD	PRICE/YIELD CHANGE	TIME
3-Month	0.000	12/27/2012	0.10 / 0.10	-0.005 / -0.005	20:16
6-Month	0.000	03/28/2013	0.13 / 0.13	-0.010 / -0.010	20:16
12-Month	0.000	09/19/2013	0.16 / 0.16	-0.005 / -0.005	20:16
2-Year	0.250	09/30/2014	99-31½ / 0.26	0-00+ / -0.008	20:17
3-Year	0.250	09/15/2015	99-24 / 0.33	0-00+ / -0.005	20:16
5-Year	0.625	09/30/2017	100-01½ / 0.63	0-04+ / -0.027	20:16
7-Year	1.000	08/31/2019	99-26+ / 1.03	0-08 / -0.038	20:16
10-Year	1.625	08/15/2022	100-01+ / 1.62	0-14 / -0.048	20:17
30-Year	2.750	08/15/2042	99-08+ / 2.79	1-06 / -0.059	20:17

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

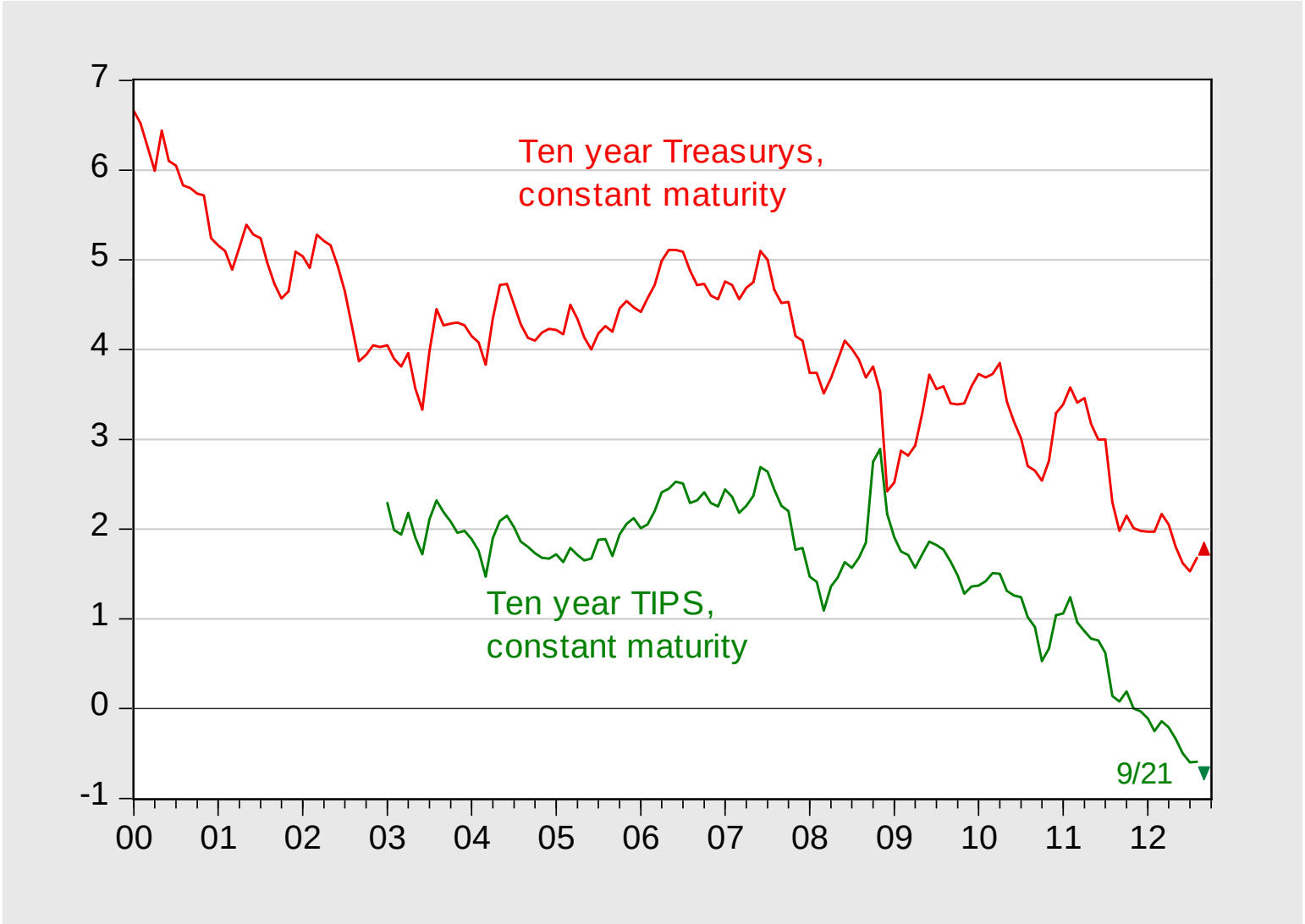
Wednesday, September 26, 2012 Find Historical Data | WHAT'S THIS?

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.

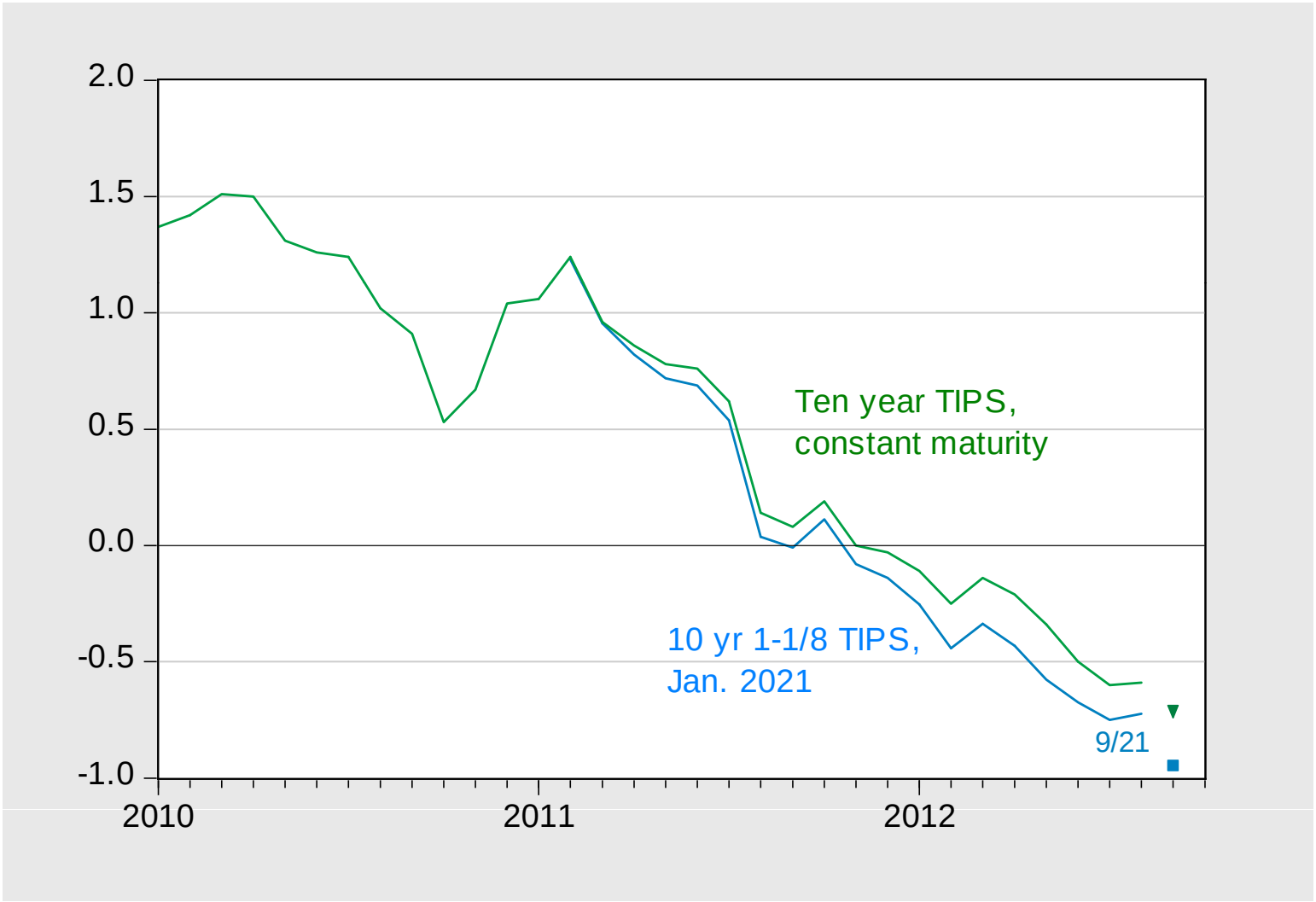
Maturity	Coupon	Bid	Asked	Chg	Yield*	Accrued principal
2013 Apr 15	0.625	100.32	101.00	- 2	-1.183	1084
2013 Jul 15	1.875	102.30	102.30	- 2	-1.773	1247
2014 Jan 15	2.000	104.17	104.17	+ 1	-1.449	1240
2014 Apr 15	1.250	104.01	104.02	- 2	-1.327	1082
2014 Jul 15	2.000	106.22	106.22	- 6	-1.655	1215
2015 Jan 15	1.625	107.10	107.11	- 4	-1.506	1200
2015 Apr 15	0.500	105.03	105.04	- 5	-1.470	1057
2015 Jul 15	1.875	110.01	110.02	- 5	-1.628	1178
2016 Jan 15	2.000	112.04	112.05	- 5	-1.577	1154
2016 Apr 15	0.125	105.32	106.01	- 4	-1.524	1038
2017 Apr 15	0.125	107.22	107.24	- 6	-1.516	1008
2017 Jul 15	2.625	120.28	120.30	- 7	-1.562	1105
2018 Jan 15	1.625	117.04	117.07	- 2	-1.487	1093
2018 Jul 15	1.375	117.12	117.15	unch.	-1.499	1062
2029 Jan 15	2.500	144.07	144.16	+ 32	-0.188	1067
2029 Apr 15	3.875	167.16	167.27	+ 38	-0.166	1393
2032 Apr 15	3.375	167.27	168.07	+ 44	-0.085	1291
2040 Feb 15	2.125	148.01	148.16	+ 44	0.283	1060
2041 Feb 15	2.125	148.31	149.15	+ 45	0.304	1046
2042 Feb 15	0.750	110.10	110.23	+ 40	0.365	1014

*-Yld. to maturity on accrued principal.

Nominal vs. Real

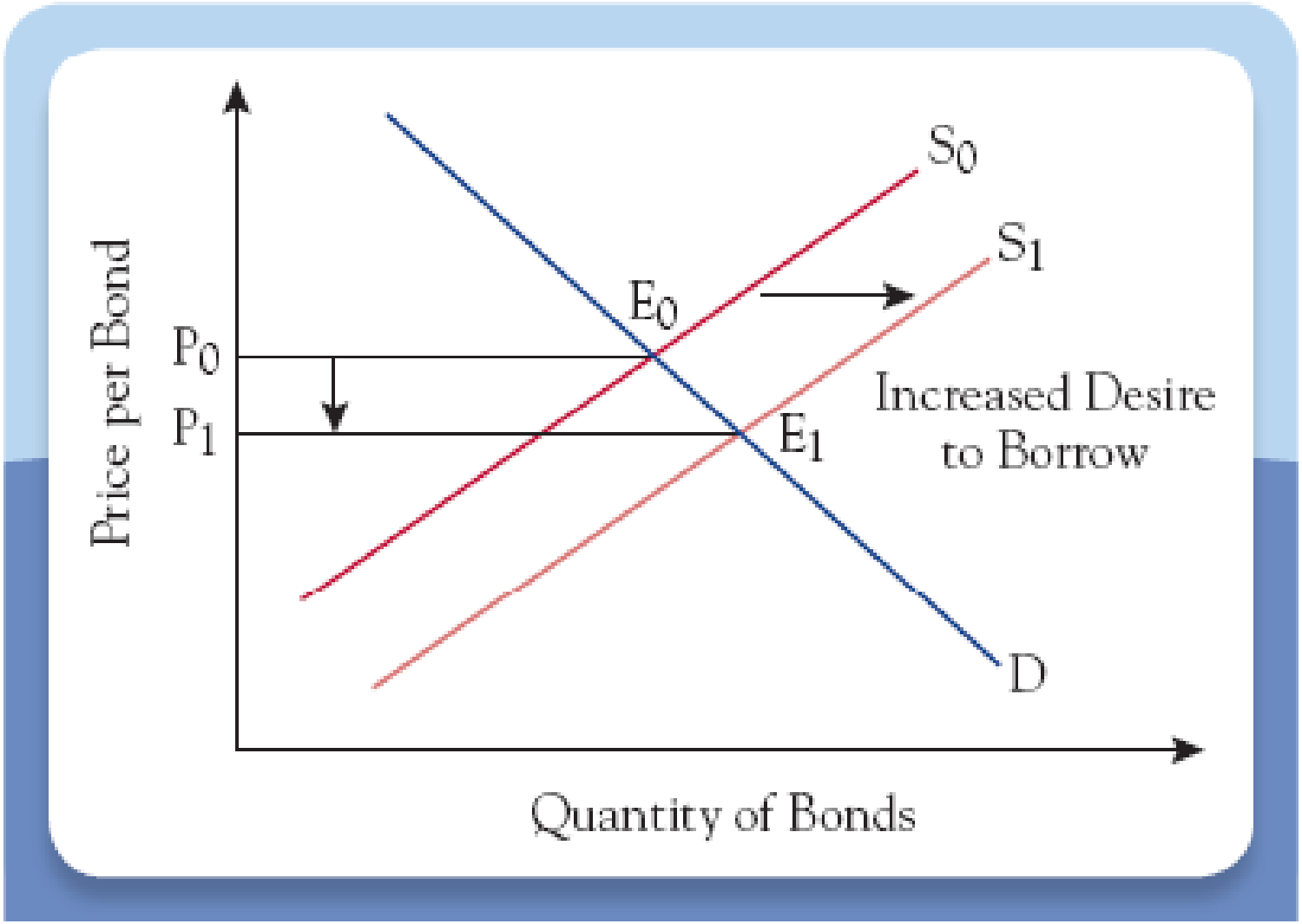


Constant Maturity vs. On the Run



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