MONEY AND BANKING
LECTURE 3: RISK AND TERM STRUCTURE OF INTEREST RATES

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Outline

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2 The Risk Structure of Interest Rates
- Default Risk
- Liquidity and Information Costs
- Tax Treatment

3 Term Structure of Interest Rates
- Outline of Term Structure Theory
- Empirical Studies of Yield Curve
- Theoretical Explanation
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INTRODUCTION

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   - Why do bonds with same maturities differ?
   - Why do bonds with same issuer differ?
2. After this lecture, you will understand the comovement of interest rates in financial markets (e.g., money market, bond market, and mortgage market).

THE RISK STRUCTURE OF INTEREST RATES

OUTLINE OF RISK STRUCTURE

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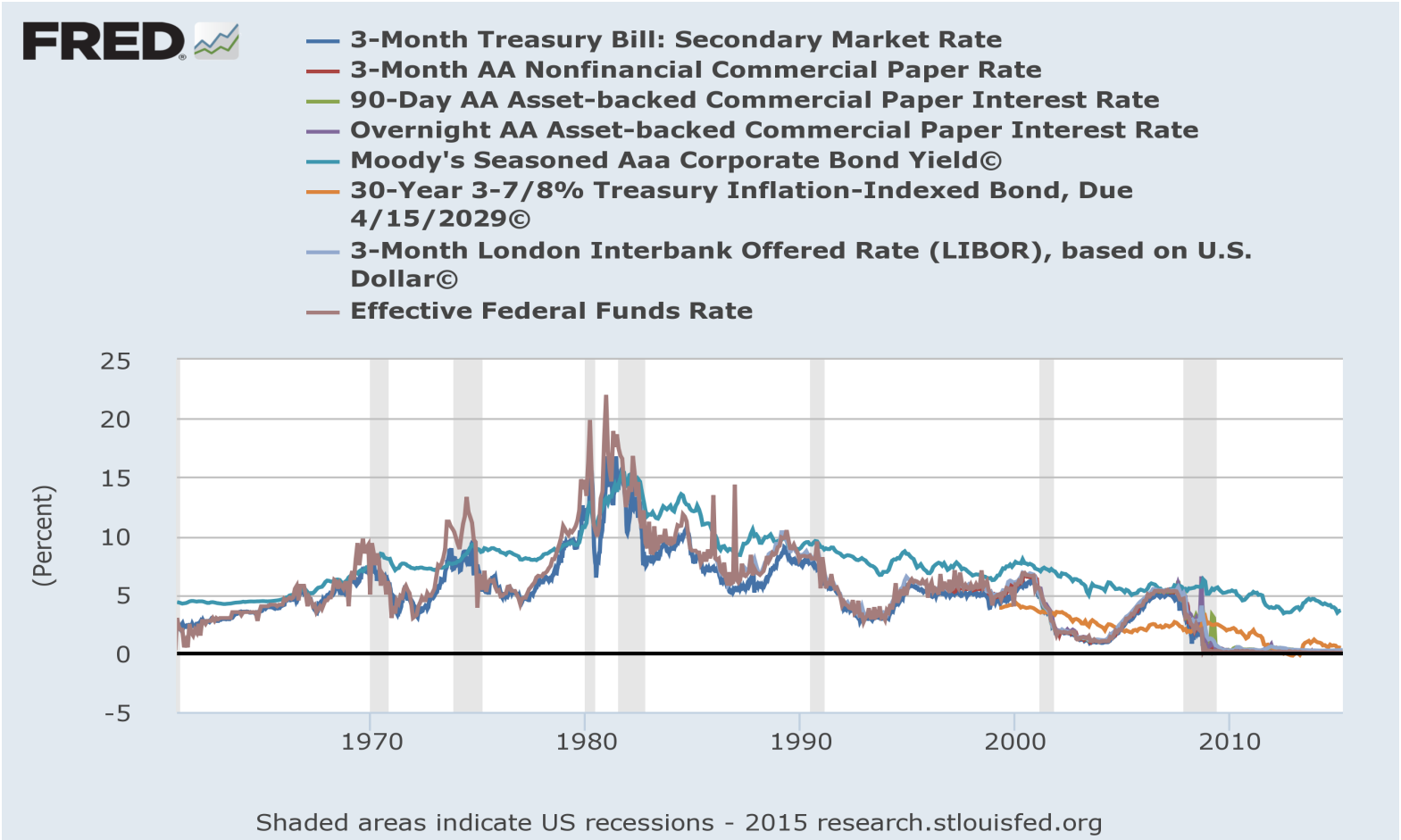
1. Why might bonds that have the same maturities - for example, all the bonds that will mature in 20 years - have different interest rates, or yield to maturity?
2. Because they are different with respect to other characteristics that investors believe are important.
3. Economists use the term **risk structure of interest rates** to describe the relationship among the interest rates on bonds that have different characteristics but the same maturities.

The Risk Structure of Interest Rates

Default Risk



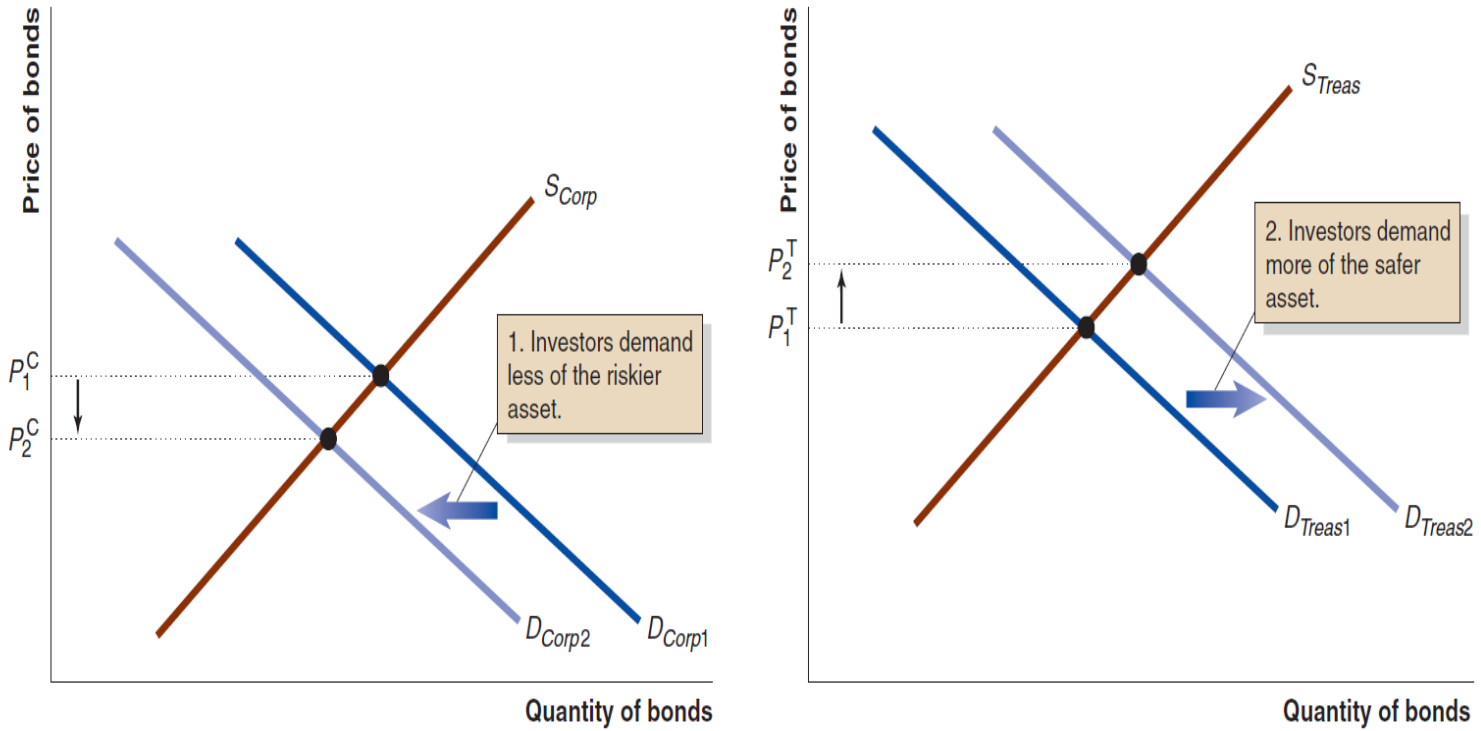
THE RISK STRUCTURE OF INTEREST RATES

DEFAULT RISK

	Moody's Investors Service	Standard & Poor's (S&P)	Fitch Ratings	Meaning of the Ratings
Investment-grade bonds	Aaa	AAA	AAA	Highest credit quality
	Aa	AA	AA	Very high credit quality
	A	A	A	High credit quality
	Baa	BBB	BBB	Good credit quality
Non-investment-grade bonds	Ba	BB	BB	Speculative
	B	B	B	Highly speculative
	Caa	CCC	CCC	Substantial default risk
	Ca	CC	CC	Very high levels of default risk
	C	C	C	Exceptionally high levels of default risk
	—	D	D	Default

THE RISK STRUCTURE OF INTEREST RATES

DEFAULT RISK



THE RISK STRUCTURE OF INTEREST RATES

LIQUIDITY AND INFORMATION COSTS

1. Investors care about liquidity, they are willing to accept a lower interest rate on more liquid investments than on less liquid - *illiquid* - investment, all other things being equal (ceteris paribus) .

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3. Spending time and money acquiring information on a bond, for example, reduces the bond's expected return.
4. An increase in a bond's liquidity or a decrease in the cost of acquiring information about the bond will increase the demand for the bond.

THE RISK STRUCTURE OF INTEREST RATES

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4. Investors care about the *after-tax return* on their investment.

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Tax Treatment

1. Suppose two bonds each with $1,000 face values and 8% coupon rates, meaning they pay coupons of $80 per year.
2. Assume that on the first bond, issued by General Electric (GE), the investor has to pay a 40% tax on the coupon received.
3. On the second bond, issued by the U.S. Treasury, the investor pays only a 25% tax on the coupon received.

The Risk Structure of Interest Rates

Tax Treatment

Type of bond	Taxed by state and local government?	Taxed by the federal government?
Corporate bond	Taxed by most states and some cities	Yes
Treasury bond	No	Yes
Municipal bond	No	No

THE RISK STRUCTURE OF INTEREST RATES

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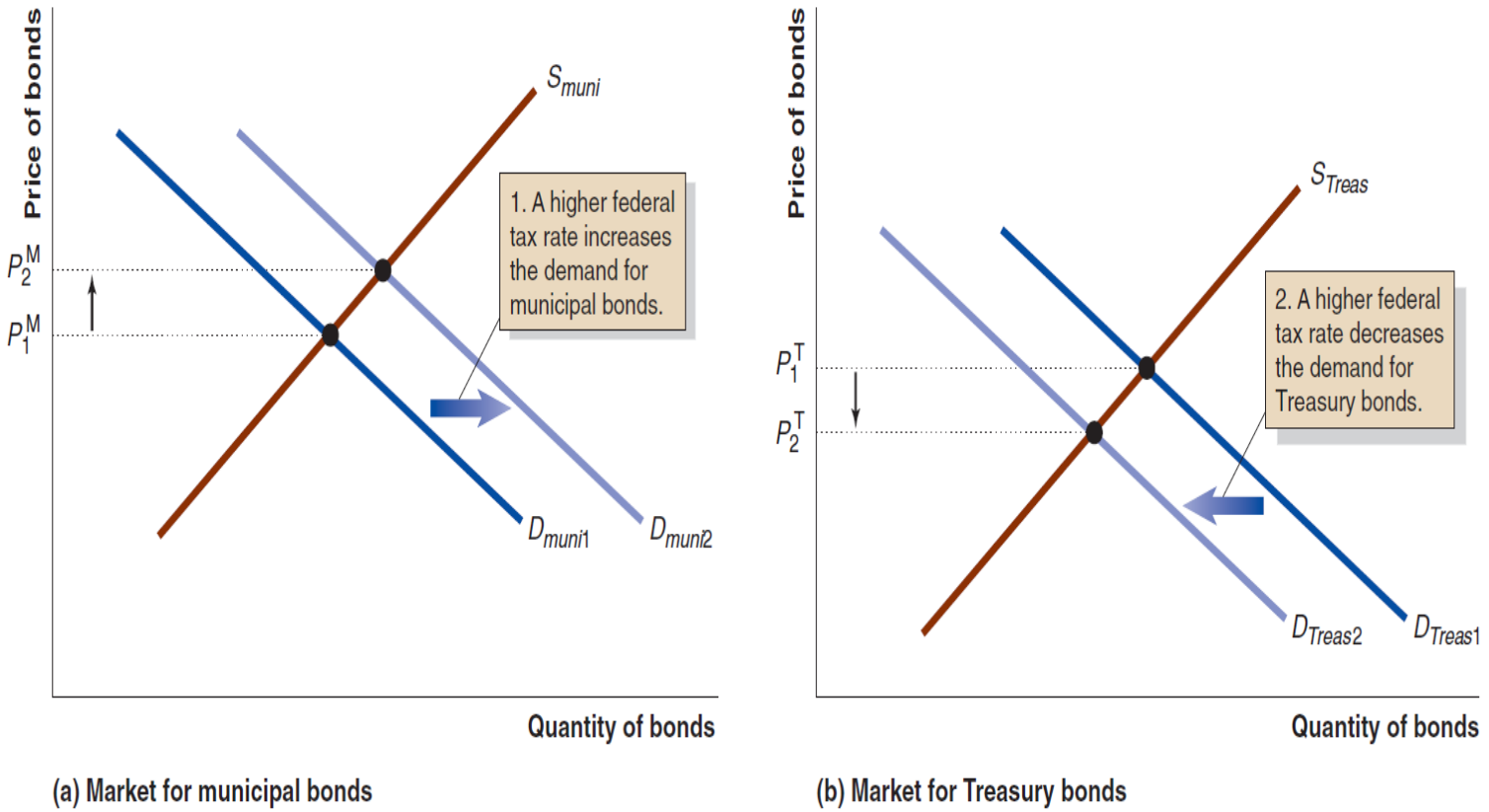

Term Structure of Interest Rates

Outline of Term Structure Theory

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4. **Term structure of interest rates** is going to list underlying reasons of this question.

Term Structure of Interest Rates

Empirical Studies of Yield Curve

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TERM STRUCTURE OF INTEREST RATES

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4. Recall what we have learned: $\leq$ one year $\rightarrow$*Treasury bills*, $2 \leq$ maturity ≤ 10 years $\rightarrow$ *notes*, and ≥ 10 years $\rightarrow$ bonds.

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3. You use choose some data and plot yield curve with Matlab, R, Julia, or Python.

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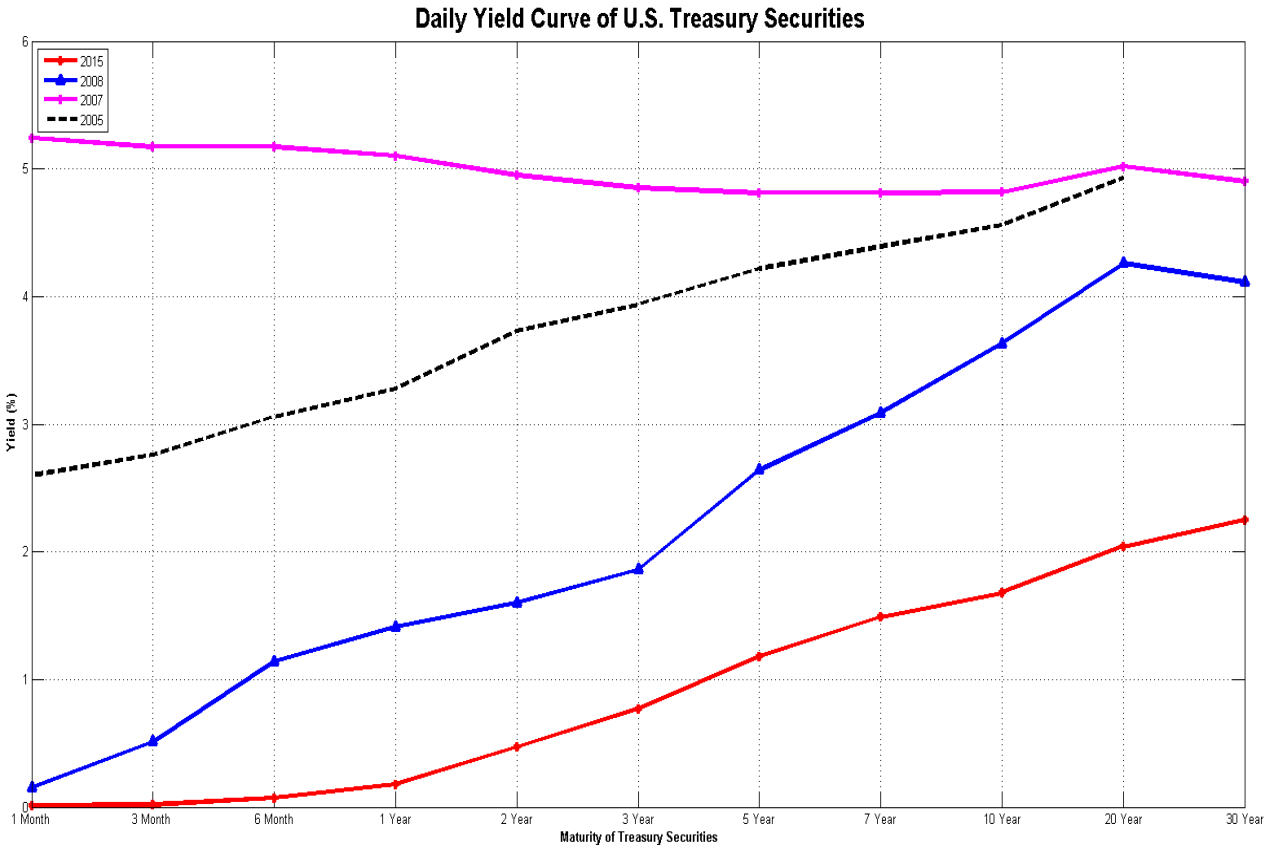

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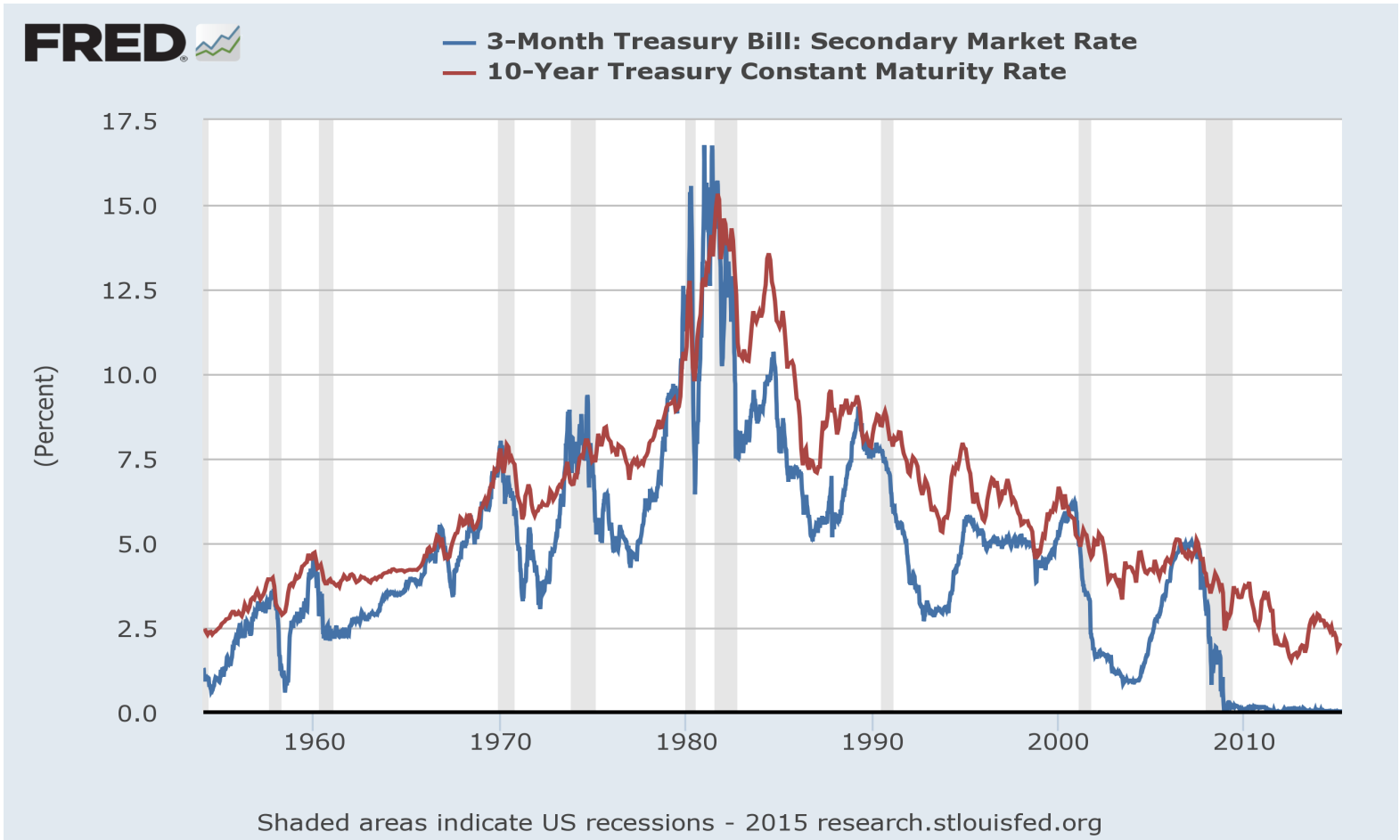

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   - Yield curves almost always slope upward.

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   - predictive power: how well does the theory explain actual data on yield curve?

Theoretical Explanation

Expectation Theory

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   - Investors have the same investment objectives.
   - During investment horizon, investors are indifferent between long-term bonds and short-term bonds. i.e., they are perfect substitutes.

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Expectation Theory: Numerical Example

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4. Denote the interest rate (per annum) of this bond is i_{2t}.

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2. Notice that with this strategy, you don't know the second one-year bond's interest rate in advance.
3. You need to take expectation. Denote the rate on the one-year bond today is i_{1t}, and expected rate is $i^e_{1,t+1}$.

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$$\$1,000(1+i_{2t})^2 = \$1,000(1+i_{1,t})(1+i^e_{1,t+1}),$$
3. Some basic algebraic rearrangement give you
$$1+2i_{2t}+i^2_{2t} = 1+i_{1,t}+i^e_{i,t+1}+i_{1,t}i^e_{1,t+1},$$

Theoretical Explanation

Expectation Theory: Numerical Example

1. As before in Fisher equation, we assume i_t^2 and the cross product of $i_{1,t} i^e_{1,t+1}$ are negligible.

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3. In words, the rate on two-year (long-term) bond is approximately the average of two rates of one-year (short-term) bonds.

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2. Should any violation happen, you can do arbitrage. For example, if short-term rate is lower than long-term rate, then you can borrow at short term rate, buy long-term bonds. Till mature, pay off the debt you borrowed. You still have profit margin.
3. Such arbitrage will push up the prices of long term bond, lowering its yield (Why?). Arbitrage stops when two investment strategies yield the same.

Theoretical Explanation

Expectation Theory

1. In general, we can write Expectation Theory in mathematical form as follows:

$$i_{n,t} = \frac{i_{1,t} + i^e_{1,t+1} + i^e_{1,t+2} + \cdots + i^e_{1,t+n-1}}{n}, \tag{1}$$

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2. Predictive power: suppose short-term interest rate moves up in next two periods. Based on (1), long-term rate $i_{n,t}$ moves up as well.
3. However, it cannot explain the third empirical fact.
4. No guarantee that short rates in the future always move upward.

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Segmented Markets Theory

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2. The departure from this assumption bring us another theoretical explanation of terms of structure, **segmented markets theory**.
3. In segmented market theory, it is assumed that short-term and long-term bonds are traded in totally different (segmented) markets.

Theoretical Explanation

Segmented Markets Theory

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   - investors in the bond market do not all have the same objectives.
   - investors do not see bonds of different maturities as being perfect substitutes for each other.

Theoretical Explanation

Segmented Markets Theory

1. The first assumption is reasonable in financial market. Some large corporations, for example, involved in money market just for cash management; while insurance companies are more likely to invest in long-term bond markets.

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1. The first assumption is reasonable in financial market. Some large corporations, for example, involved in money market just for cash management; while insurance companies are more likely to invest in long-term bond markets.
2. Since market is segmented, factors that affect the demand for Treasury bills or other short-term bonds have no effect on the demand for Treasury bonds or other long-term bonds.

Theoretical Explanation

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2. Long term bonds have two shortcomings
   - they are subject to greater interest-rate risk than short-term bonds;
   - they are often less liquid then short-term bonds.
3. As a result of preferring short-term bonds, the prices of those bonds are driven up and their yields are driven down relative to those of long-term bonds.

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Segmented Markets Theory

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Segmented Markets Theory

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2. There are more investors who are in the market for short-term bonds, causing their prices to be higher and their interest rates lower, and fewer investors are in the market for long-term bonds, causing their prices to be lower and their interest rates higher.
3. In addition, long-term investors require a higher interest rate to compensate them for the additional interest rate risk and lower liquidity.

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1. However, segmented markets theory cannot offer explanations of the rest two empirical facts.
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3. It seems the failure falls into assumptions too.

THEORETICAL EXPLANATION

THE LIQUIDITY PREMIUM THEORY

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Theoretical Explanation

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2. The fundamental assumptions of this theory are:
   - investors have different objectives;
   - investors view bonds with different maturities as substitutes - but not perfect substitutes.

Theoretical Explanation

The Liquidity Premium Theory

1. The additional interest rate investors require in order to be wiling to buy a long-term bond rather than a comparable sequence of short-term bonds is called **term premium**.

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2. The liquidity premium theory has a modified mathematical form as follows:

$$i_{n,t} = \frac{i_{1,t} + i^e_{1,t+1} + i^e_{1,t+2} + \cdots + i^e_{n,t+n-1}}{n} + i^{TP}_{n,t}, \qquad (2)$$

Theoretical Explanation

The Liquidity Premium Theory: A Numerical Example

1. Assume that the liquidity premium holds. On February 19, 2010, what did investors expect the interest rate to be on the one-year Treasury bill two years from that time if the term premium on a two-year Treasury note was 0.05% and the term premium on a three-year Treasury note was 0.10%.

Theoretical Explanation

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2.

Date	1 Year	2 Year	3 Year
02/19/2010	0.39%	0.95%	1.51%

Theoretical Explanation

The Liquidity Premium Theory: A Numerical Example

1. The interest rate expected on the one-year bond one year in the future:

$$i_{2,t} = 0.95\% = \frac{0.39\% + i^e_{1,t+1}}{2} + 0.05\%\,, \quad \Rightarrow \quad i^e_{1,t+1} = 1.41\%\,,$$

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The Liquidity Premium Theory: A Numerical Example

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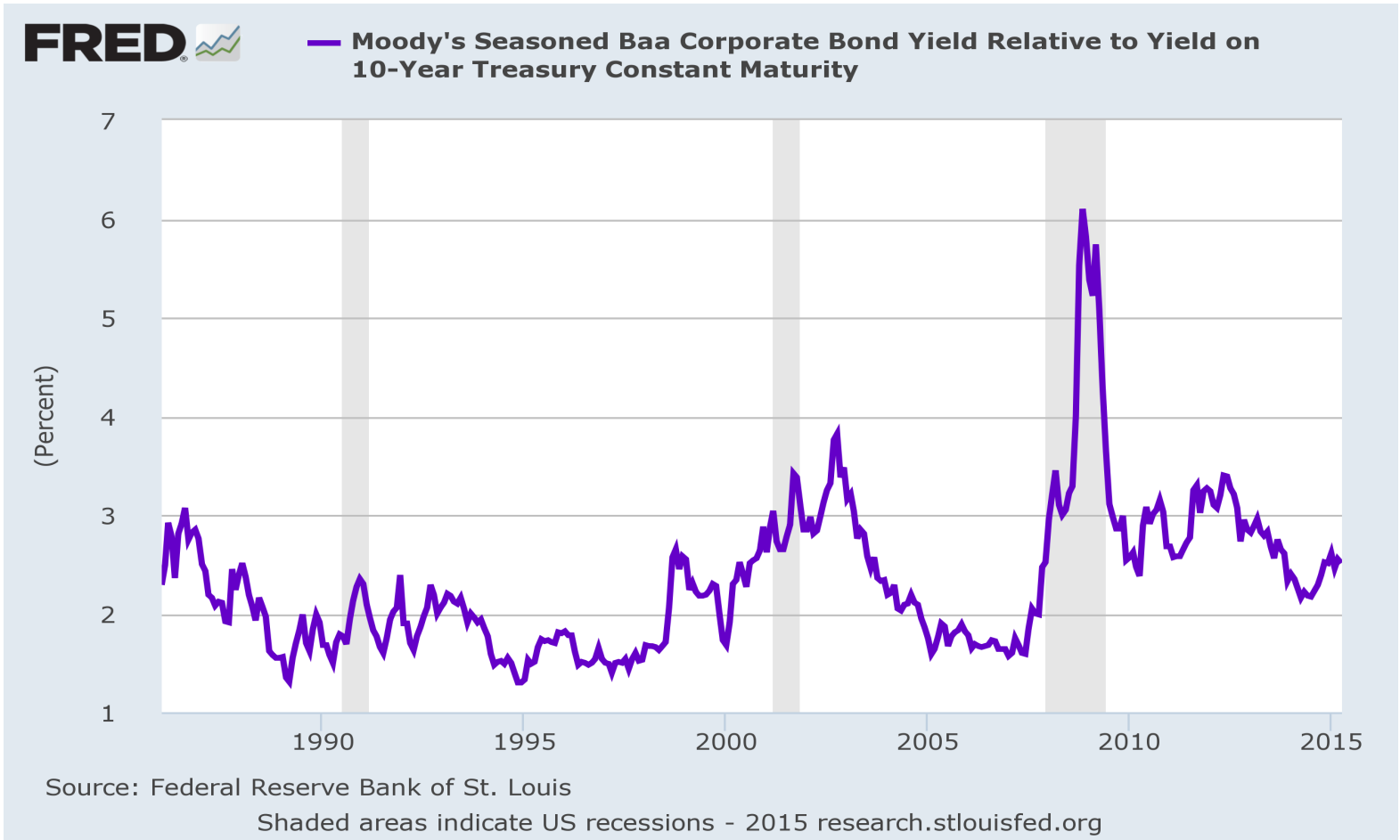
2. The interest rate investors expected on the one-year Treasury bill two years from February 19, 2010 is

$$i_{3,t} = 1.51\% = \frac{0.39\% + 1.41\% + i^e_{1,t+2}}{3} + 0.10\%, \quad \Rightarrow \quad i^e_{1,t+2} = 2.43\%,$$

Theoretical Explanation

The Liquidity Premium Theory: A Numerical Example



Theoretical Explanation

Summary

Theory	Assumptions	Predictions	What the theory explains
Expectations	Investors have the same investment objectives, and, for a given holding period, investors view bonds of different maturities as perfect substitutes for each other.	The interest rate on a long-term bond equals the average of the interest rates expected on the one-year bonds during this period.	Explains the slope of the yield curve and why interest rates on short-term and long-term bonds move together but does not explain why the yield curve is usually upward sloping.
Segmented markets	Investors in the bond market do not all have the same objectives, and investors do not see bonds of different maturities as being substitutes for each other.	Interest rates on bonds of different maturities are determined in separate markets.	Explains why the yield curve is usually upward sloping but does not explain why it should ever be downward sloping or why interest rates on bonds of different maturities should move together.
Liquidity premium	Investors view bonds of different maturities as substitutes for each other—but not as perfect substitutes.	The interest rate on an n-year bond equals the average of the interest rates expected on the n one-year bonds during these n years plus a term premium.	Explains all three important facts about the term structure.