FN211
Term Structure of Interest Rates

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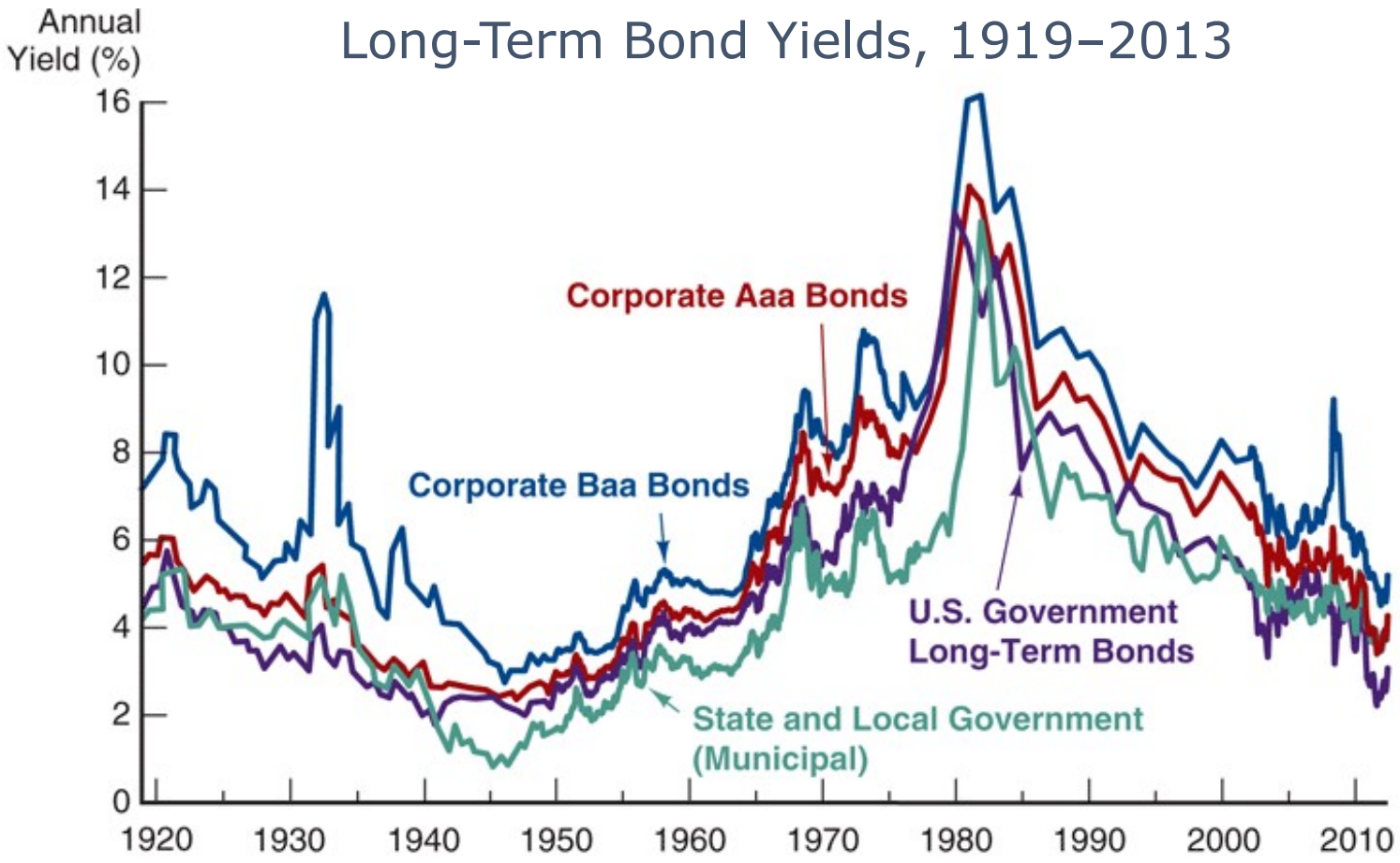
Preview

- Why do bonds with same maturity offer different yields and prices? - **risk structure of interest rates**

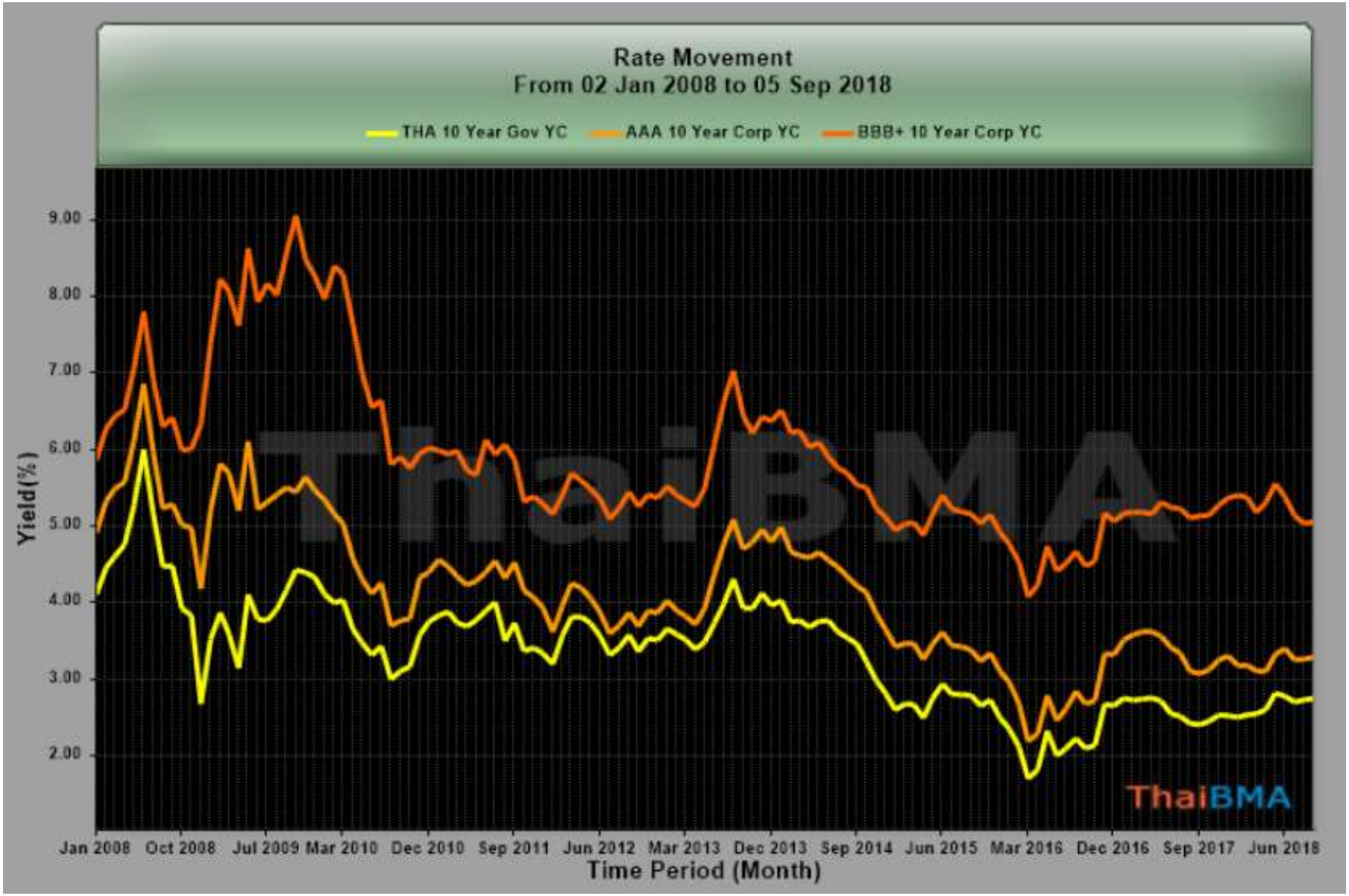
- Why do bonds with different maturities offer different prices? - **term structure of interest rates or the yield curve**

Risk Structure of Long Bonds in the U.S.

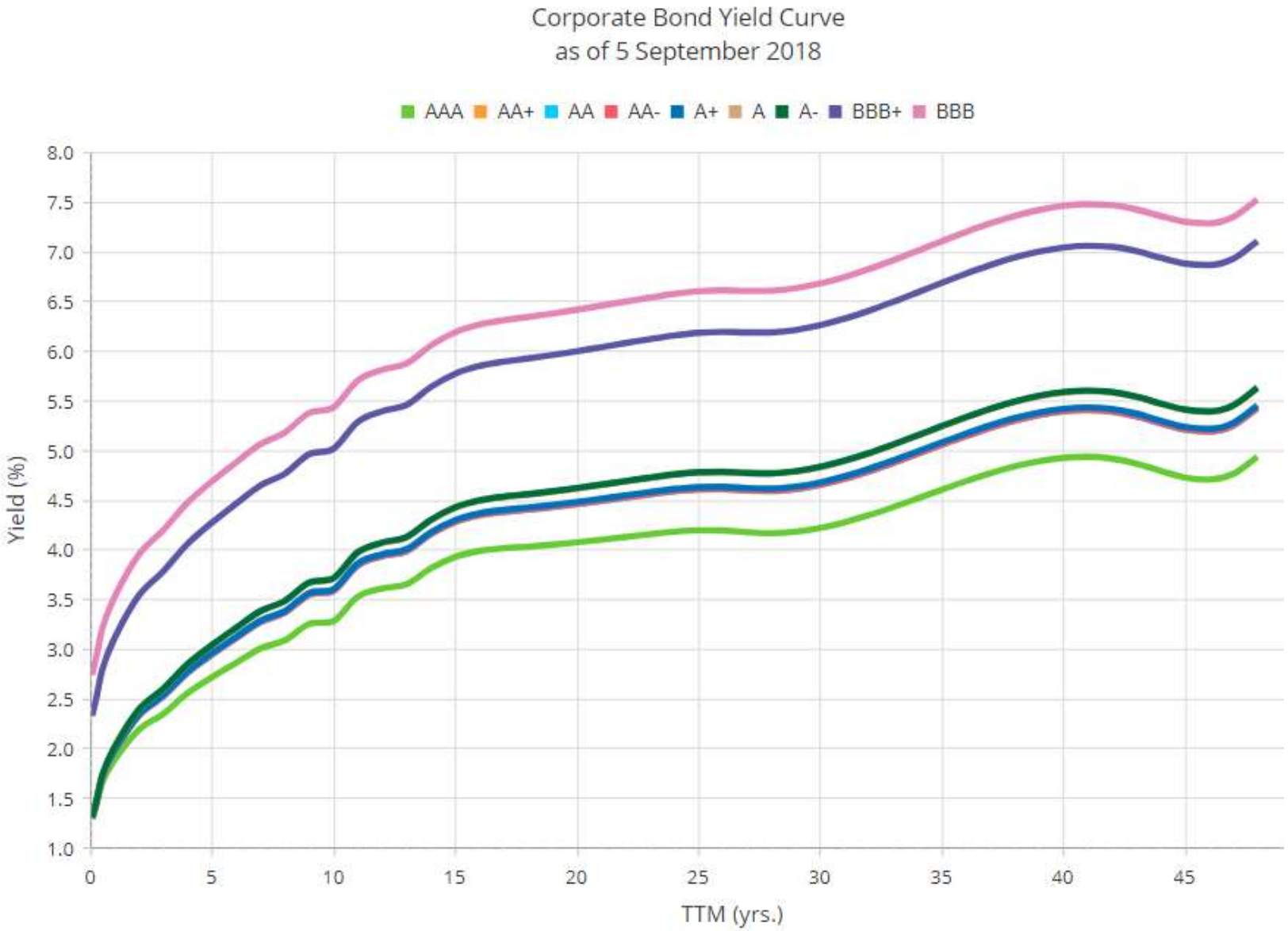


Sources: Board of Governors of the Federal Reserve System, *Banking and Monetary Statistics, 1941–1970*; Federal Reserve Bank of St. Louis FRED database, http://research.stlouisfed.org/fred2/.

Risk Structure of Long Bonds in Thailand



Corporate bond yield curve in Thailand



Risk Structure of Interest Rates

To further examine these features, we will look at three specific risk factors.

- Default Risk (ความเสี่ยงจากการผิดนัดชำระหนี้)
- Liquidity
- Income Tax Considerations

1 Default Risk

- **Default risk** – occurs when the issuer of the bond is unable or unwilling to make interest payments when promised.

- U.S. Treasury bonds have usually been considered to have no default risk because the federal government can always increase taxes to pay off its obligations (or just print money). Bonds like these with no default risk are called **default-free bonds.**

Default Risk

- **Risk premium** - the spread between the interest rates on bonds with default risk and default-free bonds.
  - It indicates how much additional interest people must earn in order to be willing to hold that risky bond.

- A bond with default risk will always have a positive risk premium, and an increase in its default risk will raise the risk premium.

Default Risk Factor

- Default risk is an important component of the size of the risk premium.

- Because of this, bond investors would like to know as much as possible about the default probability of a bond.

- One way to do this is to use the measures provided by credit-rating agencies: Moody's and S&P are examples.

Bond Ratings

Bond Ratings by Moody's and Standard and Poor's

Rating			
Moody's	Standard and Poor's	Descriptions	Examples of Corporations with Bonds Outstanding in 2013
Aaa	AAA	Highest quality (lowest default risk)	Microsoft, Johnson & Johnson, Mobil Corp.
Aa	AA	High quality	Shell Oil, Sanofi, General Electric
A	A	Upper-medium grade	Bank of America, Intel Corp., McDonald's, Inc.
Baa	BBB	Medium grade	Hewlett-Packard, FedEx, Harley Davidson
Ba	BB	Lower-medium grade	Charter Communications, Netflix, Best Buy
B	B	Speculative	Rite Aid, United Airlines, Delta Airlines
Caa	CCC, CC	Poor (high default risk)	Western Express, RadioShack, J.C. Penney
C	D	Highly speculative	American Airlines

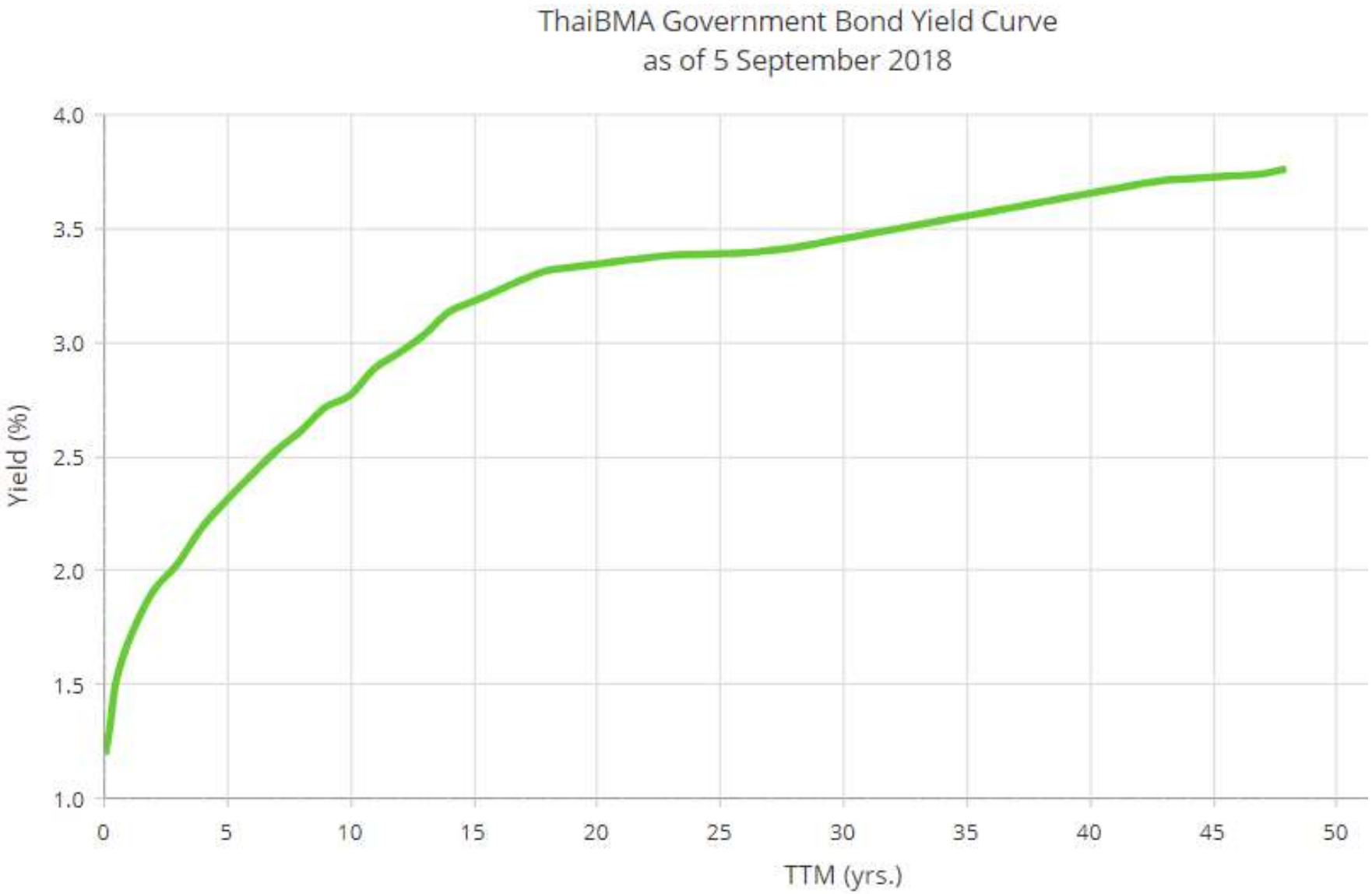
2 Liquidity Factor

- A liquid asset is one that can be quickly and cheaply converted into cash if the need arises.
- The more liquid an asset is, the more desirable it is (higher demand), holding everything else constant.
- Liquidity can also be explained with the use of previous figure.

3 Income Taxes Factor

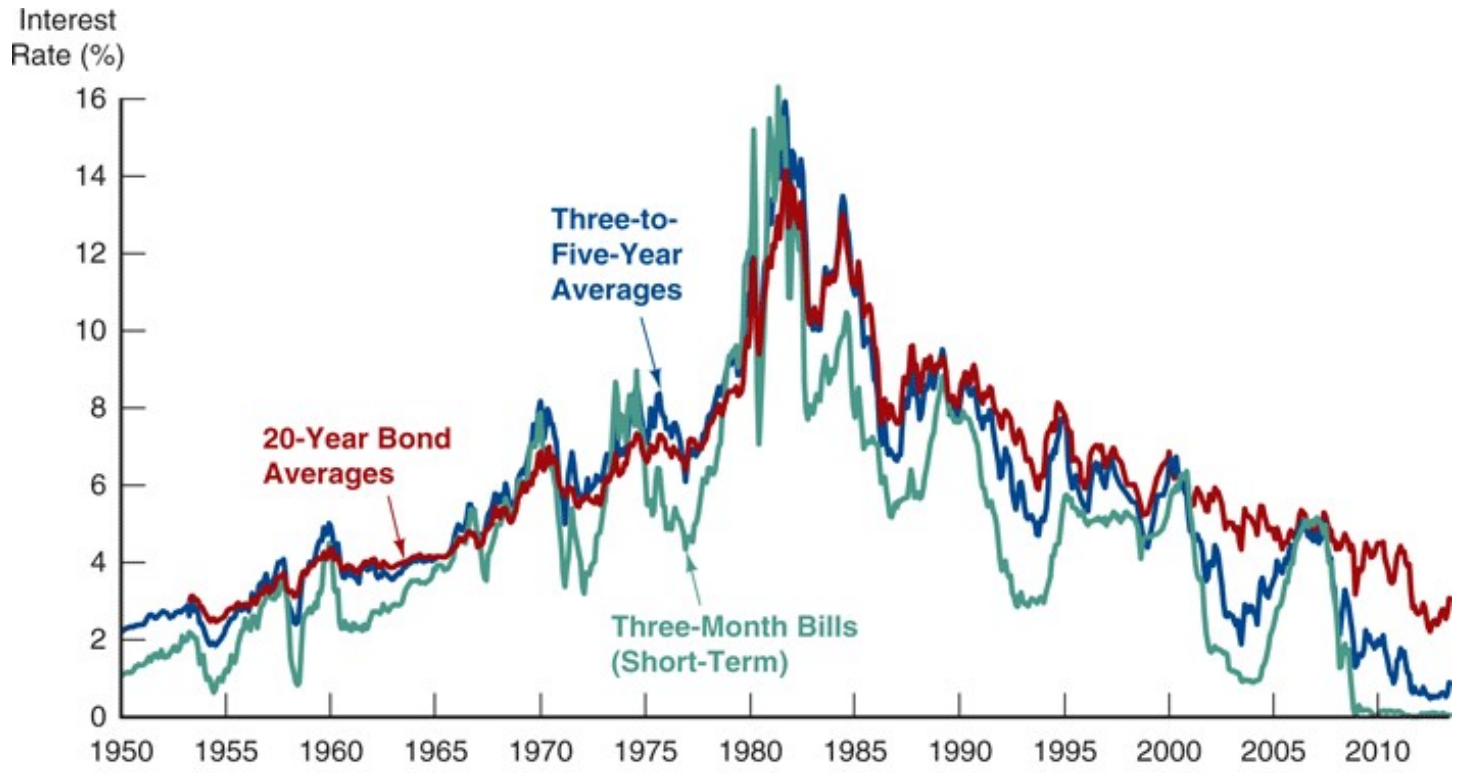
- Interest payments on *municipal bonds* are exempt from income taxes, a factor that has the same effect on the demand for municipal bonds as an increase in their expected return.
- Suppose you are in the 35% tax bracket. From a 10%-coupon T-bond, you only net $65 of the coupon payment because of taxes
- However, from an 8%-coupon muni, you net the full $80. For the higher return, you are willing to hold a riskier muni (to a point).

Government bond yield curve in Thailand



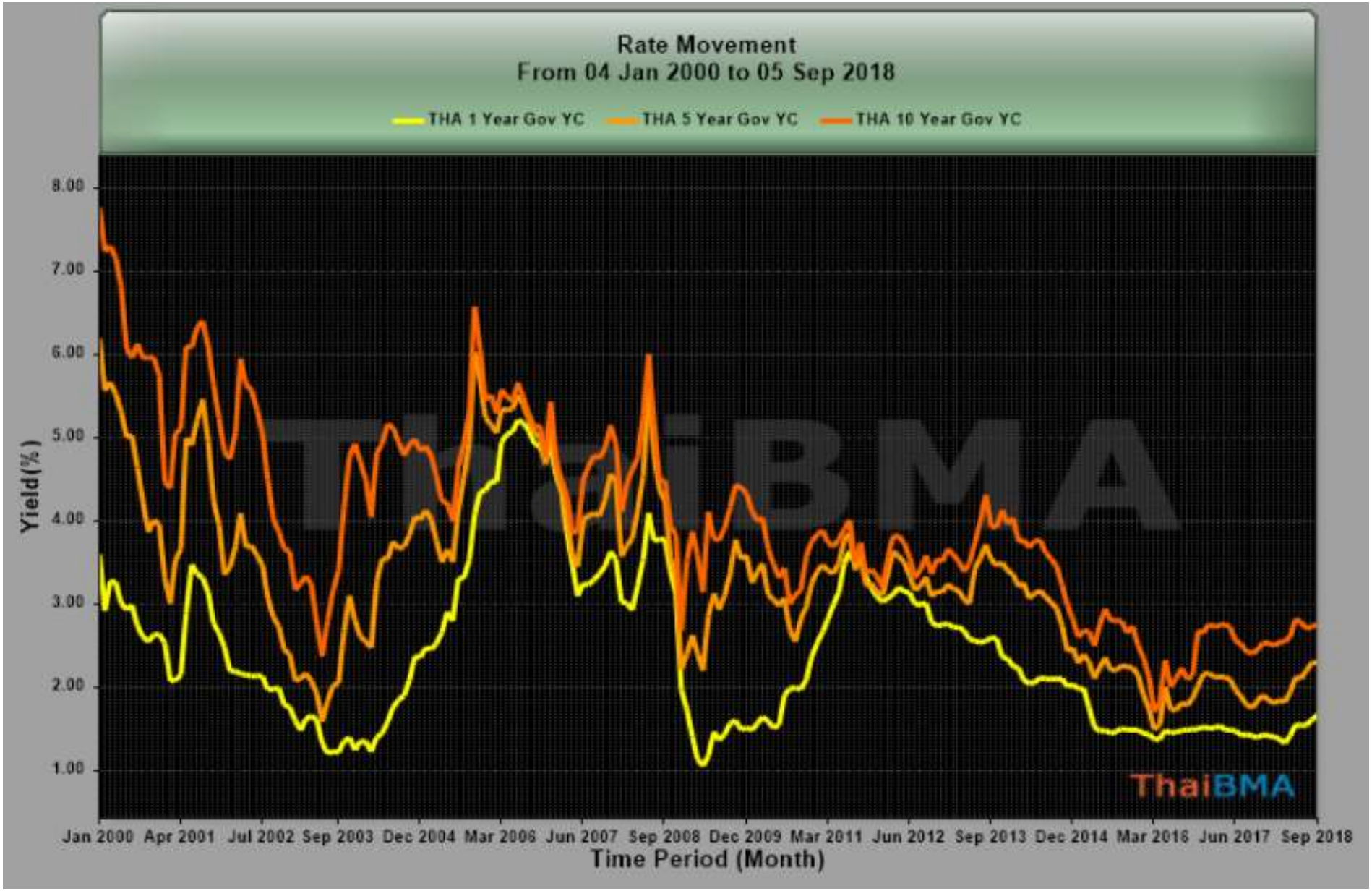
Interest Rates on Different Maturity

Movements over Time of Interest Rates on U.S. Government Bonds with Different Maturities



Source: Federal Reserve Bank of St. Louis FRED database, http://research.stlouisfed.org/fred2/.

Interest Rates on Different Maturity: Thailand



Term Structure Facts to Be Explained

Besides explaining the shape of the yield curve, a good theory must explain why:

1. Interest rates for different maturities move together.
2. Yield curves tend to have steep upward slope when short rates are low and a downward slope when short rates are high.
3. Yield curve is typically upward sloping.

3 Theories of Term Structure

- Expectations Theory
  - Pure Expectations Theory explains 1 and 2, but not 3
- Market Segmentation Theory
  - Market Segmentation Theory explains 3, but not 1 and 2
- Liquidity Premium Theory
  - Solution: Combine features of both Pure Expectations Theory and Market Segmentation Theory to get Liquidity Premium Theory and explain all facts

1 Expectations Theory

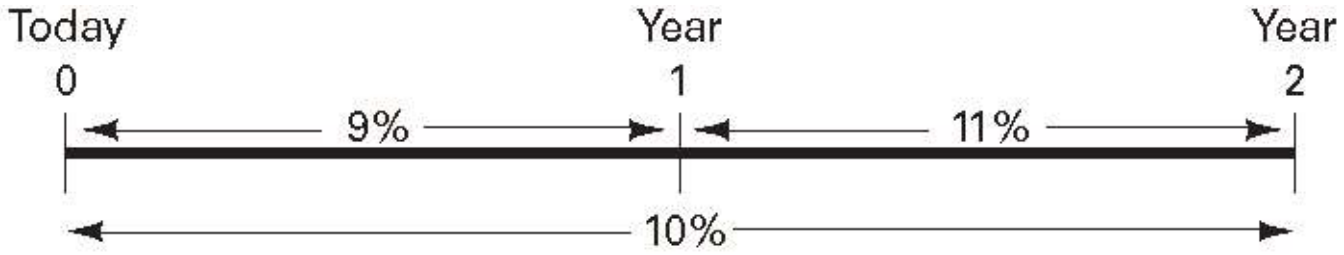
- **Key Assumption:** Bonds of different maturities are perfect substitutes
- **Implication:** Expected returns on bonds of different maturities are equal

To illustrate what this means, consider 2 alternative investment strategies for a 2-yr time horizon**.**

1. Buy $1 of 1-yr bond, and when it matures, buy another one-year bond with your money.
2. Buy $1 of 2-year bond and hold it.

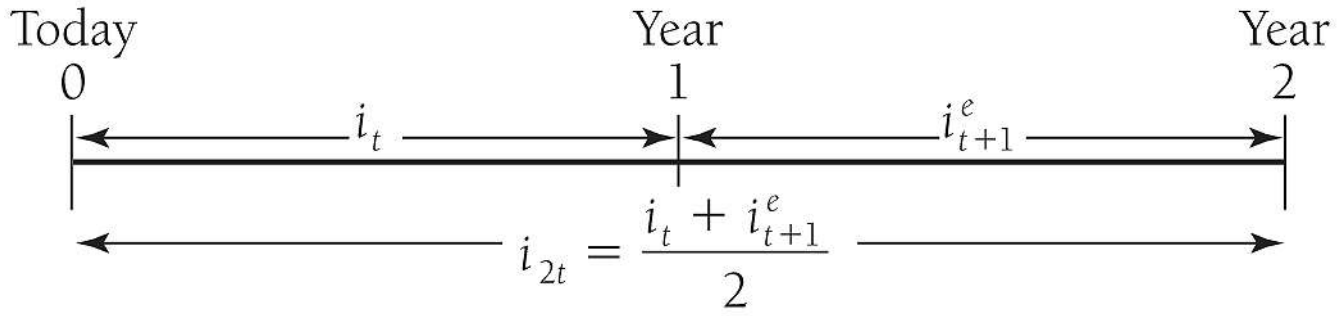
Example: Expectations Theory

- This is an example, with actual #'s:



Expectations Theory

- To help see this, here's a picture that describes the same information:



Expectations Theory

- Expected return from strategy 1

$$(1 + i_2)(1 + i^e_{t+1}) - 1 = 1 + i_t + i^e_{t+1} + i_t(i^e_{t+1}) - 1$$

- Since $i_t(i^e_{t+1})$ is also extremely small, expected return is approximately

$$i_t + i^e_{t+1}$$

Expectations Theory

- Expected return from strategy 2

$$(1 + i_{2t})(1 + i_{2t}) - 1 = 1 + 2(i_{2t}) + (i_{2t})^2 - 1$$

- Since $(i_{2t})^2$ is extremely small, expected return is approximately $2(i_{2t})$

Expectations Theory

- From implication above expected returns of two strategies are equal
- Therefore $2(i_{2t}) = i_2 + i^e_{t+1}$

Solving for i_{2t}

$$i_{2t} = \frac{i_t + i^e_{t+1}}{2}$$

More generally for *n*-period bond…

$$i_{nt} = \frac{i_t + i_{t+1} + i_{t+2} + \ \ldots \ + i_{t+(n-1)}}{n}$$

- 1-yr interest rate over the next 5 years are expected to be 5%, 6%, 7%, 8%, and 9%
- What are the interest rates on 2-yr and 5-yr bonds?

Expectations Theory and Term Structure Facts

- Explains why yield curve has different slopes
  1. When short rates are expected to rise in future, average of future short rates $= i_{nt}$ is above today's short rate; therefore yield curve is upward sloping.
  2. When short rates expected to stay same in future, average of future short rates same as today's, and yield curve is flat.
  3. Only when short rates expected to fall will yield curve be downward sloping.

Expectations Theory and Term Structure Facts

- Pure expectations theory explains fact 1—that short and long rates move together
  1. If short rates today increase, short rates in the future will also increase
  2. If $i_t \uparrow$ today, i^e_{t+1}, i^e_{t+2} etc. $\uparrow \Rightarrow$ average of future rates $\uparrow \Rightarrow i_{nt} \uparrow$
  3. Therefore: $i_t \uparrow \Rightarrow i_{nt} \uparrow$ (i.e., short and long rates move together)

Expectations Theory and Term Structure Facts

- Explains fact 2—that yield curves tend to have steep slope when short rates are low and downward slope when short rates are high
  1. When short rates are low, they are expected to rise to normal level $\Rightarrow$ long rate $=$ average of future short rates will be well above today's short rate; yield curve will have steep upward slope.

  2. When short rates are high, they will be expected to fall in future $\Rightarrow$ long rate will be below current short rate; yield curve will have downward slope.

Expectations Theory and Term Structure Facts

- Does not explain fact 3—that yield curve usually has upward slope
  - — In practice, short rates are as likely to fall in future as they are to rise
  - — So the expectations theory suggests that the typical yield curve should be flat

2 Market Segmentation Theory

- **Key Assumption:** Bonds of different maturities are not substitutes at all

- **Implication:** Markets are completely segmented; interest rate at each maturity are determined separately

Market Segmentation Theory

- Explains fact 3—that yield curve is usually upward sloping
  - — People typically prefer short holding periods and thus have higher demand for short-term bonds, which have higher prices and lower interest rates than long bonds

- Does not explain fact 1 or fact 2 because it assumes long-term and short-term rates are determined independently.

3 Liquidity Premium Theory

- **Key Assumption:** Bonds of different maturities are substitutes, but are not perfect substitutes

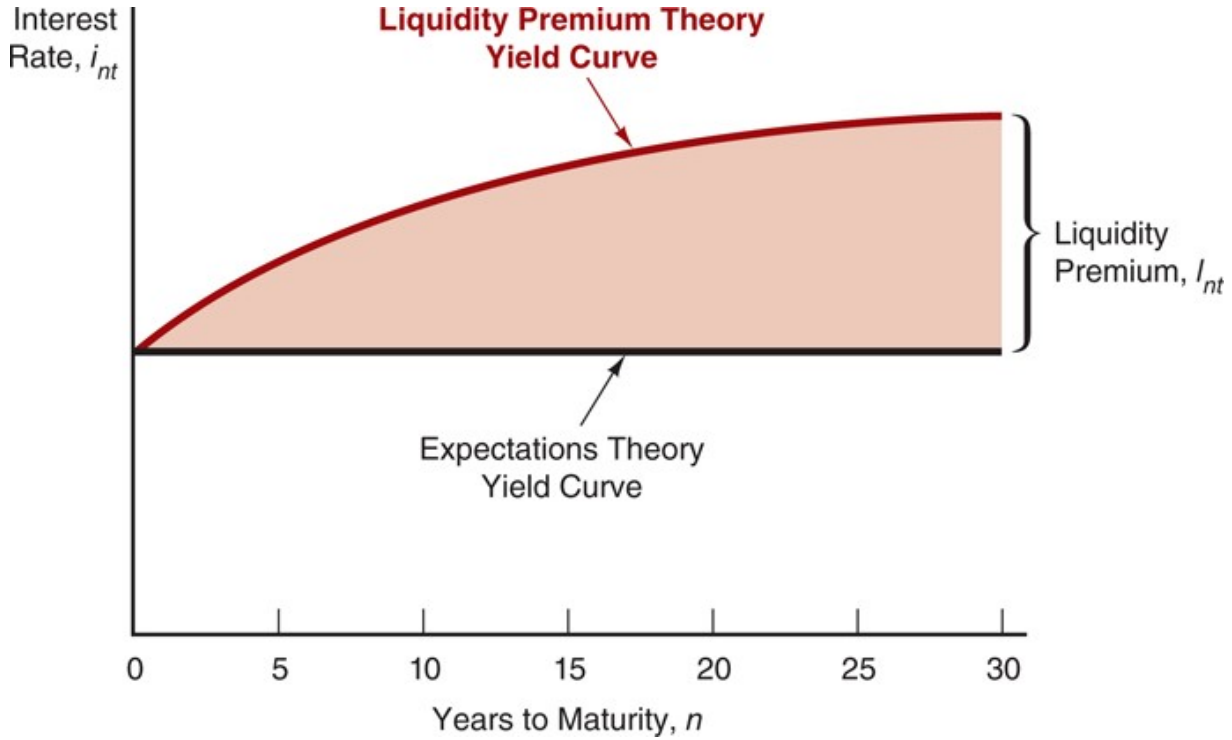
- **Implication:** Modifies Pure Expectations Theory with features of Market Segmentation Theory

- Investors prefer short-term rather than long-term bonds. This implies that investors must be paid positive liquidity premium, i_{nt}, to hold long term bonds.

Liquidity Premium Theory

- Results in following modification of Expectations Theory, where ℓ_{nt} is the liquidity premium.

$$i_{nt} = \frac{i_t + i^e_{t+1} + i^e_{t+2} + \ \cdots \ + i^e_{t+(n-1)}}{n} + l_{nt}$$



Numerical Example

1. 1-yr interest rate over the next 5 years: 5%, 6%, 7%, 8%, and 9%
2. Investors' preferences for holding short-term bonds so liquidity premium for 1-yr to 5-yr bonds: 0%, 0.25%, 0.5%, 0.75%, and 1.0%

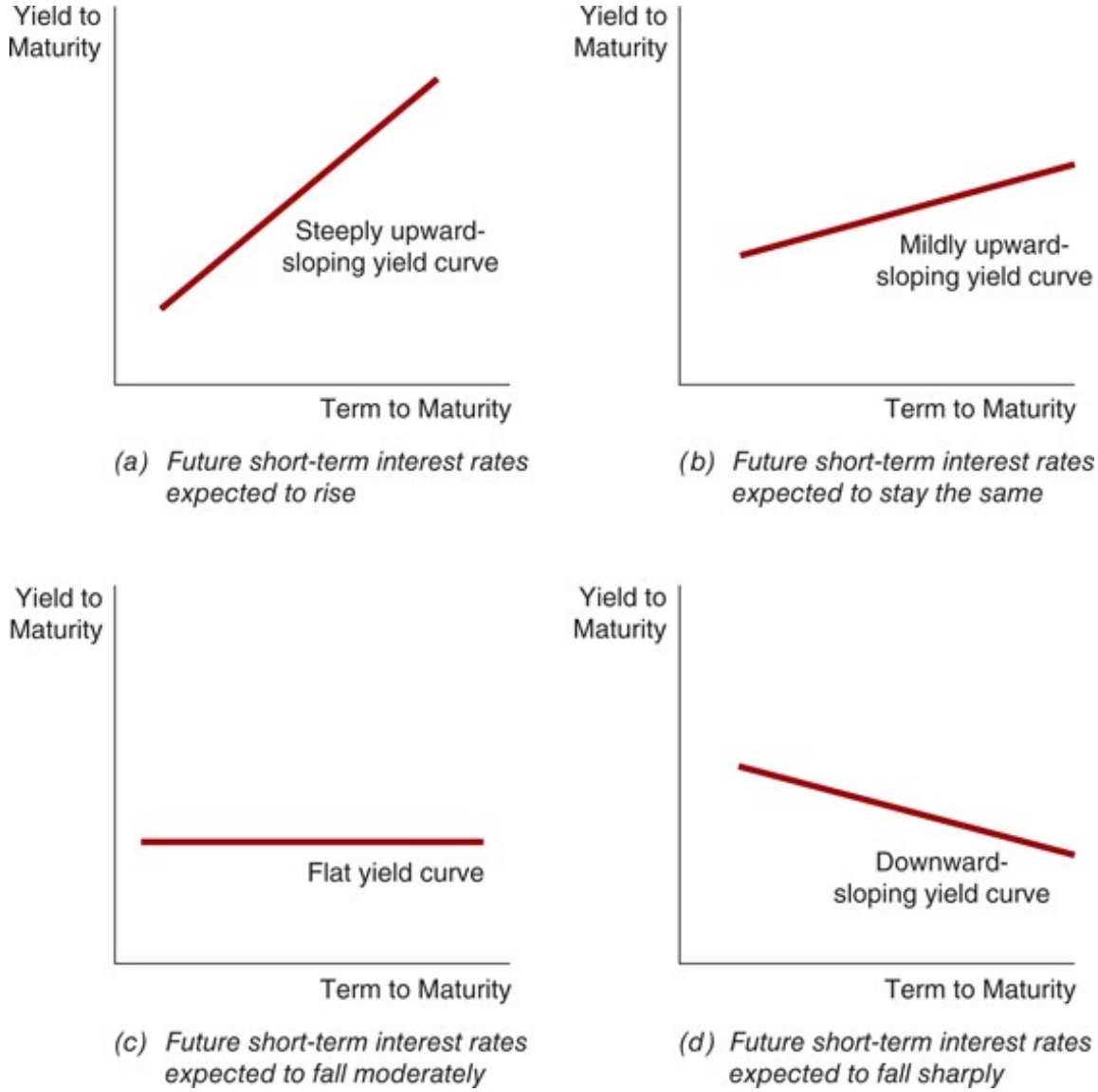
What are interest rates on 1-yr to 5-yr bonds?

Liquidity Premium Theory: Term Structure Facts

- Explains All 3 Facts
  - Explains fact 3—that usual upward sloped yield curve by liquidity premium for long-term bonds
  - Explains fact 1 and fact 2 using same explanations as pure expectations theory because it has average of future short rates as determinant of long rate

Market Predictions of Future Short Rates

Yield Curves and the Market's Expectations of Future Short-Term Interest Rates According to the Liquidity Premium Theory



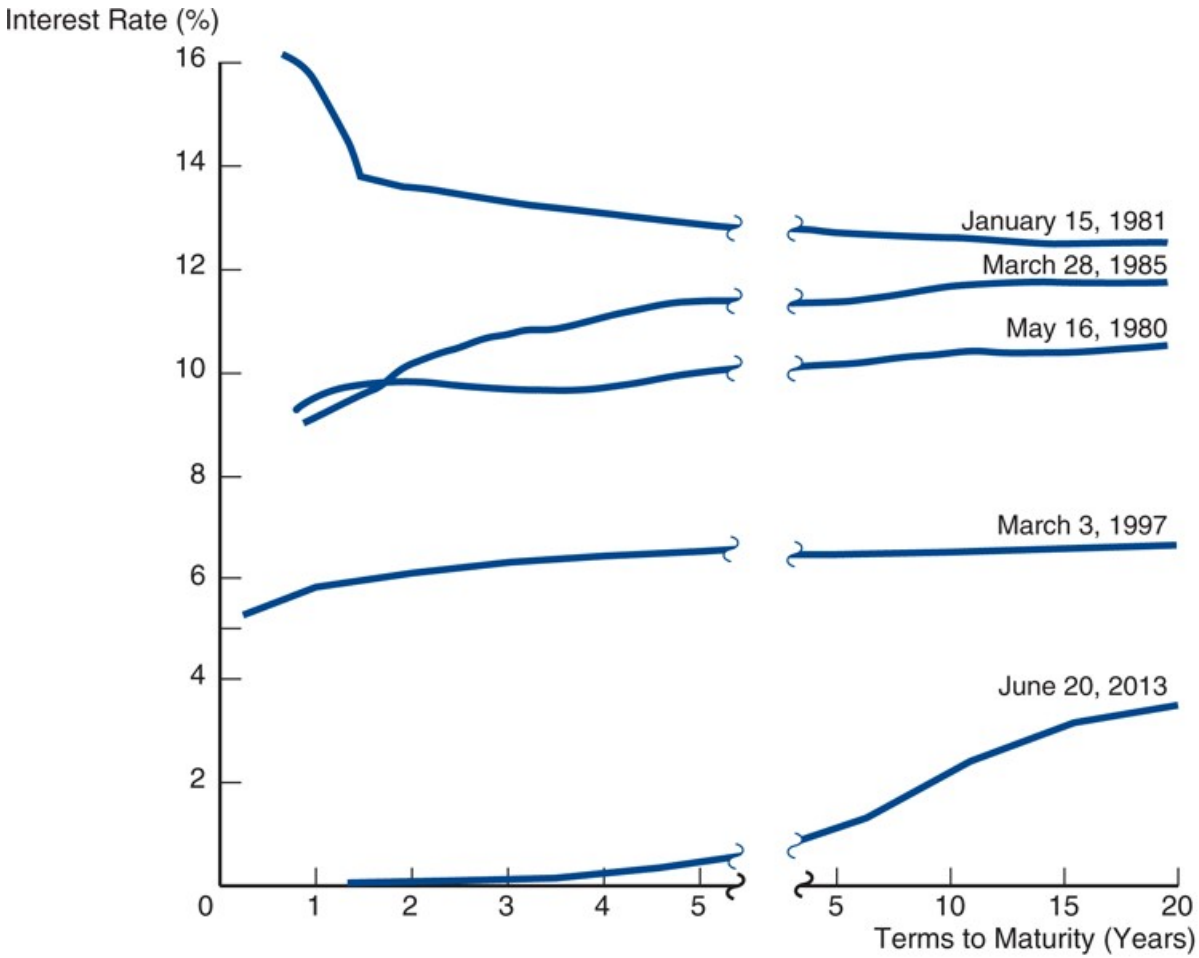
Evidence on the Term Structure

- Initial research (early 1980s) found little useful information in the yield curve for predicting future interest rates.

- Recently, more discriminating tests show that the yield curve has a lot of information about very short-term and long-term rates, but says little about medium-term rates.

Interpreting Yield Curves, 1980–2013

Yield Curves for U.S. Government Bonds



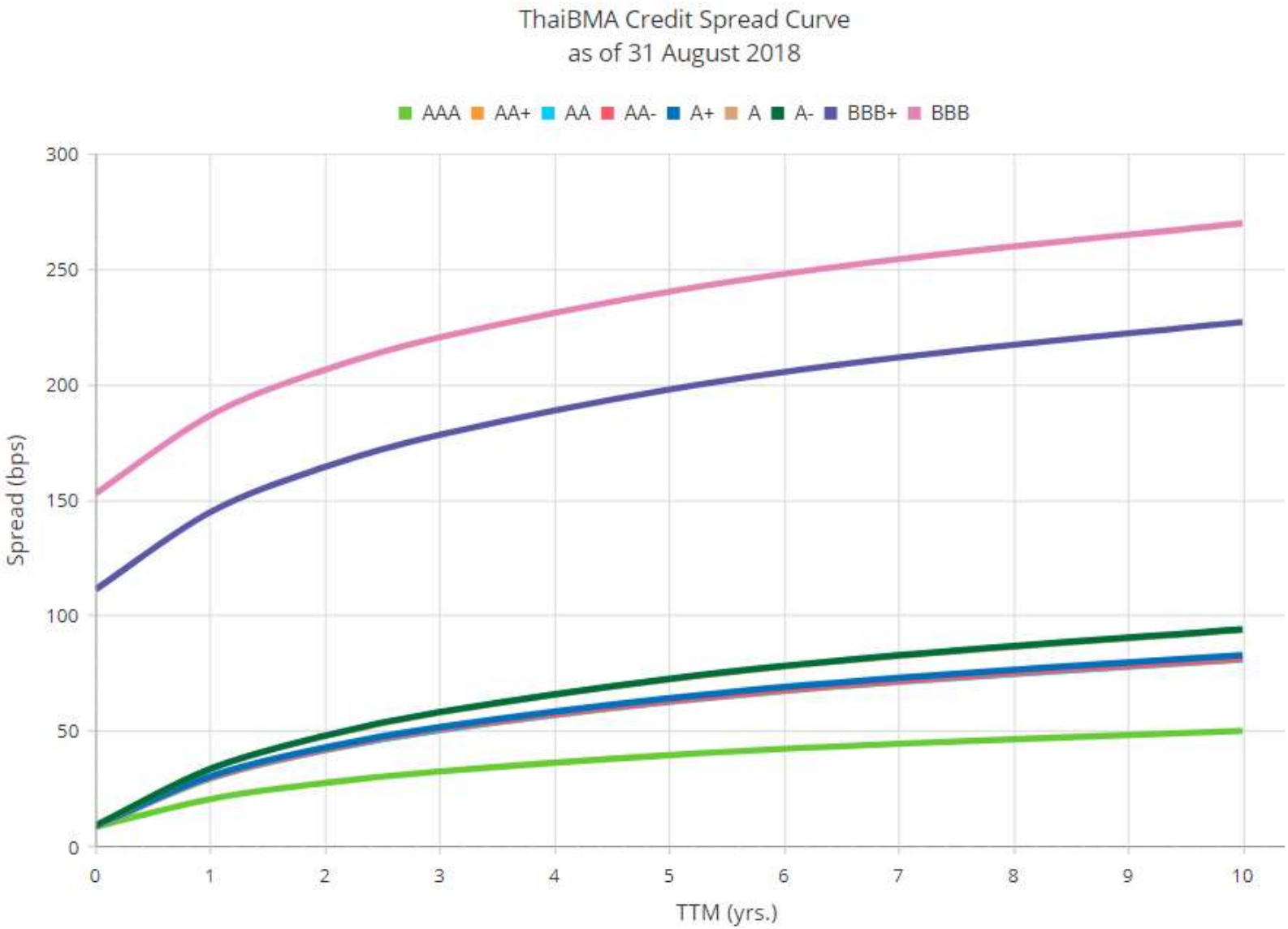
Sources: Federal Reserve Bank of St. Louis; FRED database, http://research.stlouisfed.org/fred2/; *Wall Street Journal*, various dates.

Corporate Bond Yield Curve

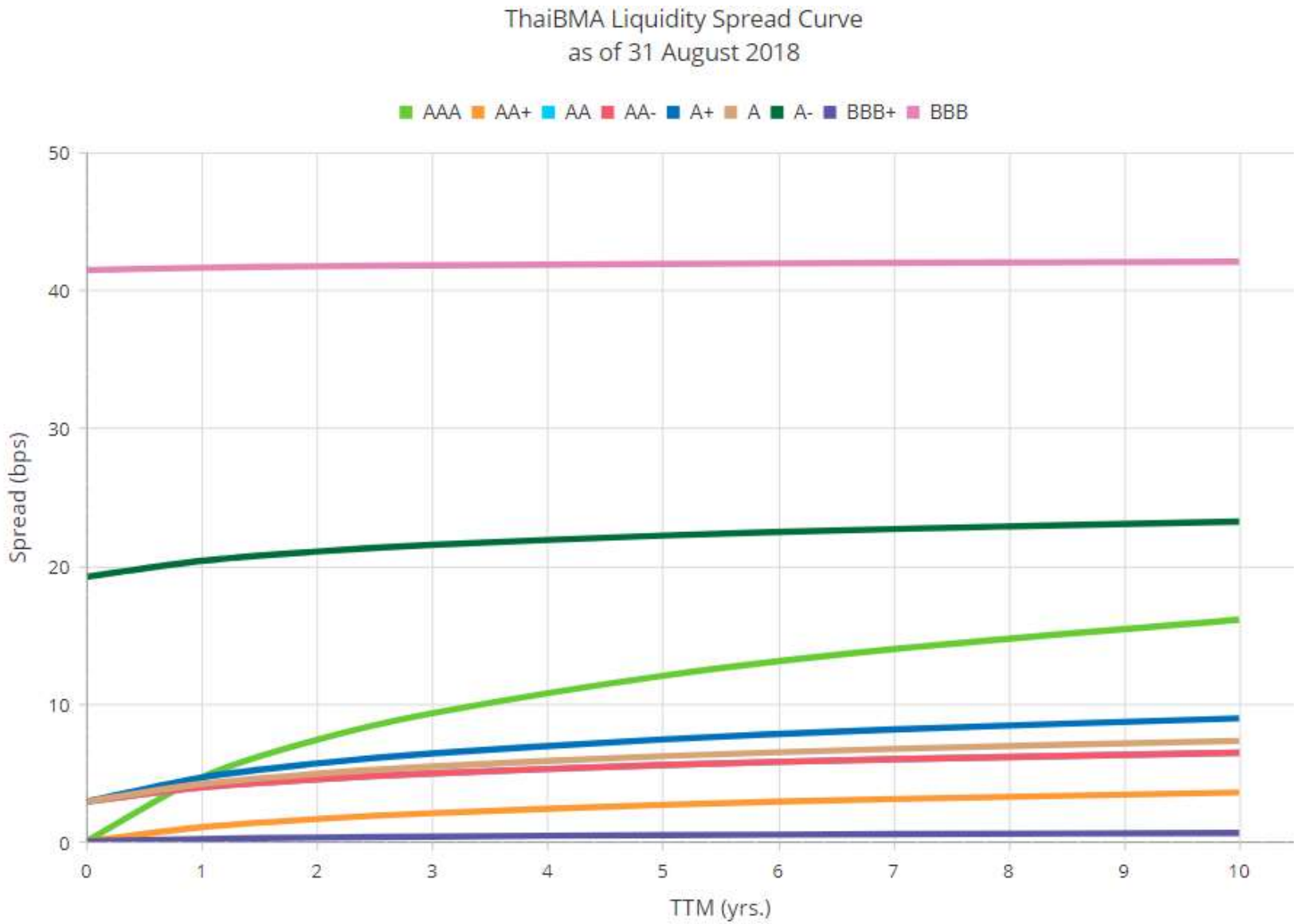
- Corporate bond yield curve = government bond yield curve + credit spread curve + liquidity spread curve
- Basis point or BPS or BIPS

Basis Points	Percentage Terms
1	0.01%
10	0.1%
50	0.5%
100	1%
1000	10%
10000	100%

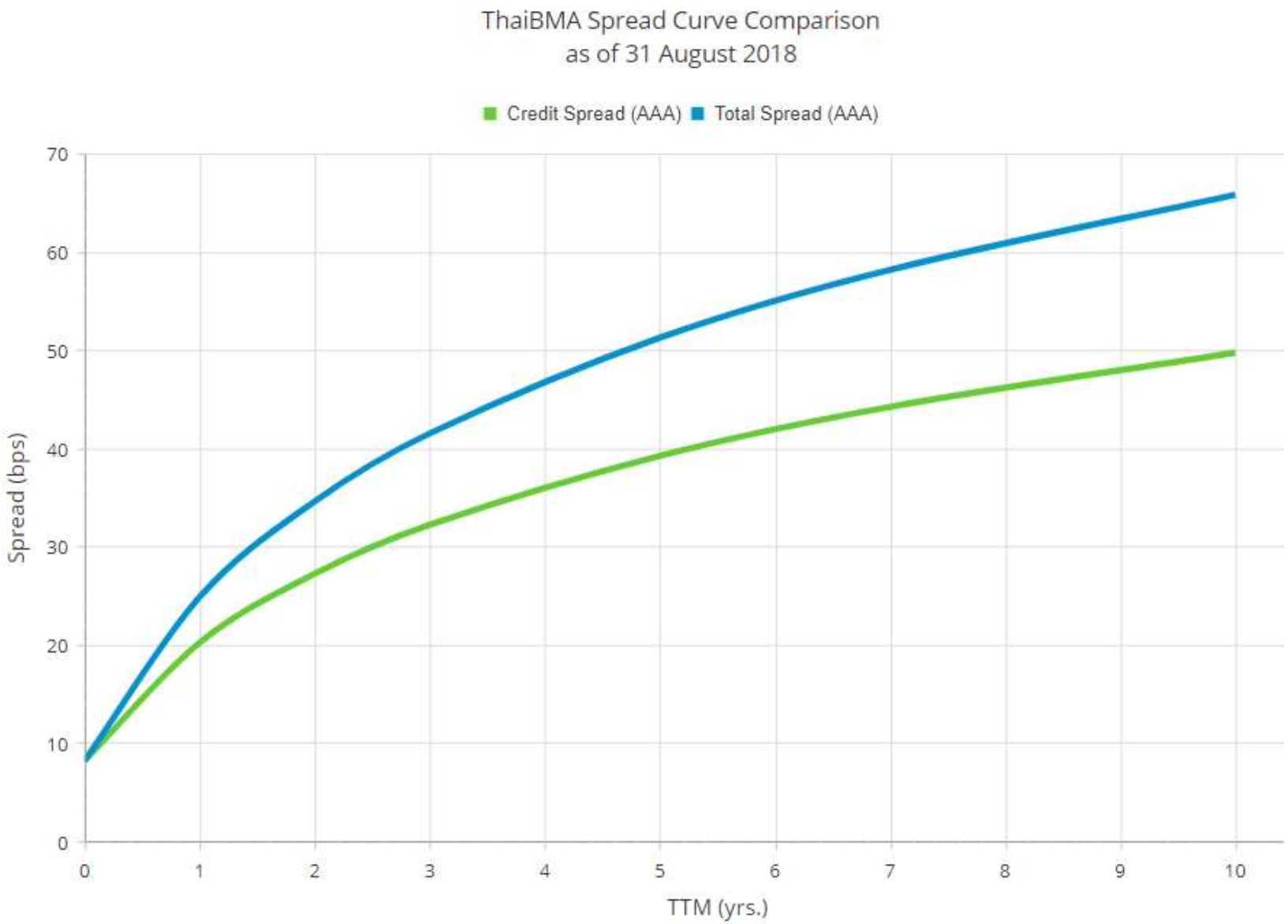
Credit spread curve



Liquidity spread curve



Total spread = credit spread + liquidity spread



Total spread = credit spread + liquidity spread