2 - Term Structures (TS)

Empirical Evidence and Classical Theories

2.1. Types of TS

2.2. Dynamics of the TS

2.3. Stylized Facts

2.4. Theories of the TS

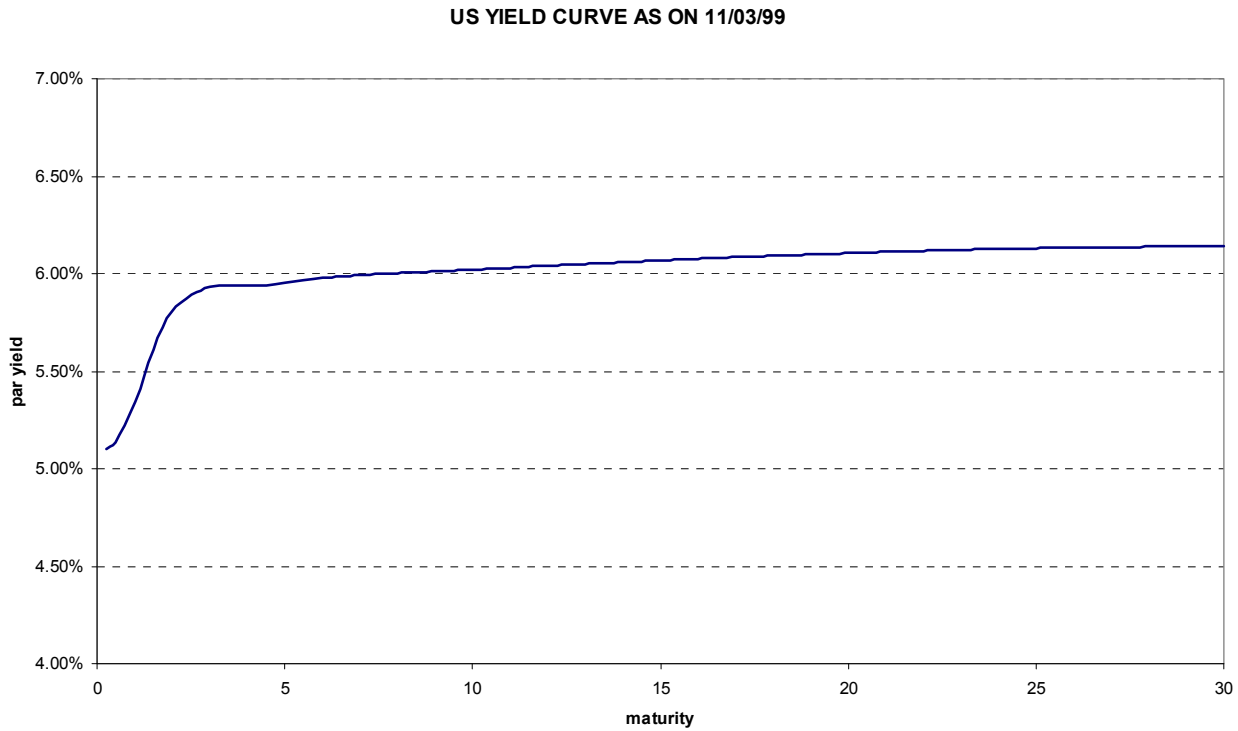
2.1. - TYPES OF TS

- The **term structure of interest rates (TSIR)** is the relationship between "risk-free" interest rates and maturities at a given time.

- The TSIR may be represented in 3 ways:
  - The spot (or zero-coupon) curve
  - The forward curve
  - The discount factor curve

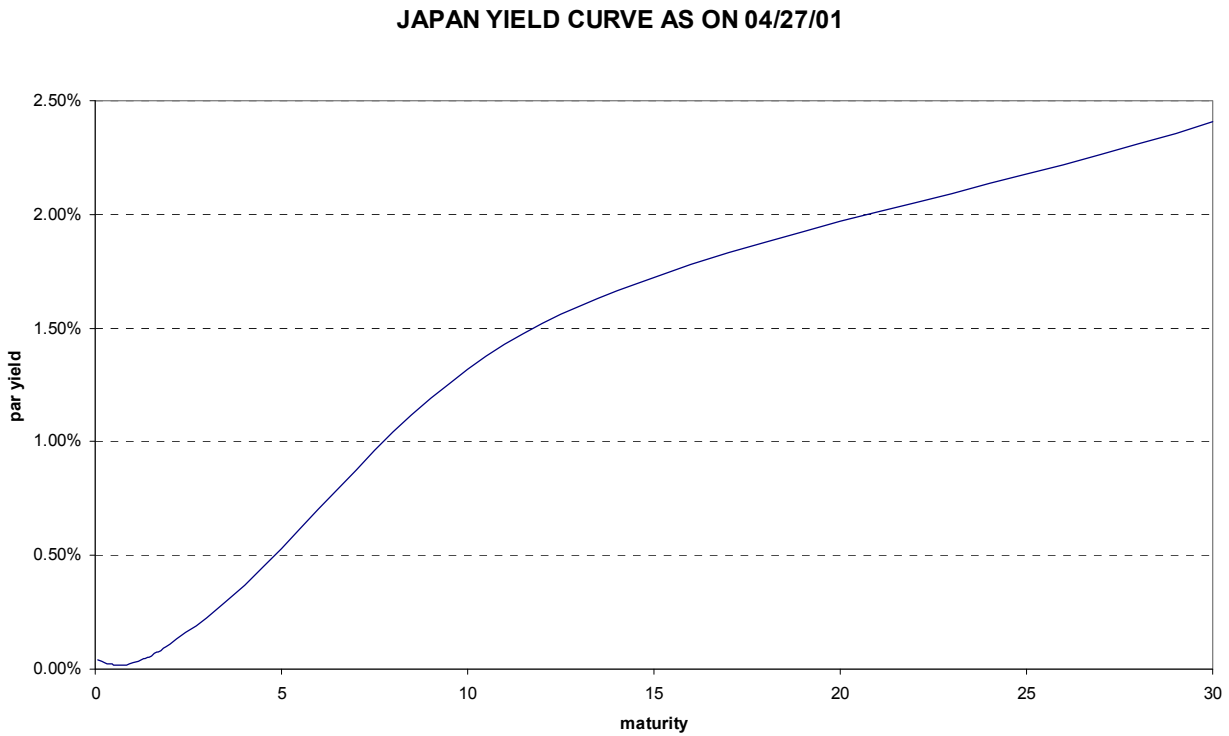
- The TSIR is most commonly illustrated by the yield curve (graphical representation of the spot curve) and may assume different monotonic or non-monotonic shapes:
  - Quasi-flat
  - Increasing
  - Decreasing
  - Humped

ILLUSTRATION: QUASI-FLAT



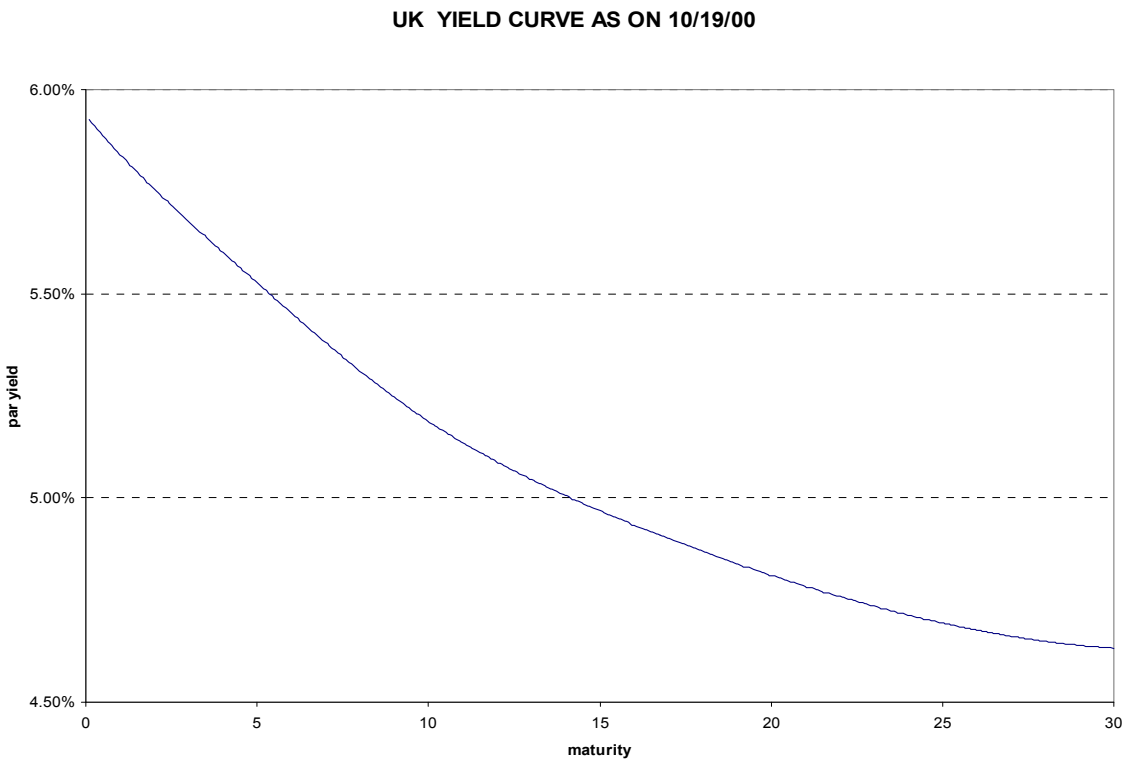
Quasi-Flat

ILLUSTRATION: INCREASING



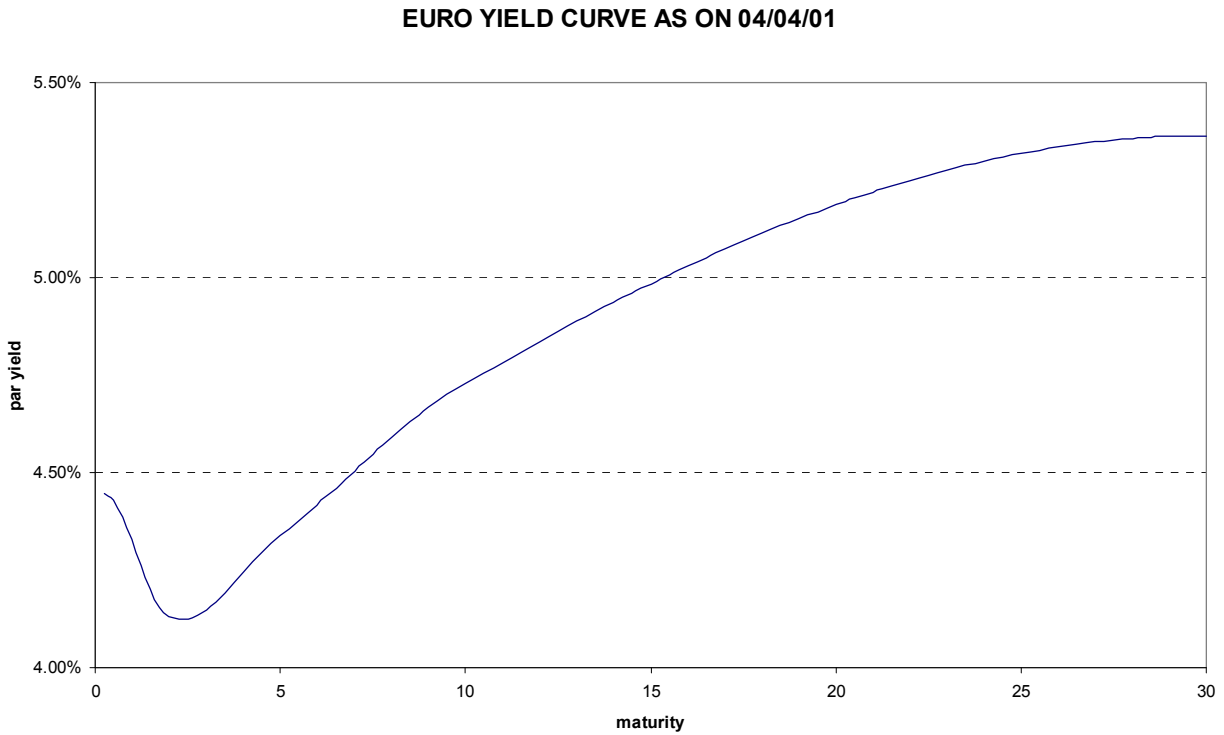
Increasing

ILLUSTRATION: DECREASING



Decreasing (or inverted)

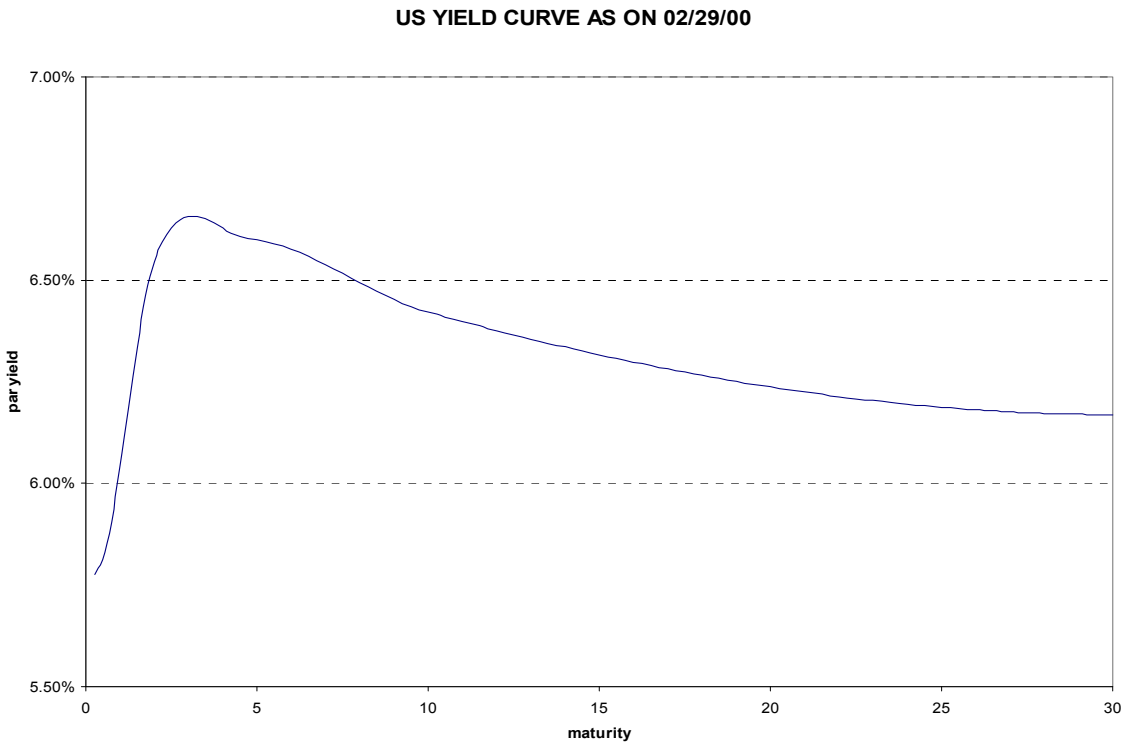
ILLUSTRATION: HUMPED (1)



Humped

(decreasing then increasing)

ILLUSTRATION: HUMPED (2)



Humped

(increasing then decreasing)

2.2 - DYNAMICS OF THE TS

- The term structure of interest rates changes in response to
  - Economic shocks
  - Market-specific events
  - Policy decisions

- Example
  - The recent announcement by the Italian Government that next year's budget will involve a higher deficit => sell-off Italian Govt. bonds => increase in Italian yield and also some contagion on Spanish and Portuguese Govt. bonds.

2.3 - Stylized Facts

- Volatility
- Correlation
- Standard Movements
  - Shift Movements
  - Twist Movements
  - Butterfly Movements

STYLIZED FACTS (1) : VOLATILITY

- Yields and bond prices are typically much less volatile than prices in other asset classes.
- In countries where the credibility of monetary policy is lower, or, correspondingly, the currency is weaker, the volatility of short term interest rates is usually higher than long term interest rates.
- In countries where credit risk issues arise, long term interest rates typically become more volatile.
- Even though volatility of long-term rates is usually lower than short-term rates, volatility of bond prices in longer maturities may be higher, due to the higher impact of interest rate shifts on bond prices in higher maturities (durations).

STYLIZED FACTS (2) : CORRELATION

- Rates with different maturities are
  - Positively but not perfectly correlated, meaning that there is more than one factor behind the yield curve dynamics
  - Correlation decreases with differences in maturity

- Example:

	1M	3M	6M	1Y	2Y	3Y	4Y	5Y	7Y	10Y
1M	1									
3M	0.999	1								
6M	0.908	0.914	1							
1Y	0.546	0.539	0.672	1						
2Y	0.235	0.224	0.31	0.88	1					
3Y	0.246	0.239	0.384	0.808	0.929	1				
4Y	0.209	0.202	0.337	0.742	0.881	0.981	1			
5Y	0.163	0.154	0.255	0.7	0.859	0.936	0.981	1		
7Y	0.107	0.097	0.182	0.617	0.792	0.867	0.927	0.97	1	
10Y	0.073	0.063	0.134	0.549	0.735	0.811	0.871	0.917	0.966	1

STYLIZED FACTS (3): STANDARD MOVEMENTS

- The evolution of the interest rate curve can be split into 3 standard movements, regardless the time period or the market:

  - **Shift movements** (changes in level), which account for 70 to 80% of observed movements on average.
  - **Twist movements** (changes in slope), which accounts for 15 to 30% of observed movements on average.
  - **Butterfly movements** (changes in curvature), which accounts for 1 to 5% of observed movements on average.

  => 1 or 2-factor models tend to be enough to explain the behavior of the yield curve in most occasions.

2.4 - THEORIES OF THE TS

- Explanatory theories of the TSIR depend mostly on:
  - the preferences of market participants for maturities, i.e. their credit and liquidity risk aversion.
  - the expectations on the future behavior of short-term interest rates, i.e. monetary policy.
- Term structure theories attempt to explain the relationship between interest rates and their residual maturity.
- Explanatory theories:
  - Expectations
  - Preferred habitat
  - Liquidity premium
  - Market segmentation

- The **expectations theory** postulates that long term rates depend on the current short term rates and the expectations on their future path.

- Let us assume that an investor has 2 investment alternatives:
  - A long term bond (*T* maturity)
  - A set of bonds with short term maturities (maturity = 1, being T>1)

- The expected returns for these 2 alternatives must be equal (being r(t,T) the yield in time = t of a bond maturing at a later period T):
  - $[1+r(t,T)]^n = (1+r(t,1)) \times (1+E(t)\,(r(t+1),1)) \times (1+E(t)\,(r(t+2),1)) \times \ldots \times (1+E(t)\,(r(T-1),1))$
  - $r(t,T)=[(1+r(t,1)) \times (1+E(t)\,(r(t+1),1)) \times (1+E(t)\,(r(t+2),1)) \times \ldots \times (1+E(t)\,(r(T-1),1))]^{1/n}-1$

- If one assumes that there is no risk premium (i.e. investors are risk-neutral regarding investing in short or in long term interest rates), expected interest rates are equal to forward rates.
- According to this theory, the yield curve may assume different shapes and positively (negatively) sloped curves correspond to expectations of short tem interest rate increases (decreases).
- Therefore, changes in yield curves are interpreted as changes in market expectations.
- 2 versions of the expectations theory:

(i) pure – there is no risk premium => forward rates correspond to the expected future interest rates => $f_t^j = E_t(r_{t+j})$

(ii) non-pure – there is risk premium, but it's constant along time => forward rates do not correspond to expected future interest rates, but changes in forward rates correspond to chamges in expectations about future interest rates.

- The **preferred habitat theory** sustains that investors have preferred maturities, but they accept to invest in different maturities if they are compensated for that.
- Therefore, this theory may be seen as a smoothed version of the previous one, with premiums paid to attract investors to maturities different from those preferred, but not necessarily increasing with the maturity.
- Consequently, under this theory, moves in the yield curve do not correspond necessarily to changes in investors' expectations about the future path of short-term interest rates and the yield curve may have different shapes.

- Forward rates (or their changes) cannot be used to gauge expectations about future interest rates.

- **Liquidity premium theory** is a particular case of the preferred habitat theory

- Investors always prefer short to long maturities

- Investors always demand a premium to invest in longer maturities

- Long term interest rates > short term interest rates

- The yield curve will always be positively sloped

- A positively sloped curve is usually considered as a regular curve, given that investors tend to be risk-averse => premium to invest in longer maturities due to the uncertainty on the future path of interest rates.

- The **market segmentation theory** postulates that interest rates in each maturity stem only from the supply and demand in that maturity.
- As a consequence, there is no relationship between interest rates in different maturities and the yield curve may have very irregular shapes.
- **Main conclusions:**

(i) the yield curve shape is explained by a mix of all these theories, even though market participants usually consider that a normal yield curve is a positively sloped one.

(ii) the risk premium is usually considered as increasing with maturities.

(iii) even though the risk premium is not nil, changes in long-term interest rates may be considered as changes in expectations on future short-term interest rates' behavior if one assumes that risk premium is constant along time, which tends to happen, at least, in short periods of time.