Yield Curve

By Glen Cooper for Dr. Kiser's Econ 5322.001
February 13, 2018

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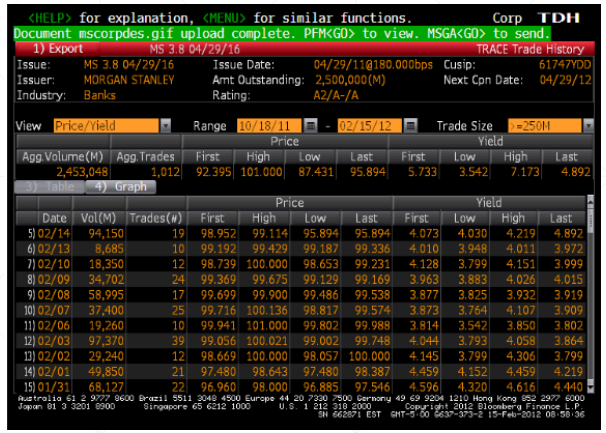
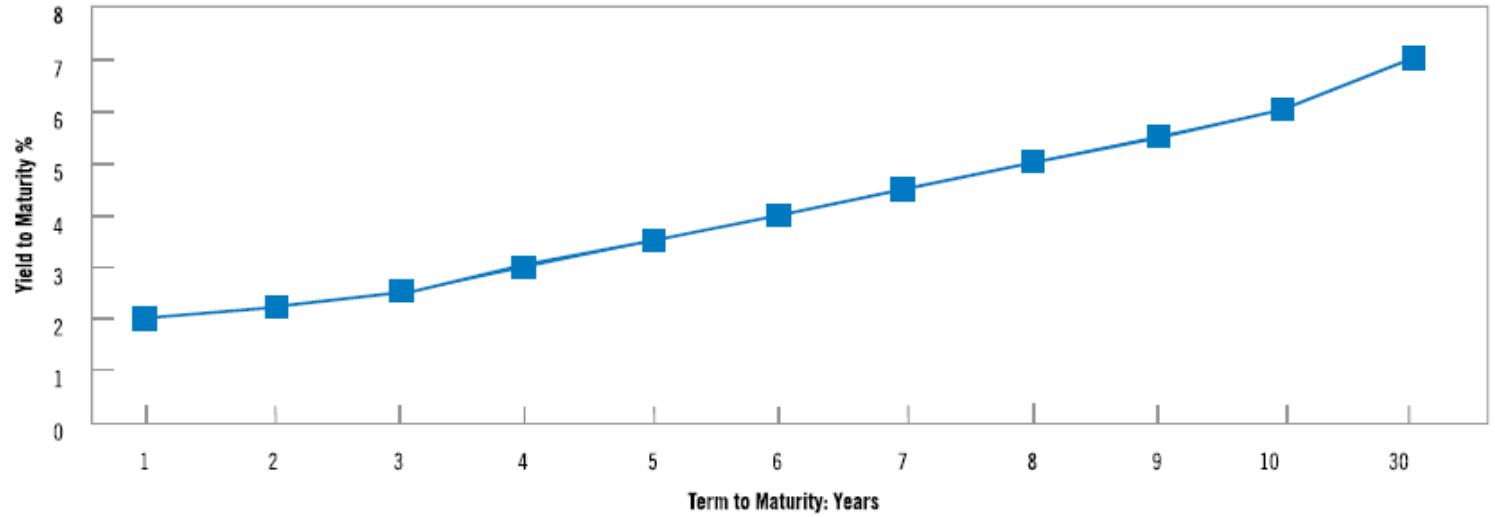
Definitions: Interest Rates and Bond Prices

- Interest Rates are Rental Price of Money
  - Generally Quoted in terms of yield to maturity (YTM) (e.g. 1%, 5%, 10%)
    - Basis Points (i.e. BPS) are 100th of 1%, that is 25 BPS is .25%
- Interest Rate Vary Depending Upon Term
  - Term is time period money is borrowed / lent
  - Typically terms are 1 month, 3 mo, 6 mo, 1 year, 3 yr, 5 yr, 10 yr, 20 yr, 30 yr
- Bond Prices are Quoted as Discounts from 100
  - A bond quote is expressed as a percentage of par value then converted to a point scale
  - Par value generally set at 100, representing 100% of a bond's face value of $1,000.
    - Example: a bond quoted at 99 is trading at 99% of face value or means the cost of buying each bond is $990.
- Increases in Bond Prices Represent an Inverse Relationship to YTM Rates
  - Higher bond prices mean lower interest rates and vice versa



Yield Curve Description

- Basic Yield Curve Plots YTM Rates on Vertical Axis and Maturity on Horizontal Axis



For illustrative purposes only.

Source: PGIM Investments, "Understanding Yield Curves"

Why Long-term Rates Tend to be Greater than Short-term Rates

- Market Expectation Theory
  - Assumes current rates based on expectations of future rates; therefore, current maturity for “n” term is based on geometric average of current period rate and expected future rates
  - $(1+i_{long\text{-}term})^n = (1+i^{year\ 1})(1+i^{year\ 2}) \ldots (1+i^{year\ n})$
- Liquidity Premium Theory
  - Assumes market expectation theory includes risk premium, rp_n, added due to risk of default from holding security over long term
  - $(1+i_{long\text{-}term})^n = rp_n + (1+i^{year\ 1})(1+i^{year\ 2}) \ldots (1+i^{year\ n})$
- Preferred Habitat Theory
  - Investors have preferred maturities and require a premium to buy maturities outside their habitat; and most investors are short-term investors
- Market Segmentation Theory
  - Different terms are no substitutes and each have a specific market; as investors prefer short-term they will have a higher demand and drive prices up and yields down

Yield Curve Types and Uses

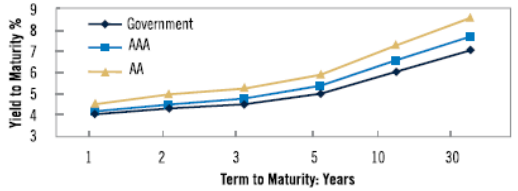
- Types of Yield Curves
  - LIBOR or Swap Curve
    - Banks with high credit ratings (Aa/AA or above) borrow from each other at LIBOR
      - LIBOR = London Interbank Offer Rate
  - Corporate Curves
    - Corporate yield curves often quoted in terms of spread over LIBOR rate
      - Example LIBOR + 25 bps
  - Government Bond Yield Curves
    - Bonds issued by governments in their own currency
    - Our Focus Will be on US Treasury Yield Curve

Yield Curve Types and Uses

- Compare US Treasury yields against corporate bond yields to evaluate potential for additional yield by assuming additional credit risk
  - Note: US Treasury yields are considered “risk free”
- Compare yield spreads to historical to evaluate attractive vs. unattractive yields
- Compare relationship between same security types to determine appropriate compensation for assumption of additional risk
  - Spread between 2 yr and 10 yr US Treasuries (called 2s/10s) or 3 mo versus 10 yr US Treasuries
- Predict future economic performance
  - Example, yield curve spreads included in:
    - Financial Stress Index published by St. Louis Fed
    - Index of Leading Economic Indicators published by The Conference Board

US GOVERNMENT VS. AAA-/AA-RATED CREDIT CURVES

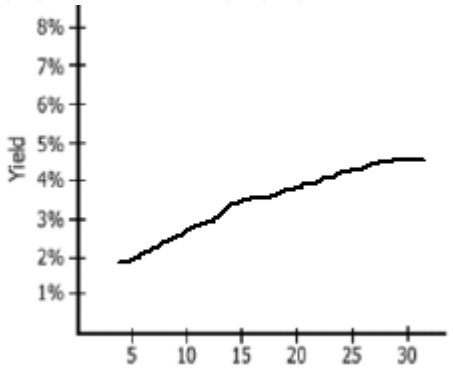
	Yield to Maturity			Spread over Govt Bonds	
	Govt	AAA	AA	AAA	AA
1-Year	4.00%	4.15%	4.45%	0.15%	0.45%
2-Year	4.25	4.45	4.90	0.20	0.65
3-Year	4.50	4.75	5.20	0.25	0.70
5-Year	5.00	5.30	5.90	0.30	0.90
10-Year	6.00	6.50	7.25	0.50	1.25
30-Year	7.00	7.70	8.50	0.70	1.50



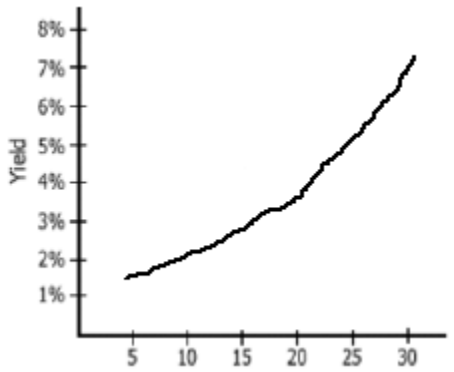
For illustrative purposes only.

Source: PGIM Investments, “Understanding Yield Curves”

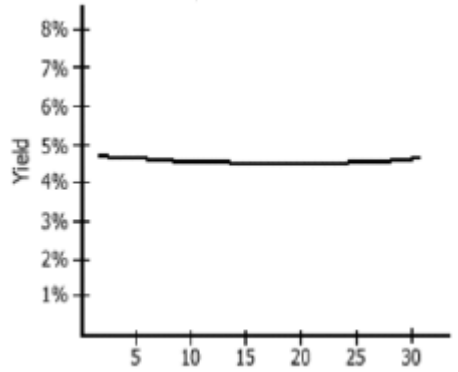
Stylized Yield Curve Shapes



Normal

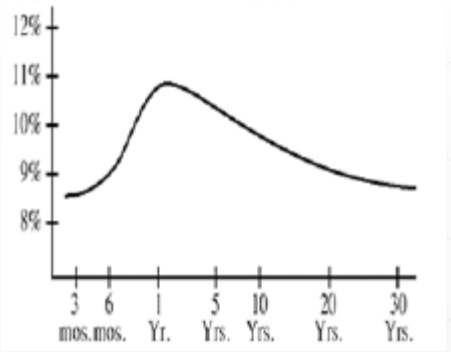


Steep

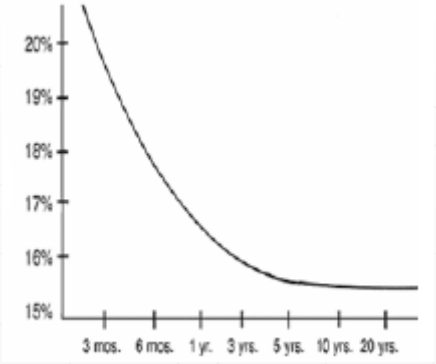


Flat

Generally yield curves are available continuously



Humped



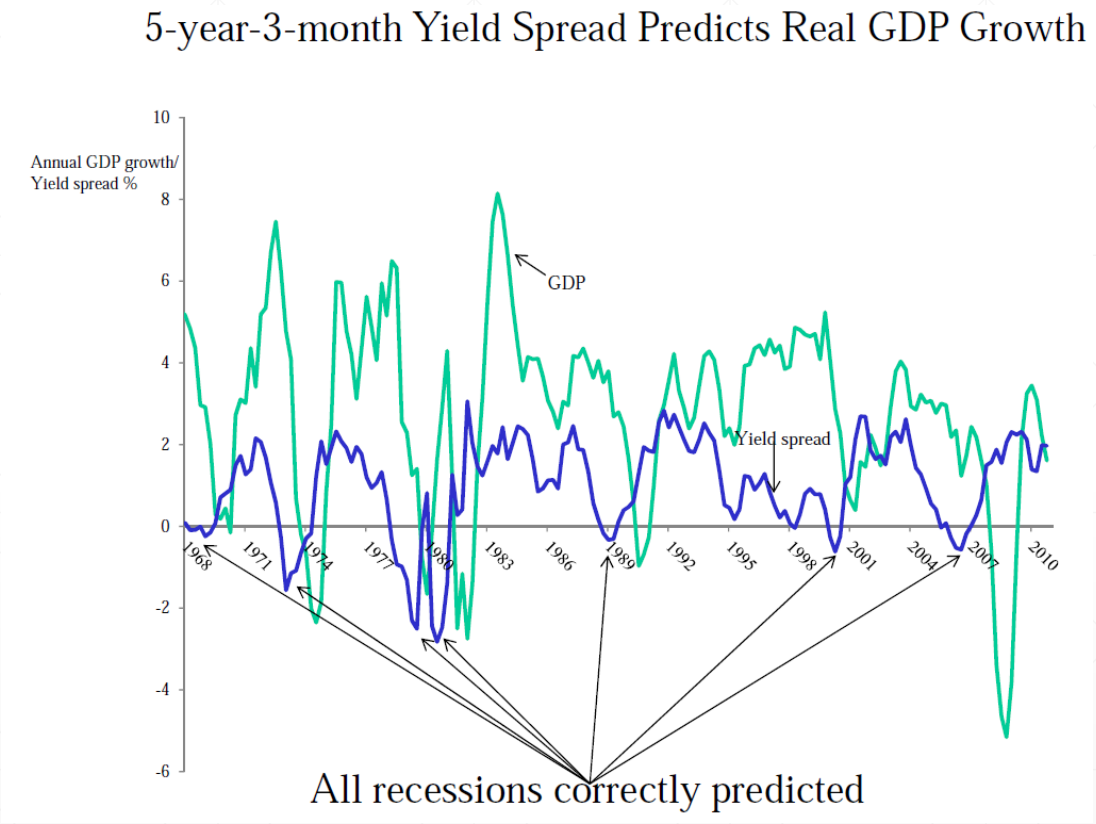
Inverted

Yield Curve and Forecasting the US Economy

- Normal
  - Signals that investors expect the economy to expand and for the stronger growth to lead to higher inflation and higher interest rates; thereby investors require higher long-term rates to compensate for this expectation
- Steep
  - Historically the difference between the 20 yr and 3 mo treasuries has averaged 2 percentage points; when the economy is coming out of a recession or about to enter an expansionary phase, future interest rates are expected to increase because of corporate desire for investment/borrowing which increases demand for money and rates; thus when the yield curve steepens above the 2% average spread expect that the economy will improve quickly
- Flat
  - When inflation expectations decrease to where investors are demanding little or no premium for long-term investment rates flatten; this generally represents uncertainty in the market and can either revert to a normal or inverted curve
- Humped
  - Generally a supply vs. demand phenomena in the longer term bond market; namely, either there has been an increase in demand for or a reduction in the supply of longer term bonds; similar to a flat curve, this can either revert to a normal or inverted curve
- Inverted Yield Curve
  - Here investors anticipate less future demand for money and therefore lower interest rates in the future, this is one of the surest signs of an upcoming economic recession; Dr. Campbell R. Harvey's 1986 dissertation showed that yield curve inversion forecasts US recessions; the NY Fed Reserve regards it as a tool for predicting recessions two to six quarters ahead

Yield Curve and US Recessions … a closer look

- Based on 5 yr v 3 mo Yield Spread
- Accurately Predicted all 7 of the Last Recessions



Source: Campbell R. Harvey, 2010. The Yield Curve: An update. (http://faculty.Fuqua.duke.edu/~charvey/Term_structure/)

Yield Curve and US Recessions … a closer look

- 11 months = Average lead from Inversion to Peak
- 8 months = Average lead from Normal to Trough
- Note: current episode's greater lead times; perhaps owing to severity

Lead Lag Analysis in Months

NBER = National Bureau of Economic Research

Business Cycle			*5-Year Yield Spread*				
NBER Peak	**NBER Trough**	**Length of Cycle**	**Inversion**	**Lead**	**Normal**	**Lead**	**Length of Inversion**
Dec-69	Nov-70	11	Oct-68	14	Feb-70	9	16
Nov-73	Mar-75	16	Jun-73	5	Jan-75	2	19
Jan-80	Jul-80	6	Nov-78	14	May-80	2	18
Jul-81	Nov-82	16	Oct-80	9	Oct-81	13	12
Jul-90	Mar-91	8	May-89	14	Feb-90	13	9
Mar-01	Nov-01	8	Jul-00	8	Mar-01	8	8
Average last six		11		11		8	14
Current Episode							
Dec-07	Jun-09	18	Jan-06		Aug-07		19

Source: Campbell R. Harvey, 2010. The Yield Curve: An update. (http://faculty.Fuqua.duke.edu/~charvey/Term_structure/)

Current Episode

# of Months

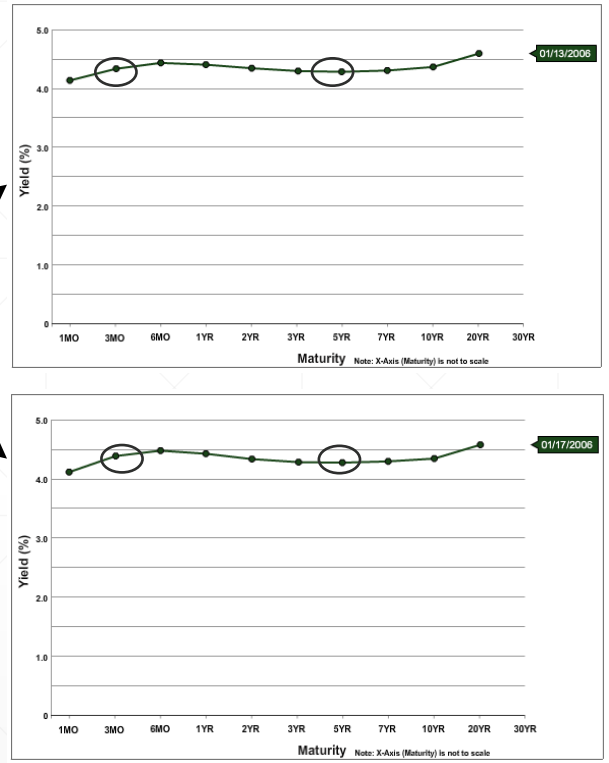
23 From Inversion to Peak

22 From Normal to Trough

Yield Curve and US Recessions … a closer look

- Current Episode
  - Inversion first occurred 1/13

Date	3 Mo	5 Yr	Diiference
1/3/2006	4.16	4.3	0.14
1/4/2006	4.19	4.28	0.09
1/5/2006	4.2	4.29	0.09
1/6/2006	4.22	4.32	0.10
1/9/2006	4.23	4.32	0.09
1/10/2006	4.29	4.36	0.07
1/11/2006	4.3	4.39	0.09
1/12/2006	4.32	4.35	0.03
1/13/2006	4.33	4.28	(0.05)
1/17/2006	4.38	4.27	(0.11)
1/18/2006	4.35	4.28	(0.07)
1/19/2006	4.35	4.31	(0.04)
1/20/2006	4.35	4.31	(0.04)
1/23/2006	4.38	4.3	(0.08)
1/24/2006	4.4	4.32	(0.08)
1/25/2006	4.42	4.41	(0.01)
1/26/2006	4.45	4.44	(0.01)
1/27/2006	4.45	4.45	0.00
1/30/2006	4.48	4.46	(0.02)
1/31/2006	4.47	4.47	0.00



Source: U.S. DEPARTMENT OF THE TREASURY (https://www.treasury.gov/resource-center/data-chart-center/interest-rates/

Yield Curve and US Recessions … a closer look

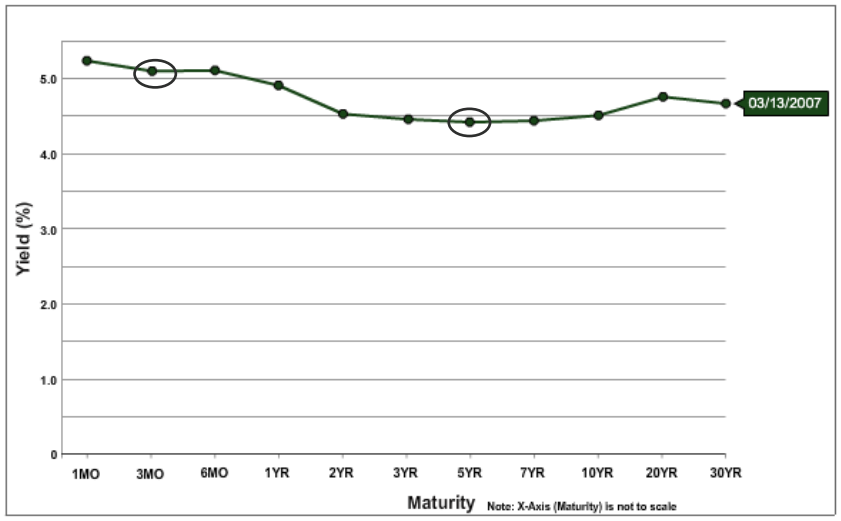
- Current Episode
  - Dates 7/1/2006 to 5/30/2007 (inversion in red)
  - March 13, 2007 highlighted

Date	3 Mo	5 Yr	Diiference
	0		
	0		
	0		
7/13/2006	5.05	5.04	(0.01)
7/14/2006	5.06	5.02	(0.04)
7/17/2006	5.11	5.04	(0.07)
7/18/2006	5.13	5.1	(0.03)
7/19/2006	5.11	5.02	(0.09)
7/20/2006	5.08	4.98	(0.10)
7/21/2006	5.1	4.99	(0.11)
7/24/2006	5.1	4.99	(0.11)
7/25/2006	5.13	5.02	(0.11)
7/26/2006	5.11	4.99	(0.12)
7/27/2006	5.1	4.98	(0.12)
7/28/2006	5.07	4.92	(0.15)
7/31/2006	5.1	4.91	(0.19)
8/1/2006	5.12	4.9	(0.22)
8/2/2006	5.1	4.88	(0.22)
8/3/2006	5.11	4.9	(0.21)
8/4/2006	5.09	4.84	(0.25)
8/7/2006	5.12	4.86	(0.26)
8/8/2006	5.1	4.85	(0.25)
8/9/2006	5.07	4.86	(0.21)
8/10/2006	5.05	4.86	(0.19)
8/11/2006	5.07	4.91	(0.16)
8/14/2006	5.12	4.95	(0.17)
8/15/2006	5.1	4.88	(0.22)
8/16/2006	5.07	4.81	(0.26)
8/17/2006	5.09	4.82	(0.27)
8/18/2006	5.1	4.78	(0.32)
8/21/2006	5.11	4.77	(0.34)
8/22/2006	5.1	4.77	(0.33)
8/23/2006	5.09	4.77	(0.32)
8/24/2006	5.09	4.78	(0.31)
8/25/2006	5.11	4.76	(0.35)
8/28/2006	5.1	4.77	(0.33)
8/29/2006	5.07	4.77	(0.30)
8/30/2006	5.05	4.72	(0.33)
8/31/2006	5.05	4.7	(0.35)
9/1/2006	5.02	4.68	(0.34)
9/5/2006	5	4.73	(0.27)
9/6/2006	4.97	4.75	(0.22)
9/7/2006	4.97	4.74	(0.23)
9/8/2006	4.93	4.71	(0.22)
9/11/2006	4.93	4.74	(0.19)
9/12/2006	4.9	4.71	(0.19)
9/13/2006	4.91	4.7	(0.21)
9/14/2006	4.95	4.74	(0.21)
9/15/2006	4.96	4.76	(0.20)
9/18/2006	4.94	4.77	(0.17)
9/19/2006	4.94	4.69	(0.25)
9/20/2006	4.93	4.7	(0.23)
9/21/2006	4.92	4.6	(0.32)
9/22/2006	4.93	4.55	(0.38)
9/25/2006	4.88	4.51	(0.37)
9/26/2006	4.88	4.55	(0.33)
9/27/2006	4.88	4.56	(0.32)
9/28/2006	4.87	4.57	(0.30)
9/29/2006	4.89	4.59	(0.30)
10/2/2006	4.88	4.56	(0.32)

Date	3 Mo	5 Yr	Diiference
10/3/2006	4.9	4.56	(0.34)
10/4/2006	4.93	4.5	(0.43)
10/5/2006	4.94	4.55	(0.39)
10/6/2006	4.95	4.64	(0.31)
10/10/2006	5	4.71	(0.29)
10/11/2006	5.02	4.75	(0.27)
10/12/2006	5.06	4.74	(0.32)
10/13/2006	5.05	4.77	(0.28)
10/16/2006	5.09	4.76	(0.33)
10/17/2006	5.09	4.73	(0.36)
10/18/2006	5.09	4.74	(0.35)
10/19/2006	5.1	4.75	(0.35)
10/20/2006	5.09	4.76	(0.33)
10/23/2006	5.12	4.8	(0.32)
10/24/2006	5.13	4.81	(0.32)
10/25/2006	5.12	4.75	(0.37)
10/26/2006	5.12	4.69	(0.43)
10/27/2006	5.11	4.64	(0.47)
10/30/2006	5.1	4.64	(0.46)
10/31/2006	5.08	4.57	(0.51)
11/1/2006	5.07	4.52	(0.55)
11/2/2006	5.07	4.55	(0.52)
11/3/2006	5.09	4.7	(0.39)
11/6/2006	5.09	4.69	(0.40)
11/7/2006	5.08	4.63	(0.45)
11/8/2006	5.1	4.61	(0.49)
11/9/2006	5.09	4.6	(0.49)
11/10/2006	5.1	4.57	(0.53)
11/13/2006	5.09	4.6	(0.49)
11/14/2006	5.09	4.57	(0.52)
11/15/2006	5.09	4.62	(0.47)
11/16/2006	5.09	4.67	(0.42)
11/17/2006	5.09	4.6	(0.49)
11/20/2006	5.08	4.6	(0.48)
11/21/2006	5.07	4.58	(0.49)
11/22/2006	5.05	4.57	(0.48)
11/24/2006	5.04	4.55	(0.49)
11/27/2006	5.05	4.54	(0.51)
11/28/2006	5.04	4.5	(0.54)
11/29/2006	5.04	4.51	(0.53)
11/30/2006	5.03	4.45	(0.58)
12/1/2006	5.03	4.39	(0.64)
12/4/2006	5.01	4.39	(0.62)
12/5/2006	4.99	4.39	(0.60)
12/6/2006	4.99	4.44	(0.55)
12/7/2006	4.98	4.45	(0.53)
12/8/2006	4.97	4.53	(0.44)
12/11/2006	4.93	4.5	(0.43)
12/12/2006	4.93	4.45	(0.48)
12/13/2006	4.94	4.54	(0.40)
12/14/2006	4.96	4.58	(0.38)
12/15/2006	4.91	4.57	(0.34)
12/18/2006	4.96	4.57	(0.39)
12/19/2006	4.96	4.57	(0.39)
12/20/2006	4.96	4.57	(0.39)
12/21/2006	4.97	4.52	(0.45)
12/22/2006	4.99	4.59	(0.40)
12/26/2006	4.99	4.58	(0.41)
12/27/2006	4.97	4.64	(0.33)
12/28/2006	5	4.69	(0.31)
12/29/2006	5.02	4.7	(0.32)

Date	3 Mo	5 Yr	Diiference
1/2/2007	5.07	4.68	(0.39)
1/3/2007	5.05	4.66	(0.39)
1/4/2007	5.04	4.61	(0.43)
1/5/2007	5.05	4.65	(0.40)
1/8/2007	5.08	4.66	(0.42)
1/9/2007	5.08	4.65	(0.43)
1/10/2007	5.09	4.68	(0.41)
1/11/2007	5.11	4.73	(0.38)
1/12/2007	5.09	4.76	(0.33)
1/16/2007	5.11	4.74	(0.37)
1/17/2007	5.12	4.78	(0.34)
1/18/2007	5.12	4.75	(0.37)
1/19/2007	5.14	4.78	(0.36)
1/22/2007	5.13	4.77	(0.36)
1/23/2007	5.14	4.81	(0.33)
1/24/2007	5.13	4.81	(0.32)
1/25/2007	5.14	4.85	(0.29)
1/26/2007	5.13	4.87	(0.26)
1/29/2007	5.14	4.89	(0.25)
1/30/2007	5.13	4.86	(0.27)
1/31/2007	5.12	4.82	(0.30)
2/1/2007	5.13	4.84	(0.29)
2/2/2007	5.14	4.82	(0.32)
2/5/2007	5.15	4.8	(0.35)
2/6/2007	5.14	4.76	(0.38)
2/7/2007	5.15	4.74	(0.41)
2/8/2007	5.16	4.73	(0.43)
2/9/2007	5.15	4.78	(0.37)
2/12/2007	5.18	4.8	(0.38)
2/13/2007	5.17	4.81	(0.36)
2/14/2007	5.16	4.72	(0.44)
2/15/2007	5.17	4.68	(0.49)
2/16/2007	5.17	4.68	(0.49)
2/20/2007	5.19	4.67	(0.52)
2/21/2007	5.18	4.68	(0.50)
2/22/2007	5.19	4.72	(0.47)
2/23/2007	5.18	4.67	(0.51)
2/26/2007	5.19	4.62	(0.57)
2/27/2007	5.14	4.46	(0.68)
2/28/2007	5.16	4.52	(0.64)
3/1/2007	5.15	4.5	(0.65)
3/2/2007	5.12	4.46	(0.66)
3/5/2007	5.1	4.45	(0.65)
3/6/2007	5.14	4.48	(0.66)
3/7/2007	5.12	4.45	(0.67)
3/8/2007	5.1	4.45	(0.65)
3/9/2007	5.1	4.55	(0.55)
3/12/2007	5.09	4.5	(0.59)
3/13/2007	5.09	4.41	(0.68)
3/14/2007	5.06	4.44	(0.62)
3/15/2007	5.05	4.46	(0.59)
3/16/2007	5.04	4.47	(0.57)
3/19/2007	5.06	4.5	(0.56)
3/20/2007	5.06	4.47	(0.59)
3/21/2007	5.05	4.43	(0.62)
3/22/2007	5.06	4.49	(0.57)
3/23/2007	5.08	4.52	(0.56)
3/26/2007	5.06	4.48	(0.58)
3/27/2007	5.08	4.5	(0.58)
3/28/2007	5.06	4.5	(0.56)
3/29/2007	5.05	4.53	(0.52)

Date	3 Mo	5 Yr	Diiference
3/30/2007	5.04	4.54	(0.50)
4/2/2007	5.04	4.54	(0.50)
4/3/2007	5.05	4.56	(0.49)
4/4/2007	5.07	4.55	(0.52)
4/5/2007	5.04	4.57	(0.47)
4/6/2007	5.05	4.67	(0.38)
4/9/2007	5.02	4.66	(0.36)
4/10/2007	5.03	4.63	(0.40)
4/11/2007	5.04	4.66	(0.38)
4/12/2007	5.03	4.66	(0.37)
4/13/2007	5.02	4.68	(0.34)
4/16/2007	5.01	4.67	(0.34)
4/17/2007	5.01	4.61	(0.40)
4/18/2007	5	4.56	(0.44)
4/19/2007	4.99	4.57	(0.42)
4/20/2007	4.99	4.57	(0.42)
4/23/2007	4.98	4.55	(0.43)
4/24/2007	4.98	4.51	(0.47)
4/25/2007	4.97	4.55	(0.42)
4/26/2007	4.96	4.59	(0.37)
4/27/2007	4.95	4.59	(0.36)
4/30/2007	4.91	4.51	(0.40)
5/1/2007	4.9	4.54	(0.36)
5/2/2007	4.91	4.55	(0.36)
5/3/2007	4.9	4.59	(0.31)
5/4/2007	4.9	4.55	(0.35)
5/7/2007	4.89	4.55	(0.34)
5/8/2007	4.9	4.54	(0.36)
5/9/2007	4.88	4.58	(0.30)
5/10/2007	4.87	4.56	(0.31)
5/11/2007	4.87	4.58	(0.29)
5/14/2007	4.85	4.61	(0.24)
5/15/2007	4.83	4.63	(0.20)
5/16/2007	4.75	4.62	(0.13)
5/17/2007	4.81	4.68	(0.13)
5/18/2007	4.84	4.74	(0.10)
5/21/2007	4.88	4.71	(0.17)
5/22/2007	4.93	4.76	(0.17)
5/23/2007	4.91	4.79	(0.12)
5/24/2007	4.91	4.79	(0.12)
5/25/2007	4.88	4.8	(0.08)
5/29/2007	4.9	4.82	(0.08)
5/30/2007	4.85	4.83	(0.02)
	0		
	0		
	0		



Source: U.S. DEPARTMENT OF THE TREASURY (https://www.treasury.gov/resource-center/data-chart-center/interest-rates/

Resources

- Government Yield Curve
  - https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/Historic-Yield-Data-Visualization.aspx
- Government Rate Tables
  - https://www.treasury.gov/resource-center/data-chart-center/interest-rates/
- Government Yield Curve to S&P 500
  - http://stockcharts.com/freecharts/yieldcurve.php

Conclusions

- Yield curves are generally upward sloping and there are various theories for why this is true
- Yield curves come in various types and are useful for different purposes
- Five basic stylized yield curves exists: Normal, Steep, Flat, Humped, & Inverted
- Each stylized US treasury yield curve can signal a different direction for the US economy and the most powerful predictor of a US recession is the inverted yield curve

Questions