



Introduction to Term Structure of Interest Rates
An Interpretation of the Yield Curves
during the Covid-19 Pandemic (2019-2022)

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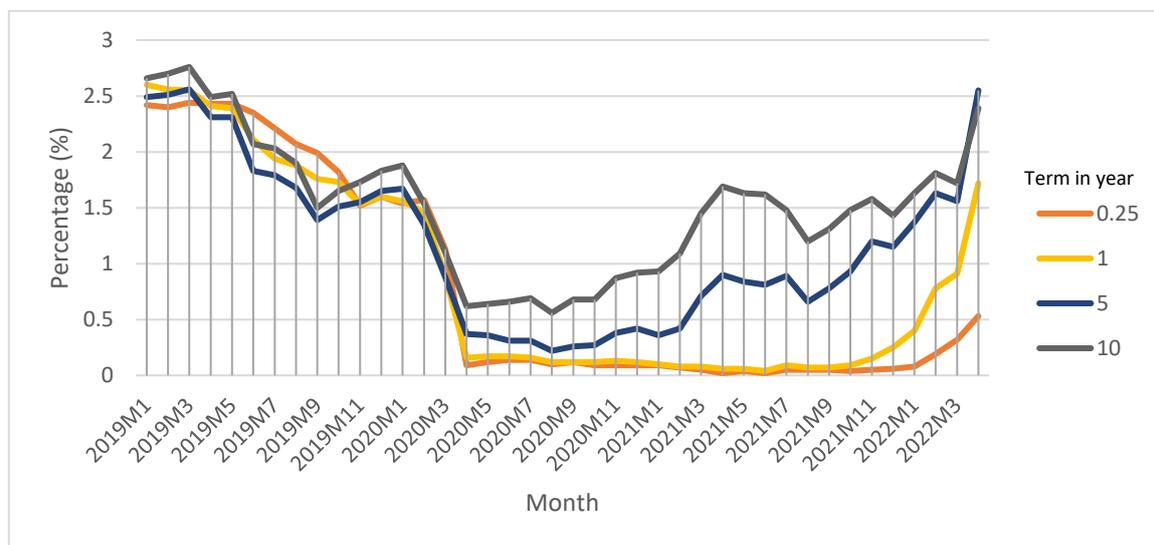
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Introduction

Since the outbreak of Covid-19 pandemic in early 2020, the term structure of interest rates has been unstable, with positive and inverted yield curves occurred in United States. Instead, prior to the outbreak of the pandemic, the spread between 3-month and 10-year treasury securities have already shown sign of inversion for the first time after the 2008 Global Financial Crisis, registering a spread of -0.02% in March 2019. The yield spread turned negative again when the US Stock market reached its lowest level after the outbreak of the pandemic in early 2020, registering a spread of -0.03% in February 2020. At the time of writing this article, the yield spread is positive at 1.86% in April 2022, which is the higher level recorded since the outbreak of the pandemic (Figure 1).

Figure 1 US Short-term and Long-term Interest Rates (2019-2022)



Source: Federal Reserve Database

<https://www.federalreserve.gov/releases/h15/>

What makes long-term interest rates differ from short-term rates? What are the elements that determine the variation of interest rates over time? The purpose of this article is to help readers develop a fundamental understanding of term structure of interest rates and the commonly cited traditional theories.

The knowledge on term structure of interest rates is important for participants in the debt markets. The difference between a long-term interest rate and a short-term interest rate is an indicator to assess economic conditions and to predict real economic activity (Duarte, et al., 2005). Therefore, an understanding the factors driving the term structure of interest rates is crucial for interpretation and investment decision-making.

In this article, I first introduce the concept of term structure of interest rates and yield curve. This is followed by explanations on what kind of shape a yield curve can take. Next, I present the classical theories of the term structure of interest rates to determine what explain the relationship between long-term and short-term interest rates.

The explanation and elaboration are supported with recent real-world empirical data, so that readers will get a better understanding of the recent trend. The sample period covers year 2019-

2022, spanning a period when the world economies were severely affected by Covid-19 pandemic, to a time when recovery begins to set in.

When first writing this article, my original target readers are my students who learn about Introductory Finance at Henley Business School Malaysia. I believe this article is also useful for any readers who are keen to learn more about the term structure of interest rates. I hope that readers will build up the foundation knowledge about yield curve and relate the theory to real world scenarios.

Term Structure of Interest

The term structure of interest rates is the relationship between the rate of return and maturity for bonds with similar quality or level of risk (Gitman & Zutter, 2012). Term structure of interest can also be defined as the relationship between short- and long-term interest rates (Ross, et al., 2010). It is the series of interest rates ordered by term-to-maturity at a given time (Lionel, et al., 2003).

Yield Curve

What information does the yield curve reveal?

The yield curve is a graphical depiction of the term structure of interest rates. It shows the relationship between the yield to maturity and term to maturity for bonds of the same credit quality but different maturities (Fabozzi & Steven, 2010). Plotting the yield to maturity on the vertical axis and the time to maturity across the horizontal axis for a group of bonds of the same class will give us the yield curve.

As yield is related to the price of bond, the yield curve can be used as a benchmark for the cost of funds at various maturities. The yield curve shows how interest rates vary between short-, medium-, and long-term bonds. When market participants refer to the yield curve, they usually mean the government treasury yield curve of a country, because Treasury securities are generally considered to be free of default risk (Fabozzi & Steven, 2010). The Treasury yield curve serves as a benchmark for pricing bonds in other sectors of the debt market (e.g., corporate debt, mortgages, bank loans, etc.). Yield curve commonly compares the one-month, three-month, six-month, one-year, two-year, five-year, 10-year and 30-year Treasury debt.

Yield curve plays a crucial role in identifying the current state of an economy and provides a valuable framework for monitoring economic cycles. Hasse & Lajaunie (2022) re-examine the predictive power of the yield spread across countries and over time. Using a dynamic panel/dichotomous model framework and a unique dataset covering 13 OECD countries over the period 1975–2019, they find that the yield spread signals recessions. This result is robust to different econometric specifications, controlling for recession risk factors and time sampling.

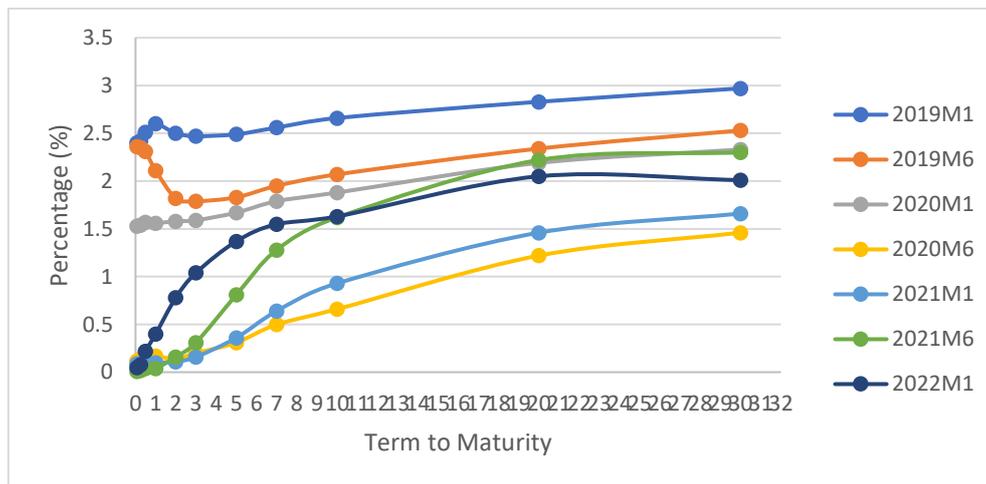
Yield curve is also useful for forecasting, and it reflects the expectation of market participants about future changes in interest rates and their assessment of monetary policy conditions. When the yield curve shifts or changes in shape, it can be used as a leading economic indicator on

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where interest rates and the economy in general are headed in the future (Gitman & Zutter, 2012).

How is the shape of the yield curve after the outbreak of the Covid-19 pandemic? Figure 2 gives a visual presentation of how the shape of yield curve have changed for the sample period of 2019-2022.

Figure 2 Yield Curve 2019-2022

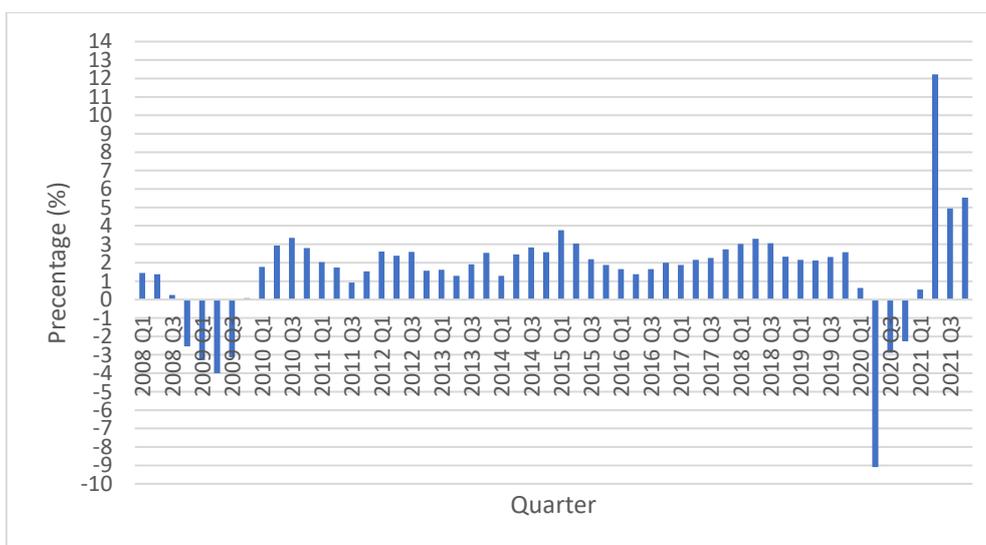


Source: Federal Reserve website and author's compilation.

Data is collected from <https://www.federalreserve.gov/releases/h15/>.

The US economy was badly affected by the Covid-19 pandemic. At the peak of the pandemic, the GDP of US recorded a severe contraction of -9% in 2020 Q2. By 2021 Q1, the economy started to recover (Figure 3).

Figure 3 United States GDP Growth (Year-on-Year)

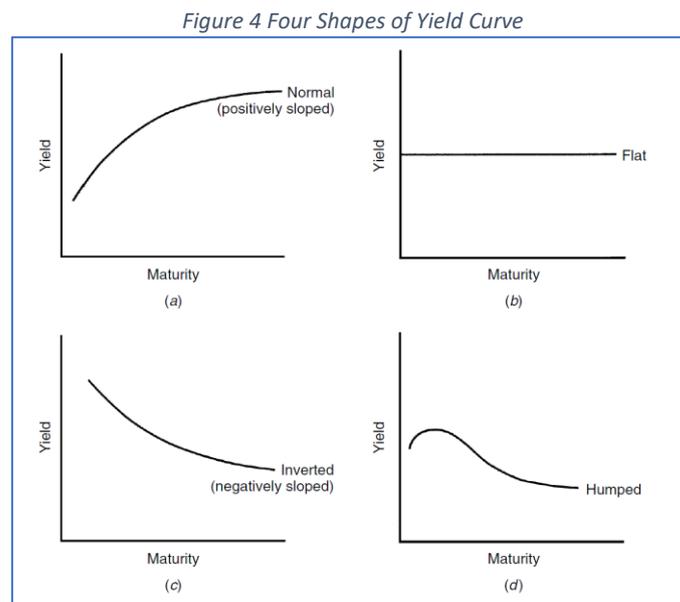


Source: Bureau of Economic Analysis (BEA), US Department of Commerce

Amidst the Covid-19 pandemic, the US Federal Reserve cut the federal funds rate by 1.5 percentage points at its meetings on March 3 and March 15, 2020 to support spending by lowering the cost of borrowing for households and businesses (Milstein & Wessel, 2021). These cuts lowered the funds rate to a range of 0% to 0.25%. This move had implication on short-term and long-term rates. As a result, yield curve shifted down.

Shape of Yield Curve

The yield curve may take different shapes at different points in the economic cycle. Four shapes of yield curve have been observed.



Source: Fabozzi (2007)

1. The most common shape is a positively sloped yield curve (panel a), in which the longer the maturity, the higher the yield. This shape is referred to as a normal yield curve. Long-term yields are higher than short-term yields. Investors are rewarded for holding longer maturity Treasuries in the form of a higher potential yield. An upward sloping yield curve signals that the economy is in an expansionary mode.
2. A flat yield curve (panel b) is one in which the yield for all maturities is approximately equal. This means the yield of a short-term bond is about the same as that of a long-term bond. A flattening of the yield curve usually occurs when there is a transition between the normal yield curve and the inverted yield curve, or the market is uncertain about the future direction of the economy.
3. There have been times when the slope of the yield curve is negatively sloped (panel c), in which the longer the maturity the lower the yield. This shape is referred to as an inverted yield curve. Short-term yields are higher than long-term yields. Long-term investors have the perception that interest rates will decline in the future. A downward sloping yield curve signifies that the economy is in, or about to enter, recessive period.

4. A humped yield curve (panel d) shows yields increasing with maturity for a range of maturities and then the yield curve becoming inverted (Fabozzi, 2007). This means medium-term yields are greater than both short-term yields and long-term yields.

When long-term rates are higher than short-term rates, we say that the term structure is upward sloping; when short-term rates are higher, we say it is downward sloping. The most common shape of the term structure, particularly in modern times, is upward sloping. (Ross, et al., 2010)

The degree of steepness of the yield curve may vary. A steep curve indicates that long-term yields are rising at a faster rate than short-term yields. Steep yield curves have historically indicated the start of an expansionary economic period (Gitman & Zutter, 2012).

Historical Examples of Normal and Inverted Yield Curves

In this section, I will move back in history to show some examples about the economic environment in which different shape of yield curves occurred.

Usually, the normal yield curve is upward sloping, where short-term interest rates are lower than long-term interest rates, as they were on May 13, 2004, in United States. Interest rates on April 5, 2010, were unusually low, largely because at that time the economy was just beginning to recover from a deep recession and inflation was very low (Figure 5).

Figure 5 Selected Positive Yield Curves in United States

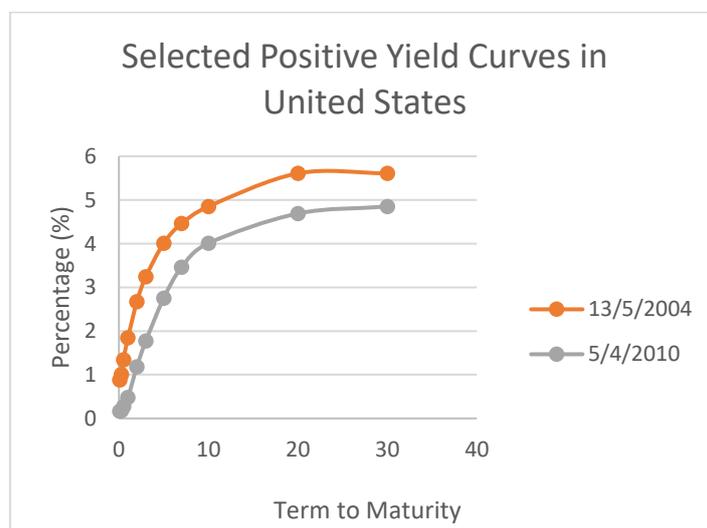
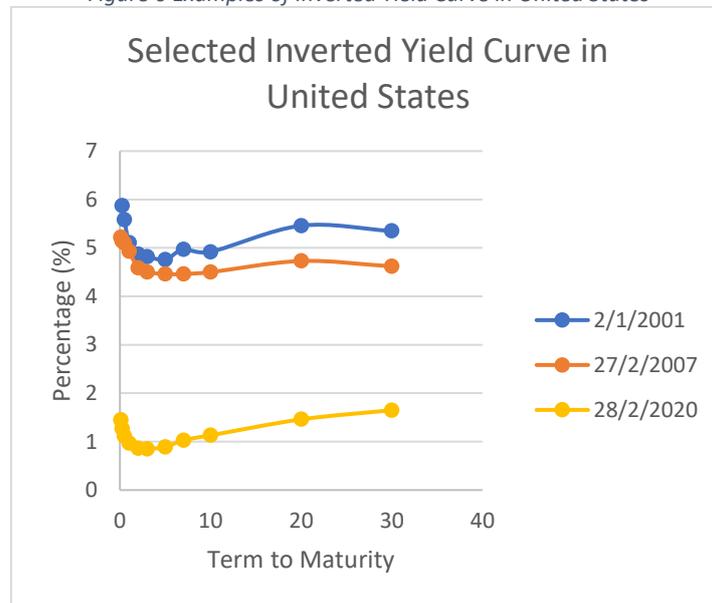


Figure 6 shows the example of inverted yield curve in United States. The periods correspond with the 2001 Dot-com Bubble, the global financial crisis 2007 and the Covid-19 pandemic in early 2000. The inverted yield curve indicates that short-term interest rates at that time were above longer-term rates. Historically, a downward-sloping yield curve occurs infrequently and

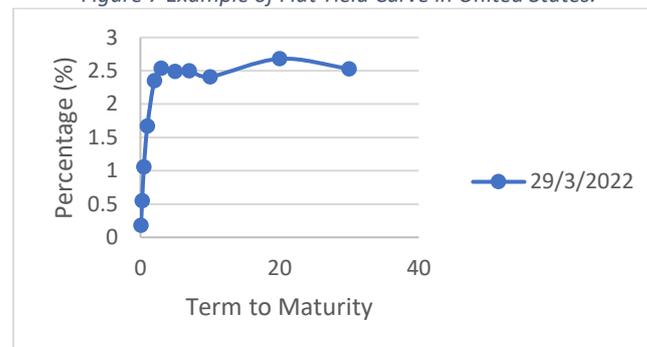
is often a sign that the economy is weakening. Most recessions in the United States have been preceded by an inverted yield curve (Gitman & Zutter, 2012).

Figure 6 Examples of Inverted Yield Curve in United States



On March 29, 2022, a flat yield curve existed, in which the rates did not vary much at different maturities (Figure 7)

Figure 7 Example of Flat Yield Curve in United States.

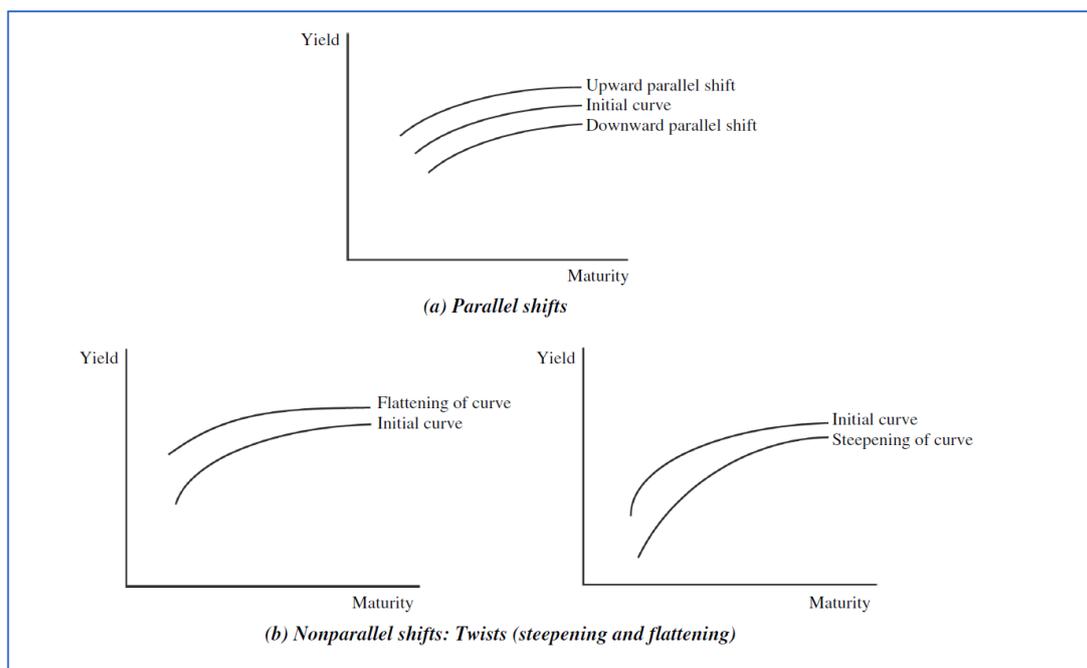


Yield Curve Shifts

A shift in the yield curve refers to the relative change in the yield for each Treasury maturity. A parallel shift in the yield curve refers to a shift in which the change in the yield for all maturities is the same. A nonparallel shift in the yield curve means that the yield for different maturities does not change by the same number of basis points (Fabozzi, 2007).

A flattening of the yield curve means that the slope of the yield curve (i.e., the spread between the yield on a long-term and short-term Treasury) has decreased; a steepening of the yield curve means that the slope of the yield curve has increased (Figure 8).

Figure 8 Shift in Yield Curve



Source: Fabozzi (2007)

Kucera (2020) examines the sources of daily movements in U.S. Treasury yields for the period 2001-2019. The findings show that the U.S. macroeconomic news was the core trigger of U.S. Treasury yield volatility over most of the period under analysis. However, the importance of non-macroeconomic news associated with capital flight has increased significantly since 2011, and they became the dominant source of movements in the long end of the U.S. yield curve after 2016.

A Review of the Theories

How can we explain and interpret the shapes and shifts in the yield curve? This question is of interest to anyone concerned with the valuation of securities and economic forecasting.

The main traditional theories that are frequently cited to explain the shape of the yield curve include:

- the pure expectations theory (unbiased expectations theory)
- the liquidity preference theory (or liquidity premium theory)
- the market segmentation theory (or preferred habitat theory)

Expectation Theory

The expectation theory can be traced back to the work Fisher (1930), who develops the relationship between short-term and long-term interest rates, and posits that short-term and long-term rates tend to move together, with short-term rates moving over a wider range. The

theory is further extended by Lutz (1940), who posits that long-term interest rate is a sort of average of the future short-term rates.

The expectations theory suggests that the yield curve reflects investor expectations about future interest rates (Gitman & Zutter, 2012). When investors expect short-term interest rates to rise in the future, today's long-term rates will be higher than current short-term rates, and the yield curve will be upward sloping. The opposite is true when investors expect declining short-term rates, today's short-term rates will be higher than current long-term rates, and the yield curve will be downward sloping. A flat term structure reflects an expectation that future short-term rates will be unchanged from today's short-term rates (Table 1).

Table 1 Shape of Yield Curve and its implication

Shape of term structure	Implication according to pure expectations theory
Upward sloping (normal)	Rates expected to rise
Downward sloping (inverted)	Rates expected to decline
Flat	Rates not expected to change

Referece: Fabozzi (2007)

The long-term interest rate is a geometric average of expected future short-term rates (Choudhry, 2010). For example, if the yield on the two-year bond is higher than the yield on the one-year bond, according to this theory, investors expect the one-year rate a year from now to be sufficiently higher than the one-year rate available now so that the two ways of investing for two years have the same expected return (Fabozzi, 2007). Therefore, current long-term rates can be used to predict short term rates of future.

Liquidity Preference Theory

The liquidity preference theory can be traced back to Keynes (1937). The Liquidity Preference Theory assumes that investors have a general bias towards short-term securities, which have higher liquidity as compared to the long-term securities. Investors will not agree to tie-up their funds for a longer period of time unless they receive compensation in the form of a higher rate of return.

Generally, borrowers prefer to borrow over long-term, if possible, while lenders prefer to lend as short a term as possible. Therefore, lenders have to be compensated for lending over the longer term. This compensation is considered as a premium for a loss in liquidity for the lender. The longer the term, the higher the yield when investor lends across the term structure (Choudhry, 2010).

In addition, market participants want to be compensated for the interest rate risk associated with holding longer term bonds. The longer the maturity, the greater the price volatility when interest rates change and investors want to be compensated for this risk (Fabozzi, 2010).

The preference for liquidity and the risk inherent in longer-term investments explain a positive shaped yield curve (Choudhry, 2010). The liquidity preference theory asserts that the yield premium increases with maturity (Fabozzi, 2010).

O'Sullivan & Papavassiliou (2020) study the liquidity dynamics in the eurozone sovereign bond market over tranquil and crisis periods and report a flight-to-liquidity effect as investors prefer to trade on shorter-term benchmarks during liquidity dry-ups.

Preferred Habitat Theory

The preferred habitat theory is a variant of the market segmentation theory. The market segmentation theory is introduced by Culbertson (1957), while the preferred habitat theory is proposed by (Walker, 1954) Walker (1954) and Modigliani & Sutch (1966).

The market segmentation theory is related to the supply-demand dynamics of the market. Proponents of the market segmentation theory argue that within the different maturity sectors of the yield curve, the supply and demand for funds determine the interest rate for that sector. That is, each maturity sector is an independent or segmented market for purposes of determining the interest rate in that maturity sector (Fabozzi, 2007).

The capital markets are made up of a wide variety of lenders and borrowers, whom have different preferences and requirements and for instruments of a specific maturity for various reasons. Certain classes of investors will prefer dealing for short-term, while others will concentrate on the longer term. For example, banks and building societies concentrate a large part of their activity at the short end of the curve, as part of daily cash management (known as asset and liability management) and for regulatory purposes (known as liquidity requirements). Fund managers, such as pension funds and insurance companies, however, are active at the long end of the market. Few institutional investors, however, have any preference for medium-dated bonds (Choudhry, 2010).

The segmented market theory suggests that market participants will tend to stick to securities of the corresponding maturity, without paying attention to rates of return on other maturities. Activity is concentrated in certain specific areas of the market, and there are no interrelationships between the different segments of the market. The relative amounts of funds invested in each of the maturity spectra causes differentials in supply and demand. Hence, the rates for different terms to maturity tend to be determined, each in its separate market, by their independent supply and demand schedules (Modigliani & Sutch, 1966). The shape of the yield curve is determined by supply and demand for certain specific maturity investments, each of which has no reference to any other part of the curve (Choudhry, 2010).

According to the preferred habitat theory, any shape of yield curve (positive sloping, inverted, or humped) is possible (Fabozzi, 2007). An upward-sloping yield curve indicates greater borrowing demand relative to the supply of funds in the long-term segment of the debt market relative to the short-term segment (Gitman & Zutter, 2012).

Proponents of this theory do not assert that investors would be unwilling to shift out of their preferred maturity sector. Instead, if investors are given an inducement to do so in the form of a yield premium, they will shift out of their preferred habitat (Fabozzi, 2007).

Most tests of preferred habitat theory are indirect, by examining the behaviour of asset prices to infer the existence of preferred habitat behaviour in financial markets. Using cluster analysis, Giese, et al. (2021) find that investors can be classified into distinct groups, some of which more closely display the behavioural properties associate with preferred habitat investors. These groups of investors are less sensitive to price movements than other investor groups and include institutional investors, like life insurers and pension funds, which are typically associated with preferred habitat behaviour (Giese, et al., 2021).

Conclusion

The recent yield curve in April 2022 has a positive slope but flattens off at 10-year maturity. Drawing from the discussion in this article, the yield curve shows that the US economy is recovering. An upward sloping yield curve signals that the economy is in an expansionary mode, but there is still sign of uncertainty. The long-term rates have increased during the second half of 2020, indicating investors are compensated with higher liquidity and risk premium for holding long-term bond. Investors are rewarded for holding longer maturity Treasuries in the form of a higher potential yield. The pattern of the yield curve reveals that the worst is over after a two-year fight against the pandemic, with the vaccination of the population, and the reopening of various economic sectors.

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