MARKET SEGMENTATION THEORY: A PEDAGOGICAL MODEL FOR EXPLAINING THE TERM STRUCTURE OF INTEREST RATES

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Four theories have evolved over the years to explain the term structure of interest rates: Market Segmentation Theory (MST), Preferred Habitat Theory (PHT), Pure Expectation Theory (PET), and the Liquidity Premium Theory (LPT). In explaining term structure, many financial markets texts emphasize PET and LPT as the primary theory in explaining the shape of yield curves. Since MST is based on fundamental supply and demand factors, the de-emphasis of MST as a term structure explanation means that such important factors as economic conditions and monetary and fiscal policy, as well as the interrelation between different debt market segments and sectors, are not being fully examined in many financial market texts. This paper presents the MST in terms of a basic supply and demand model. This model, in turn, can be used to explain how important economic forces influence the term structure of interest rates and also as a foundation for explaining the other three term structures theories.

INTRODUCTION

Over the last three decades interest rates have often followed patterns of persistent increases or persistent decreases with fluctuations around these trends. This is illustrated in Figure 1 where the rates on Treasury bills are shown from 1970 to 2003. As shown, in the 1970s and early 1980s the U.S.'s inflation led to increasing interest rates during that period. This period of increasing rates was particularly acute from the late 1970s through early 1980s when the U.S. Federal Reserve changed the direction of monetary policy by raising discount rates, increasing reserve requirements, and lowering monetary growth. This period of increasing rates was followed by a period of declining rates from the early 1980s to the late 1980s, then a period of gradually increasing rates for most of the 1990s, and finally a period of decreasing rates from 2000 through 2003. The different interest rates levels observed since the 1970s can be explained by such factors as economic growth, monetary and fiscal policy, and inflation.

Insert Figure 1 Here

In addition to the observed fluctuations in interest rate levels, there have also been observed spreads between the interest rates on bonds of different categories and terms to maturity over this same period. In general, spreads can be explained by differences in each bond's characteristics: risk, liquidity, and taxability. Interest rate differences can also be observed between similar bonds with different maturities. Figure 2 shows two yield curve plots of the yields to maturity, YTM, on U.S. government bonds with different maturities for early 2002 and early 1981. The lower graph in Figure 2 shows a positively-sloped yield curve in early

2002 and the upper graph shows a negatively sloped curve in early 1981. Understanding what determines both the overall level and term structure of interest rates is an important subject in financial economics. One of the best ways to understand how market forces determine interest rates is to use fundamental supply and demand analysis. Many financial markets texts examine the level of interest rates by explaining a supply and demand for loanable funds model. One excellent supply and demand exposition is presented by Mishkin and Eakins [2003]. Using such a model, they show how changes in the economy, future interest rate expectations, inflation expectations, risk, liquidity, and monetary and fiscal policy policies affect interest rates by shifting bond demand and supply curves.

Insert Figure 2 Here

With respect to the term structure of interest rates, four theories have evolved over the years to try to explain the shapes of yield curves: Market Segmentation Theory (MST), Preferred Habitat Theory (PHT), Pure Expectation Theory (PET), and the Liquidity Premium Theory (LPT). In explaining term structure, many financial markets texts, including Mishkin's and Eakins', emphasize PET and LPT as the primary theory in explaining the term structure. Since MST, though, is based on fundamental supply and demand factors, the de-emphasis of MST as a yield curve explanation means that such important factors as economic conditions and monetary and fiscal policy, as well as the interrelation between different debt market segments and sectors, are not being fully examined in many financial market texts.

In general, each of the four theories by itself is usually not sufficient to explain the shape of a yield curve; rather, the full explanation underlying the term structure of interest rates depends on elements of all four theories. The purpose of this paper is to present the MST in terms of a basic supply and demand model based on the Mishkin and Eakins' model used for explaining the level of interest rates. This model, in turn, can be used to explain how important economic forces influence not only the level, but also the term structure, of interest rates and also as a foundation for explaining the other three term structures theories. We begin by defining the basic supply and demand model used for explaining the level of interest rates. We then extend the model to explain the MST. Finally, given the MST, we explain the other theories of term structure as extensions of the basic MST supply and demand conditions.

INTEREST RATES LEVELS: SUPPLY AND DEMAND ANALYSIS

Bond Demand

The general level of interest rates can be explained in terms of a basic bond supply and demand model. In determining the supply and demand for bonds, let us treat different bonds as being alike and simply assume the bond in question is a one-period, zero-coupon bond paying a principal of F equal to 100 at maturity and priced at P_0 to yield a rate i.

$$P_0 = \frac{F}{1+i} = \frac{100}{1+i}$$

$$i = \frac{F - P_0}{P_0} = \frac{F}{P_0} - 1 = \frac{100}{P_0} - 1$$

In general, the quantity demanded of a bond, B^D, depends on such factors as its price or interest rate, the overall wealth or economic state of the economy, perhaps as measured by aggregate real output, gdp, the bond's risk relative to other assets, its liquidity relative to other assets, expected future interest rates, E(i), and inflation, and government policies:

$$B^D = f(\underset{+\quad -}{i \text{ or } P_0}, \underset{+}{gdp}, \underset{-}{E(i)}, \underset{-}{E(inflation)}, \underset{-}{risk}, \underset{+}{liquidity}, \underset{+ \text{ or } -}{Government\ Policy})$$

Using traditional supply and demand analysis, the impacts of these variables can be examined by first generating a demand curve for the bond. The curve shows the relationship between B^D and its price, P_0, or interest rate, i, with the assumption that the other factors are constant. Given the demand curve, we can then analyze the impact the other factors have on demand by observing how changes in those variables shift the demand curve. Figure 3 shows a bond demand curve B^DB^D. To illustrate the relation between bond demand and both its price and interest rate, Figure 3 has two vertical axes. The left axis shows the bond's price, with the price increasing as we go from the bottom up. The right vertical axis shows the associated interest rate, with the interest rate increasing as we move from the top to the bottom. Combined, the two axes capture the inverse relation between a bond's price and interest rate. Thus, at point A on B^DB^D, the price of the bond is at 96.1538 and its associated interest rate is 4%; at point B the price is 92.5926 and the associated rate is 8%. The bond demand curve in Figure 3, in turn, is negatively sloped. This reflects the fundamental assumption that investors will demand more bonds the lower the price or equivalently the greater the interest rate. Thus, at point B investors are shown to demand \$500B worth of the bond (number of bonds times the face value) when P_0 is 92.5926 and i is 8%, and at point A, bond demand is shown to be only \$300B when P_0 is 96.1538 and i is 4%. It should be noted that since buying or demanding a bond is equivalent to supplying a loan, the bond demand curve in Figure 3 can also be identified as a supply of loanable funds curve.

Insert Figure 3 Here

The impact of changes in the economy, future interest rate expectations, inflation expectations, risk, liquidity, and government policies on bond demand is captured by either rightward or leftward shifts in the demand curve. A priori, we would expect an increase in the demand for the bond at each price or interest rate when the economy is growing and aggregate wealth and output (gdp) are increasing, and a decrease in demand when the economy is in recession. Thus, the bond demand curve will shift to the right in periods of economic growth and to the left in periods of economic decline. In contrast, we would expect an inverse relation to exist between bond demand and the market's expectation of future interest rate. That is, for those investors who plan to sell their bonds before maturity, an expectation of higher interest rates would mean lower futures bond prices and therefore a lower expected rate of return on our assumed zero coupon bond. If investors expect the prices on goods and services, as well as cars, houses, and other consumer durables, to be higher in the future, they will decrease their current purchases of bonds and other securities and buy more consumption goods and consumer durables. A similar inverse relation also exists between bond demand and its relative risk. If bonds become riskier relative to other investments, we would expect a decrease in demand, and if they become less risky relative to other investments, we would expect an increase in demand. In terms of liquidity, if more investors trade the bond, making it more marketable or liquid, then we would expect the demand for the bond to increase at each price or interest rate. Finally, any change in government policy, such as a change in monetary or fiscal policy, that changes bond demand would shift the bond demand curve. For example, a Fed action of changing the discount rate they charge banks for borrowing or changing the amount of reserves banks are required to maintain in order to secure their deposits, would change the amount of loans banks are willing to offer. In this model, a change in the supply of loanable funds is equivalent to a change in the demand for bonds and would be reflected by a shift in the bond demand curve.

Bond Supply

In general, the quantity supplied of bonds by corporations, governments, and intermediaries, B^S, depends on such factors as the bond's price or interest rate, the state of the economy, government policy, and expected future inflation:

$$B^S = f(\underset{-}{i} \text{ or } \underset{+}{P_0}, \underset{+}{gdp}, \underset{+ \text{ or } -}{\text{Government Policy}}, \underset{+}{E(\text{inflation})})$$

The bond supply curve in Figure 3, $B^S B^S$ is positively sloped. This reflects the fundamental assumption that corporations, governments, and financial intermediaries will sell more bonds the greater the bond's price or equivalently the lower the interest rate. Thus, at point C issuers are shown to supply only \$300B worth of the bond when P_0 is 92.5926 and i is 8%, while at point D bond supply is shown to be \$500B when P_0 is 96.1538 and i is 4%. It should be noted that since selling or supplying a bond is equivalent to obtaining or demanding a loan, the bond supply curve in Figure 3 can also be identified as a demand for loanable funds curve.

The bond supply curve will shift in response to changes in the state of the economy, government policy, and expected inflation. A priori, we would expect an increase in the supply for the bond at each price or interest rate when the economy is growing and a decrease in supply when the economy is in recession. When an economy is expanding, business demand for both short-term assets, such as inventories and accounts receivable, and long-term assets, such as plants and equipment, will increase. As a result, companies find themselves selling more bonds (demanding more loans) to finance the increases in their short-term and long-term capital formation. In contrast, in recessionary periods, there is less capital formation and fewer bonds being sold by corporations, governments, and intermediaries Thus, we would expect the bond supply curve to shift to the right in periods of economic growth and to the left in periods of economic decline. The bond supply can also change as a result of the federal government's fiscal and monetary policy. If the federal government has a deficit, then the Treasury will be raising funds in the financial market by selling more Treasury securities. This would increase the supply of bonds at each price, shifting the supply curve to the right. In contrast, if there were a government surplus, the bond supply would decrease if the Treasury decided to use the surplus to buy up existing Treasury securities in order to reduce the government's outstanding debt. In this case, the bond supply curve would shift to the left. In addition to Treasury financing, bond supply is also affected by central bank policies. For example, in an expansionary open market operation (OMO), the central bank buys existing Treasury securities. If we limit the definition of bond supply to those bonds held by the public and not the central bank, then an expansionary OMO leads to a decrease in the supply of bonds and a leftward shift in the supply curve. In contrast, when the central bank is fighting inflation, it may try to slow the economy down by increasing interest rates through a contractionary OMO. Here the bank sells some of its holdings of Treasury securities, increasing the supply of bonds and shifting the supply curve to the right. Finally, if inflation is expected to be higher in the future, then expected borrowing cost will be higher in the future and more funds (inflated funds) will be needed to finance capital formation. As a result, corporations will find it advantageous to borrow more funds now. This would cause the bond supply to increase and the bond supply curve to shift to the right.

Market Equilibrium

Given the factors determining the supply and demand for bonds, the bond price or interest rate that ultimately prevails in the market is the one at which the quantity demanded of the bond equals the quantity supplied: $B^D = B^S$. The equilibrium rate, i* and price, P_0*, are graphically defined by the intersection of the supply and demand curves. In Figure 3, this occurs at P_0* = 94.34 and i* = 6% where the quantity demanded and supplied are both $400B. The equilibrium interest rate of 6% is the market-clearing interest rate and the equilibrium price of 94.34 is the market-clearing price. If the bond price were below this equilibrium price (or equivalently the interest rate were above the equilibrium rate), then investors would want more bonds than issuers were willing to sell. This excess demand would drive the price of the bonds up, decreasing the demand (movement down along the demand curve) and increasing the supply (movement along the supply curve) until the excess was eliminated. On the other hand, if the price on bonds were higher than its equilibrium (or interest rates lower that the equilibrium rate), then bondholders would want fewer bonds, while issuers would want to sell more bonds. This excess supply in the market would lead to lower prices and higher interest rates, increasing bond demand (movement along the bond demand curve) and reducing bond supply (movement along the supply curve) until the excess supply was eliminated. Thus, only at P_0* and i*, where bond demand equals bond supply, is there an equilibrium where bondholders and suppliers do not want to change.

Comparative Analysis

The insights that one can gain from supply and demand analysis come from identifying the important factors that affect the positions of the demand and supply curves. Analytically, changes in these factors cause shifts in the demand or supply curves that, in turn, lead to new equilibrium bond price and interest rate levels. To illustrate, consider an OMO in which the central bank either purchases (expansionary OMO) or sells (contractionary OMO) Treasury securities. Such actions change not only the public's holdings of securities, but also the general level of interest rates in the economy. In addition to open market operations, we also noted that the central bank can also affect the level of interest rates by changing the discount rate it charges banks for borrowing and by reducing the amount of reserves banks are required to maintain to secure their deposits. One of the most dramatic monetary actions was undertaken by the U.S. Federal Reserve (Fed) in the late 1970s and early 1980s. Beginning in October of 1979 and extending through October 1982, the Fed raised the discount rate, increased reserve requirements, and set lower monetary growth targets for its OMOs in an effort to combat the U.S.'s high inflation and balance of payments problems. These actions, in turn, represented a directional change in the Fed's policies from the preceding three-year period in which they maintained lower discount rates and reserve requirements. While higher energy prices had already contributed to inflation and high interest rates, these contractionary monetary actions served to push up rates even higher. By 1982, rates on Treasury Bonds were 10%, mortgage rates were 15%, the prime lending rate charged by banks was 21%, and the Dow Jones Average was at 700. These empirical observations are consistent with our supply and demand model. In our model, a contractionary OMO causes the bond supply curve to shift to the right as the Fed sells some of its government bonds, and the increase in both reserve requirements and the Fed's discount rate decreases the supply of loanable funds. As noted, the decrease in loanable funds is equivalent to a decrease in bond demand and therefore leads to a leftward shift in the bond demand curve. As shown in Figure 4, at the initial bond price and interest rate level, the monetary actions of shifting the supply curve to the right and the demand curve to the left, create an excess supply of bonds in the market. The excess supply, in turn, causes bond prices to decrease and rates to increase until a new equilibrium is attained.

Insert Figure 4 Here

MARKET SEGMENTATION THEORY

Market Segmentation Theory (MST) posits that investors and borrowers have strong maturity preferences that they try to attain when they invest in or issue fixed income securities. As a result of these preferences, the financial markets, according to MST, are segmented into a number of smaller markets, with supply and demand forces unique to each segment determining the equilibrium yields for each segment. Thus according to MST, the major factors that determine the interest rate for a maturity segment are supply and demand conditions unique to the maturity segment. For example, the yield curve for high quality corporate bonds could be segmented into three markets: short-term, intermediate-term, and long-term. The supply of short-term corporate bonds, such as commercial paper, would depend on business demand for short-term assets such as inventories, accounts receivables, and the like, while the demand for short-term corporate bonds would emanate from investors looking to invest their excess cash for short periods. The demand for short-term bonds by investors and the supply of such bonds by corporations would ultimately determine the rate on short-term corporate bonds. Similarly, the supplies of intermediate and long-term bonds would come from corporations trying to finance their intermediate and long-term assets (plant expansion, equipment purchases, acquisitions, etc.), while the demand for such bonds would come from investors, either directly or indirectly through institutions (e.g., pension funds, mutual funds, insurance companies, etc.), who have long-term liabilities. The supply and demand for intermediate funds would, in turn, determine the equilibrium rates on such bonds, while the supply and demand for long-term bonds would determine the equilibrium rates on long-term debt securities.

Important to MST is the idea of unique or independent markets. According to MST, the short-term bond market is unaffected by rates determined in the intermediate or long-term markets, and vice versa. This independence assumption is based on the premise that investors and borrowers have a strong need to match the maturities of their assets and liabilities. Moreover, according to

MST, the desire by investors and borrowers to avoid market risk leads to hedging practices that tend to segment the markets for bonds of different maturities.

MST in Terms of the Supply and Demand Model

One way to examine how market forces determine the shape of yield curves is to examine MST using our supply and demand analysis. Consider a simple world in which there are two types of corporate bonds -- long-term (B^c_{LT}) and short-term (B^c_{ST}) -- and two types of government Treasury bonds -- long-term (B^T_{LT})) and short-term (B^T_{ST})). Exhibit 1 shows the markets for each of the sectors and segments and the resulting yield curves for Treasury and corporate bonds. The supplies and demands for each sector and segment are based on the following assumptions:

- The most important factors determining the demand for short-term bonds (both corporate and Treasury) are the bond's own price or interest rate, government policy, liquidity, and risk. Short-term bond demand, BD_{ST}, is assumed to be inversely related to its price and directly related to its own rate (negatively sloped bond demand curves); government actions that affect the supply of loanable funds also can change bond demand (e.g., monetary policy changing bank reserve requirements).

- The demand for the short-term bond in one sector is also assumed to be an inverse function of the short-term rate in the other sector, but not the long-term rate in either its sector or the other sector given the assumption of segmented markets. Thus, if the interest rate on the short-term Treasury security, i^T_{ST}, were to increase, investors would want more of the government bond and less of the short-term corporate bond. The increase in i^T_{ST} would therefore have an inverse effect on the demand for the short-term corporate, decreasing its demand and shifting its demand curve to the left. Conversely, an increase in the corporate short-term rate, i^c_{ST}, would lower the demand for the short-term Treasury security, shifting its demand curve to the left.

$$BD^c_{ST} = f(i^c_{ST},\ i^T_{ST},\ \text{risk},\ \text{liquidity},\ \text{government policy})$$
$$BD^T_{ST} = f(i^T_{LT},\ i^c_{ST},\ \text{risk},\ \text{liquidity},\ \text{government policy})$$

- The most important factors determining the demand for long-term bonds (both corporate and Treasury) BD_{LT}, are the bond's own price or interest rate, government policy such as monetary actions (e.g., change in bank reserve requirements), liquidity, and risk. Demand is assumed to be inversely related to its price and directly related to its own rate (negatively sloped bond demand curves). In addition, the demand for the long-term bond in one sector, BD_{LT}, is an inverse function of the long-term rate in the other sector, but not a function of the short-term rates given the market segmentation assumption.

$$BD^c_{LT} = f(i^c_{LT},\ i^T_{LT},\ \text{risk},\ \text{liquidity},\ \text{government policy})$$
$$BD^T_{LT} = f(i^T_{LT},\ i^c_{LT},\ \text{risk},\ \text{liquidity},\ \text{government policy})$$

- The supplies of short-term and long-term corporate bonds are directly related to their own price and inversely to their interest rate (positively sloped corporate bond supply curve) and directly related to general economic conditions, increasing in economic expansion and decreasing in recession.

$$BS^{c}_{ST} = f(i^{c}_{ST}, gdp)$$
$$BS^{c}_{LT} = f(i^{c}_{LT}, gdp)$$

- The supplies of Treasury bonds depend only on government actions (monetary and fiscal policy), and not on the economic state or interest rates. This assumption says that the sale or purchase of Treasury securities by the central bank or the Treasury is a policy decision. The assumption that the supply of Treasury securities depends on government actions and not interest rates means that the bond supply curve is vertical.

$$BS^{T}_{ST} = f(\text{government policy})$$
$$BS^{T}_{LT} = f(\text{government policy})$$

Insert Exhibit 1 Here

In Exhibit 1, the two equilibrium rates for short-term and long-term corporate bonds are plotted against their corresponding maturities (simply denoted as S-T and L-T) to generate the yield curve for corporate bonds. Similarly, the equilibrium rates for short-term and long-term Treasury bonds are plotted against their corresponding maturities to generate the yield curve for Treasury bonds. These yield curves, in turn, capture a MST world in which interest rates for each segment are determined by the supply and demand for that bond, with the rates on bonds in the other maturity segments having no effect. In general, the positions and the shapes of the yield curves depend on the factors that determine supply and demand for short-term and long-term bonds. In this analysis, the state of the economy determines the positions of the supply curves; the rates on government securities determine the positions of the corporate bond demand curves, while the rates on corporate securities determine the positions of the Treasury bond demand curves; and depending on the type of policy, Treasury and central bank actions affect the Treasury bond supply curves and possible the bond demand curves. Changes in these factors will cause a change in the structure of interest rates that will be reflected by different shifts in the yield curves. Several cases of yield curve shifts are discussed below.

Case 1: Economic Recession

Suppose the economy moved from a period of economic growth into a recession. As noted, when an economy moves into a recession, business demand for short-term and long-term assets tends to decrease. As a result, many companies find themselves selling fewer short-term bonds, given that they plan to maintain smaller inventories and expect to have fewer accounts receivables. They also find themselves selling fewer long-term bonds, given that they tend to cut planned investments in plants, equipment, and other long-term assets. In the bond market, these actions cause the short-term and the long-term supplies of bonds to decrease as the economy moves from growth to recession. At the initial interest rates, the decrease in bonds outstanding creates an excess demand, with bondholders now competing to buy fewer available bonds. This drives bond prices up and the YTM down, decreasing demand until a new equilibrium rate is attained.

Using our supply and demand model (see Exhibit 2), the recession shifts the corporate short-term and long-term bond supply curves to the left, creating an excess demand for short-term bonds at $i^c_{ST}*$ and an excess demand for long-term bonds at $i^c_{LT}*$. The excess demand causes corporate bond prices to rise and rates to fall until a new equilibrium is reached ($i^c_{ST}**$ and $i^c_{LT}**$). As the rates on short-term and long-term corporate bonds decrease, short-term and long-term Treasury securities become relatively more attractive. As a result, the demands for short-term and long-term Treasuries increase, shifting the short-term and long-term Treasury bond demand curves to the right and creating an excess demand in both Treasury markets at their initial rates. Like the corporate bond markets, the excess demand in the Treasury security markets will cause their prices to increase and their rates to fall until a new equilibrium is attained. Thus, the supply and demand analysis shows that a recession has a tendency to decrease both short-term and long-term rates for corporate bonds, and by a substitution effect, decrease short-term and long-term Treasury rates. Thus, a recession causes the yield curves for both sectors to shift down as shown in Exhibit 2.

Insert Exhibit 2 Here

Note that with this model we cannot explain whether or not the slope of the yield curve also changes. To address that question we need information about the magnitudes of the shifts, as well as their relative slopes. Also, note that the opposite results would occur if the economy moved from recession to economic expansion.

Case 2: Treasury Financing

Interest rates on government securities depend, in part, on the size and growth of federal government debt. If federal deficits are increasing over time, then the Treasury will be constantly trying to raise funds in the financial market. The Treasury sells a number of short-term, intermediate, and long-term securities. Which securities the Treasury uses to finance a federal deficit affects the yield curve for Treasury securities, and through a substitution effect, the yield curve for corporate bonds. For example, if the Treasury were to finance a deficit by selling short-term Treasury securities, then there would be an increase in the supply of the short-term Treasuries (rightward shift in the BS^T_{ST} curve). The increase in supply would push the price of the short-term government securities down, providing a higher short-term Treasury yield (see Exhibit 3). In the corporate bond market, the higher rates on short-term government securities would lead to a decrease in the demand for short-term corporate securities (leftward shift in the BD^c_{ST} curve), which, in turn, would lead to an excess supply in that market as short-term corporate bondholders try to sell their corporate bonds in order to buy the higher yielding Treasury securities. As bondholders try to sell their short-term corporate bonds, the prices on such bonds would decrease, causing the rates on short-term corporate bonds to rise until a new equilibrium is reached. Thus, the sale of the short-term Treasury securities increases both short-term government and short-term corporate rates. Since the long-term market is assumed to be independent of short-term rates, the total adjustment to the Treasury's sale of short-term securities would occur through the increase in short-term corporate and Treasury rates. Moreover, given corporate and Treasury yield curves that are initially flat, as shown in Exhibit 3, the Treasury's action causes the yield curves to become negatively sloped. By contrast, if the Treasury had financed the deficit with long-term securities, the impact would have been felt in the long-term bond market. In this case, the Treasury and corporate bond yield curves would have become positively slope.

Insert Exhibit 3 Here

In the case of a budget surplus (such as the brief one that occurred in the U.S. in the late 1990s and early 2000), the yield curve could become negatively sloped if the Treasury used some of the surplus to buy up long-term Treasury securities as a policy to reduce the government's debt. That is, the Treasury's purchase of long-term securities would create an excess demand for long-term Treasury bonds, and by the substitution effect, excess demand for long-term corporate bonds, leading to higher price and lower rates on long-term securities.

Case 3: Open Market Operations

The yield curve can also be affected by the direction of monetary policy and how it is implemented. For example, if the central bank were engaged in an expansionary OMO in which it were buying short-term Treasury securities, there would be a tendency for the yield curve to become positively sloped if the central bank were buying short-term securities, and a tendency for the yield curve to be become negatively sloped if it were to purchase long-term securities. On the other hand, in a contractionary OMO, there would be a tendency for the Treasury yield curve to become negatively sloped if the central bank were to sell some of its holdings of short-term bills and positively sloped if it were to sell some of its long-term security holdings.

In addition to affecting the Treasury yield curve, open market operations also change the yield curve for corporate securities through a substitution effect. For example, an expansionary OMO in which the Fed purchases short-term Treasury securities would tend to cause the yield curve for corporate securities to become positively sloped. That is, as the rate on short-term Treasury securities decreases as a result of the OMO (short-term Treasury bond supply decreases, see Exhibit 4), the demand for short-term corporate bonds would increase (short-term corporate bond demand curve shifts right), causing higher prices and lower yields on the short-term corporate securities. Again, since the long-term market is assumed to be independent of short-term rates, the total adjustment to the Fed's purchase of short-term securities would only occur in the short-term corporate and Treasury market and not in the long-term markets. If both the Treasury and corporate yield curves were initially flat, as shown in Exhibit 4, then the expansionary OMO would result in new positively sloped yield curves.

Insert Exhibit 4 Here

Summary of MST

The MST provides an economic foundation for explaining the shapes of yield curves in terms of fundamental supply and demand forces. As such, the model can be used to analyze the impacts of a number of economic activities on the term structure of interest rates. While the theory can be used to explain a number of important economic forces, it has two shortcomings. First, by assuming independent markets, the MST does not recognize that it is possible that the rate of return on a bond in a particular maturity segment could increase to a level sufficient to induce investors to move out of their preferred segment and buy the bond with the higher rate in exchange for greater risk exposure. Secondly, MST does not take into account the role of expectations in determining the structure of interest rates. An investor with a two-year horizon period, for example, might prefer a series of one-year bonds to a two-year bond, if she expects relatively high yields on one-year bonds next year. If there are enough investors with such expectations, they could have an effect on the current demands for one- and two-year bonds. These limitations of MST are addressed in the other theories of term structures: the Preferred Habitat Theory, Pure Expectations Theory, and Liquidity Preference Theory.

OTHER TERM STRUCTURE THEORIES

Preferred Habitat Theory

MST assumes that investors and borrowers have preferred maturity segments or habitats determined by the maturities of their securities that they want to maintain. The Preferred Habitat Theory (PHT) posits that investors and borrowers may stray away from desired maturity segments if there are relatively better rates to compensate them. Furthermore, PHT asserts that investors and borrowers will be induced to forego their perfect hedges and shift out of their preferred maturity segments when supply and demand conditions in different maturity markets do not match.

To illustrate PHT, consider an economic world in which, on the demand side, investors in corporate securities, on average, prefer short-term to long-term instruments, while on the supply side, corporations have a greater need to finance long-term assets than short-term, and therefore prefer to issue more long-term bonds than short-term. Combined, these relative preferences would cause an excess demand for short-term bonds and an excess supply for long-term claims and an equilibrium adjustment would have to occur. As summarized in Exhibit 5, the excess supply in the long-term market would force issuers to lower their bond prices, thus increasing bond yields and inducing some investors to change their short-term investment demands. In the short-term market, the excess demand would cause bond prices to increase and rates to fall, inducing some corporations to finance their long-term assets by selling short-term claims. Ultimately, equilibriums in both markets would be reached with long-term rates higher than short-term rates, a premium necessary to compensate investors and borrowers/issuers for the risk they've assumed.

Insert Exhibit 5 Here

As an explanation of term structure, the PHT would suggest that yield curves are positively sloped if investors, on the average, prefer short-term to long-term investments and borrowers/issuers prefer long to short. A priori, such preferences may be the case. That is, investors may prefer short-term investments given that longer maturity bonds tend to be more sensitive to interest rate changes or because there are more investors in the upper middle-age class (with shorter investment horizons) than in the young adult or middle-age class (with longer horizon periods). Borrowers also may have greater long-term than short-term financing needs and thus prefer to borrow long-term. Hence, one could argue that the yield curve is positively sloped because investors' and borrowers' preferences make the economy poorly hedged. Of course, the opposite case in which investors want to invest more in long-term securities than short-term and issuers desire more short-term to long-term debt is possible. Under these conditions the yield curve would tend to be negatively sloped.

Pure Expectations Theory

Expectations theories try to explain the impact of investors' and borrower' expectations on the term structure of interest rates. A popular model is the pure expectation theory (PET), also called the Unbiased Expectations Theory (UET). Developed by Fredrick Lutz, PET is based on the premise that the interest rates on bonds of different maturities can be determined in equilibrium where implied forward rates are equal to expected spot rates. The model can be explained in terms of basic supply and demand adjustments to expectations.

To illustrate PET, consider a market consisting of only two bonds: a risk-free one-year zero-coupon bond and a risk-free two-year zero-coupon bond, both with principals of $1,000. Suppose that supply and demand conditions are such that both the one-year and two-year bonds are trading at an 8% YTM. Also suppose that the market expects the yield curve to shift up to 10% next year, but, as yet, has not factored that expectation into its current investment decisions (see Exhibit 6). Finally, assume the market is risk-neutral, such that investors do not require a risk premium for investing in risky securities (i.e., they will accept an expected rate on a risky investment that is equal to the risk-free rate). To see the impact of market expectations on the current structure of rates, consider the case of investors with horizon dates of two years. These investors can buy the two-year bond with an annual rate of 8%, or they can buy the one-year bond yielding 8%, then reinvest the principal and interest one year later in another one-year bond expected to yield 10%. Given these alternatives, such investors would prefer the latter investment since it yields a higher expected average annual rate for the two years of 9%:

$$E(R) = [(1.08)(1.10)]^{1/2} - 1 = .09$$

Similarly, investors with one-year horizon dates would also find it advantageous to buy a one-year bond yielding 8% than a two-year bond (priced at \$857.34 = \$1,000/1.08^2) that they would sell one year later to earn an expected rate of only 6%:

$$P_{Mt} = P_{2,0} = \frac{\$1{,}000}{(1.08)^2} = \$857.34$$

$$E(P_{11}) = \frac{\$1{,}000}{(1.10)^1} = \$909.09$$

$$E(R) = \frac{\$909.09 - \$857.34}{\$857.34} = .06$$

Thus, in a risk-neutral market with an expectation of higher rates next year, both investors with one-year horizon dates and investors with two-year horizon dates would purchase one-year instead of two-year bonds.

Insert Exhibit 6 Here

If enough investors do this, an increase in the demand for one-year bonds and a decrease in the demand for two-year bonds would occur until the average annual rate on the two-year bond is equal to the equivalent annual rate from the series of one-year investments (or the one-year bond's rate is equal to the rate expected on the two-year bond held one year). In the example, if the price on a two-year bond fell such that it traded at a YTM of 9%, and the rate on a one-year bond stayed at 8%, then investors with two-year horizon dates would be indifferent between a two-year bond yielding a certain 9% and a series of one-year bonds yielding 10% and 8%, for an expected rate of 9%. Investors with one-year horizon dates would likewise be indifferent between a one-year bond yielding 8% and a two-year bond purchased at 9% and sold one year later at 10%, for an expected one-year rate of 8%. Thus in this case, the impact of the market's expectation of higher rates would be to push the longer-term rates up.

In the above example, the yield curve is positively sloped, reflecting expectations of higher rates. By contrast, if the yield curve were currently flat at 10% and there was a market expectation that it would shift down to 8% next year, then the expectation of lower rates would cause the yield curve to become negatively sloped (see Exhibit 7). In this case, an investor with a two-year horizon date would prefer the two-year bond at 10% to a series of one-year bonds yielding an expected rate of only 9% ($E(R) = [(1.10)(1.08)]^{1/2} - 1 = .09$); an investor with a one-year horizon would also prefer buying a two-year bond that has an expected rate of return of 12% ($P_2 = 100/(1.10)^2 = 82.6446$, $E(P_{11}) = 100/1.08 = 92.5926$, $E(R) = [92.5926-82.6446]/82.6446 = .12$) to the one-year bond that yields only 10%. In markets for both one-year and two-year bonds, the expectations of lower rates would cause the demand and price of the two-year bond to increase, lowering its rate, and the demand and price for the one-year bond to decrease, increasing its rate. These adjustments would continue until the rate on the two-year bond equaled the average rate from the series of one-year investments, or until the rate on the one-year bond equaled the expected rate from holding a two-year bond one year. In this case, if one-year rates stayed at 8%, then the demand for the two-year bond would increase until it was priced to yield 9% - the expected rate from the series: $[(1.10)(1.08)]^{1/2} - 1 = .09$ (see Exhibit 7).

Insert Exhibit 7 Here

It should be noted that PET intuitively captures what should be considered as normal market behavior. That is, whether or not the market is risk neutral, has perfect expectations, or bonds are perfect substitutes, investors, as well as borrowers/issuers do factor in expectations. For example, if long-term rates were expected to be higher in the future (based perhaps on the expectation of greater economic growth), long-term investors (e.g., life insurance company, pension fund, etc.) would not want to purchase long-term bonds now, given that next period they would be expecting higher yields and lower prices on such bonds (they also would be exposed to possible capital losses if they did buy such bonds and were forced to liquidate them next year). Instead, such investors would invest in short-term securities now, reinvesting later at the expected higher long-term rates. In contrast, borrowers/issuers wishing to borrow long-term would want to sell long-term bonds now instead of later at possibly higher rates. Combined, the decrease in demand for long-term bonds by investors and the increase in the supply of long-term bonds by borrowers would serve to lower long-term bond prices and increase yields, leading to a positively-sloped yield curve.

Thus, a salient feature of PET is that it incorporates expectations as an important variable in explaining the structure of interest rates.

Liquidity Premium Theory

The Liquidity Premium Theory (LPT), also referred to as the Risk Premium Theory (RPT), posits that there is a liquidity premium for long-term bonds over short-term bonds. According to LPT, if investors are risk averse, then they would require some additional return (liquidity premium) in order to hold long-term bonds instead of short-term ones. Thus, if the yield curve were initially flat, but had no risk premium factored in to compensate investors for the additional volatility they assumed from buying long-term bonds, then the demand for long-term bonds would decrease and their rates increase until risk-averse investors were compensated. In this case, the yield curve would become positively sloped

SUMMARY OF TERM STRUCTURE THEORIES

As we noted earlier, the structure of interest rates cannot be explained in terms of any one theory; rather, it is best explained by a combination of theories. Of the four theories, the two major ones are MST and PET. MST is important because it establishes how the fundamental market forces governing the supply and demand for assets determines interest rates. PET, in turn, extends MST to show how expectations impact the structure of interest rates. PHT, by explaining how markets will adjust if the economy is poorly hedged, and LPT, by including a liquidity premium for longer-term bonds, both represent necessary extensions of MST and PET. Together, the four theories help us to understand how supply and demand, economic conditions, government deficits and surpluses, monetary policy, hedging, maturity preferences, and expectations all affect the bond market in general and the structure of rates in particular.

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Figure 1
Treasury Bill Rates, 1970-2003

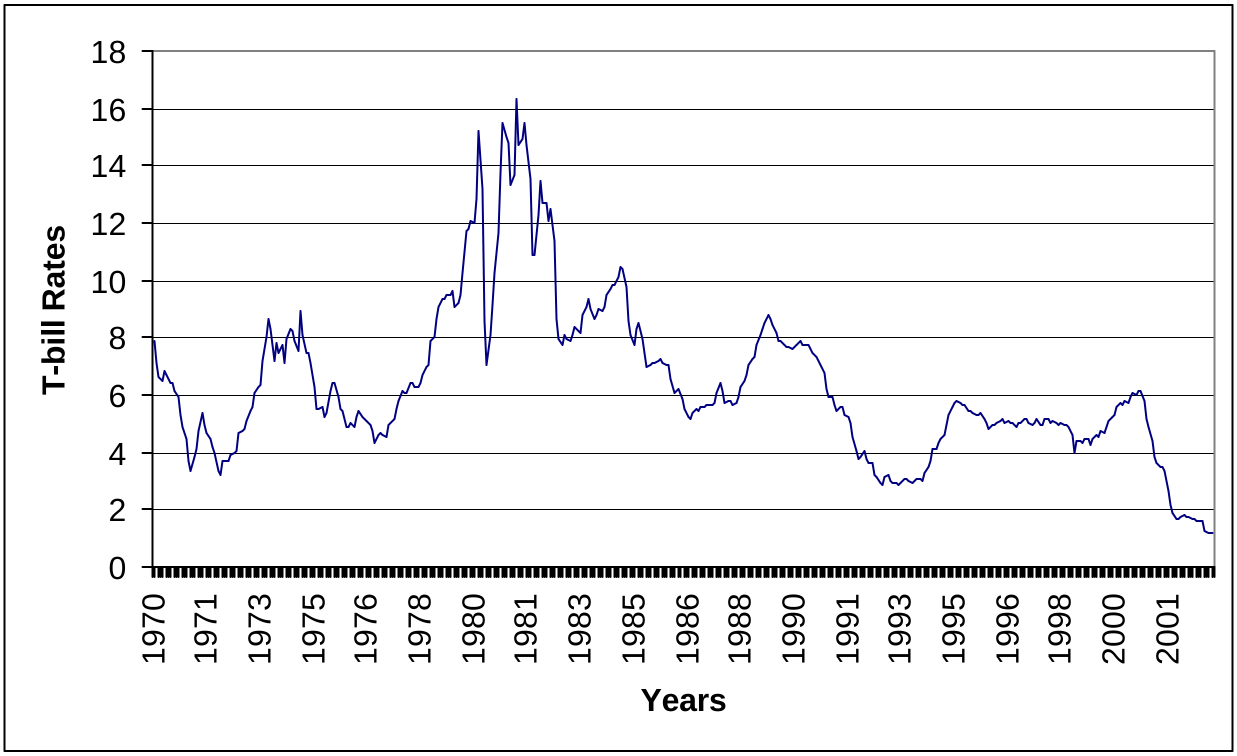


Figure 2
Yield Curve for U.S. Government Bonds

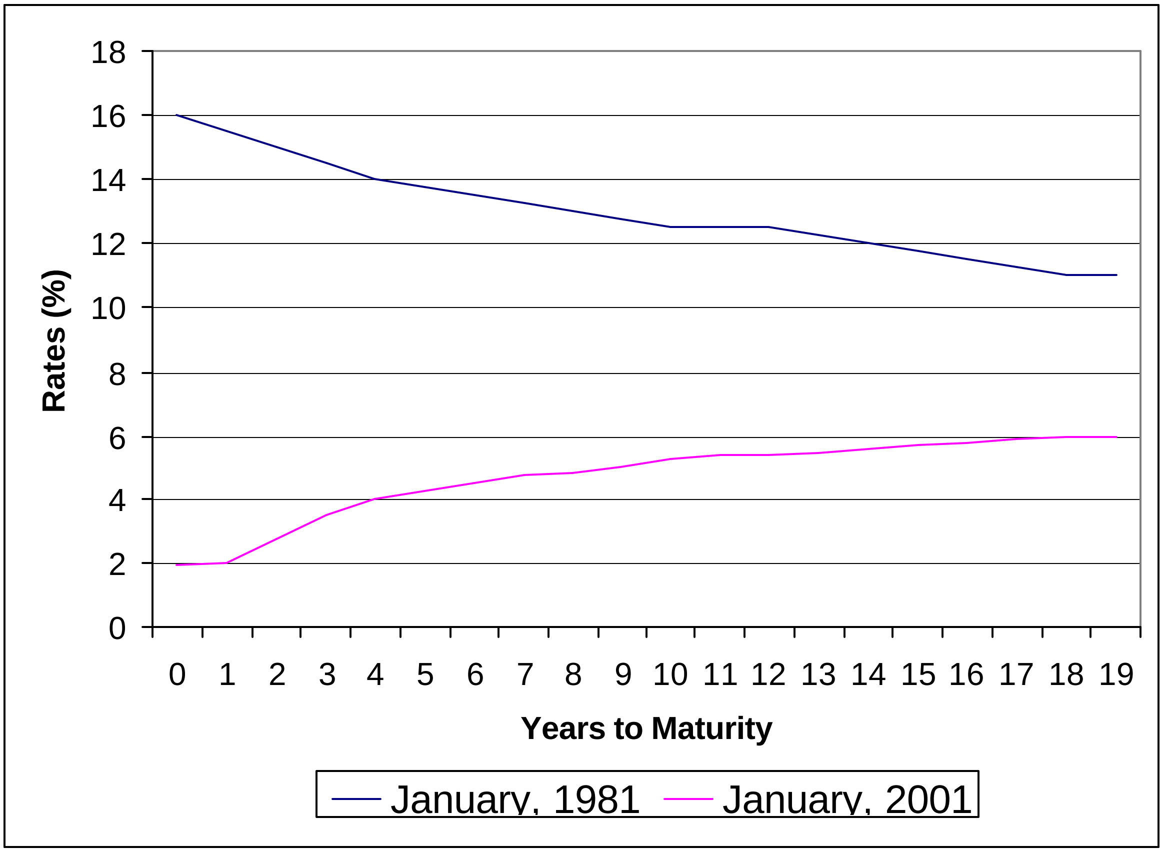
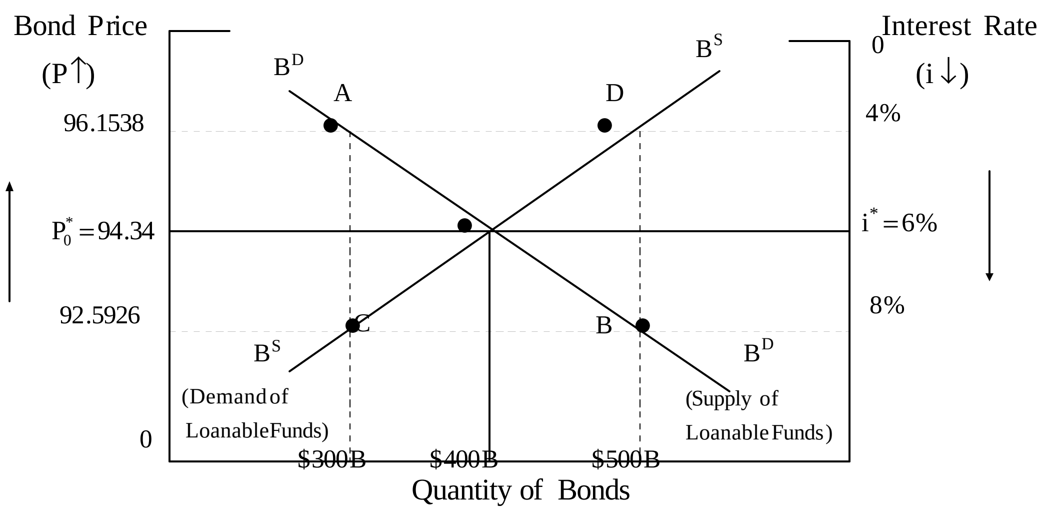


Figure 3
Bond Demand and Supply

- Supply and Demand for Bonds
- Equilibrium is at 94.33 and i*=6%



$$B^D = f(i \text{ or } P_0, \overline{g}dp, \overline{E}(i), E(\overline{I}nflation), \overline{r}isk, \overline{L}iq, \overline{g}ovt.policy)$$

$$B^S = f(i \text{ or } P_0, \overline{g}dp, \overline{E}(Inflation), \overline{g}ovt.policy)$$

Figure 4: Comparative Equilibrium Analysis
Impact of a Contractionary Monetary Policy

Impact of a Contractionary Monetary Policy

- Contractionary open market operation: Central bank sells bonds, increasing the bond supply and shifting the bond supply curve to the right.
- An increase in the reserve requirement and an increase in the discount rate charged on bank loans by the central bank decreases the supply of loanable funds, shifting the bond demand curve to left.
- Impact: Interest Rates Increase

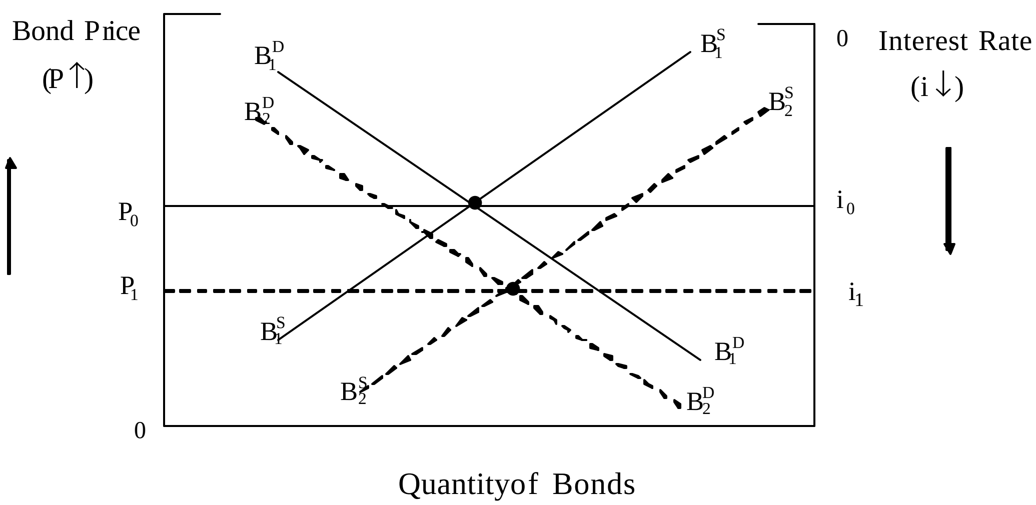


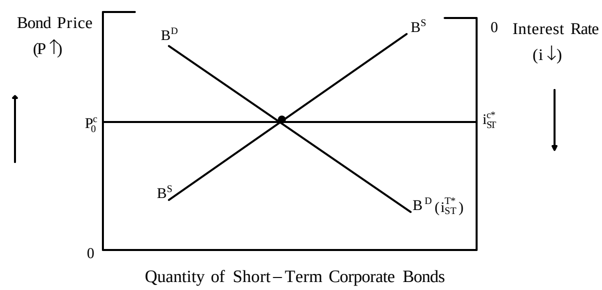
Exhibit 1: MST Model
Market Equilibrium for Short-Term and Long-Term Corporate and Treasury Bonds

Corporate Bond Market

- Short-Term Bonds

$BD^c_{ST} = f(i^c_{ST}, i^T_{ST}, \text{risk, liquidity, government policy})$

$BS^c_{ST} = f(i^c_{ST}, \text{gdp})$

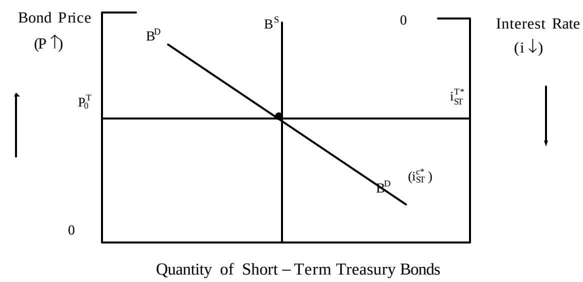


Treasury Bond Market

- Short-Term Bonds

$BD^T_{ST} = f(i^T_{LT}, i^c_{ST}, \text{risk, liquidity, government policy})$

$BS^T_{ST} = f(\text{government policy})$

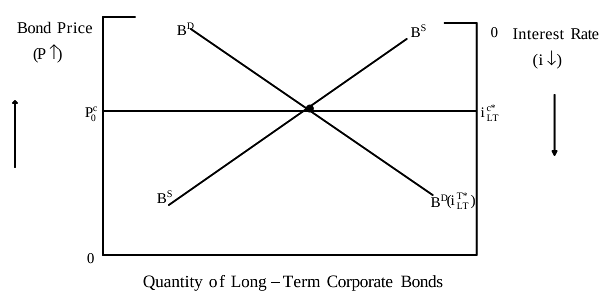


Corporate Bond Market

- Long-Term Bonds

$BD^c_{LT} = f(i^c_{LT}, i^T_{LT}, \text{risk, liquidity, government policy})$

$BS^c_{LT} = f(i^c_{LT}, \text{gdp})$

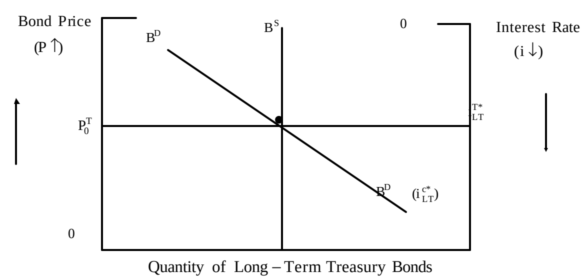


Treasury Bond Market

- Long-Term Bonds

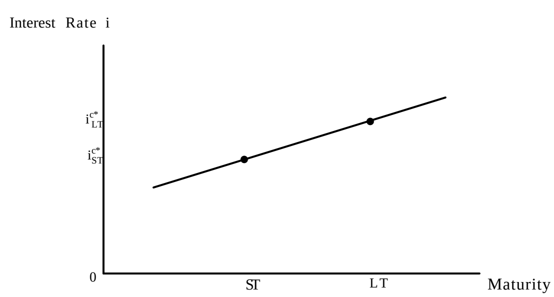
$BD^T_{LT} = f(i^T_{LT}, i^c_{LT}, \text{risk, liquidity government policy})$

$BS^T_{LT} = f(\text{government policy})$



Corporate Bond

- Yield Curve



Treasury Bond

- Yield Curve

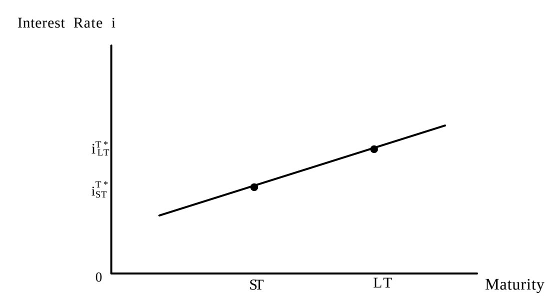
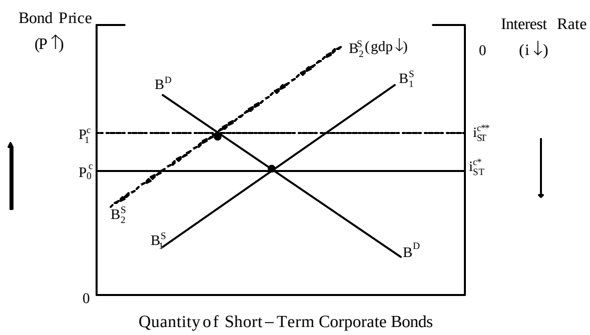
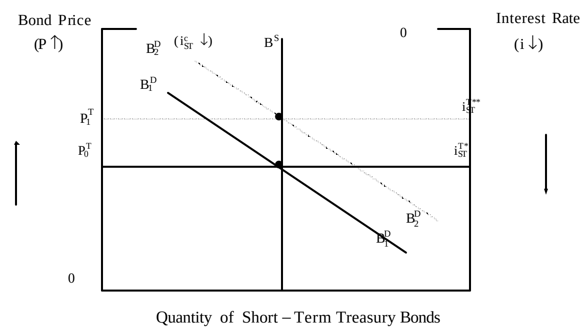


Exhibit 2: MST Model
Recession Case

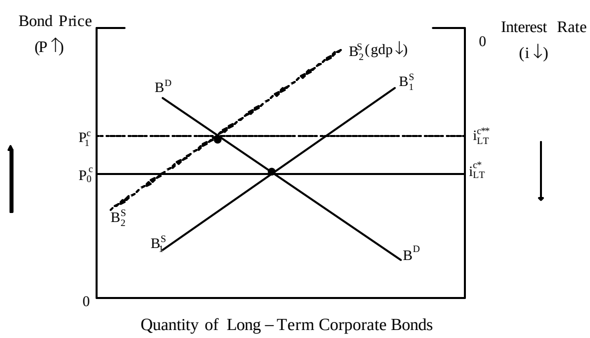
Corporate Bond Market
- Short-Term Bonds



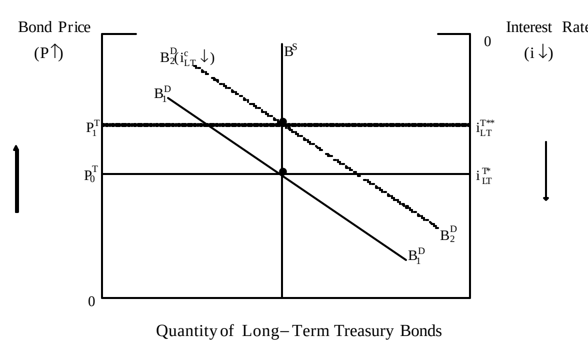
Treasury Bond Market
- Short-Term Bonds



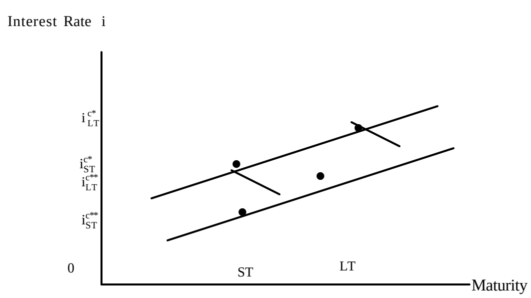
Corporate Bond Market
- Long-Term Bonds



Treasury Bond Market
- Long-Term Bonds



Corporate Bond
- Yield Curve



Treasury Bond
- Yield Curve

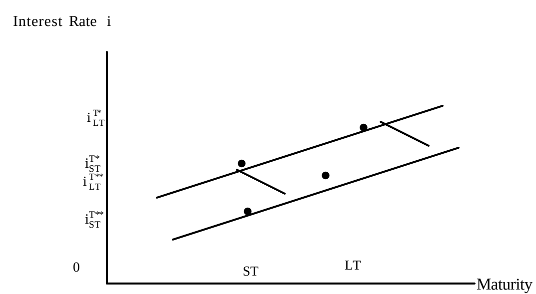


Exhibit 3: MST Model
Treasury Issue of Short-Term Securities

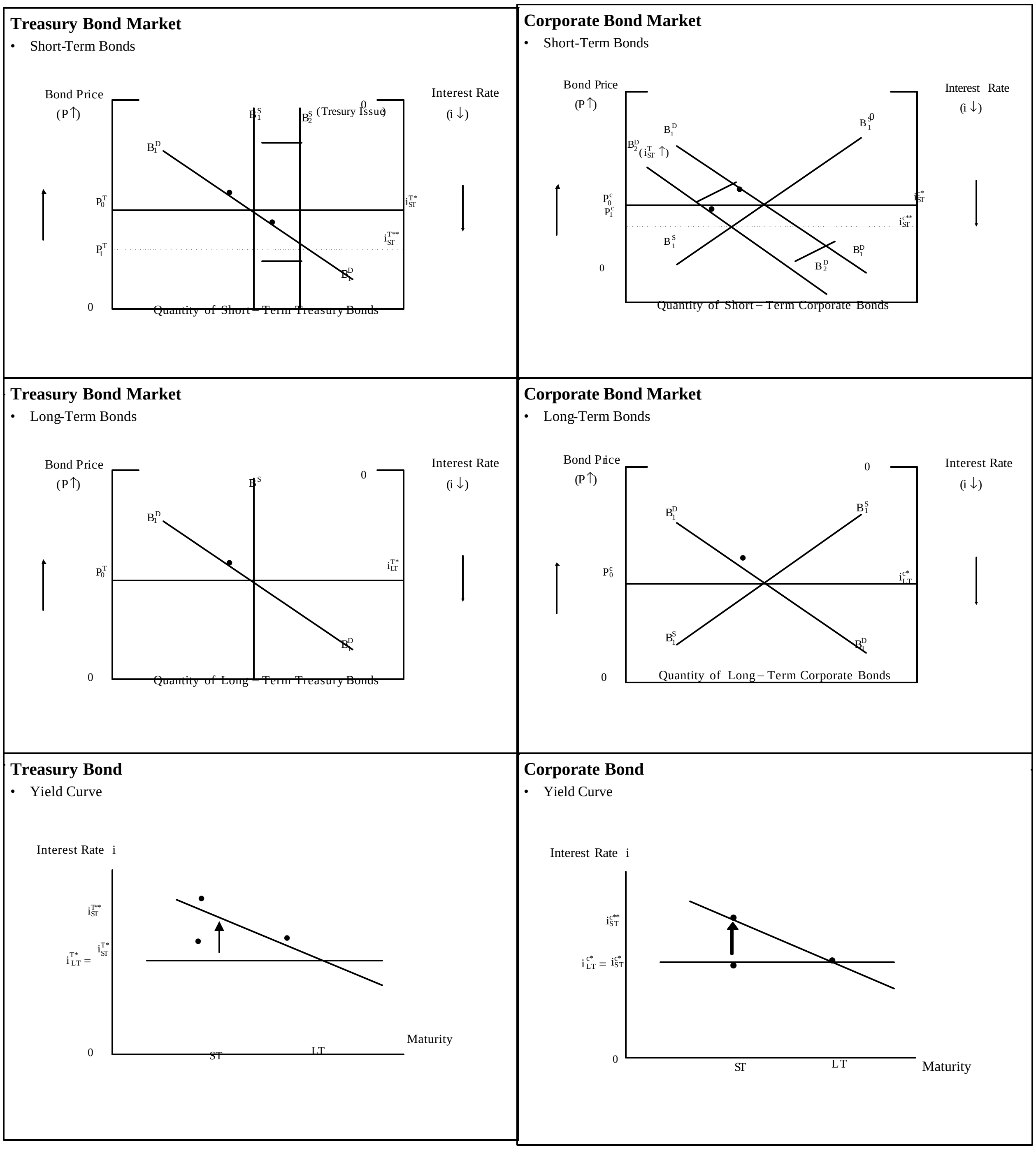
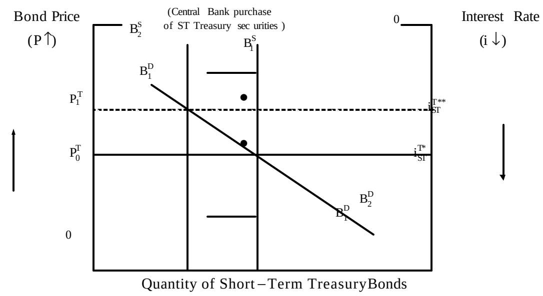
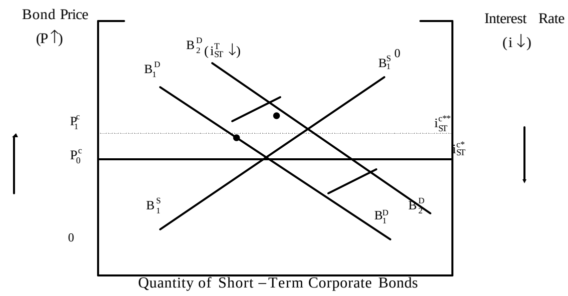


Exhibit 4: MST Model
Central Bank Purchase of
Short-Term Treasury Securities

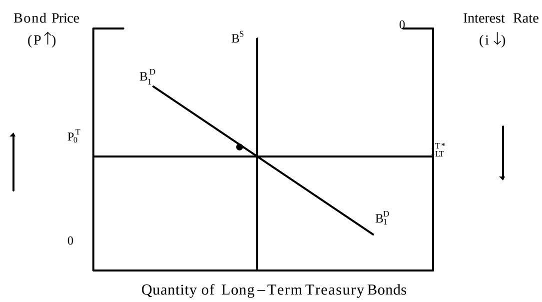
Treasury Bond Market
- Short-Term Bonds



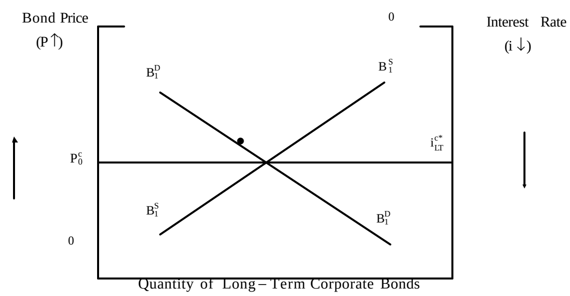
Corporate Bond Market
- Short-Term Bonds



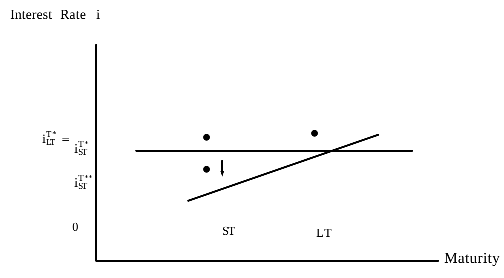
Treasury Bond Market
- Long-Term Bonds



Corporate Bond Market
- Long-Term Bonds



Treasury Bond
- Yield Curve



Corporate Bond
- Yield Curve

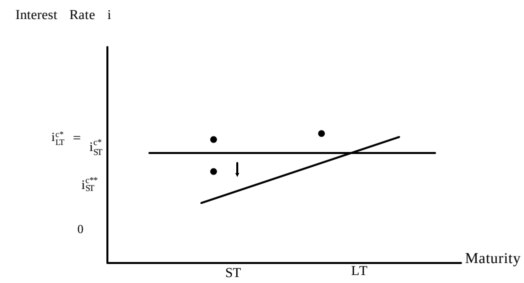


Exhibit 5: Preferred Habitat Theory
Market Adjustments to Poorly Hedged Economy

- Poorly Hedged Economy: Investors, on average, prefer ST investments; corporate issuers/borrowers, on average, prefer to borrow LT (sell LT corporate bonds):

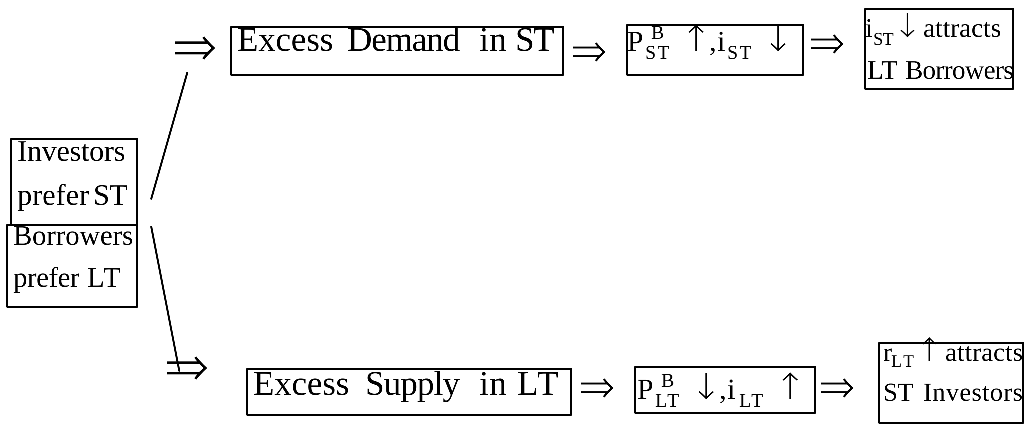


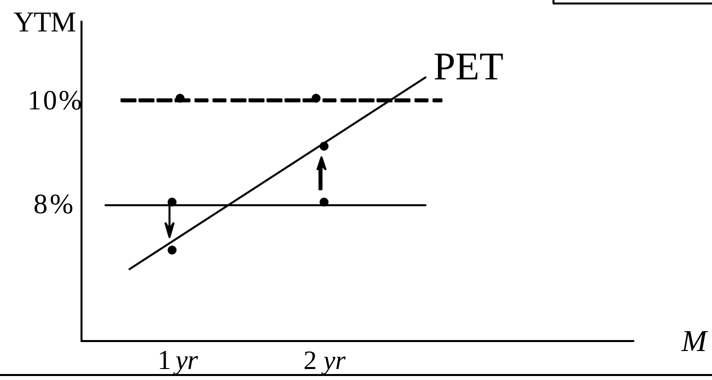
Exhibit 6: Pure Expectations Theory
Market Expectation of Higher Interest Rate

- Expectations of rates increasing from 8% to 10%.
- Investors with HD of 2 years and those with HD of 1 year would prefer one-year bonds over two- year bonds.
- Market Response:

$B_2^D \downarrow \Rightarrow P_2^B \downarrow \Rightarrow YTM_2 \uparrow$

$B_1^D \uparrow \Rightarrow P_1^B \uparrow \Rightarrow YTM_1 \downarrow$

YC Becomes Positively Sloped



- If the market response to the expectation is only in terms of a change in the two-year bond, then then equilibrium yield on the two-year will be 9%.

$B_2^D \downarrow \Rightarrow P_2^B \downarrow \Rightarrow YTM_2 \uparrow$
$YTM_2 \uparrow$ until $YTM_2 = YTM_{2:series} = 9\%$

When $YTM_2 = 9\%$, $YTM_1 = 8\%$,
then $f_{11} = E(R_{11}) = 10\%$.

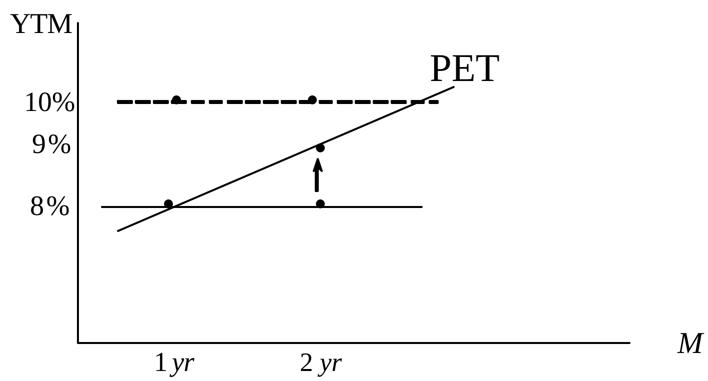
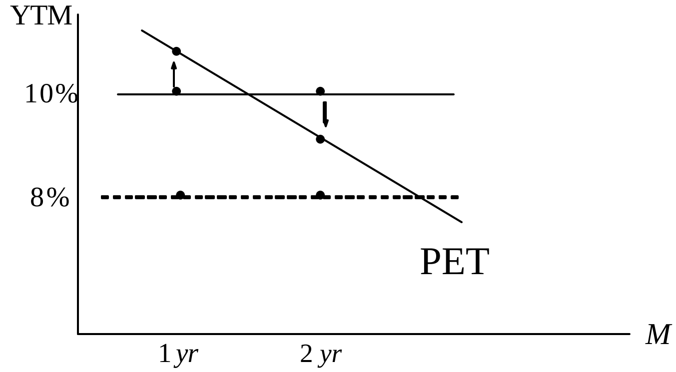


Exhibit 7: Pure Expectations Theory

Market Expectation of Lower Rates

- Expectations of rates decreasing from 10% to 8%.
- Investors with HD of 2 years and those with HD of 1 year would prefer two-year bonds over one- year bonds.
- Market Response:

$B_2^D \uparrow \Rightarrow P_2^B \uparrow \Rightarrow YTM_2 \downarrow$ | $B_1^D \downarrow \Rightarrow P_1^B \downarrow \Rightarrow YTM_1 \uparrow$ | YC Becomes Negatively Sloped



- If the market response to the expectation is only in terms of a change in the two-year bond, then then equilibrium yield on the two-year will be 9%.

$B_2^D \uparrow \Rightarrow P_2^B \uparrow \Rightarrow YTM_2 \downarrow$
$YTM_2 \downarrow$ until $YTM_2 = YTM_{2:series} = 9\%$

When $YTM_2 = 9\%$, $YTM_1 = 10\%$, then $f_{11} = E(R_{11}) = 8\%$.