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**THE IMPACT OF U.S. MACROECONOMIC NEWS  
ANNOUNCEMENTS ON BOND PRICES: EVIDENCE FROM  
U.S. BOND MARKETS**

Master's Thesis in  
Accounting and Finance

Finance

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## ABSTRACT

This study analyzes how U.S. macroeconomic news affect daily U.S. government bond yields. More accurately the study tries to find out what is the impact of scheduled U.S. macroeconomic news announcements on bond prices around the announcement moment. To investigate the behaviour, this thesis focuses on observations of U.S. government 2-year note, 10-year note and 30-year bond indices during the period of 2005 to 2010. Moreover, yields are analyzed during the whole sample period focusing on bond price changes in the specific macroeconomic news announcement days to see the impact of the difference between speculation and reality.

The analysis focuses on 7 macroeconomic news announcements selected on the basis of previous studies in the field and the Bureau of Labor Statistics classifications of major economic indicators. These factors are Consumer Price Index (CPI), Producers Price Index (PPI), Consumer Confidence Index (CCI), the Import and Export Price Indices (USIEX), Institute of Supply Management Survey (ISM), Retail Sales and Employment Situation. These same indicators are used in many previous research papers and by reading those papers these are the ones with the largest effects on bond prices.

The impact created by the unexpected part of arrival information is regressed on the difference of daily logarithmic returns of three different maturity Treasuries, to examine the effect of economic news releases on bonds. Moreover this thesis tries to tract the information that is creating the sharpest daily bond price changes. This is made simply by putting the daily bond price movements in order from smallest to largest, and see what would have created this movement.

The empirical results show that U.S. macro announcements have statistically significant effect on Treasury yields. Moreover, the results contain proves that in general the positive surprise creates negative bond returns, but there are some exceptions.

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**KEYWORDS:** Bond price, U.S. macroeconomic news announcements, surprise component





## 1. INTRODUCTION

The fact that majority of research in the field of finance is one way or another concerning the stock markets, as a student's opinion, had a lot of criterion in decision making when the subject of this study was planned. Yet the stock market is commonly the most monitored market worldwide, since the access to information is made easier and easier, it must be remembered that research on bond markets is also importantly needed.

This thesis studies the response of prices of U.S. government bonds, also known as U.S. Treasuries, to scheduled U.S. macroeconomic news announcements. In this thesis the macroeconomic news data consists of the expected and actual outcome of the most important monthly and quarterly news announcements. With the data it is calculated the surprise component like Balduzzi, Elton and Green (2001). This data together with intraday price information of U.S. government bonds, allow us to differentiate if there is a correlation between news announcements and bond prices.

According to previous studies, there seems to be an inverse relationship between macroeconomic news announcements and bond prices. So, a better than expected outcome of the announcement seems to lead to a negative bond returns. Some of these news announcements create more movement in bond prices than others.

Because of the nature of financial assets is looking forward, pricing these assets stands on the information concerning the future cash flows. Therefore news affecting future cash flows or interest rates is closely followed in the markets. Bonds and more precisely government bonds are securities with fixed income and therefore the only relevant variable for pricing bonds is the discount rate which is determined by ongoing state of the general macroeconomic environment. Furthermore it is logical to suppose that government bond prices should vary with news concerning macroeconomic indicators of the economic environment.

### **1.1. Purpose of the Study**

The purpose of the thesis is to find out what is the impact of scheduled U.S. macroeconomic news announcements to U.S. government bond prices. More precisely the paper investigates scheduled U.S. macroeconomic news announcements and how the difference between expected and actual outcome of these announcements affect on government bond prices. The time period in this thesis is from 2005 to 2010. What makes this time period interesting is that it contains first a strong period of economic growth and then a sudden fall down after the sub-prime-bubble went off in 2008. Moreover, after the market went down during 2008, the next two years have been a great investment season.

The seven macroeconomic news announcements used in this study are chosen mostly by previous investigation in this field. These are Consumer Price Index (CPI), Producers Price Index (PPI), Consumer Confidence Index (CCI), the Import and Export Price Indices (USIEX), Institute of Supply Management Survey (ISM), Retail Sales and Employment Situation. These same indicators are used in many previous research papers and by reading those papers these are the ones with the largest statistically significant effects on bond prices. Furthermore, as the U.S. government bond market plays the key role in the whole world's economic life, it is seen that research in this particular market is most important of its relevancy.

### **1.2. Research Hypotheses**

As this thesis concentrates to macroeconomic news announcements, followed by the possible changes in bond prices as the results of those announcements, the first research hypothesis must be set as follows to illustrate the basic importance of the chosen announcements:

H1: The scheduled U.S. macroeconomic news announcements affect to U.S. government bond prices.

In case the scheduled U.S. macroeconomic news announcements have statistically significant effects on U.S. government bond prices, it contributes the earlier studies of this particular subject meaning that the U.S. news releases are consequential.

The second theme of this thesis discusses about the sign and size of response to economic news announcements. In other words thesis studies how bond prices react when the actual outcome of announcement is whether positive or negative compared to expected. According to previous studies (e.g. Balduzzi et. al. 2001), there seems to be an inverse relationship between macroeconomic news announcements and bond prices. So a better expected outcome of the announcement seems to lead to a negative bond returns. Some of these news announcements create more movement in bond prices than others. Based on what is mentioned above the second research hypothesis takes the following form:

H2: A better than expected outcome of the announcement leads to a negative bond returns.

As the sign and size of response is studied, it is also under investigation which specific news announcements are making Treasuries' prices move the most.

### 1.3. Previous Studies

The range of previous studies in this field is rather large and one reason for that is that financial markets are evolving all the time. Pearce and Roley (1985) examined in their paper the daily response of stock prices to announcements about the money supply, inflation, real economic activity, and the discount rate. The announcements they used were the CPI, the PPI, the unemployment rate, industrial production, and the Federal Reserve's discount rate. They used a measure of the market's expectation to represent the new information provided by an economic announcement. According to author there was only limited evidence of an impact from inflation surprises and no evidence of an impact from real activity surprises on the announcement days. They also found out that there was only weak evidence of stock price responses to surprises beyond the announcement day.

Balduzzi, Elton and Green (2001) examined in their study the effect of economic announcements on the price, volume, bid-ask spread, and price volatility of Treasury securities. They used intraday data of bid and ask quotes from the inner market for U.S. government bonds. They found out that at least 17 news announcements had a significant effect on some of the four (3-month T-bill, 2-year-note, 10-year and 30-year bond) instrument prices they used in their study. They also found out that for most of the announcement, public news tend to be incorporated very quickly into prices.

In 2005 Boyd, Hu and Jagannathan investigated the short-run response of stock prices to arrival of macroeconomic news. Not like other studies they concentrated in only one specific news announcement, the Bureau of Labor Statistic's (BLS) monthly announcement of the U.S. unemployment rate. They also tested bond price response to unemployment news and found out that stock price responses and bond price responses are different from each others. While stock returns are higher in expansions than in contractions, bond returns seems to yield better in contractions than in expansions.

Fleming and Remolona (1997) made an attempt to identify information that may account for the sharpest price changes and the most active trading episodes in the U.S Treasury securities market. In other words they examined

whether there is some correlation between these two events. They collect the twenty-five largest price changes and twenty-five most active trading periods from every five-minute interval from their data sample. They find that there is a strong correlation between these two events on announcement days in sample period from August 23, 1993, to August 19, 1994. Moreover the important finding is that the bond market's reactions depend on the surprise component of a given announcement.

In 1993 Ederington and Lee examined the impact of macroeconomic news announcements on interest rate and foreign exchange markets. They took a closer look of nineteen monthly announcements such as the employment report, the consumer price index (CPI), and the producer price index (PPI). Furthermore they analysed the impact of the announcements on the Treasury bond, Eurodollar, and deutsche mark futures markets. It is generally believed by market participants that such announcements have a major impact on financial markets. They identified that these announcements are responsible for most of the observed time-of-day and day-of-the-week volatility patterns in these markets. They also found that most of the significant impact on return volatility occurs in the first minute after the release, although volatility remains considerably higher than normal for roughly fifteen minutes and slightly higher for several hours.

Green (2004) examined the impact of trading on government bond prices surrounding the release of macroeconomic news. The author studied transaction data from the U.S. Treasury market in order to clarify the informational role of trading in financial markets. Green uses methodology where he measures the informational role of trading by isolating the component of effective bid-ask spreads that is related to informational asymmetry. The results show a significant increase in the informational role of trading following economic announcements, which suggest that the release of public information increases the level of information asymmetry in the government bond market. Although post-announcement trading activity stays in high level for several hours, the level of information asymmetry returns close to normal levels within 15 minutes. Furthermore, unlike in previous studies by Flemming (2001) and Brandt and Kavajecz (2004), Green finds that macroeconomic announcement lead to high liquidity as well as increased trade impact, suggesting clearly that

the release of economic information generates uncertainty about the appropriate level of riskless rates.

#### **1.4. The Structure of the Study**

This study consists of theoretical framework and empirical part. The theoretical part is processed in four partial sections. The first section introduces both theme and subject of the thesis to reader. This section covers the purpose of the study, the research hypotheses as well as an insight to previous studies made in the particular field of financial research. The second and the third part takes a closer look to the two underlying subjects of the study. First, the second part leads a reader through bond characteristics followed by the third part, macroeconomic news announcements. Moreover, the third part also explains briefly how financial market works and represents the concept of market efficiency as its main point to explain the *efficient market hypothesis* (EMH) and introduce the three levels of market efficiency. After the theoretical framework the thesis proceeds to the key point in sections four and five. The fourth section represents the data and methodology used to investigate the interests of this thesis. Empirical results are then presented in the fifth chapter. Chapter six summarises the thesis.

## 2. BOND CHARACTERISTICS

Basically, a bond is a loan. When buying a bond, one lends money to a large borrower such as a federal government and its agencies, municipal governments, and corporations. These borrowers routinely raise needed capital by selling bonds for periods as brief as a few days to as long as 30 or 40 years. Bonds differ from stocks, as stockholders are owners of an issuing company, but bondholders are only lenders to the issuer. The distinguishing characteristic of a bond is that the borrower enters into a legal agreement to compensate the lender through periodic interest payments in the form of coupons and also to repay the original sum in full on a predefined date, which is known as the bond's maturity date. The exact terms of the loan agreement between the buyer and the issuer are described fully in a legal document known as the indenture, which is legally binding on the issuer for the entire period that the bond remains outstanding.

The most elementary distinction between bonds is based on who issues bonds. Bonds issued directly by the U.S. government are classified as Treasury bonds as mentioned earlier. The ones issued by corporations are naturally called corporate bonds, and those issued by local and state governmental units, which are generally exempt from federal taxes, are called municipals. Moreover a government bond is a bond issued by national government in the country's own currency to borrow funds for financing its budget. (Thau 2000: 2-5.)

Altogether the U.S. bond market is divided into six sectors, which are U.S. Treasury sector, agency sector, municipal sector, corporate sector, asset-backed securities, and mortgage sector. This thesis concentrates to the Treasury sector meaning as mentioned earlier, securities issued by U.S. government. These securities include Treasury notes and bonds. The U.S. Treasury sector plays a key role in the valuation of securities and the determination of interest rates throughout the world because of its state as the biggest security issuer of the world. (Fabozzi 2000: 2.)

The number of years over which the issuer has promised to meet the conditions of the specific obligation is called the *term to maturity* of a bond. The term to maturity of a bond is important in three ways. As mentioned above the first and



most obvious reason is that it indicates the time period over which the holder of a bond can expect to receive the *coupon payments* and the number of years before the *principal* will be paid in full. The second reason is that the *yield* on a bond depends on its term to maturity. The third importance of bonds term to maturity is the bonds *price volatility*. Yet the longer the maturity of a bond is, the greater is the price volatility that results from a change in market yields. Also important when introducing bonds are the *principal value* or just principal that is the amount issuer has agreed to repay the bondholder at maturity. The principal is also referred as *redemption value, maturity value, par value, or face value*. (Fabozzi 1997: 4.)

Generally thinking different kind of bonds share one common feature, they all make periodic coupon payments, regular, annual or semi-annual fixed interest, excluding one exception which doesn't make one. These kinds of bonds are called zero-coupon bonds. Basic concept is that the bond price is substantially below its principal when buying the bond. So the interest the bondholder gets at maturity is the difference of principal and the price paid for the bond. There also exist bonds where coupon rates are reset periodically according to a predetermined benchmark. Where the coupon rate is reset on the basis of some financial index on most floating-rate bonds, there exist some issues where the benchmark is a nonfinancial index such as the price of a commodity. In case there is a provision included in the bond issue it gives the right for either the issuer or bondholder an option to take some action during the bonds maturity. In practice the issuer may have the right to call the bond meaning that the issuer pays back the loan, fully or partially, before bonds maturity. The Treasury no longer issues callable bonds, but some previously issued callable bonds still outstands in the market. An issue with a put provision gives the bondholder the right to sell the loan back to issuer at its principal value before its maturity. In case where the bondholder is given the right to exchange the bond for a known number of shares of common stock, it is issued a convertible bond. (Fabozzi 2000: 4-5; Bodie, Kane & Marcus 2005: 448.)

As we live in modern global economy it is natural that bonds are issued in many different currencies. In U.S. markets there are two kinds of bonds issued in U.S. dollars, domestic bonds and sovereign bonds. The difference between these two is that while domestic bonds are issued by some U.S. institution and

sovereign are issued by some foreign institution respectively. Bonds issued in a foreign currency are called eurobonds.

Investing in bonds is in general kept more riskless than investing for example in stock market. An investor must always remember that also bonds are exposed to some risks existing in the market. According to Fabozzi (2000: 5-8) there are quite a few risks involved in investing in bonds:

- **Interest-rate risk:** Rising interest rates cause a fall in the bond price. Therefore if a an investor has to sell the bond before its maturity, an increase in interest rates means it is most likely that investor faces capital loss.
- **Reinvestment risk:** Refers to risk of falling interest rates at the time of reinvesting the cash flows received from a security.
- **Call risk:** From investor's point of view it means exposure to three additional risks in investing this kind of bond. These are uncertain cash flow pattern of bond, reinvestment risk in case the issuer calls bond before maturity, and reducing of the capital appreciation potential.
- **Default risk:** Issuer of a bond may not be able to make timely principal and coupon payments on the bond.
- **Inflation risk:** The value of security's cash flows varies due to inflation, as measured in terms of purchasing power.
- **Exchange-rate risk:** In case where the payments of an issue are executed in foreign currency, the investor's cash flows are dependent on the exchange rate of the time the payments are realized.
- **Liquidity risk:** Depends on how easy it is to sell an issue near or at its value. The size of bid-ask spread, quoted by dealer, is the primary measure of liquidity risk.
- **Volatility risk:** An adverse impact on the bond price caused by a change in the volatility of for example interest rates.
- **Risk risk:** Condition where it is not known what the associated risk of an exact bond is.

Out of all options this thesis concentrates on the U.S. government notes and bonds mostly because these government securities are commonly kept as one of the safest form of investing. This assumption can be seen as low yields in the market, meaning that investors require least risk premium to invest in such securities. One important reason for this general opinion is the U.S.

government's role as a taxing authority. U.S. Treasury securities are also very liquid in the market. The basic concepts of bonds and the bond characteristics as funding sources of the U.S. government are presented in the next chapter. (Nissenbaum, Raach & Ratner 2004: 71.)

## **2.1. Basic Concepts Concerning U.S. Government Bonds**

U.S. Treasury securities are the most ideal debt instruments compared to theoretical framework as government bonds have qualities like the fact that they have almost zero default risk and nowadays there are very few securities with call provision. Moving on with U.S. Treasury securities they show up in two varieties. Investing in Treasury bills means a one single payment in prescheduled date in the future. The payment is called face or par value, and the particular date is called the maturity date. The Treasury bills, as money market instruments, have always a maturity from one to less than one year. These kind of fixed income securities are called zero-coupon securities.

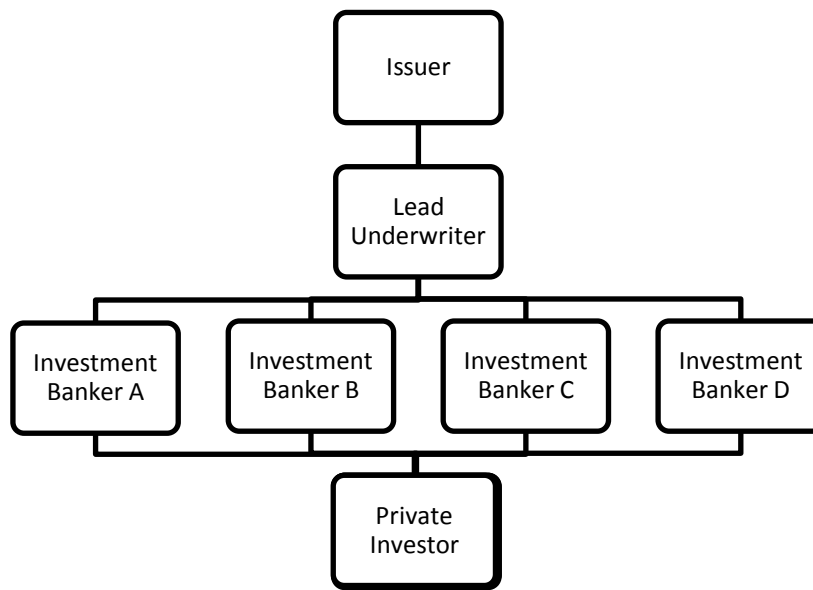
Treasury Securities with maturity longer than one year are known as Treasury notes and bonds. In this sort of debt contracts the issuer promises the investor to produce a series of fixed coupon payments until the maturity, when a large final payment of par value is made along with the last coupon. Coupon payments in U.S. Treasury securities are made semi-annually. Treasury notes have a maturity from more than one year to maturity of ten years, as Treasury bonds have a maturity from ten to thirty years respectively. (Campbell 1995: 130-131.)

The U.S. government issues also securities with protection against the negative influences of inflation. These securities are called TIPS (Treasury Inflation-Protected securities). TIPS are considered as an extremely low-risk investment since they are backed by the U.S. government and since their face value rises with inflation, as measured by the Consumer Price Index (CPI), while their interest rate remains fixed. Interest on TIPS is paid semiannually. (Investopedia 2010.)

### 2.1.1. Markets for U.S. Government Bonds

There are two different markets where the trading of U.S. Government bonds takes its place. These markets are called primary and secondary markets. The difference between the two markets is basically the participants at both markets. In primary markets new issues of bonds are sold to initial buyers by the government. In secondary markets the initial buyers can resell the bonds they previously bought in primary markets. Both markets are open for all investors but in general the primary markets are not so well known along public since the initial security transactions normally takes place behind closed doors. A typical initial buyer is a big investment bank who assists the initial sale by underwriting securities meaning that it guarantees a price for issuer. Then in the secondary markets the investment bank is ready to offer these bonds to public. In the nutshell the role of primary markets is to raise funds for government or corporations to invest, and the role of secondary markets is to be the facility where the trading takes its place, respectively. (Mishkin 2003: 23-24; Bodie, Kane & Marcus 2005: 66.)

In figure 1. we have a practical example of a bond issuing process. The issuer raise funds when dealing with the lead underwriter who is willing to secure a price for issuer. Thenceforth the lead underwriter is free to take actions to distribute the issue all the way to circumstances where also the public has an access to invest on this issue. In this simple example the lead underwriter makes business with investment bankers who are willing to sell bonds to private investors respectively.



**Figure 1. Relationship among issuer, the underwriters, and the public.**

Secondary markets differ from primary markets in interesting ways. One interesting quality in secondary markets is that when transactions are made in secondary markets, money and a known security change owners. Unlike in primary markets the original issuer of the security does not attain new funds. Secondary markets have also one feature that is crucial to primary markets. They determine the price of the security that the issuer sells in the primary market. The investors making investments in the primary market are willing to pay the issuer no more than the price they think the secondary market will set for this particular security. Consequently the higher the security price in the secondary market, the better the issuer of the security will yield from the issue.

Secondary market can be organized in two optional ways. The first one is to organized exchanges, (e.g. NYSE), where security sellers and buyers meet in one central location to manage trades. The optional way to organize secondary market is to have an OTC (over-the-counter) market, in which dealers at different locations stand ready to make trades “over the counter” with anyone who is ready to face their prices. In practice this means that security dealers quote prices at which they are willing to trade securities. The OTC market is not a formal exchange like for example NYSE, but it is not very different from organized formal one. The traders in OTC market are linked by computers and

so the trading is effective and quick because all the participants know the prices set by each other. The OTC market is the major market place set for the U.S. government securities. Just to illustrate, the trading volume of the U.S. government bond in OTC market overcomes the trading volume in NYSE. (Mishkin 2003: 24; Bodie et al. 2005: 72-73.)

### 2.1.2. Credit Ratings

Credit ratings have been widely used by bond investors, debt issuers, and governmental officials as a surrogate measure of riskiness of the companies and bonds. They are important determinants of risk premiums and even the liquidity of bonds. There are two basic types of credit ratings, one is for specific debt issues or other financial obligations and the other is for debt issuers. The first one is the one most frequently studied and can be referred to as a *bond rating* or *issue credit rating*. The meaning of this is to inform the private investors of the likelihood of an investor receiving the promised principal and interest payments associated with a bond issue. The second one is a current opinion of an issuer's overall capacity to pay its financial obligations, which reflects the issuer's fundamental creditworthiness. It focuses on the issuer's ability and willingness to meet its financial commitments on a timely basis. This rating can be referred to as *counterparty credit rating*, *default rating* or *issuer credit rating*.

Both types of ratings are very important to any investor who is planning investments. A lower rating usually indicates higher risk, which causes an immediate effect on the subsequent interest yield of the debt issue. Moreover, many regulatory requirements for investment or financial decision in different countries are specified based on such credit ratings. Many agencies allow investment only in companies having the top four rating categories as illustrated in *table 1*. There is also substantial empirical evidence in the finance and accounting literature that have established the importance of information content contained in credit ratings. (Huang, Chen, Hsu, Chen & Wu 2004: 544.)

One difference between corporate ratings and treasury ratings is that corporate bonds always have higher interest rates than U.S. Treasury bonds. This is just because corporate bonds always have some default risk while U.S. Treasury

bonds don't. Due to this feature the U.S. government securities are kept as risk-free assets, meaning they are rated in the highest quality. Moreover for sake of this nature, the bonds default risks are measured by an objective institution like for example Fitch, Standard and Poor's or Moody's who makes a living out of these kinds of figures and ratings. Furthermore bonds are given a fair financial status and so investors can make their investment decisions based on these ratings. To reduce exposure to default as much as possible, bond investors watch bond ratings very closely. The two bond rating organizations mentioned above, Standard and Poor's and Moody's, are the best known participants in this business area. Their ratings represent the current opinions they have about the quality of most large bond issues and commercial papers.

In evaluating a bond, the rating services are most interested in an issuer's (e.g. corporation or a government) health, as evidenced by its financial statement. These ratings will change based on issuers financial performance as the ratings are periodically updated. (New York Institute of Finance 1988: 174-175; Bodie et al. 2005: 471.)

Bond Rating		Grade	Risk
Moody's	S&P/ Fitch		
Aaa	AAA	Investment	Highest Quality
Aa	AA	Investment	High Quality
A	A	Investment	Strong
Baa	BBB	Investment	Medium Grade
Ba, B	BB, B	Junk	Speculative
Caa/Ca/C	CCC/CC/C	Junk	Highly Speculative
C	D	Junk	In Default

**Table 1. The different bond rating scales from the major rating agencies in the U.S.**

The chart above (Table 1.) illustrates the different bond rating scales from the major rating agencies in the U.S. such as: Moody's, Standard and Poor's and Fitch Ratings. Notice that if the dept issuer falls below a certain credit rating, its grade changes from investment quality to junk status. Named as junk bonds means they are the debt of companies in some sort of financial difficulty. Because they are so risky, they have to offer much higher yields than any other debt. This brings up an important point of view that not all bonds are naturally

safer than stocks. Certain types of bonds can be just as risky, if not riskier, than stocks.

## 2.2. Bond Price and Yield Determination

As this thesis focuses on the influence of arrival news announcements on bond prices, it is natural to take a closer look at the price determination. The simplest way to think this through is to imagine the value of the bond as a sum of expected future cash flows and par value of the bond discounted to present, using an appropriate discount rate. The cash flows from a bond consist of annual or semi-annual coupon payments until the bonds maturity plus the final payment of par value. Based on above, the price of an n-period U.S. government bond at time  $t_0$  is the sum of the future coupon payments and the present value of par value  $PV$ , and therefore written as follows: (Bodie et al. 2005: 455.)

(2.1)

$$P_0 = \sum_{t=1}^n \frac{C_t}{(1+r)^t} + \frac{PV}{(1+r)^n}$$

Where  $P_0$  denotes the present value of the bond.  $C$  denotes coupon payments and  $PV$  is the *par value* of the bond. Now, it's important to note that government bonds are considered as risk-free investments meaning that the payments for bond are fixed. Therefore, the only factor that has influence on bond price is the discount rate. Taking account to the previously mentioned, it is easy to see that there is a certain relation between the bond price and the discount rate. A higher discount rate leads to lower present value and lower market price, and conversely. In this thesis it can be considered that a change in the discount rate is an implication of arrival economic news. (Andersson, Hansen & Sebestyén 2006: 9)

The present value of a zero coupon bond takes a simpler form, since zero coupon bond doesn't yield any coupon payments to investors. The idea of a zero coupon bond is that the investor yields the difference of price at maturity



and the purchase price. The price of a zero coupon bond is the present value of the final par value, as presented in equation (2.2):

(2.2)

$$P_0 = \frac{PV}{(1 + r)^n}$$

Moving forward, taking a closer look in to bond market. Important concepts concerning bond price are clean prices, dirty prices and accrued interest. In the bond market the quoted prices are clean prices. The clean price is the price of a bond excluding any interest that has accrued since issue or the most recent coupon payment. Furthermore the accrued interest is the fraction of the coupon payment that the bond seller earns for holding the bond for a period of time between bond payments. Now, the dirty price is the bonds clean price added with accrued interest. That is why the dirty price is also called the full price. Clean prices are more stable over time than dirty prices (e.g. when clean prices change, it is for an economic reason, for instance a change in interest rates or in the bond issuer's credit quality). Dirty prices, on the other hand, change day to day depending on where the current date is in relation to the coupon dates, in addition to any economic reasons. (Investopedia 2011)

Illustrating how this works in practice, the accrued interest is a kind of compensation to bond seller who is willing to let the next coupon to the buyer. During the period between coupon payments the clean price stays the same (e.g. it's a constant). The dirty price instead, increases when time goes by and decreases when the next coupon payment is made. The day the coupon goes ex dividend, the accrued interest is zero, and the clean price and the dirty price are equal. The net accrued interest which the seller gets from holding period is defined in equation (2.3): (Fabozzi 1997: 56.)

(2.3)

$$AI = C \cdot \left( \frac{\text{Number of days from the last coupon payment to settlement date}}{\text{Number of days in coupon period}} \right),$$

where:

AI           = net accrued interest  
C            = annual coupon payment

Unlike the coupon interest rate, which is constant or fixed, the yield of a bond varies from day to day depending on current market conditions. Moreover, the yield can be calculated in different ways. The commonly used calculation is called *current yield*. It relates the annual coupon interest to the market price. The problem with current yield is that it takes in consideration only the coupon interest, leaving the other effecting factors outside of the yield measure. These factors could be for example capital gains or losses. The formula for the current yield is: (Fabozzi 1997: 58; Bodie et al. 2005: 459.)

(2.4)

$$CY = \frac{C}{P_0},$$

where:

CY           = current yield  
C            = annual coupon  
P<sub>0</sub>         = current price

Introducing *the yield to maturity* which is the calculation of an average rate of return on a bond (with maturity over one year) assuming it is held to its maturity date and also assuming that all cash flows are reinvested at the same rate of interest. The yield to maturity includes an adjustment for any premium paid or discount received. Yet the yield to maturity is probably the most commonly used measure it must be remembered that practically thinking there are at least two pitfalls in its theoretical form. Above, first mentioned assumption was that the bond is held to its maturity. If investor is planning to sell the bond before its maturity, this assumption is not relevant when calculating yields. Secondly mentioned assumption was that all cash flows are reinvested at the same interest rate. In practice, if there prevails a period of fluctuating economy and the interest are going up and down, a constant interest rate may not be realistic. (New York Institute of Finance 1988: 267.)

Amihud & Mendelsson (1991) studied the effects of the liquidity of capital assets on their prices. They also defined yield to maturity to be used in their research. They calculated the annualized yield to maturity  $Y$  relative to the ask price by solving for  $Y$  from the following equation:

(2.5)

$$P + AI = \frac{\frac{1}{2}C + 100}{(1 + Y)^{T/365}}$$

where:

- P = clean (ask) price
- AI = accrued interest
- C = coupon (annual)
- T = time to maturity (number of days until next coupon payment date)
- Y = yield to maturity (YTM)

The equation they used is tailored for their purposes. They included in their sample only bills and notes with less than 6 months to maturity. For these maturities, notes have only one coupon left to be paid at maturity, and thus they become pure discount securities, just as Treasury bills are.

This thesis focuses in Treasury securities with maturity over one year (e.g. 2- and 10-year notes, and 30-year bond). That is why another YTM measure is presented. The next equation (2.6) is not so different of equation (2.5), but it is an equation to solve the yield to maturity of a semiannual bond.

(2.6)

$$P + AI = \left[ \frac{1}{(1 + \frac{Y}{2})^{T/182,5}} \right] \cdot \left[ \sum_{t=0}^{S-1} \frac{C/2}{(1 + \frac{Y}{2})^t} + \frac{PV}{(1 + \frac{Y}{2})^{S-1}} \right],$$

where:

- P+AI = dirty price

Y	= yield to maturity
T	= time to maturity
S	= number of coupons left before maturity

In this equation (2.6), the cash flows of a bond are discounted back to the date of the subsequent coupon and discount the present value at that particular date to date  $t$ . These two equations (2.5 and 2.6) have only one unknown variable included, the yield to maturity. There is no universal formula to solve YTM, which in this case is solved in the same way the IRR (internal rate of return) is, by trial and error.

*The holding-period return (HPR)* is a time-weighted average return of a bond. It measures bond's total return over given time period. The holding-period return of a bond can be better or worse than the yield it initially sells at the moment. This is because there may be fluctuations on the market during the holding period. These fluctuations are unanticipated changes in the market rates meaning they also affect to bond yields as unanticipated yield changes. Simply, when there occurs an increase in the bond's yield it means that the holding-period yield will be less than the initial yield. A single period holding-period return (HPR) is shown in equation (2.7): (Bodie et al. 2005: 468.)

(2.7)

$$HPR = \frac{[(P_1 - P_0) + I]}{P_0},$$

where:

I	= interest payment
$P_0$	= purchase price
$P_1$	= price in one period

In case the interest paid is reinvested at the YTM during the bonds holding period until its maturity, the HPR is equal to YTM (yield to maturity). This is also the case in the zero-coupon bonds. An additional way to calculate HPR is to use the following equation (2.8), where it's assumed that the bond is bought on a coupon payment date, so that *accrued interest* is equal to *zero*, and sold an

even number of coupon payment dates later, so that  $T$  is a whole number.  
(Blake 2000: 135.)

(2.8)

$$P_d \cdot \left(1 + \frac{hpr}{2}\right)^{2T} = \frac{C}{2} \cdot \left(1 + \frac{r_1}{2}\right)^{2T-1} + \frac{C}{2} \cdot \left(1 + \frac{r_2}{2}\right)^{2T-2} + \dots + \frac{C}{2} + P_1,$$

where:

- T = time of years to maturity
- $r_1, r_2, \dots$  = the interest rate at which earned coupons can be reinvested
- C = coupon
- $P_1$  = the final price bond is sold

As mentioned earlier in thesis, one of the risks including investing in bonds is called *interest-rate risk*. Depending of ongoing situation in the market, the bond is selling at par, at discount or at premium. If the interest rates at the prevailing moment of time are higher than the bonds coupon rate, the bond is said to sell at discount, and in case the rates are lower than coupon rate it is said to sell at premium, respectively. Bond sells at par when the rates are equal to coupon rate. Relationship between required yield and price at a given time, *the price-yield relation* is an important feature when discussing about bond prices. The price of a bond is the present value of the future cash flows. As the price of a bond changes it's a result of a change in the required yield. The directions of the changes are opposite to each other, meaning the price-yield relation is an inverse relationship. (Fabozzi 1997: 50.)

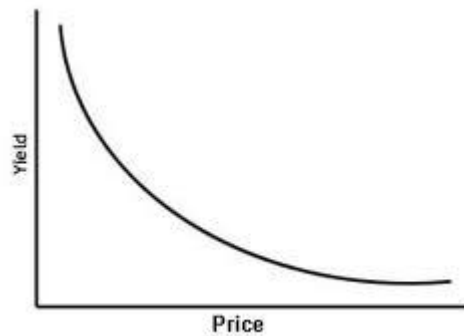


Figure 2. The inverse Price-Yield relationship.

Figure 2. illustrates one important rule in bonds pricing and valuation. As interest rates rise, price of a bond must fall since the present value of future cash flows are discounted with higher interest. Another property in price-yield relationship is called *convexity*, obviously because of the convex shape of the curve. This means that for example an increase in the interest rate results as a decrease in price that is smaller than the price gain resulting from a decrease of corresponding size in the interest rate. (Bodie et al. 2005: 456-457.)

### 2.3. Price Volatility

Bond price volatility comes as a result, mostly from two types of impacts. First one is an interest rate change and the other one is a change in credit rating. Interest rate risk is by far the greatest factor in bond pricing fluctuations especially when discussing about long term bonds. Regardless of the issuers credit rating, each and every bond is subject to an interest rate risk. When interest rates increases, the bond yield that the existing bond has becomes less attractive. Therefore the bond price must decline to compensate the investor for the lower than market coupon. So, bond price volatility measures how bond prices react to interest rate changes. Furthermore, bond price volatility is also a key to the risk management of interest-rate-sensitive securities (e.g. long-term bonds). (Investopedia 2011.)

Concentrating more to the generalizations in the mathematics of bond prices, there are three commonly recognized features affecting bond price volatility, *bonds term to maturity, coupon rate and market yield*. Below in table 2. is illustrated the price development of bond with par value of 1000 in different maturities, and coupon of 8%, when the three earlier mentioned features are taken in account.

Bond Price at Given Market Interest Rate					
Time to Maturity	4%	6%	8%	10%	12%
1 Year	1,038.83	1,029.13	1,000.00	981.41	963.33
10 Years	1,327.03	1,148.77	1,000.00	875.35	770.60
20 Years	1,547.11	1,230.15	1,000.00	828.41	699.07
30 Years	1,695.22	1,276.76	1,000.00	810.71	676.77

**Table 2. Bond prices at different interest rates (Bodie et al. 2005: 457.).**

Notable in Table 2. is how the level of market interest makes a remarkable difference in present value of bond. At lower market rates the present value of cash flows is clearly higher, and at higher market rates the present value of future payments is lower, respectively. According to Hopewell and Kaufman (1973: 749.), unlike in many book discussing the mechanics of bond prices is mentioned, “for a given change in yields, the fluctuations in market price will be greater the longer the term to maturity”, this proposition does not hold in all cases. Burton Malkiel (1966: 55.) mentioned in his book “*The Term Structure of Interest Rates*”, that in particular when bonds are selling at a discount, it is possible to find cases where longer-term securities are actually less sensitive to a given change in market interest rates than shorter issues.

### 2.3.1. Duration

*Duration* has a special meaning in the context of bonds. It’s a measurement of how long it takes, in years, for the price of a bond to be repaid by its internal cash flows. It’s an important measure for investors to consider, as bonds with higher durations bear more risk and have higher price volatility than bonds with lower durations. Duration was first introduced by Frederick Macaulay in 1938. Its function was to provide more complete summary information about bonds time structure than term to maturity. It perceives a normal coupon bond as a zero coupon serial bond with consecutive maturity payments equal to the coupons plus a larger final payment at maturity. Duration is defined in equation (2.9) as follows: (Hopewell et al. 1973.)

(2.9)

$$D = \frac{\sum_{t=1}^n \frac{(C_t)t}{(1+r_t)^t} + \frac{A_n}{(1+r_n)^n}}{\sum_{t=1}^n \frac{C_t}{(1+r_t)^t} + \frac{A}{(1+r_n)^n}},$$

where:

D	= duration
C	= coupon
A	= dollar value of maturity payment
t	= period in which payment is made
r	= interest rate applicable for period $t$
n	= maturity period

There exist many different mathematical versions of duration, and in addition to equation (2.9) the duration of a stream of payments can be expressed also in more simple form, calculated with present values ( $Pt_1, Pt_2, \dots, Pt_n$ ): (Weil 1973: 589.)

(2.10)

$$D = \frac{\sum_{i=1}^n t_i P_{t_i}}{\sum_{i=1}^n P_{t_i}},$$

where:

$P_{t_i}$	= the present value of a coupon payment to be received at time $t_i$ .
$t_i$	= time until coupon payment is made

The measure has dimension time and is, in a sense, equal to the period of time which elapses before the "average" dollar of present value from a stream of coupons is received. The duration of a stream may be thought of as the average life of the stream. Duration has interesting properties (e.g. the duration of a stream of positive payments is with no exceptions less than the time until the last payment, unless the particular stream is a single payment). Another interesting feature is that the duration of an ordinary coupon bond is an



increasing function of bond's maturity if and only if the bond sells at or above par value. (Weil 1973: 589.)

An adjusted version of Macaulay duration is known as modified duration. It is often used as a measure of the sensitivity of price to small changes in yields. More precisely, it calculates the approximate percentage change in price, when interest rates change by one percent. The formal definition of modified duration is:

(2.11)

$$Mduration = \frac{DURATION}{(1 + Yield/k)}$$

where:

$k$  = number of periods (payments) per year (e.g.,  $k = 2$  for semiannual payment bonds and  $k = 12$  for monthly payment bonds)

Along with the duration measures, the price value of a basis point is a measure of price volatility describing the change in the value of a bond, when the required yield changes with one basis point. The price value of a basis point is typically expressed as the absolute value of the change in price. The change in the yield for a particular price change is also used as a measure of price volatility of a bond. It is estimated by first calculating the bond's yield to maturity if the bond price is decreased by  $x$  dollars. The difference between the initial yield value and the new yield value is the yield value of an  $x$  dollar price change. (Fabozzi 2000: 59–60.)

One property of duration, both modified and Macaulay duration, is that the duration computed for a coupon bond is less than maturity. Taking a close look at the formula that the Macaulay duration of a zero-coupon bond is equal to its maturity. That is not the case with modified duration as it is less than a zero-coupon's maturity. There is a consistency between the features of bond price volatility and the features of modified duration. When all the other factors are constant, the longer the maturity, the greater the price volatility. A property of

modified duration is that, *ceteris paribus*, the longer the maturity, the greater the modified duration. Furthermore, the lower the coupon rate, *ceteris paribus*, the greater the bond price volatility. (Fabozzi 2000: 65.)

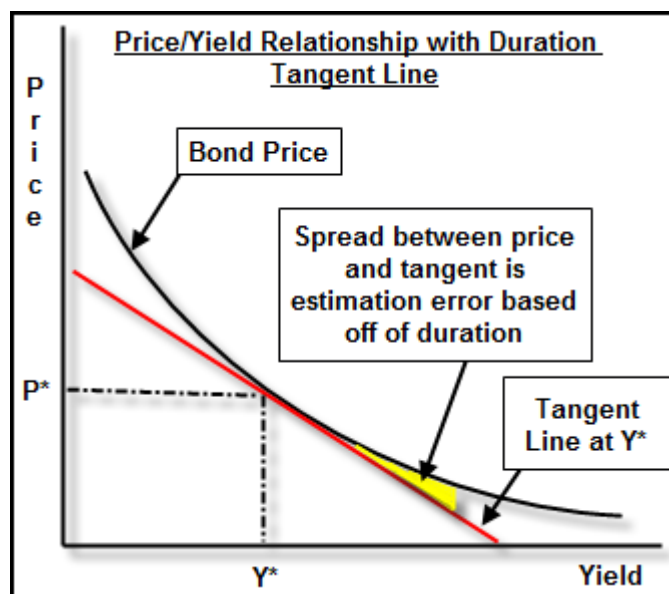


Figure 3. Line tangent to price-yield relationship.

(<http://www.mysmp.com/files/images/convexity.png>)

In figure 3, a tangent line is drawn to the price-yield relationship at yield  $Y^*$ . The tangent shows the rate of change of price with respect to a change in interest rates at that particular yield level. The slope of the tangent line is related to the price value of a basis point. Hence, for a given starting price, the tangent (which tells the rate of absolute price changes) is closely related to the duration of the bond (which tells about the rate of percentage price changes). At the same time figure 4, presents the error when measuring the price-yield relationship. When yields decrease, the estimated price change will be less than the actual price change, thereby underestimating the actual price. Turning it upside down, when yields increase the estimated price change will be greater than the actual price change leading in an underestimate of the actual price. The size of the error depends on the *convexity* of the curve. (Fabozzi 1996: 65-67.)

### 2.3.2. Convexity

Tools for measuring the impact and adjusting for the effects of interest rate changes on fixed-income instrument performance have long been available with duration and its companion adjustment factor, convexity. Like in figure 3., duration can be viewed as the slope of a straight line tangent to the price-yield curve. The slope of the tangent line estimates the change in the bond price that would occur given a change in the yield. Because the curve is convex, the accuracy of the estimate of price change depends on that degree of convexity. A convexity correction factor is often used to adjust the price change estimated by using the bond duration. (Heck, Zivney & Modani 1995: 31-33.)

## 2.4. The Term Structure of Interest Rates

The term structure of interest rates measures the relationship among the yields on default-free securities that differ only in their term to maturity. The determinants of this relationship have been a topic of concern for economists. By offering a complete schedule of interest rates across time, the term structure embodies the market's anticipations of future events. An explanation of the term structure gives us a way to extract this information and to predict how changes in the underlying variables will affect the yield curve. (Cox, Ingersoll & Ross 1985: 385.)

Culbertson (1957) summarizes the theory of the term structure as follows:

“Rates on short-term and long-term U. S. government securities, which are tied to rates on related private debt, characteristically move simultaneously in the same direction in the short run (over periods of weeks and months), with short-term rates changing over the wider range. The general coincidence of movement in rates reflects basically the simultaneous impact in various credit markets of changes in general credit conditions resulting from changes in business conditions and monetary policy, and substitutability between short-term and long-term debt on the part of both borrowers and lenders. However, this substitutability is limited in extent, and when the maturity structure of debt supplied to the economy undergoes a substantial short-run change, either because of Treasury debt management operations or actions of private borrowers, this is reflected in the rate structure. Yields on short-term debt average lower than those on long-term debt because of the advantage of the

superior liquidity of such debt to the holder and the liquidity disadvantage of issuing such debt to private borrowers. The amount of the liquidity premiums reflected in the term structure can vary with changes in the maturity structure of outstanding debt and with other factors affecting marginal preferences for liquidity in investment assets. Behavior based upon interest rate expectations is important mainly as a factor determining very short-run movements in long-term rates. Such behavior is based mainly on near-term expectations, and is ordinarily of little importance in determining average rate levels, and relationships, over considerable periods of time.”

Furthermore, discussing about the influence of bonds term to maturity on its interest rate. As mentioned earlier, bonds with identical risk, liquidity, and tax characteristics may have different interest rates because their different terms to maturity. The yield curve describes the term structure of interest rates for particular types of bonds, such as government bonds. Yield curves can be classified as upward-sloping, flat and downward-sloping (or inverted yield curve as the last one is also called). Yield curves sloping upward, the long-term interest rates are above the short-term interest rates; when yield curves are flat, both short- and long-term interest rates are at the same level; and when yield curves are downward-sloping, long-term interest rates are below short-term interest rates. (Mishkin 2006: 127.)

While there are different shapes of yield curves at different times, it is still not relevant to discuss about the reasons why they take these particular shapes. Instead of that it is more important to know that a good theory of the term structure of interest rates must explain the following important empirical facts: (Mishkin 2006: 128.)

- Interest rates on bonds of different maturities move together over time.
- When short-term interest rates are low, yield curves are more likely to have an upward slope.
- When short-term interest rates are high, yield curves are more likely to slope downward and be inverted.
- Yield curves almost always slope upward.

In case there was a theory found to be consistent with all the regularities mentioned above, it would be a valid explanation of the term structure of the interest rates. Unfortunately, none of the existing theories is capable to explain all these empirical facts. That is why no single theory is a complete explanation

of the over-time interest rate behavior yet each of the theories introduced ahead provides interesting insight into the term structure.

#### 2.4.1. The Expectations Theory

There are various versions of the expectations hypothesis. These place predominant emphasis on the expected values of future spot rates or holding period returns. In its simplest form, the expectations hypothesis postulates that bonds are priced so that the implied forward rates are equal to the expected spot rates. Generally, this approach is characterized by the following propositions: (1) the return on holding a long-term bond to maturity is equal to the expected return on repeated investment in a series of the short-term bonds, or (2) the expected rate of return over the next holding period is the same for bonds of all maturities. (Cox, Ingersoll & Ross 1985: 385.)

The hypothesis probably derives from observing the way people commonly discuss of investment choices between short- and long-term bonds. If people expect that short-term interest rates will be  $n$  % on average over the becoming  $m$  years, the expectations theory predicts that the interest rate on bonds with  $m$  years to maturity will be  $n$  % too. If short-term interest rates were expected to rise even higher after this  $m$  years period so that the average short-term interest rate over the coming (for example 20 years) is  $n+1$  %, then the interest rate on 20-year bonds would equal  $n+1$  % and would be higher than interest rate on  $m$ -year bonds. In figure 4. is illustrated the different shapes of the yield curve in different interest rate expectation situations: (Shiller 1990: 645.; Mishkin 2006: 129.)

- A: Short term rates are expected to rise in the future.
- B: Short term rates are expected to remain unchanged in the future.
- C: Short term rates are expected to decline in the future.

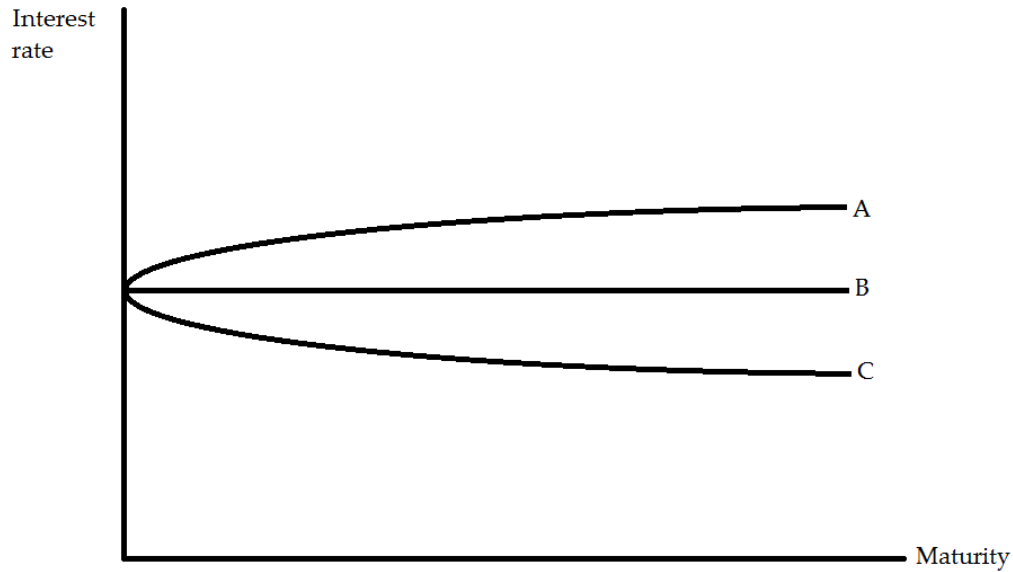


Figure 4. Expectations and the shape of the yield curve.

The broadest interpretation of the expectations hypothesis suggest that investors expect the return for any investment period to be the same, regardless of the maturity of the bond. In other words, due to expectation theory it makes no difference whether an investment is made on short- or long-period bond for a certain time period since the investor expects the return from different maturity bonds to be the same. A major criticism of this very broad interpretation of the expectations theory is that, because of price risk associated with investing in bonds with a maturity greater than the investment period, the expected returns from different maturity bond investments should differ in significant ways from each other. (Fabozzi 1996: 98-100.)

In following is presented the written form of yield of a long-term, n-period bond. The yield must equal the average of the current one period yield and expected future one period yields at the time period: (Mishkin 2006: 131.)

(2.12)

$$i_{nt} = \frac{i_t + i_{t+1}^e + i_{t+2}^e + \dots + i_{t+(n-1)}^e}{n},$$

where:

- $i_{nt}$  = the yield of n-period investment as per today  
 $i_t$  = the yield of a one period investment as per today  
 $i_{t+1}^e$  = the expected yield of a one period investment at period t+1

#### 2.4.2. The Liquidity Premium Hypothesis

The liquidity preference hypothesis, advanced by Hicks (1946), concurs with the importance of expected future spot rates, but places more weight on the effects of the risk preferences of market participants. It states that risk aversion will cause forward rates to be systematically greater than expected spot rates, usually by an amount increasing with maturity. This term premium is the increment required to induce investors to hold longer-term securities. In Other words, the theory suggests that investors will hold longer-term maturities if they are offered a long-term rate higher than the average of expected future rates by a risk premium that is positively related to the term to maturity. (Cox, Ingersoll & Ross 1985: 385-386.; Fabozzi 1996: 101.)

The liquidity premium theory's main assumption is again that bonds of different maturities are substitutes meaning that expected return on one bond influences the expected return on a bond of a different maturity, but it allows investors to prefer one bond maturity over another (i.e. bonds of different maturities are substitutes but not perfect substitutes). Investors tend to prefer shorter-term bonds because they bear less interest-rate risk. (Mishkin 2006: 133.)

The liquidity premium theory is written in equation (2.13). By adding a positive liquidity premium,  $l_{nt}$ , to the expectations theory equation that describes the relationship between long- and short-term interest rates, the liquidity premium theory takes form: (Mishkin 2006: 133.)

(2.13)

$$i_{nt} = \frac{i_t + i_{t+1}^e + i_{t+2}^e + \dots + i_{t+(n-1)}^e}{n} + l_{nt},$$

### 2.4.3. The Preferred Habitat Theory

The preferred habitat theory is closely related to the liquidity premium theory and it also adopts the view that the term structure reflects the expectation of the future track of interest rates as well as a risk premium. It takes a less direct approach to modifying the expectations hypothesis, still concluding similarly. The preferred habitat theory assumes that investors have a preference for bonds one maturity over another, a particular bond maturity in which they prefer to invest (preferred habitat). Since this feature, investors will be willing to buy bonds that do have the preferred maturity only if they earn higher expected return. This results the same as it did with the liquidity premium theory, the term premium rises typically with maturity. (Fabozzi 1996: 101.; Mishkin 2006: 134.)

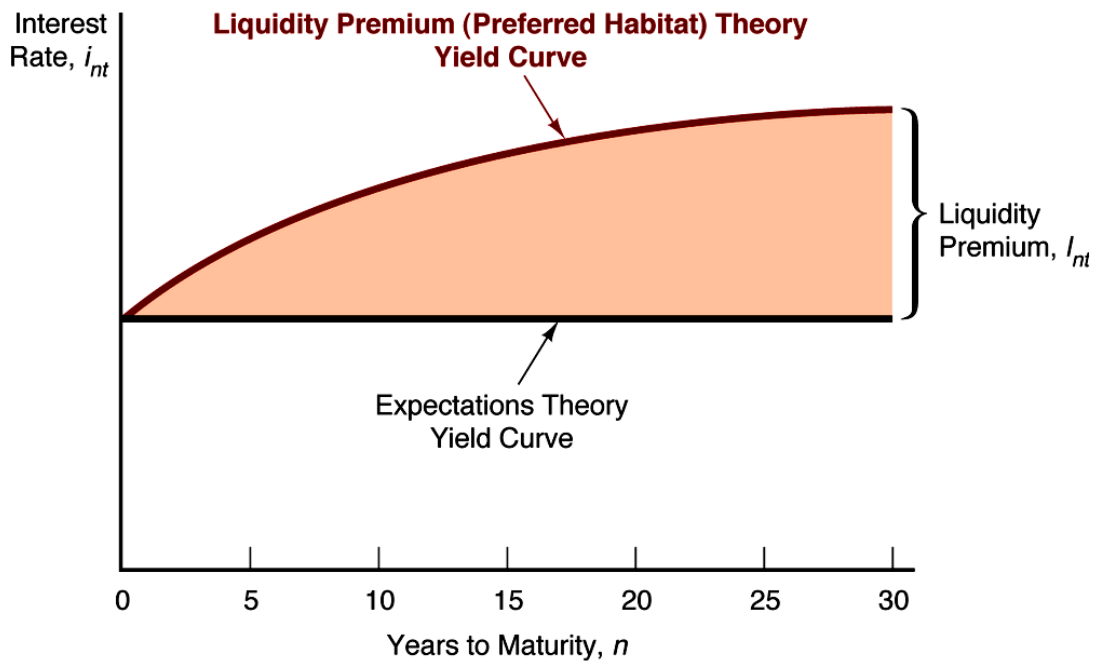


Figure 5. The relationship between the liquidity premium and expectations theory.

(Mishkin 2006: 134.)



The relationship between the expectations theory and the liquidity premiums and preferred habitat theories is shown in figure 5. In it, the yield curve implied by the expectations theory is drawn under the scenario of unchanging future one-year interest rates. Because the liquidity premium is always positive and grows as the term to maturity increases, the yield curve implied by the liquidity premium and preferred habitat theories is always above the yield curve implied by the expectations theory and has a steeper slope. (Mishkin 2006: 134.)

#### 2.4.4. The Market Segmentation Hypothesis

Furthermore, there is the market segmentation hypothesis of for example Culbertson (1957), which offers a different explanation of term premiums. Here it is asserted that individuals have strong maturity preferences and that bonds of different maturities trade in separate and distinct markets. The demand and supply of bonds of a particular maturity are presumably little affected by the prices of bonds of neighboring maturities. Of course, there is now no reason for the term premiums to be positive or to be increasing functions of maturity. Without attempting a detailed critique of this position, it is clear that there is a limit to how far one can go in maintaining that bonds of close maturities will not be close substitutes. (Cox, Ingersoll & Ross 1985: 386.)

The main assumption of the market segmentation hypothesis is that bonds of different maturities are not substitutes meaning that the expected return from holding a bond of one maturity has no effect on the demand for a bond of another maturity. This theory is complete opposite to the expectations hypothesis. According to the market segmentation hypothesis bonds of different maturities are not substitutes since investors have strong preferences for bonds of one maturity but not for another. In this situation investors are only concerned for the expected returns of the bonds of the maturity they prefer. This theory is able to explain different shapes of the yield curve, but unable to explain why market interest rates of different maturities tend to move in same directions. (Mishkin 2006: 132.)

### 3. MACROECONOMIC NEWS

The market for U.S. Treasury securities is one of the largest and most active financial markets in the world. Yet, there is a lot of research made in the stock market, the bond market is also more and more under research, since there is also high frequency (intraday) data available nowadays. Previous studies in stock market provide some evidence of the relationship between macroeconomic news and stock prices. The apparently weak informational effects found in the stock market are not entirely surprising. Much of the observable information likely to be relevant to the stock market as a whole takes the form of macroeconomic announcements. Theoretical effects of such announcements are often ambiguous for stocks, but not for bonds. The reason is that stock prices depend on both cash flows and the discount rate, while bond prices—for which cash flows are fixed in nominal terms—depend only on the discount rate. As a practical example, an upward revision of expected real activity raises the discount rate for both stocks and bonds, which would reduce prices. At the same time, however, the revision raises expected cash flows for stocks, an outcome that increases stock prices. The net effect on bond prices of such an announcement is clearly negative, but the net effect on stock prices will depend on whether the cash flow effect or the discount rate effect dominates. Theory says that movements in financial asset prices should reflect new information about fundamental asset values. In the case of risk-free government bonds, the cash-flows are fixed and the only relevant quantities for pricing are discount rates determined by the general macroeconomic environment. It follows logically that Treasury bond prices should vary with news about macroeconomic fundamentals. (Fleming & Remolona 1997: 32.; Beber & Brandt 2006: 1998.)

Evidence that new information about the economy matters for financial markets implies that uncertainty in these markets should be associated with uncertainty about the state of the economy. As previously studied, Ederington & Lee (1996) and Beber & Brandt (2006) document that the uncertainty implicit in options written on U.S. Treasury bond futures drops substantially after the release of macroeconomic news. This observation suggests that when financial markets learn about the state of the economy, some uncertainty in financial markets is resolved. Beber & Brandt (2009) measured macroeconomic uncertainty using

prices of economic derivatives and related this measure to changes in implied volatilities of stock and bond options when the economic data is released. Across the different assets they considered, they found that higher macroeconomic uncertainty is associated with greater reduction in implied volatilities. For bonds, the relationship between macroeconomic uncertainty and changes in implied volatility is statistically and economically highly significant.

### 3.1. The Relationship between Macroeconomic News and Bond Returns

According to earlier studies, findings on economic news announcement effects in the bond market suggest that it will be easier to relate this market's movements to arrival information. Market movements in these studies are typically based on daily interest rates, and announcements are measured by the difference between the forecast and the actual outcome of the news release. This particular difference is also known as the "surprise" component. Forecasts are either derived by the studies' authors from the time series of the variables or generated by the market analysis firm MMS (Money Market Services) International Inc. from surveys conducted a few days before the announcements. (Fleming & Remolona 1997: 32-33.)

As mentioned earlier in thesis, there will appear a surprising effect only if the news release contains relevant information. The surprise component  $E_i$  is written in the following form: (Balduzzi & Green 2001: 526)

(3.1.)

$$E_i = A_i - F_i,$$

where:

$A_i$  = the released value for announcement  $i$ .

$F_i$  = the median of forecasted releases.

Earlier studies are more or less resulted with the fact that relatively few of the macroeconomic news announcements have significant effects on the bond market. One reason for this kind of finding must be that the daily interest rate data on which these studies rely are not high frequency enough to capture the market's reaction cleanly. Another possible reason for the lack of significance is that the effect of a certain surprise may vary even over short periods of time, depending on what else is going on in the economic environment, (e.g. Prag (1994) shows that the effect of unemployment rate announcements on interest rates depends on the prevailing level of unemployment). The availability of high-frequency data is better at present time which allows researchers to make more accurate efforts to estimate the effects of macroeconomic news announcements. (Fleming & Remolona 1997: 33-34.)

Some of the previous studies concerning the effects of news announcements on bond returns are made using dummy variables to measure the average impact of arrival information. By using dummy variables it is possible to isolate statistically significant results about the relationship of macroeconomic news and bond returns, but at the same time it is not possible to recognize the different surprise components that actually creates the movement in bond prices. (Fleming & Remolona 1997: 34.)

One theme of the thesis is the sign and the size of the impact created by arrival relevant information. Balduzzi et al. (2001) found consistency with the generally accepted notion that longer maturity bond prices are more volatile, as they found out that for the most of the announcements, the size of the effect increases with the maturity of the instrument. Christie-David, Chaudry and Lindley (2003) found that in addition to the size of the surprise part of announcement, also the quality (sign) of the surprise matters. An interesting feature in earlier studies is also that negative surprises seem to have cumulatively larger effects than positive ones, and that price adjustment takes more time in case of negative surprises than it takes with positive surprises, respectively. Due to Fleming et al. (1997), if the impact of announcement depends only on the unexpected part of the released information, then accounting for the sign and magnitude of the unexpected component should improve the estimates of announcement effects. However, intraday studies relying on such surprises do not record more significant announcements than

the studies relying only on announcement dummy variables, respectively. The research results discussing the relationship between macroeconomic news announcements and security returns are different in bond market and in stock market. Unlike in stock market, in bond market numerous studies find a significant impact on bond prices.

Sign of response on announcements is dependent on what specific macroeconomic factor the release is concerning. Commentaries in the financial press explain the reaction of the bond market to economic news mostly in terms of revisions of inflationary expectations, where inflation is perceived to be positively correlated with economic activity. Balduzzi et al. (2001) concluded that for instance procyclical variables, like Nonfarm Payrolls, affect bond returns negatively, while counter-cyclical variables, like Initial Jobless Claims, have a positive impact on returns. Regarding the size of the price reaction it is relevant to explain how different maturity bonds react to macroeconomic news announcements.

Balduzzi et al. (2001) concentrate in their discussion on the behavior of the price of the ten-year note, which is representative of the behavior of intermediate- and long-term bond prices. Yet, they used a ten-year note as an example they had also made research with other maturity Treasuries. To examine whether the announcement effects are different across maturities, they calculated the covariance matrix of estimates of slope coefficients for the regressions. By constructing Wald test they examined whether the responses are statistically different across maturities for the eight announcements that have a significant impact on all bond prices. For each announcement, they performed individual pair-wise tests that coefficients are equal, as well as a joint test that all coefficients are equal. Only in six tests they failed to reject that the coefficients are different at the 5 % level. Hence, they concluded that the null hypothesis that the effect is same across maturities is strongly rejected.

The arrival of macroeconomic news causes also different kind of processes, such as price adjustment, increasing volatility and widening bid-ask spread. These processes have been studied in few papers. Flemming et al. (1999) found that the arrival information starts an adjustment process for bond prices, trading volume and bid-ask spreads. As due to concept of market efficiency, they also find the reaction of prices to released news announcement as a quick

process. At the same time the trading volume reduces, demonstrating that price reactions to public information do not require trading. At the time of sharp price change, the bid-ask spread widens dramatically. This suggest that it is inventory control that drives the spread. Market makers evidently widen or withdraw their quotes in response to the inventory risks of sharp price changes. The processes are divided to two stages, brief first stage and second stage. In a prolonged second stage, trading volume surges and then persists along with increased price volatility and moderately wide bid-ask spreads. This stage of the adjustment process seems to be driven by a residual disagreement among investors about what exactly the just-arrived information means for prices. The different opinions of the meanings may arise from investors'' own views including those based on dealers' knowledge. This means that the second stage extends because of different abilities to process information.

### **3.2. Revised Future Expectations and the Surprise Component**

Market reactions to economic news releases can also be explained from the angle of the future expectations of the market participants. Previously in thesis were discussed of the surprise component, and that it is the difference between the actual outcome of the news release and what was expected among market participants. Therefore, the reaction of the bond market to unanticipated economic news depends significantly on revised future expectations, concerning the main indicators reflecting the state of the country such as inflation, unemployment and economic activity and the effect these anticipated figures have on nominal rates.

The evidence in previous studies clearly indicates that the relationship between changes in interest rates and the unexpected part of the money announcement is positive. According to Dwyer and Hafer (1989) there are three possible explanations for this association An "expected liquidity" effect, an "expected inflation" effect, and a "real economic activity" effect. The expected liquidity effect is based on the supposition that a larger forecast error is associated with an expectation that the Federal Reserve will engage in more contractionary open market operations in the near future relative to what they would have done otherwise. As a result of the expected contractionary open market

operations, near-term interest rates increase. The expectation of higher interest rates in the near future, though, raises current rates to maturity on securities that mature after the expected contractionary open market operations. An unexpected increase in the money stock is thus associated with an increase in interest rates. An alternative explanation can be cast in terms of expected inflation. Under this explanation, an unexpected increase in money leads economic agents to revise their expectations of future inflation upward. Because nominal interest rates are the sum of the real interest rate and the expected inflation rate, an unexpected increase in expected inflation, *ceteris paribus*, leads to an increase in nominal interest rates. The real economic activity effect predicts that interest rates will respond positively to an unexpected money increase. According to this explanation, the money announcement reveals information about money demand in the economy. If the announced stock of money depends on the demand for money, an announced money stock greater than expected indicates that money demand is greater than expected. If the demand for money depends, among other things, on expectations of future real economic activity, an unexpected increase in the money stock reflects an increase in expected real activity. Because economic activity and real interest rates are positively correlated, an unexpected increase in the money stock is associated with an increase in real and nominal interest rates. (Dwyer & Hafer 1989: 35-36.)

Vähämaa, Watzka and Äijö (2005) examined the impact of macroeconomic news announcements on bond market expectations, as measured by option-implied probability distributions of future bond returns. They resulted that expected bond market volatilities increase in response to higher-than-expected inflation and unemployment announcements. Moreover, the asymmetries in bond market expectations were found to be affected mostly by surprises in inflation and economic production figures. In particular, it was found that higher-than-expected inflation announcements cause option-implied bond return distributions to become more negatively skewed or less positively skewed, implying a shift in market participants' perceptions toward future increases in interest rates. Furthermore, the results indicate that market expectations of future extreme movements in bond prices are virtually unaffected by macroeconomic news releases. Some evidence was found, however, that suggests that after extreme surprises in inflation announcements

market participants attach higher probabilities for extreme movements in bond prices. (Vähämaa, Watzka & Äijö 2005: 817-818.)

### 3.3 Market Efficiency

In this thesis it is assumed that the arriving of macroeconomic news creates price movements in U.S. Treasury bonds. Now, it must be considered in which circumstances the new information is allocated to prices. The concept of capital market efficiency is therefore introduced. The primary role of the capital market is allocation of ownership of the economy's capital stock. In general terms, the ideal is a market in which prices provide accurate signals for resource allocation: that is, a market in which firms can make production investment decisions, and investors can choose among the securities that represent ownership of firms' activities under the assumption that security prices at any time 'fully reflect' all available information. Moreover the statement that market prices 'instantaneously and fully reflect all relevant available information is known as the *efficient market hypothesis* (EMH). (Fama 1970: 383.)

In case the prices are bid immediately to fair levels, given all available information, it must be that prices moves only in response to new arrival information. New information is defined as unpredictable information: if it could be predicted, then the prediction would be part of that moment's information. Thus security prices that change in response to new information also must move unpredictably. This is the core of the proposition that prices should follow a random walk (i.e. price changes should be random and unpredictable). Far from a proof of market irrationality, randomly evolving security prices would be the necessary consequence of intelligent investors competing to discover relevant information on which to buy or sell securities before the rest of the market becomes aware of that information. If prices are determined rationally, then only new information will cause price movements. Therefore, a random walk would be the natural result of prices that always reflect all current knowledge. Furthermore, if security price movements were predictable, that would be damning evidence of security market efficiency, because the ability to predict prices would indicate that all available



information was not already reflected in prices. (Bodie, Marcus & Kane 2005: 370-371.)

In figure 6. (Nikkinen et. al 2001) illustrates market efficiency, and show how the arrival of new information creates movement in the price of a security.

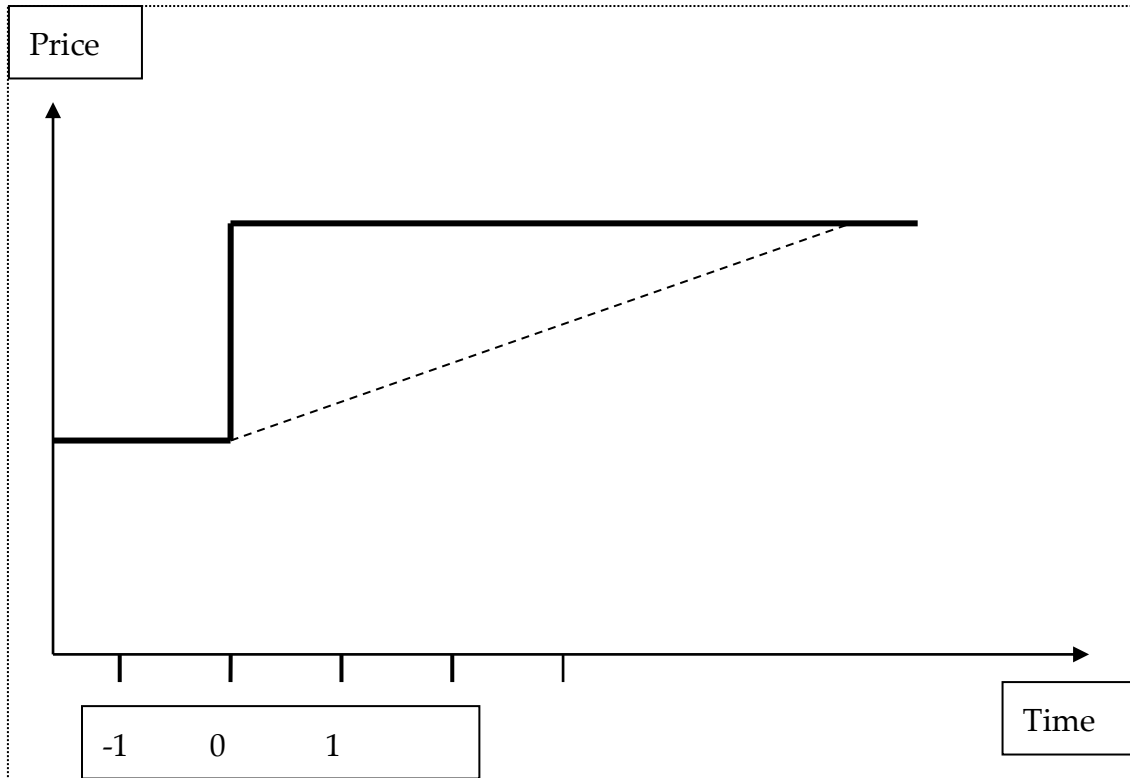


Figure 6. Efficient price adjustment.

In the figure above the solid line presents how prices reflect the new information in fully efficient markets. The dashed line presents the opportunity to make excess returns while markets are inefficient.

The efficient market hypothesis is associated with the idea of “random walk”, which was introduced to public first in 1973 by Burton Malkiel in his book, (*A Random Walk Down Wall Street*). The random walk as a term was presented before in form of “random walk theory” by Bachelier (1900), this theory discussed, translated in English, in Cootner’s (1964) work “*The Random Character of Stock Market Prices*”. The basic idea of random walk is that if the flow of information is not restrained and information is immediately reflected

in market prices, then tomorrow's price change will reflect only tomorrow's news and will be independent of the price changes today. (Malkiel 2003: 59).

Eugene Fama (1965) introduced the EMH in his article in *Financial Analysts Journal*. Since that, it has become a widely accepted concept after it made the mainstream economics literature. There are three forms of the hypothesis of EMH. The definitions according to Fama (1970) are *the weak form*, *the semi-strong form*, and *the strong form* of EMH.

### 3.3.1 Weak Form Market Efficiency

The weak-form EMH suggest that current security prices instantaneously and fully reflect all information contained in the past history of security prices. In other words, past prices provide no information about future prices that would allow an investor to earn abnormal returns from using active trading rules based on historical prices, trading volume, or short interest. This version of hypothesis implies that trend analysis is fruitless. Past security price data are publicly available and virtually costless to obtain. The weak-form hypothesis holds that if such data ever conveyed reliable signals about future performance, all investors already would have learned how to take advantage of the signals. Eventually, the signals lose their value as they become more extensively known among investors. (Blake 2000: 392; Bodie et al. 2005: 373.)

The weak form of the efficient market hypothesis has been widely accepted among financial community, especially with the practitioners of technical analysis. For a long time, researchers and practitioners have been trying to create profitable trading rules that could be used to earn excess returns in stock markets. Like Brock, Lakonishok and LeBaron (1992) did supporting findings with Dow Jones Index in U.S. markets, also Hudson, Dempsey and Keasey (1996) found that without taking into account the transaction costs it is possible to make profit out of stock market in U.K. by using simple technical trading rules. These results support the weak-form efficiency of the EMH.

### 3.3.2. Semi-strong Form Market Efficiency

The semi strong–form hypothesis states that all publicly available information regarding the prospects of a firm must be reflected already in the security price. Such information includes, in addition to past prices, fundamental data on the firm’s product line, quality of management, balance sheet composition, patents held, earning forecasts, and accounting practices. Again, if investors have access to such information from publicly available sources, one would expect it to be reflected in stock prices. (Bodie et al. 2005: 373.)

The semi-strong-form EMH suggest that current security prices instantaneously and fully reflect all publicly available information concerning securities markets. If the hypothesis is true, then when any new information becomes public, it is very rapidly incorporated into security prices. Good news will lead to a rise in stock prices and bad news will lead to opposite, but once this has happened no further predictable price changes can be expected to occur. In short, the semi-strong-form implies that there are no learning lags in the dissemination of publicly available information that can give rise to profitable trading rules. Similarly, if news does not lead to any change in security prices, then if the semi-strong-form holds, the particular news contained no relevant information. (Blake 2000: 392.)

The efficient market hypothesis is been tested in quite a few studies made considering the chance to earn excess returns by using simple trading rules. In fact, the proposition that securities markets are efficient forms the basis for most research in financial economics. Yet there is literature supporting the existing of efficient market hypothesis, there is also studies that question the existing of it. Jensen (1978) calls efficient market hypothesis the best established empirical fact in economics. Indeed, apparent anomalies such as the discounts on closed end mutual funds and the success of trading rules based on earnings announcements are treated as indications of the failures of models specifying equilibrium returns, rather than as evidence against the hypothesis of market efficiency itself.

One of the most important early tests of the semi-strong-form EMH was to see whether the information contained in company reports, particularly earnings announcements contained in reports, leads to significant changes in security

prices following the public release of the reports (Ball & Brown 1968: 159-178.). If the semi-strong-form EMH is true, then no trading rule based on the announcements can lead to positive excess returns (after adjusting for risk and transaction costs) because security prices will either have responded too quickly to the information contained in the announcements, leaving no further predictable price changes to be exploited, or will not have responded at all, because the announcement contained no relevant information. (Blake 2000: 394-395.)

The criticism that the semi-strong form of EMH has faced is listed below:

- Ball (1978) found that stock-price reactions to earnings announcements are not complete
- Watts (1978) performed corrections suggested by Ball to reduce the estimation bias and still found abnormal returns
- Rendleman, Jones and Latané (1982) found a relation between unexpected quarterly earnings and excess returns subsequent to the announcement date
- Pearce and Roley (1983) found that stock prices respond only to the unanticipated changes in the money supply, as predicted by the efficient market hypothesis
- Bamber (1986) found a continuous, positive, relation between trading volume and magnitude of unexpected earnings
- Datta and Dhillon (1993) showed that bondholders react positively to unexpected earnings increases, and vice versa.

Most of the early tests of efficient markets are made in the equity market, but corresponding results are obtained also in the bond market. In the case of bonds, testing centered on whether the expectations hypothesis was supported by the data. Modigliani and Sutch (1966), and Modigliani and Shiller (1973) used averages of ex post (past history) realized short-term interest rates as proxies for ex ante (future) forecasts of short-term interest rates to test whether these forecasts explained the term structure. The tests confirmed the expectation hypothesis. (Blake 2000: 397.)

### 3.3.3. Strong Form Market Efficiency

The strong-form EMH says that current security prices instantaneously and fully reflect all known information concerning securities markets including privately available inside information. This implies that the market response to new information is so quick that not even someone with the most valuable inside information can trade profitably basis of it. (Blake 2000: 393.)

The strong form of EMH has not been under researchers work because of the nature of being illegal to use the kind of information that it would be possible to earn excess returns while markets are at the highest level of efficiency. Moreover the EMH has been studied mostly from the predictability point of view. Most studies in the literature on predictability of stock market returns test the EMH in its weak or semi-strong form. For example, papers on the predictive performance of technical trading rules test weak form market efficiency since only past prices and maybe volume information are used as predictor variables. Studies that include an extended set of predictor variables such as default premia, term spreads and other business cycle indicators test semi strong efficiency. (Timmermann & Granger 2004: 17.)

### 3.3.4. The EMH and an Information-efficient Equilibrium

According to the EMH, security prices fully reflect all available information. An interesting content in this is to know how this process occurs. It depends on whether the markets are fully aggregating information or only averaging information. In a market that is fully aggregating information, even if a piece of information is held only by a single individual, it will be fully reflected in security prices as though every participant in the market is fully aware of that piece of information. In a market that is averaging information, security prices will only reflect the average impact of different pieces of information. This is because not every individual is equally well-informed and the response of security prices to arrival new information depends on the balance between informed and uninformed investors. (Blake 2000:393.)

A strong-form efficient market requires information to be fully aggregating: if this is the case, then not even insiders can exploit their informational advantage. A semi-strong-form efficient market requires only that the market is averaging information. In an information-averaging market there is an important distinction between 'informed' and 'uninformed' investors. Informed investors (e.g. institutional investors or rich private clients) invest in costly research and aim to use their superior information to take trading positions and hence to make excess returns. Current security prices respond to the activities of the informed investors. Uninformed investors, on the other hand, do not invest in collecting information, but, by seeing what is happening to security prices, they can infer the information acquired by the informed traders. In this way, all investors become informed. Is it better to be an informed investor, or an uninformed investor? The choice is between paying for costly information and using it to generate excess returns, or saving on information costs and allowing others to ensure that prices reflect available information. The answer depends on which strategy leads to the greatest return after costs. (Blake 2000: 393.)

## 4. DATA AND METHODOLOGY

It is commonly approved that financial markets react to the news announcements concerning macroeconomic development. Like the previous studies have shown, there exist also certain news announcements that have more informational value than the others. These are known as the major macroeconomic indicators. These releases contain information of overall conditions of the U.S. economy from the previous period of observations and hence provide important information for investors. As this thesis discuss about scheduled economic news announcements it is natural to assume the release dates are known in advance. Since the markets are not perfectly efficient the content of news release remains unknown until the actual release moment. The first section of this chapter introduces the data used in the empirical part of the thesis, and the subsequent part tells more about the research methodology.

### 4.1. Data Description

The data used in this thesis contains daily settlement values on U.S. Government benchmark bond indexes, covering maturities of thirty, ten and two years. The data is gathered from the DataStream International from the database of the University of Vaasa. This dataset spans the time period from January 2<sup>nd</sup> 2006 to December 31<sup>th</sup> 2010, including 1305 daily observations.

Table 3. summarizes the descriptive statistics for the three return series used in this thesis. The mean of this particular sample of security returns is rather small with all different maturities. Basically the mean, the standard deviations and the medians, are not statistically different from zero. Another observation is the size of the kurtosis and skewness statistics which indicate of the returns not been normally distributed.

	30-year bond	10-year note	2-year note
Mean	0,0000	0,0001	0,0001
Median	0,0000	0,0000	0,0000
Standard Deviation	0,0102	0,0055	0,0012
Kurtosis	2,0459	3,8313	8,4719
Skewness	0,0610	0,2319	-0,2457
Minimum	-0,0406	-0,0283	-0,0099
Maximum	0,0474	0,0414	0,0086
Number of observations	1305	1305	1305

**Table 3. Descriptive statistics for U.S. government bond price changes.**

#### **4.2. Macroeconomic Announcements**

The scheduled macroeconomic news announcements investigated in this thesis are chosen mostly based on the previous research papers concerning the relationship between economic news and security returns. The classifications of the major macroeconomic indicators provided by Bureau of Labor Statistics (BLS) were also a criterion in the process of choosing the final announcements. These seven macroeconomic indicators are found to have an impact on the markets when they contain new information at the releasing moment. The macroeconomic news release sample covers the time period between the beginning of January 2006 and the end of December 2010.

Six out of the seven macro announcements used in the thesis come from government agencies and one comes from the private sector. All the announcements are released monthly meaning that all the news announcements used in the thesis are released 60 times. Five of the announcements are released at 8:30 a.m. eastern time (GMT-5), the consumer confidence and the ISM indexes are released at 10:00 a.m. eastern time. Trading hours in the NYSE (New York Stock Exchange) are from 9:30 a.m. to 4:00 p.m. eastern time. While most of the announcements are released during the NYSE is



closed, the impact of the macro releases is incorporated in to the closing prices of the bonds.

Report	Issued	Issuing Institution	# of releases
Consumer Price Index	Monthly	Bureau of Labor Statistics	60
Employment situation (Non-farm payroll)	Monthly	Bureau of Labor Statistics	60
Producer Price Index	Monthly	Bureau of Labor Statistics	60
Retail Sales	Monthly	Institute for Supply Management	60
Import Prices	Monthly	Bureau of Labor Statistics	60
Consumer Confidence	Monthly	The Conference Board	60
ISM Index	Monthly	Institute for Supply Management	60

**Table 4. Macroeconomic news announcements.**

#### Consumer Price Index (CPI)

The CPI represents changes in prices of all goods and services purchased for consumption by urban households. User fees (such as water and sewer service) and sales and excise taxes paid by the consumer are also included. Income taxes and investment items (like stocks, bonds, and life insurance) are not included. The CPI-U includes expenditures by urban wage earners and clerical workers, professional, managerial, and technical workers, the self-employed, short-term workers, the unemployed, retirees and others not in the labor force. The CPI-W includes only expenditures by those in hourly wage earning or clerical jobs.

Prices for the goods and services used to calculate the CPI are collected in 87 urban areas throughout the country and from about 23,000 retail and service establishments. Data on rents are collected from about 50,000 landlords or tenants. The weight for an item is derived from reported expenditures on that item as estimated by the Consumer Expenditure Survey.

The CPI is used in many different ways to indicate the economic state. As the most widely used measure of inflation, the CPI is an indicator of the effectiveness of government policy. In addition, business executives, labor leaders and other private citizens use the index as a guide in making economic decisions. It is also used as a deflator of other economic series. The CPI and its components are utilized to adjust other economic series for price change and to translate these series into inflation-free dollars. Moreover it is used as a means for adjusting income payments. Over 2 million workers are covered by collective bargaining agreements which tie wages to the CPI. The index affects the income of almost 80 million people as a result of statutory action: 47.8 million Social Security beneficiaries, about 4.1 million military and Federal Civil Service retirees and survivors, and about 22.4 million food stamp recipients. Changes in the CPI also affect the cost of lunches for the 26.7 million children who eat lunch at school. Some private firms and individuals use the CPI to keep rents, royalties, alimony payments and child support payments in line with changing prices. Since 1985, the CPI has been used to adjust the Federal income tax structure to prevent inflation-induced increases in taxes. (Bureau of Labor Statistics 2011.)

#### Producer Price Index (PPI)

The Producer Price Index (PPI) is a family of indexes that measures the average change over time in selling prices received by domestic producers of goods and services. PPIs measure price change from the perspective of the seller. This contrasts with other measures, such as the Consumer Price Index (CPI), that measure price change from the purchaser's perspective. Sellers' and purchasers' prices may differ due to government subsidies, sales and excise taxes, and distribution costs.

The PPI tracks price change for practically the entire output of domestic goods-producing sectors: agriculture, forestry, fisheries, mining, scrap, and manufacturing. In recent years, the PPI has extended coverage to many of the non-goods producing sectors of the economy, including transportation, retail trade, insurance, real estate, health, legal, and professional services. The PPI continues to increase coverage of several other non-goods producing sectors of the economy. New PPIs are gradually being introduced for the products of

industries in the utilities, finance, business services, and construction sectors of the economy.

The PPI sample includes over 25,000 establishments providing approximately 100,000 price quotations per month. The participating establishments report price data primarily through the mail. Goods and services included in the PPI are weighted by value-of-shipments data contained in the 1997 economic censuses. Producer Price Indexes are usually made available during the second full week of the month following the reference date. The monthly news release contains a textual explanation of aggregate index movements and various supporting data tables. The PPI Detailed Report is printed and mailed during the middle of the second month following the reference date. ([www.bls.com](http://www.bls.com))

#### Consumer Confidence Index (CCI)

The Consumer Confidence Index (CCI) is a monthly release from the Conference Board, a non-profit business group that is highly regarded by investors and the Federal Reserve. CCI is a unique indicator, formed from survey results of more than 5,000 households and designed to gauge the relative financial health, spending power and confidence of the average consumer.

A strong consumer confidence report, especially at a time when the economy is lagging behind estimates, can move the market by making investors more willing to purchase equities. Because of its subjective nature and relatively small sample size, most economists will look at moving averages of between three and six months for consumer confidence figures before predicting a major shift in sentiment; some also feel that index level changes of at least five points are necessary before calling for the reversal of an existing trend. In general, however, rising consumer confidence will trend in line with rising retail sales and, personal consumption and expenditures, consumer-driven indicators that relate to spending patterns. (Investopedia 2011.)

#### The Import and Export Price Indexes (USIEX)

The U.S. Import and U.S. Export Price Indexes measure the change over time in the prices of goods or services purchased from abroad by U.S. residents

(imports) or sold to foreign buyers by U.S. residents (exports). The Import/Export Price Indexes, along with the Consumer Price Index and Producer Price Index, form the basis of three major Bureau of Labor Statistics (BLS) programs measuring the change in the prices of goods and services in the U.S. economy. The Import/Export Price Indexes are primarily used to deflate foreign trade statistics produced by the U.S. Government. The Import/Export Price Indexes are also a valuable input into the processes of measuring inflation, formulating fiscal and monetary policy, forecasting future prices, conducting elasticity studies, measuring U.S. industrial competitiveness, analyzing exchange rates, negotiating trade contracts, and analyzing import prices by locality of origin. (Bureau of Labor Statistics 2011.)

#### ISM index

A monthly index released by the Institute of Supply Management which tracks the amount of manufacturing activity that occurred in the previous month. The Institute of Supply Management surveys nearly 400 manufacturing firms on employment, production, new orders, supplier deliveries, and inventories. This data is considered a very important and trusted economic measure. If the index has a value below 50, due to a decrease in activity, it tends to indicate an economic recession, especially if the trend continues over several months. A value substantially above 50 likely indicates a time of economic growth. The values for the index can be between 0 and 100. (Investowords 2011.)

#### Retail Sales

Retail sales is an official measure of the broad consumer spending patterns based on the retail sales of consumer-durables (goods that usually last more than three years) and consumer non-durables (that usually last less than three years). Shareholders want to see the retail sales going up (which usually translate into higher corporate earnings). Bond holders favor declining retail sales that signal a slowing economy, lower inflation, and increase in bond prices. (Businessdictionary 2011.)

## Employment Situation

The Employment Situation Report, also known as the Labor Report, is an extremely broad-based indicator released by the Bureau of Labor Statistics (BLS). It is made up two separate and equally important surveys. The first, the "establishment survey", is a sampling of more than 400,000 businesses across the country. It is the most comprehensive labor report available, covering about one-third of all non-farm workers nationwide, and presents final statistics including non-farm payrolls, hours worked and hourly earnings. The data sample is both large and deep, with breakouts covering more than 500 industries and hundreds of metropolitan areas. The second survey, referred to as the "household survey", measures results from more than 60,000 households and produces a figure representing the total number of individuals out of work, and from that the national unemployment rate. The data is compiled by the U.S. Census Bureau with assistance from the Bureau of Labor Statistics. This carries a census-like component, bringing demographic shifts into the mix, which gives the results a different perspective. The development of non-farm payroll is under investigation in this thesis. (Investopedia 2011.)

### 4.3. Research Methodology

The literature, read before starting to work the dataset, offered two different kind of methodology to be used in the thesis. Instead of trying to find out if there was a relationship between the macro releases and bond price changes (e.g. Ederington and Lee 1993), with using dummy variables when running regressions, it was chosen that it is more describing to do the research with creating a new variable to explain the price changes. The idea to do so was taken from the research paper of Balduzzi et al. (2001), where they gained remarkable evidence of the relationship between certain macro releases and the benchmark U.S. bond indexes. This new variable is taken a closer look below.

Let  $F_i$  denote the median of the forecast survey and  $A_i$  the released value for announcement  $i$ . Let's measure the surprise in announcement  $i$  as in equation (3.1). Since units of measurement differ across economic variables, it is necessary to divide the surprises by their standard deviation across all

observations to facilitate interpretation. The “standardized” surprise measure is: (Balduzzi et al. 2001: 527.)

$$(4.1) \quad S_i = \frac{E_i}{\sigma_i},$$

where:

$E_i$  = surprise component of arrival information  
 $\sigma_i$  = standard deviation for a given announcement

When regressing bond returns on surprises, the regression coefficient is the change in return for a one standard deviation change in the surprise. Since the standard deviation is constant across all the observations for a given announcement, this adjustment does not affect either the significance of the estimates or the fit of the regressions. The reason for the standardization is that it allows us to compare the size of regression coefficients associated with surprises across different announcements. (Balduzzi et al. 2001: 528.)

To analyze the effect of economic news on bond prices, let's regress price changes on the surprise in the economic variable being studied and the surprises in variables announced simultaneously.

$$(4.2) \quad (P_{it} - P_{it-1})/P_{it-1} = \alpha + \beta_{1i}S_{it} + \varepsilon_{it},$$

where:

- $P_{it}$  = the closing price at time  $t$  after announcement  $i$ .  
 $P_{it-1}$  = the previous day closing price.  
 $S_{it}$  = the standardized surprise measure of the news announcement  $i$  at time  $t$ .  
 $\varepsilon_{it}$  = the error term

To examine the second theme of the study, the sign and size of bond price change, it is simply picked the group of largest negative and positive percentage bond price change of the data sample. The sharpest price changes are then analyzed by finding out the possible reason behind the particular change.

## 5. RESULTS

This section presents the results of the done examination concerning the economic news announcements and the possible impact they have on U.S. government bond prices. The section also includes analyzing the results mirroring them to the hypotheses made in the early stage of the thesis in section 1.2.. First, the concentration is on discussing the statistical significance of the impact of different macro releases on bond prices that is a result of unexpected part in the particular release. Second, the focus is on the largest bond price movements in the time period used in the thesis.

In order to examine the impact of the scheduled announcements on different maturity Treasuries, a simple regression frame work is thereby used. The results are obtained by using the Microsoft Office Excel data analysis package and IBM SPSS Statistics 19 software. The impact created by the unexpected part of arrival information is regressed on the difference of daily logarithmic returns of three different maturity Treasuries. The daily returns of the used time span are thereby calculated by using the definition below:

$$(5.1) \quad \ln(P_{it}) - \ln(P_{it-1}).$$

### 5.1. Significance of Macro Announcements on Prices

Table 5. presents the estimation results for the three instruments, 2-year note, 10-year note and 30-year bond. The table shows slope coefficients and  $R^2$  estimates. Intercept terms are rarely significant, thus they are excluded from the report.

The criterion used in the thesis is that, a coefficient is denoted significant if its  $t$ -statistics differs from zero in a two-tailed test at 5 % level. Since in all regressions there are 60 observations, the corresponding critical value the  $t$ -



statistics must be equals  $\pm 2.00$ . For 1 % significance level the equivalent critical value equals  $\pm 2.66$ .

	$\sigma_i$	30-Year Bond		10-Year Note		2-Year Note	
		Surprise		Surprise		Surprise	
		Coeff.	$R^2$	Coeff.	$R^2$	Coeff.	$R^2$
1. Consumer Price Index	6,403	-0,038 **	0,131	-0,021 *	0,097	-0,002	0,031
2. Employment situation (Non-farm payroll)	241,631	1,009 *	0,086	0,363	0,038	0,009	0,000
3. Producer Price Index	7,724	0,014	0,024	0,004	0,007	-0,001	0,004
4. Retail Sales	10413,747	0,005 *	0,069	0,003 *	0,073	0,000	0,037
5. Import Prices	3,321	0,001	0,034	0,001 *	0,091	0,000 **	0,147
6. Consumer Confidence	27,843	-0,0135	0,062	-0,012	0,038	-0,001	0,029
7. ISM Index	6,516	0,010 *	0,107	0,005 *	0,097	0,001 *	0,100

\* and \*\* indicate that the coefficients are significant at level 5% and 1% levels, respectively.

**Table 5. The Effect of Announcement Surprises on Bonds of Different Maturity.**

From the analyzing process the following results are identified. The prices of the three instruments react significantly on five announcements. These five announcements are: Consumer Price Index, Nonfarm Payrolls, Retail Sales, Import Prices and ISM Index. Interesting notion is that in only two cases the price of 2-year note is affected statistically significantly (i.e. Import Prices and ISM Index) which are indicators of manufacturing industries. ISM Index was the only one to affect all the three different maturity instruments at 5 % significance level. It is not surprising that ISM Index affect prices, as it indicates the evolving of national GDP (Gross Domestic Product). In addition, there were just two cases where the 1 % significance level was reached, and these were Consumer Confidence Index affecting 30-year bond price and Import Prices affecting 2-year note price. Two out of seven announcements did not reach the 5 % significance level in any instrument. These two are Producer Price Index and Consumer Confidence. The results may suggest that with the chosen time span in this thesis, there did not occur statistically significant surprises in case of these two news releases compared to what was expected in the market. Furthermore it may indicate that market efficiency is at high level so that the predicted values concerning these two releases contain all relevant information.

One noteworthy issue came up when the data analysis was made. The original idea was to analyze both U.S. Exports and U.S. Imports but as it can be seen from the Table 5., Exports is excluded. This is unfortunate but it was not possible to make the analysis with the data received. For some reason the U.S. Exports predictions are not made in monthly basis, unlike U.S. Imports. Exports predictions were only available as quarterly figures. This is with no doubt affecting as a bias in the significance level of monthly U.S. Imports because the Exports are naturally released at the same day at the same time meaning that multivariable regression could not be run like was planned.

In most of the scheduled news announcements that were under investigation in the thesis, the most sensitive instrument occurred to be the 30-year U.S. government bond. This conclusion is based to what sort of values were gotten from running the regressions with the different bond maturities and with the different macroeconomic announcements. Then there was for example Import prices which had the opposite statistical results to the rest of announcements. Import prices had actually a stronger correlation with the short term instrument than with long term, respectively.

In summary, two announcements affect significantly the price of the 2-year note, four announcements affect the price of the 10-year note, and four announcements affect the price of the 30-year bond. It seems that different maturity benchmark instruments react differently on the arrival release depending on the quality of the particular announcement. Furthermore, it seems like the first hypothesis H1, in the circumstances of this thesis, holds as the scheduled U.S. macroeconomic news announcements affect to U.S. government bond prices.

R<sup>2</sup> estimates are also presented in Table 5. In earlier studies like in Balduzzi et al. (2001) the R<sup>2</sup> for the significant announcements could be quite high. This indicates that a substantial portion of price volatility around announcement time could be explained by public news. In this thesis similar results were not achieved, in fact the highest R<sup>2</sup> was measured, in the case of 2-year note, for the U.S. Import prices resulting R-squared of 14.7 %. Second highest R<sup>2</sup> was measured for Consumer Price Index, in the case of 30-year bond, resulting R-squared of 13.1 % which is preferred as more reliable result because of the problems with U.S. Export prices predictions explained earlier in this section.

Another mentionable fact is that for most macroeconomic announcements, the size of the effect generally increases with the maturity of the instrument. For the ISM Index releases, for example, the surprise coefficient increases from 0.001 for 2-year note to 0.005 for the 10-year note, and to 0.010 for the 30-year bond. This is consistent with the notion that shorter maturity bond prices are less volatile than longer maturity bond prices.

## **5.2 Sign and Size of Response on Arrival Information**

One purpose of the study was to find out the sign and the size of response of different maturity U.S. government bonds to scheduled macroeconomic news releases. In other words to study which releases are positively correlated to bond prices and which releases are negatively correlated, respectively. In addition it was also under interest to find out which news announcements create the largest movements in different maturity bond prices.

To find out if the macro announcement used in the thesis were related to the sharpest price changes over the time span from January 2006 to December 2010, the bond price changes were sorted from largest to smallest percentage change in different maturities. By doing so it was possible to recognize the top 25 positive bond price changes and the top 25 negative changes, respectively. The observation period between years 2006 - 2010 was full of surprises outside the macroeconomic news releases calendar including subprime crisis, stock market crash of 2008 and also the bull-market period of 2009 and 2010 in stock market.

Table 6. shows evidence of significant relation between the economic indicators used in the thesis and largest positive price reactions in the U.S. government bond market during the whole sample period. Due to given results, 35 % out of top 25 positive price reactions of different maturity Treasuries occurred on scheduled economic news announcement days. As mentioned before, knowing that during the used time span many unexpected news occurred as total shock to the market, a 35 % cut of top 25 positive bond price reactions on economic news release days is found as substantial evidence of prevailing relationship

between the surprise component of an announcement and the price reaction of a government bond.

<u>30-Y</u>		<u>10-Y</u>	
20.11.2008	4,738 %	18.3.2009	4,136 % CPI
1.12.2008	4,721 % ISM	20.11.2008	2,116 %
18.3.2009	4,278 % CPI	15.9.2008	2,109 %
17.2.2009	3,716 %	1.12.2008	2,086 % ISM
17.12.2008	3,713 %	25.11.2008	2,033 % Consumer Confidence
5.3.2009	3,613 %	17.2.2009	1,896 %
29.9.2008	3,354 %	6.10.2008	1,868 %
6.10.2008	3,248 %	29.5.2009	1,768 %
29.5.2009	3,241 %	5.3.2009	1,678 %
6.5.2010	3,058 %	29.9.2008	1,618 %
10.2.2009	3,053 %	29.2.2008	1,559 %
19.11.2008	3,038 % CPI	21.10.2008	1,541 %
15.9.2008	2,977 %	10.2.2009	1,474 %
16.11.2010	2,736 % PPI	16.12.2008	1,470 % CPI
20.5.2010	2,651 %	8.7.2009	1,447 %
27.1.2009	2,628 % Consumer Confidence	4.6.2010	1,414 % Nonfarm Payrolls
16.8.2010	2,618 %	17.12.2008	1,337 %
16.12.2008	2,568 % CPI	26.11.2007	1,303 %
26.11.2007	2,561 %	22.1.2008	1,296 %
4.6.2010	2,466 % Nonfarm Payrolls	20.5.2010	1,271 %
8.7.2009	2,461 %	11.12.2007	1,240 %
2.2.2009	2,328 % ISM	19.11.2008	1,236 % CPI
31.7.2009	2,326 %	17.12.2010	1,227 %
20.2.2009	2,281 % CPI	6.5.2010	1,221 %
14.1.2009	2,259 % Retail Sales	18.11.2008	1,197 % PPI
<u>2-Y</u>			
15.9.2008	0,864 %		
29.9.2008	0,644 %		
17.9.2008	0,542 %		
22.1.2008	0,522 %		
6.10.2008	0,434 %		
2.10.2008	0,412 %		
29.2.2008	0,404 %		
18.3.2009	0,400 % CPI		
2.1.2008	0,397 % ISM		
16.8.2007	0,381 %		
15.11.2007	0,367 % CPI		
14.3.2008	0,364 % CPI		
24.7.2008	0,359 %		
11.12.2007	0,352 %		
7.9.2007	0,336 % Nonfarm Payrolls		
17.10.2007	0,321 % CPI		
3.11.2008	0,313 % ISM		
26.6.2008	0,312 %		
26.7.2007	0,311 %		
24.9.2008	0,311 %		
9.8.2007	0,305 %		
15.10.2008	0,303 % Retail Sales, PPI		
27.2.2007	0,301 % Consumer Confidence		
28.8.2007	0,287 % Consumer Confidence		
2.11.2007	0,282 % Nonfarm Payrolls		

Table 6. Sharpest Positive Bond Price Changes.

Earlier in the study it was discussed about how different news releases create different impacts in bond price behavior. In Table 7 is presented the top 25 negative price reactions of different maturity Treasuries on the time period of 2006 – 2010. In case of negative impacts, 32 % of the sharpest price movements occurred on scheduled economic news release days indicating corresponding relationship as with the positive impacts. In both positive and negative bond price changes, the percentage share of top 25 sharpest bond price changes covers only the news releases used in the thesis. If all scheduled macro announcements were taken into account the corresponding share in top changes would have been naturally larger.

Taking into account that the forecasted values concerning the specific news releases are calculated and updated daily and further information containing macroeconomic figures concerning the key macroeconomic indicators, it is interesting to notice there are still so much bond price movement on the actual release dates. It is without a doubt a sign of nervousness among the market participants, and more importantly it brings out the fact that markets are not completely efficient in practice.

A lot of unscheduled news was published especially in the year 2008 when the subprime crisis and rather deep depression took over and made many companies and banks go through rough financial problems. In Table 6., the sharpest positive movement in 30-year bond price took place on November 20, 2008 when General Motors shares fell to the lowest price since the Great Depression as the chances of a bail-out diminished. Ford shares also fell drastically. This kind of news makes markets very nervous leading to possible large movements in market rates and prices. This is because of the fact that for example General Motors is taken granted as a stable domestic company. Before the problems of the mentioned car manufacturers, on October 6, 2008 the Dow Jones industrial average fell by as much as 800.06 points, its biggest intraday drop on record. The Dow closed below the 10,000 mark for the first time since October 26, 2004. This single phenomenon created significant movement in the government 30-year bond, 10-year and 2-year note as it can be seen in Table 6. Treasuries of different maturities have also differences in what news they respond. A good example is from Table 6. on January 22, 2008 after further losses in international markets, the United States Federal Reserve System cuts

<u>30-Y</u>		<u>10-Y</u>	
19.9.2008	-4,061 %	19.9.2008	-2,833 %
5.1.2009	-3,956 %	1.6.2009	-2,076 % ISM
13.2.2009	-3,875 %	7.12.2010	-1,911 %
1.6.2009	-3,853 % ISM	24.1.2008	-1,726 %
28.1.2009	-3,507 %	27.5.2009	-1,693 %
21.1.2009	-3,404 %	8.10.2008	-1,689 %
27.8.2010	-3,239 %	30.9.2008	-1,600 % Consumer Confidence
7.5.2009	-3,107 %	24.3.2008	-1,571 %
19.2.2009	-2,936 % PPI	18.6.2009	-1,552 %
24.1.2008	-2,813 %	15.11.2010	-1,516 % Retail Sales
3.2.2009	-2,656 %	21.1.2009	-1,489 %
27.5.2010	-2,621 %	14.12.2010	-1,472 % Retail Sales, PPI
3.4.2009	-2,615 % Nonfarm Payrolls	1.12.2010	-1,459 % ISM
27.5.2009	-2,584 %	27.8.2010	-1,417 %
18.6.2009	-2,577 %	14.10.2008	-1,413 %
9.7.2009	-2,557 %	2.1.2009	-1,394 % ISM
21.5.2009	-2,539 %	4.6.2009	-1,377 %
12.8.2010	-2,492 % Import/Export	24.3.2010	-1,377 %
4.6.2009	-2,422 %	24.10.2008	-1,375 %
24.3.2008	-2,415 %	24.11.2008	-1,371 %
30.9.2008	-2,379 % Consumer Confidence	31.12.2008	-1,348 %
13.11.2008	-2,376 %	3.4.2009	-1,328 % Nonfarm Payrolls
15.7.2009	-2,273 % CPI	27.5.2010	-1,326 %
14.2.2008	-2,269 %	11.3.2008	-1,313 %
28.12.2010	-2,256 % Consumer Confidence	29.1.2009	-1,299 %
<u>2-Y</u>			
19.9.2008	-0,987 %		
5.6.2009	-0,711 % Nonfarm Payrolls		
9.6.2008	-0,615 %		
11.3.2008	-0,541 %		
30.9.2008	-0,536 % Consumer Confidence		
18.3.2008	-0,486 % PPI		
24.3.2008	-0,465 %		
24.1.2008	-0,436 %		
11.7.2008	-0,371 % Import/Export		
10.6.2008	-0,368 %		
12.6.2008	-0,353 % Import/Export, Retail Sales		
13.5.2008	-0,353 % Import/Export, Retail Sales		
24.4.2008	-0,346 %		
14.10.2008	-0,341 %		
25.9.2008	-0,325 %		
1.4.2008	-0,320 % ISM		
24.11.2008	-0,295 %		
17.4.2008	-0,290 %		
17.7.2008	-0,286 %		
12.12.2007	-0,281 % Import/Export		
3.11.2006	-0,280 % Nonfarm Payrolls		
16.4.2008	-0,266 % CPI		
25.2.2008	-0,256 %		
28.11.2007	-0,248 %		
22.5.2008	-0,243 %		

Table 7. Sharpest Negative Bond Price Changes.

its primary interest rate by 75 basis points to 3.5%, the largest move in the interest rate since 1982. This made the top 25 sharpest positive bond price changes list in 10-year and 2-year note.

While examining data sheets about bond price movements and surprises in announcements, a picture of how different news releases and price development are correlated became clear. All the announcements used in this thesis were whether positively or negatively correlated with the sign of surprise in actual news release. The magnitude of correlation differed across maturities mostly so that longer maturity bond price changes correlated with surprise components stronger than in case of shorter maturity. As mentioned before, in case of the Import Prices, the shorter the maturity the stronger the correlation. One deviation from other results was found when the total correlations were calculated. In case of Producer Price Index, the price changes were positively correlated with the surprise components of 30-year bond and 10-year note, but for some reason the correlation between 2-year note price changes and surprises in news releases turned out to be negative. The announcements which had a negative correlation with different maturity Treasury prices were Consumer Price Index and Consumer Confidence. The rest of the announcement had a positive correlation, respectively. According to this, it seems that the second hypothesis H2, is partially been proved to be wrong in case of the announcements concerning the Employment Situation. Moreover, it came up that in the case of the Non-farm payrolls, the bond prices may react negatively even though the index did not reach or beat the forecasts.



## 6. SUMMARY AND CONCLUSIONS

This thesis investigates how the scheduled U.S. macroeconomic news announcements affect on U.S. government bond prices. More specifically, it is found out if the unexpected part of news release, a surprise component, has a statistically significant impact on bond price development on the announcement release day. To investigate the behavior, the thesis focused on observations of U.S. Treasuries; 2-year note, 10-year note and 30-year bond indices. The covered period of time was from the January of 2005 to December of 2010. The three different maturity bonds were analyzed during the whole sample period keeping the main focus on bond price changes at the specific macroeconomic news announcement days to see the impact of the difference between the ongoing speculation and the reality. The thesis is built mainly on the research of Fleming and Remolona (1997) and Balduzzi and Green (2001), and the motivation behind the thesis is the role of scheduled economic news announcements mirroring the national economic development, and how these indicators affect on government bond prices.

The analysis focuses on 7 macroeconomic news announcements selected on the basis of previous studies in the field and the Bureau of Labor Statistics classifications of major economic indicators. These factors are Consumer Price Index (CPI), Producers Price Index (PPI), Consumer Confidence Index (CCI), the Import and Export Price Indices (USIEX), Institute of Supply Management Survey (ISM), Retail Sales and Employment Situation. These same indicators are used in many previous research papers and by reading those papers these are the ones with the largest effects on bond prices.

In a nutshell there are three key results to be noted in the thesis. First, like in the previous studies on the subject this paper also finds a statistical significance between the outcome of scheduled U.S. macroeconomic news announcement releases and the price development of the U.S. Treasuries on the news releasing day. Second, according to statistical results it seems that the market is getting more efficient as time goes on at least when comparing statistical coefficients of this thesis to previous studies made over ten years ago the coefficients are smaller nowadays that what they were in earlier studies. Third, this thesis shows clearly that a better outcome of actual release compared to forecasted

value impacts the bond prices both negatively but also positively depending on the news announcement at hand. It came up that in the case of Employment Situation (Non-farm payrolls), the bond prices may react negatively even though the index did not beat the forecasts. This differs from the study of for example Balduzzi and Green (2001) in which they resulted that a positive surprise in announcement create negative bond yield. This finding is one to be a scientific contribution to previous studies.

As time goes on it is interesting to be part of the developing global financial markets. In the becoming years there are to be many challenges for modern capital markets to solve. One of the challenges is surely the fact that correlation between different industries and in general, among different assets, is changing to be more and more positive. This sets a remarkable challenge to effective portfolio diversification, as an example. Taking a sight to future from this thesis point of view, the next step to study in the field could be how the correlations between macroeconomic news announcements and bond prices are evolving. Moreover one could study, is it possible that a particular surprise component of the some specific news announcement that earlier always created a negative price change in the Treasuries, is turning to create positive price change as markets are evolving by time? In another words, can this kind of correlation relationships change over time?

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