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The Correlation Between Treasury Securities and the Stock Market

A Study of Explanatory Variables

Supervisor:
Hossein Asgharian

Authors:
Sandra Svensson
Sebastian Dietzsch

Abstract

Title:	The Correlation Between Treasury Securities and the Stock Market: *A Study of Explanatory Variables*
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Authors:	Sebastian Dietzsch Sandra Svensson
Advisor:	Hossein Asgharian
Key words:	Treasury securities, stock market, flight into quality, bond-stock correlation, macroeconomic variables
Purpose:	The purpose of the thesis is to retrieve the correlation between treasury securities of different maturities and the stock market and find significant variables to explain this relationship.
Methodology:	Correlation time series were retrieved and used as dependent variables in a multivariate regression in order to find significant explanatory variables.
Theoretical perspective:	The theory includes prior research done on the relationship between the stock market and treasury securities. Further the stock market and treasury securities are studied in detail.
Results:	The highest explanatory power for the model was found for the 10 year note and stock market correlation. Significant variables of main importance were the volume traded, federal funds rate return and the business cycle.
Conclusions:	Support for the flight into quality theory was retrieved, as well as evidence of the importance for variables based on macroeconomic factors for the three correlation series.

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1. Introduction

1.1. Background

The stock and the bond market are sources of external financing, where the bond market is not only available to companies, but also to governments to finance their proceedings. The developments of both markets are interconnected in several different ways.

Since the stock and bond markets are fairly liquid and busy markets with daily trading, both take changes in underlying macroeconomic factors into account. Caused by its risk-return profile, the bond market is supposed to be the safer and less volatile market, but also the one with lower returns. Especially when talking about government treasury bonds. The stock market is the more volatile and thereby the more risky market. Due to their characteristics of riskiness and return, the two profiles indicate an inverse relationship in times of changing market conditions. In turn, the market conditions can be captured by macroeconomic factors, such as inflation rate and interest rates etcetera. The assigned importance of these factors varies over time and this way the impact on the bond- and stock market relationship varies over time too. Taking this into account, the extent and also the direction of this inverse relationship are supposed to vary over time (Saleem, 2008).

The relationship between the bond and the stock market can be described as the following; there is a direct connection by the level of interest rates, which is one of the macroeconomic factors. The rates are influenced by the current as well as the prospects of the future economic conditions. This way, the interest rate on bonds can be seen as an economic health factor, especially when looking at treasury bonds.

There is also an indirect connection, contributing to the suggested negative correlation. In times of rising stock markets and good economic conditions, the federal funds rate is increasing, according to the policy objective to fight inflation. In these times, stocks are usually very attractive; hence rational investors are not willing to hold bond positions that yield lower returns. With the interest rates then being one of the major determinants for the cost of capital in a company that is financed with public debt, it thereby has a major impact on the hurdle rate for the projects of a company. In order to attract investors in that case the bond sellers raise the coupons on their bonds to make them more attractive, which in turn increases the cost of capital. Thereby the hurdle rate for investments is raised, which with a time lag

results in lower market values of the companies. In times of declining stock markets the process is vice-versa. Hence, when the interest rate is high rational investors tend to hold stocks and when it is low they tend to invest in bonds.

When seeing the direct and indirect connection on a larger scale we have to examine the development of the stock market vis-à-vis the development of the bond market. The direct connection is supposed to be driven by the economic conditions, so a severe change in the underlying macroeconomic factors should also affect the interest rate on treasury bonds. The indirect relationship is driven by all factors that influence the interest rate on corporate bonds, as well as investors' expectations. A variable that might capture the investors' belief in the stock market is the trading volume. If there are possibilities to earn returns in a market the activity level increases. This activity level is captured by the trading volume (Girard & Biswas, 2007). For corporate bonds the main drivers are the rates on governmental treasury securities, accompanied by the risk premium that is rewarded for taking on company default risk.

Another major underlying driver for all bond rates – corporate and governmental – is the federal funds rate, the rate at which banks are lending money from the central bank. It determines the floor for bond rates as the minimum cost of money (Burda & Wyplosz, 2002, p. 209). By looking at the overall stock market, we should abstract company risk and only look at the development of long- and short-term treasury bonds. As theory and other studies suggest, the bond movement should explain a large portion of the stock markets development. This is simply based on the ideas: what happens to me will happen to you, but later (Tan, 2006; Weir, 2002; Weir, 2001), and the run into quality-postulate (Castelman, 2004; Platt, 2002; Anderson, 2007; MacKee, 2006). The first quote suggests that in times of economic downturn and low stock market performance, the bond markets will go down as well. There are different sources for this development. On the one hand, there is intervention by the central bank and the state, by lowering of the federal funds rate and the treasury security rates. This is one of the devices the two institutions have in order to improve the economy's performance. On the other hand, there is the property of the treasury securities rates as an economic health factors. Meaning that if the government, being the largest lender, has to lower its interest rates, then all market actors have to do the same. Otherwise there will be close to no lending on the markets, resulting in an even worse economic environment.

The run into quality-postulate suggests that in times of economic downturn investors tend to shift their money to safer investments, taking on lower risk and therefore also lower yields. Especially during times when the equity markets are very volatile, many investors want to pass these periods in safer positions (Cohen, 2003). The bond markets and especially the high-rated governmental treasury securities can provide such safety with a good risk-return profile.

The support for a negative correlation, as mentioned above, becomes even stronger when taking the results of Castleman (2004) into account. His empirical analysis of the S&P 500 versus the 10-year Treasury note revealed a negative correlation of -0.39 between bond and stock markets. The explanations he provides are in line with the run-into-quality idea. He fund that investors move into bonds when they feel uncomfortable in their equity position and vice-versa.

Furthermore, the correlation between the treasury securities and the stock market is something that every investor looking to diversify needs to consider. For diversification purposes it is important to realize that there is a relationship and understand how they correlate to each other. Hence, the correlation is of great importance to all actors on the financial market.

1.2. Discussion of Problem

Starting with the subprime crisis in the United States of America in 2007 the economy has seen a rapid economic slowdown. The stock market volatility has increased and by that also market uncertainty. The Fed lowered their federal funds rate to a record low 0-0.25 percent in December 2008, as a response to try to stimulate the stagnating economy (The Federal Reserve Board, 2008). Treasury-bills and -notes have also seen a rapid decrease in their rates, with the stock market moving in the same direction. This is against theory, where treasury securities and the stock market should be negatively correlated, as will be discussed in the next chapter. Therefore, we thought it to be interesting to look at the correlation between the US treasury securities and the stock market. Moreover, is the relationship between the bond and stock market constant or is it depending on the stability in the economy? It would be interesting to compare today's situation to pervious times with low volatility and stable development of the stock market.

It has been argued that this is the by far worst crisis since the 1930s and it would therefore be interesting to compare today's downturn to other less severe ones. Hence, we go back to the 1980s in our data collection.

What other factors can be found that might have an impact on this correlation? Variables that can explain the estimated relationship might be market volatility, the economic conditions and the volume traded. Also macro-economic factors such as inflation might influence.

1.3. Purpose

The purpose of this master thesis is to examine the relationship between the United States of America's treasury bill and note rates and the market performance measured by the S&P500 stock market index. Namely, to determine if movements in the correlation between the stock market index and the government securities can be explained by changes in various macroeconomic and market factors.

1.4. Delimitations

The study will be focusing on the market of the United States. It will be using only actively traded treasury securities, 3 month and 1 year bills and 10 year notes, since an active secondary market is essential for retrieving daily data. Further, the stock market data is measured by the S&P 500 index. Depending variables are found from previous similar studies and also from existing relevant theory.

1.5. Outline of Thesis

Chapter 2 presents the theoretical background that is of importance to the study. Outlining relevant factors for the stock and treasury securities market together with different theories behind the correlation. In the following chapter we introduce the method used and relevant proceedings. The fourth chapter contains our results, which are there also being analyzed. We summarize the study in chapter 5, stating what conclusion can be drawn and suggest further research alternatives.

1.6. Audience

This study is of interest to academics focusing on the stock- and bond-market area, for comparison reasons or to serve as a reference. Moreover to professionals and participants in the financial market; where it can be used to make more informed decisions and to better understand the market, and to anyone wishing to learn more about the topic.

2. Theoretical Framework

2.1. The function of treasury securities

When it comes to US government securities there are several different types, of which the treasury-bill, treasury-note and treasury-bond are of importance in this thesis. The main difference between the three is the maturities. Treasury-bills are defined as "short-term government securities with maturities ranging from a few days to 52 weeks" (Treasury Direct, 2009). A treasury-note and a treasury-bond both pay interest, or a coupon, in every six months. The note has a maturity between 2 to 10 years, while the treasury-bond matures in 30 years (Treasury Direct, 2009).

The US treasury securities are issued on the primary market through regularly scheduled auctions (Treasury Direct, 2009). The secondary market is a highly active financial market, with global over-the-counter transactions (Federal Reserve Board, June 2005, p. 36). The value of the coupon securities are expressed as yield to maturity. It is "the constant interest rate at which the present discounted value of future coupon and principal payments equals the current price of the security" (Dupont & Sack, December 1999). For a treasury bill the yield to maturity is "difference between the face value and the market price as a percentage of the market price, scaled to an annual rate using the actual number of days in the year" (Dupont & Sack, December 1999). They are sold at a discount from their face values (Treasury Direct, 2009), while the notes are sold by their clean price plus the accrued interest (Dupont & Sack, December 1999). The yields are an important benchmark among market participants and are used for pricing other debt securities and they are "analyzed for the information they might reveal about market participants' expectations about the future path of the economy and monetary policy" (Dupont & Sack, December 1999).

It is several parties involved in the structure of the treasury market, the Federal Reserve System, the Department of the Treasury, along with dealers, brokers and holders of securities (Dupont & Sack, December 1999). There is also a variety of investors that use the treasury securities for investment and hedging purposes, "commercial banks, investment banks, money market funds, insurance companies, individual investors, and foreign central banks, among others" (Dupont & Sack, December 1999). Treasury securities have a very low probability of default and attract investors for their safety (Dupont & Sack, December 1999).

The yield is linked to the maturity of the treasury security; securities with similar maturities should bear similar yields. Further the yield for the different maturities is also linked as stated by the expectations hypothesis. The expectations hypothesis states that the interest rate for a long term investment should depend on several short term similar investments (Diebold, Rudebusch, & Aruoba, 2006). As the maturity increases the yields tend to stabilize, indicating that fluctuations in short term yields are only temporary (Dupont & Sack, December 1999). However, most investors demand a premium for the additional interest rate risk that comes with long term maturities, hence resulting in higher yields (Dupont & Sack, December 1999).

The yield on securities with shorter maturities is in addition affected by the monetary policy carried out by the Federal Reserve. The Federal Reserve uses open market operations in order to up withhold the federal funds rate to the target level of the Federal Open Market Committee (FOMC) (Federal Reserve Board, June 2005, p. 35). Open market operations includes purchasing and selling of assets by the Federal Reserve, where the Federal Reserve mainly trades with US government securities due to the high activity of the treasury market (Federal Reserve Board, June 2005, p. 36). The holdings of the portfolio depend on the current wish for liquidity by the FOMC (Federal Reserve Board, June 2005, p. 37).

Moreover, two important factors that can influence the rate of securities of similar maturities are the supply and demand for the given security. The supply depends on the cumulative budget deficits of the US that need financing and is therefore sensitive to the national budget deficit or surplus (Dupont & Sack, December 1999). The current deficit of 2009 has increased the amount of treasury securities issued and hence decreased the yield (Treasury Direct, 2009). While the demand, on the other hand, depends on investment and hedging purposes of investors (Dupont & Sack, December 1999). Other influences on the demand are the derivatives market and the repurchase agreements market, where investors take short positions in the securities to hedge their interest rate risk coming from other holdings and hence “as part of their hedging activity [and] as part of their portfolio strategies” (Dupont & Sack, December 1999).

Another factor of importance is the liquidity. On-the-run issues, namely the latest issue of the given security, are much more liquid than off-the-run securities. Due to this difference some investors are willing to accept a lower yield for trading with on-the-run posts, and when the need for liquidity increases so does the spread between the on- and off-the-run issues (Dupont

& Sack, December 1999). Instruments with lower maturity tend to have higher liquidity as well.

What also is considered to have an impact on the rates of the treasury securities is inflation and expectations about inflation (Federal Reserve Bank of San Fransisco, 2002). Inflation and treasury bill interest rates are positively correlated, meaning that high inflation is connected with high interest rate and the other way around.

2.2. The function of the stock market

The primary function of the stock market is to supply a market where firms can raise capital by issuing shares. Thereafter, it is to function as a marketplace where investors can trade in the issued shares.

The three main economic influences of the stock market value are inflation, interest rates and earnings growth (Koller & Williams, 2001; Evans, 2000; Humpe & Macmillan, 2009; Rapacha, Woharb, & Rangvid, 2005). Prior studies have found that the interest rate can be used as a good prediction of stock market movements (Rapacha, Woharb, & Rangvid, 2005). Another study found that the excess returns a company earns over its cost of capital, together with the investors' expectations, are one of the main drivers for the stock market performance (Andersen, Bollerslev, Diebold, & Vega, 2005). Koller and Williams, in turn, found that these three factors explain most of the movements in the S&P 500 for medium and long-term movement. They also state that because of the close connection between the economy and market, the performance in the long-term is fairly predictable on an aggregated level (Koller & Williams, 2001). New influences, such as new technology, might drive up stock prices and create a temporary bubble (Koller & Williams, 2001). However, the market tends to correct itself, as seen by for example the IT boom and crash and now latest the subprime crisis.

On the other hand, the stock market in turn also affects the economy. The impact it has on businesses is mainly serving as a source of financing and when the economic conditions tightens the availability of financing decreases (Duca, 2001). Moreover, it is debated what kind of impact the stock market has on household spending, whether it is a direct or only indirect household response. Lower stock prices generally mean lower confidence and a greater amount of uncertainty in the market (Duca, 2001), implying less household spending. With the traditional investor being risk averse, this would also indicate lower trading on the stock market and investors seeking alternative placements.

The effect of monetary policy on the stock market is that an unexpected cut in the federal funds rate would increase the stock market value and vice versa (Bernanke & Kuttner, 2005).

The stock market could, together with other measures, be used as an indication of the economic health of the country (The Conference Board Leading Economic Index™ (LEI) for the United States, 2009).

The S&P 500 is covering approximately 75 percent of the US equities market (Standard & Poor's, 2009), and this makes it a broad and suitable index to use as an overall measurement of the US stock market.

2.3. Correlation between stock and bond market

An established theory among researchers is the flight to quality reasoning (Dungey, McKenzie, & Tambakis, 2009; Platt, 2002; Andersson, Krylova, & Vähämaa, 2008). It is stating that in economic upturns investors hold riskier positions, such as stocks, where they can retrieve a higher return. However, as the market condition dampens the investors tend to shift to less risky and more stable investments, for example treasury securities. This is then the resulting flight to quality, which in turn is causing negative correlation between the stock and the treasury securities market.

The changes in interest can also help explain this negative correlation. It is also the underlying reason for why we see the flight to quality phenomenon. The interest rate and stock market usually move in opposite directions, for instance an increase in the interest rate will result in a lowering of the stock market value (Chiarella, Mittnik, Semmler, & Zhu, 2002). Treasury securities respond to rising interest rates with rising yields. The relationship between the yield and price of the securities are invert, therefore the price would fall as interest rates increases (TIAA-CREF, 2006). Thus it is more attractive to buy treasury bills and notes during times of high interest rates because of their stability and the stock market is subsequently more attractive in times of low interest rate. Generally stating, everything affecting the interest rate is in turn influencing the relationship between the stock and treasury market.

The correlation between the stock and treasury securities market is important for the central bank to fight inflation, hence it is important for monetary policy. In order to fight inflation the Federal Reserve uses the federal funds rate. For example with increasing stock prices inflation

might start growing, forcing an increase in the federal funds rate and thus lower the stock market value and inflation (Laopodis, 2006).

Moreover, the correlation matters for asset allocation purposes and portfolio management. Rational investors wish to diversify their resources among different types of assets, including stocks and treasury securities. The importance of negative, or at least weak, correlation between the markets is for diversification purposes essential when it comes to risk reduction (U.S. Securities and Exchange Commission, 2007). The positions the investors then take in the specific assets depends on their risk aversion.

2.4. Other factors to explain relationship

In order to explain the stock-bond relationship, several other factors have to be taken into account, too. The flight into quality is among other factors caused by investors losing their faith in the market. Factors that can be used as indicators for this are the market volatility, the trade volume and also the inflation rate. Flight into quality periods are characterized by increasing market volatility (Connolly, Stivers, & Sun, 2007), thereby decreasing trade volumes (Bae, Yamada, & Ito, 2008) and increasing inflation (Laopodis, 2006). Hence these three factors are supposed to have significant impact on the relationship, especially in case the respective assigned importance changes.

As stated by Li (2002) and Christiansen and Ranaldo (2005), the importance change over the business cycle. Hence, another factor with explanatory power is the current state of the economy, characterized by a business cycle variable.

2.5. Previous studies

The attempt to explain the time-varying correlation between stock and bond return has been undertaken by many researchers. To establish what has previously been done, a short summary is provided below.

2.5.1. Estimating correlation

Usually the studies differ in terms of how they retrieve the time-varying correlation measure as well as in the character and amount of explanatory variables. In terms of used data, most US-related studies have chosen the correlation between the S&P 500 and the 10-year treasury

notes, based on daily returns, as for example Christiansen & Ranaldo (2005), as well as Connolly, Stivers & Sun (2007) did.

To estimate the correlation there are different approaches in the literature. Some authors as Andersson, Krylova & Vähämaa (2008), together with Connolly et al (2007) used a rolling-window correlation measure with a 20 to 22 days period, to retrieve monthly correlation estimates. Another common approach is the use of GARCH-models of different kinds. Here the DCC-GARCH method proposed by Engle (2002) is used by authors such as Saleem (2008) and Andersson et al (2008).

2.5.2. Variables

The greatest difference between the different studies and probably also our study is the analysis of what drives the correlation between stock and bond returns. Very commonly used variables are CPI-index based inflation measures, used by Andersson et al (2008) for example and interest rates, mentioned by Christiansen & Ranaldo (2005).

GDP growth and volatility measures of the stock market, like the S&P-500 variance or the implied volatility retrieved from options are also supposed to have explanatory power, as Andersson et al (2008), Christiansen & Ranaldo (2005) and Connolly et al (2007) propose.

Nearly all authors use the business cycles as explanation for correlation changes, but rather as an underlying trend determinant, as by Christiansen & Ranaldo (2005) and Andersen, Bollerslev, Diebold & Vega (2005).

2.5.3. Results of previous studies

In terms of which variables were significant, there are no real differences. Authors who incorporated the same variables usually came to the same results. The significance of volatility measures was found by Andersson et al (2008) and Connolly et al (2007). Li (2002) found that the real interest rate is significant. In addition, Li (2002) and Andersson et al (2008) retrieved the result of a significant inflation rate measure. The often mentioned business cycle was rarely modeled and only Christiansen & Ranaldo (2005) gave an idea how they have done it, but they did not show any results. Moreover, GDP dependent variables were found to be insignificant, for example by Andersson et al (2008).

Regarding the matter whether these findings are only US-specific, Andersson et al (2008) provide evidence that there are similar results in terms of GDP growth, inflation and volatility observable in the German as well as in the UK market.

2.5.4. Guidance for this study

For our model we consider some of the results in terms of suitable modeling and significant variables. We are going to incorporate measures for the significant variables, but we are also going to examine more variables besides those, like an explicitly modeled business cycle variable, in line with Christiansen & Ranaldo (2005).

3. Methodology

3.1. Methodological approach

The purpose of this thesis is to find the correlation between (US government securities) treasury-bills and the stock market and further to establish variables that can help explain this correlation. This is performed by a taking a quantitative approach for retrieving the correlation. For finding good explanatory variables similar prior studies are used as a guideline together with current theories about the US economy.

3.2. Data

To avoid inconsistency in the data, all data has been collected from the same database, Datastream Advance 4.0, except for the business cycle data, which was taken from the National Bureau of Economic Research (NBER) database. Comparable previous studies and theory related articles were taken from the ELIN-Article database. The statistical framework is provided by Brooks (2008).

In order to follow prior studies, the analysis is based on daily data from stock and bond markets. As a broad stock market representative, the S&P 500 is used. For the treasury securities market there were three indices chosen, a 3 month-, a 1 year- and a 10 year rate, to examine the effects across different maturities. We collected the data for the period 1982-01-04 until 2009-03-31. This means we started in the middle of the recession of the early 1980s and finished in today's recession.

3.2.1. Correlation estimation

The next step was to turn the data into log-returns. Then the particular correlations between the S&P 500 return series and the different security return series were calculated. We choose to calculate the correlation for the particular months, irrespective of the individual month's length. To base the analysis on monthly representatives of the stock-bond-market correlation is in line with Andersson, Krylova & Vähämaa (2008) and Connolly, Strivers & Sun (2007), even though their methods differ slightly. The result of these correlation estimations were three separate time-series of correlation data.

3.2.2. Variables incorporated

As mentioned before, the analysis will incorporate measures for the variables other authors found to be significant, as well as additional variables that we consider to have explanatory power.

This study takes measures for the inflation rate, different bond market returns, namely the 3 month bill return, the 1 year bill return and the 10 year note return, the S&P 500 return, as well as measures for the bond market uncertainty, the variance of the 3 month bill, 1 year bill and 10 year note, together with the variance of the S&P 500 as the stock market uncertainty. It also takes the state of the economy into account by including the business cycle variable and the federal funds rate return. Finally the S&P 500 trading volume is considered.

The inflation rate is in line with Andersson et al (2008) and Li (2002). The interest rate is suggested by Christiansen & Ranaldo (2005), as well as Li (2002). We take the different bond market returns as proxies for the interest rate and add the federal funds rate of the American central bank. As a measure for the market uncertainty Andersson et al (2008), Christiansen et al (2005) and Connolly et al (2007) suggest the stock market volatility. Additionally this analysis takes the volatility of the particular bond indices and the stock market trading volume into account. Among others, Christiansen et al (2005) and Andersen, Bollerslev, Diebold & Vega (2005) point out the importance of the business cycle. To cover this, a digital variable is created with the help of the data from the NBER website.

3.3. Data Processing

To support our work we used different kinds of computer software. Microsoft Excel 2007 is used for processing the data and turning it into the right format. For estimating all model parameters, as well as conducting the required tests, we work with EViews 6.0, unless stated otherwise.

Before doing any analysis and interference with an ordinary least squares (OLS) model, its assumptions have to be checked. These are necessary to obtain reliable Best Linear Unbiased Estimators (BLUE). The assumptions deal with the error term, hence we checked for the following (Brooks, 2008):

a. $E(u_t) = 0$, which means that the errors have zero expected mean

b. $Var(u_t) = \sigma^2 < \infty$, which means that the variance of the errors is finite and constant over time
c. $Cov(u_i, u_j) = 0$, which means that the errors are linearly independent of one another
d. $Cov(u_t, x_t) = 0$, which means, that the errors are independent of the corresponding explanatory variable.

To make reliable and valid inferences we also need the errors to be normally distributed- $u_t \sim N(0, \sigma^2)$.

For a: There is no theoretic reason why there should not be an intercept in this model, so following Brooks (2008), the first assumption will never be violated.

For b: This is the homoscedasticity assumption. If violated, the estimates would not be efficient anymore. EViews 6.0 provides the White test for heteroscedasticity, as well as the White heteroscedasticity correction function.

For c: According to this assumption, the errors are not allowed to be auto-correlated. Ignoring this can lead to wrong inferences about the importance of variables. Besides graphical tests EViews 6.0 provides the Durbin-Watson and the Breusch-Godfrey test.

For d: This assumption requires the error terms to be uncorrelated with the corresponding explanatory variables. Violations lead to inconsistent estimators. To check for this, the correlation matrix EViews 6.0 provides will be used.

To check for the normal distribution of the error term, EViews 6.0 offers the Bera-Jarque test. In case of non-normality, we will assume normality based on the central limit theorem, due to a sufficient amount of data.

Also the explanatory variables have to fulfill some criteria before they can be used. To use OLS, the explanatory variables should not be correlated (Brooks, 2008). By looking at the correlation matrix of the proposed explanatory variables, we try to detect those with high correlation. If we find high correlation, then one of the detected variables will be excluded from the model. Otherwise the standard errors of the coefficients will be very high and the model will become very sensitive to changes in model specifications and significance tests might lead to wrong inferences (Brooks, 2008).

3.4. Modeling approach

The purpose of this paper is to find variables that can explain the correlation between treasury securities and the stock market, and the modeling approach for retrieving this is given in the following subsections.

3.4.1. Finding the correlation

We started by taking the normal log returns on the dependent variables. Thereafter we found the correlation between the stock market index S&P 500 and the 3 month treasury bill, the 1 year treasury bill and the 10 year treasury note respectively. This means that three correlation time series were found.

Dividing the sample into sub-samples is done to find significant variables under different market and economy circumstances. The breakpoint chosen is based on the characteristics of the traded volume, and the traded volume is in turn chosen due to the close connection to the flight to quality phenomena and thus the correlation. The objective of this analysis is to identify significant variables, which can explain the time-varying correlation.

3.4.2. Explanatory variables included

In order to run a multiple regression with independent variables, the data from Datastream was turned into log-returns, except for the volume and the business cycle variable. Then we turned the daily data into monthly as for the dependent variables, where necessary. This approach gave us the following explanatory variables; 10 year note return, 1 year bill return, 3 month bill return, business cycle, federal funds rate return, inflation, S&P 500 return, 10 year note variance, 1 year bill variance , 3 month bill variance, S&P 500 variance and the volume traded.

3.4.3. The multivariate regression

To analyze the correlation between short-term, as well as long-term bond indices and the stock market, we run three OLS-regressions. This is done with the corresponding monthly treasury bill or note to stock market correlation as the dependent variable, where the other variables are used as the explanatory variables. The regressions are conducted for the total period, as well as for the sub-periods, which are characterized by the significant breakpoint.

The model we used is the following:

$$T - corr_p = \alpha_p + \beta_{1,p} 10y\ note\ return_p + \beta_{2,p} 1y\ bill\ return_p + \beta_{3,p} 3m\ bill\ return_p$$
$$+ \beta_{4,p} business\ cycle_p + \beta_{5,p} Federal\ Funds\ Rate\ Return_p$$
$$+ \beta_{6,p} Inflation_p + \beta_{7,p} S\&P500\ return_p + \beta_{8,p} Variance\ 10y\ note_p$$
$$+ \beta_{9,p} Variance\ 1y\ bill_p + \beta_{10,p} Variance\ 3m\ bill_p$$
$$+ \beta_{11,p} Variance\ S\&P\ 500_p + \beta_{12,p} Volume_p + \varepsilon_{T,p}$$

Where:

- T-corr$_p$ describes the correlation between the particular bond return series and the S&P 500 return series – retrieved by a non-overlapping estimation of the correlation for the respective month
    - T stands for the particular bond series; possible realizations of T are 10y for the 10 year note series, 1y for the 1 year bill series and 3m for the 3 months series
    - p describes the period the model parameters are estimated for; possible realizations are tp for the total period (1982-01 to 2009-03), 1 for the first subsample (1982-01 to 1994-09) and 2 for the second subsample (1994-10 to 2009-03)
- α_p is the intercept estimate for the particular period
- $\beta_{i,p}$ with $i \in \{1 \dots 12\}$ describes the loading of the dependent variable on the particular factor for the particular period
- 10y note return$_p$ represents the 10 year note return for period p – retrieved by calculating the log-returns of the daily 10 year note market data and then summed over the respective month
- 1y bill return$_p$ represents the 1 year bill return for period p – retrieved by calculating the log-returns of the daily 1 year bill market data and then summed over the respective month
- 3m bill return$_p$ represents the 3 month bill return for period p – retrieved by calculating the log-returns of the daily 3 month bill market data and then summed over the respective month
- business cycle$_p$ is a dummy variable describing the state of the economy over the period p – retrieved from the NBER website, by putting a 1 for a month in an expansion period and a zero vice-versa

- Federal Funds Rate Return_p describes the change in the Federal Funds Rate over the period p – retrieved by calculating the log-returns of the daily federal funds rate data and then summed over the respective month
- Inflation_p describes the inflation in period p – retrieved by calculating the log-return of the monthly realization of the US Consumer Price Index
- S&P500 return_p describes the return on the S&P 500 in period p – retrieved by calculating the log-returns of the daily S&P 500 market data and then summed over the respective month
- Variance 10y note_p describes the volatility of the 10 year Treasury note in period p – retrieved by calculating the variance for the particular month based on the daily 10 year note market data
- Variance 1y bill_p describes the volatility of the 1 year Treasury bill in period p – retrieved by calculating the variance for the particular month based on the daily 1 year bill market data
- Variance 3m bill_p describes the volatility of the 3 months Treasury bill in period p – retrieved by calculating the variance for the particular month based on the daily 3 month bill market data
- Volume_p represents the S&P 500 trading volume in period p – retrieved on daily basis and averaged for the respective month
- $\varepsilon_{T,p}$ describes the residuals of series T in period p

Where possible, we also included lagged variables of the business cycle and the federal funds rate return. This is based on the assumption that institutional interventions and changes in the economy's state need some time to cause actions on the particular markets.

3.4.4. Testing if the estimators are BLUE

The model, the analysis is based on, is a multivariate OLS regression. Thus, before proceeding with the analysis, we checked the data and the model for the OLS requirements. We choose the OLS-regression because of the properties of the estimators it produces. The retrieved estimators will be, in case the assumptions are fulfilled; consistent, unbiased and efficient, namely BLUE.

Even though it is beyond the focus of this analysis to find a model with high explanatory power, we will check our model in terms of functional form by running Ramsey's RESET test. In order to check for the stability of our model, we will also run the Chow breakpoint test

(Brooks, 2008), to detect significant breakpoints based on our business cycle variable findings. Those will be used to divide the sample into sub samples, as mentioned before.

To sum up our modeling approach, we start by taking the natural log returns on the treasury securities and the stock market index and thereafter find the correlation between the two, retrieving three time series. We move on to taking the natural log return for the explanatory variables, apart from the traded volume and the business cycle. After that we check the assumptions stated above and run three multiple regressions, with the dependent variable as the correlation between the 3 month treasury bill and the S&P 500, the 1 year bill and the S&P 500, and the 10 years note and the S&P 500. Although the dependent variable changes in the three regressions the independent variables used remain unchanged, them being twelve in total. Namely, 10 years note return, 1 year bill return, 3 months bill return, business cycle, federal funds rate return, inflation, S&P 500 return, variance of 10 years note, variance of 1 year bill, variance of 3 months bill, variance of S&P 500 and the volume traded. Then two sub-samples are created and we run regressions on these as well. To further test our findings we will also run the multivariate regressions on the three correlation series on a quarterly and yearly basis. The results retrieved will be given in the following chapter.

3.5. Methodological problems

In order to be a useful and trustworthy analysis, there has to be a review of the methods and the inputs being used. Hence two aspects have to be regarded. First there is the validity of the study, which questions whether the applied methods measure what they are supposed to measure. Second the method has to be reviewed for reliability. This questions the method for the fact whether it will create the same results every time it is used, independently of used data.

3.5.1. Validity

In order to retrieve valid results, we take an approach many other studies have taken as well. The rolling window estimation of the dependent variable is in line with common practice, even though we did not standardize the months. The search for significant variables by using a multiple regression is also very commonly used in this field of study. When conducted in line with the underlying assumptions, the results this method produces can be used for strong inferences. In terms of underlying assumptions there are at least two problems that we have to

deal with. The first comes from the amount of macroeconomic variables we use in this regression. Here the problem of multi-co-linearity can occur. As stated before, we will check for this and if necessary exclude one of the variables with high correlation from the regression. Another problem can be the normality assumption of the error distribution. But as mentioned, we are looking at a fairly huge amount of observations, so that the central limit theorem can solve this problem. All other model assumptions will be tested with the corresponding tests, proposed by the statistical theory framework. Thus the method can be said to be valid.

All transformations of data, such as turning price series into log-return series are also common practice and therefore valid.

This analysis incorporates 12 variables that all have either been proven to have an impact on the stock-bond correlation, or are in line with previously used ones. Hence their validity is assured.

To divide the sample into different sub-samples in order to see the change in impact of different variables is also common, especially when the analysis covers a large period as in this case.

3.5.2. Reliability

When it comes to reliability, the trustworthiness of the method and the data is questioned. The data to calculate the variables is taken from the Datastream Advance 4.0 database, except for the business cycle data, which comes from the NBER database. Both are well recommended and thus reliable sources for data collection.

In terms of the data transformation, all are in line with common statistical and econometrical frameworks. Thus, together with the use of standardized spreadsheets and carefully reviewed computations, the variables' realizations are reliable.

According to Brooks (2008), the multiple OLS-regression is a reliable method, especially when the underlying assumptions are fulfilled. Violations of the assumptions will be corrected if necessary and possible.

The reliability of the inferences, in case of non-normality of the error terms depends on the number of observations. Compared with other studies, 328 is a small sample, but we use monthly data in order to match the availability of the variables. Taking this into account, we

look at a very long period in comparison to other studies. Thus the number of observations will be seen as sufficiently large to serve the central limit theorem, which makes the inferences reliable.

EViews 6.0 and Microsoft Excel 2007 are commonly used computer programs; hence their outputs are taken as reliable.

4. Results and analysis

The objective of this paper is to estimate the correlation between three U.S. treasury securities of different maturities and the stock market, then find different variables that can explain the found relationship. Starting by stating the results retrieved for each correlation series separately, we will then follow with an analysis under each correlation. In the analysis we will present the estimated models, together with an interpretation of the variables found to be significant. Thereafter the chapter will be concluded with a comparison across the different regressions.

4.1. The correlation

To get an idea of what the three correlation series retrieved look like we have plotted them in three separate diagrams displayed below, together with separate tables showing the mean and standard deviation for all the series and their periods.

Figure 1. Correlation between 10 year note and stock market

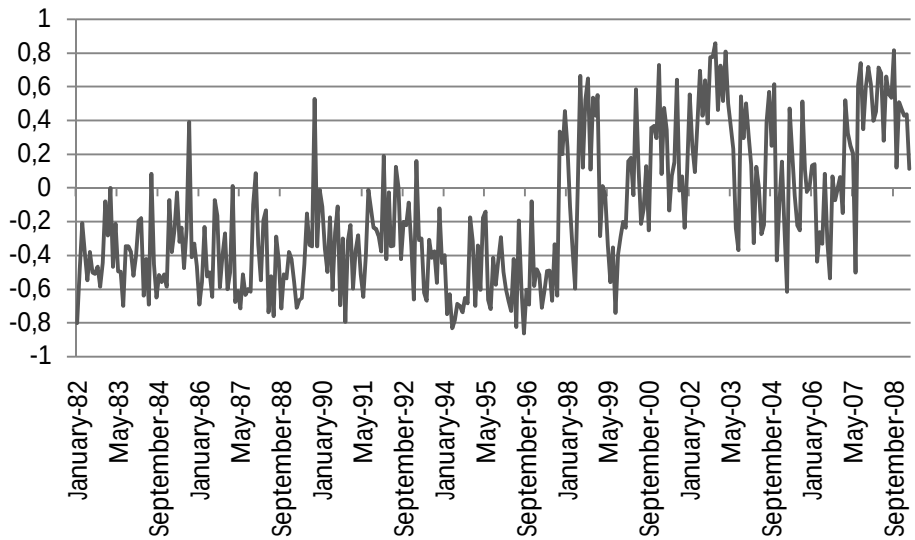

Table 1. Descriptive figures for the correlation between 10 year note and stock market

	Mean	Standard deviation
Total period	-0,162	0,424
Sub period 1	-0,391	0,245
Sub period 2	0,04	0,446

Figure 2. Correlation between 1 year bill and stock market

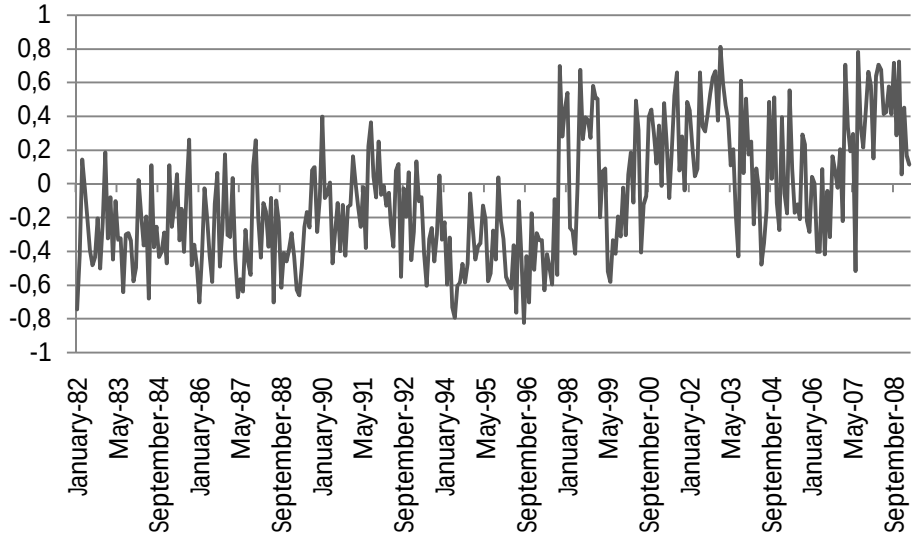

Table 2. Descriptive figures for the correlation between 1 year bill and stock market

	Mean	Standard deviation
Total period	-0,09	0,37
Sub period 1	-0,254	0,254
Sub period 2	0,056	0,396

Figure 3. Correlation between 3 month bill and stock market

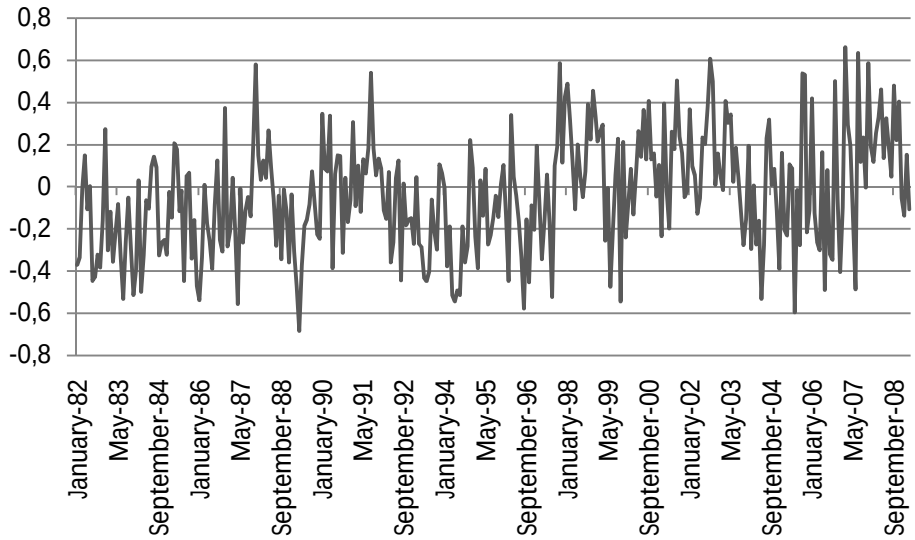

Table 3.Descriptive figures for the correlation between 3 month bill and stock market

	Mean	Standard deviation
Total period	-0,039	0,272
Sub period 1	-0,131	0,237
Sub period 2	0,042	0,276

All three of the figures show signs of time varying correlation. The correlation between the 10 year note and stock market and the correlation between the 1 year bill and the stock market are the most similar. For both these correlations two trends are apparent, starting with a stable mean-reverting movement that is after 1994-1997 becoming much more volatile. As indicated by the figures as well as by the difference in the standard deviation for the two sub periods and the two correlation time series. A shift in the mean for the two correlation series is also apparent when looking at the two sub samples. But for the correlation between the 3 month bill and the stock market no such apparent signs of trends can be spotted based on the plot. This is also supported by the mean and standard deviation numbers given in table 3.

4.2. Multivariate regression

Starting by finding the multivariate regressions, we will see which variables are significant and thus help explain the correlation. For interpretation we have chosen a 5% significance level, although several variables lie just above this figure. The significance level chosen are the most commonly used and widely considered to be statistically sound.

The results will be given for each correlation series in turn. First we ran the regressions on the total period. Thereafter we separated the three samples into two subsamples, where evidence of significant breakpoints was found.

We started by taking an idea about the breakpoints from the business cycle variable, following Christiansen & Ranaldo (2005). However, this yielded only insignificant breakpoints and was thus rejected. Instead we focused on the most significant and closest variable to the correlation, hence the breakpoint for the subsamples were decided based on the volume traded. The first period is characterized by stabile growth, whereas the second is of more volatile manners as illustrated by the figure below.

Figure 4. Volume Traded

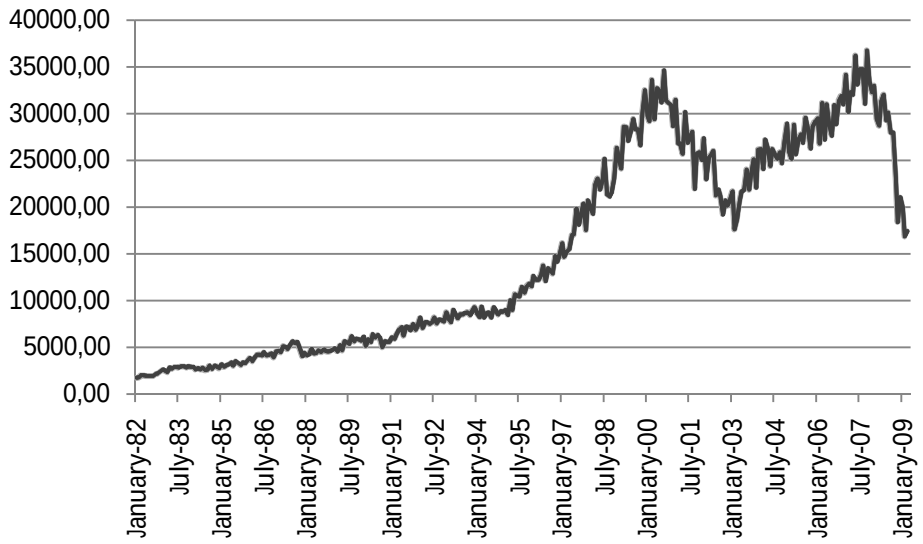

Table 4. Covariance/Correlation dependent variables vs. trading volume

Covariance Correlation	10 year correlation	1 year correlation	3 month correlation	Volume
Volume	2.708.931	2.022.830	9.841.619	1.15E+08
	0.595577	0.509047	0.337639	1.000.000

The volume traded was chosen due to its close connection to the correlation between the stock- and treasury securities market, as can be seen in table 4. The volume explains a lot about the relationship, as stated above, due to its close link to the flight to quality theory. We consider the breakpoint to be September 1994 because of very stable and even growth in the volume traded up until this date. Thereafter the curve shows signs of a much more volatile and unpredictable development. Hence the first time period is January 1982 to September 1994 and the second on is October 1994 up until March 2009. This finding regarding breakpoints is also supported by the graphs displayed in section 4.1, and then in particular by the two figures showing the correlation between the 10 year note and stock market, and the correlation between the 1 year bill and the stock market.

A possible explanation for the breakpoint in September 1994 starts with finding a reason for the increased trading volume. Reasons for this might be the development of more complex instruments being traded. Further there was an economic upturn and it might have been that the general public wanted to participate in the economic expansion and hence there was an increase in the amount of investors in the market.

4.3. Testing if the estimators are BLUE

In this section we present the results from the tests checking the properties of the estimators. This is done in order to determine if we can make valid inferences based on the variables, namely to see if the estimators are BLUE. A short overview of the tests, what they are testing for and the respective null hypotheses are given in the figure underneath.

Table 5. Overview of residual tests

	Testing for	Nullhypothesis (if applicable)
Dickey-Fuller	Unit roots in series	The correlation series has an unit root
Covariance matrix	Mulitcollinearity	
White's test	Heteroscedasticity	There is no heteroscedasticity
Breusch- Godfrey	Autocorrelation	There is no autocorrelation
Residual series	Non-stochastic explanatory variables	
Jarque-Bera	Non-normality	The residuals are normally distributed
Ramsey RESET	Misspecification of the functional form	The regression equation is linear
Chow-breakpoint test	If specified breakpoint is significant	There is no breakpoint

Then the above tests were applied to the regressions for the total period and when necessary for the subsamples. Due to all assumptions not being fulfilled at all times for the regressions we decided to run all the tests using the Newey-West function, since it corrects for underestimation of standard errors due to heteroscedasticity and autocorrelation.

4.3.1. Testing the 10 year note and stock market correlation

Table 6. Residual tests for 10 year correlation

	Total period		1982M01-1994M09		1994M09-2009M03	
	Probability	Reject/ Do not reject H_0	Probability	Reject/ Do not reject H_0	Probability	Reject/ Do not reject H_0
Dickey-Fuller	0.0025	Reject H_0	-	-	-	-
White's test	0.0972	Do not reject H_0	0.8625	Do not reject H_0	0.4609	Do not reject H_0
Breusch- Godfrey	0.0000	Reject H_0	0.2956	Do not reject H_0	0.0000	Reject H_0
Jarque-Bera	2.7810	Do not reject H_0	18.9004	Do not reject H_0	0.7669	Do not reject H_0
Ramsey RESET	0.6352	Do not reject H_0	0.3052	Do not reject H_0	0.0040	Reject H_0
Chow-breakpoint test	0.0113	Reject H_0	-	-	-	-

After having retrieved the correlation series for the 10 year note and the stock market index, we first ran all tests based on the total period of data. The overall results, as stated above, for the total period states that the residual assumptions are not violated, except for the assumption about autocorrelation where we cannot reject the null hypothesis for no autocorrelation. This might be explained by the use of a linear model to explain the data, or that there is a

significant breakpoint in the data for which the property of the data is behaving differently before and after the breakpoint.

Then we ran all the tests again, but this time having separated the sample into two sub samples. We found signs of multicollinearity in the first sub period (see Appendix 1) and thus we take out the highly correlated variables, 1 year return and 3 month return, from the regression for this sample. Moving on, we now had no problem with autocorrelation in the first sub sample. However, the second sub sample, dating 1994-09 to 2009-03, also showed signs of autocorrelation and that the regression equation for this sample is not linear.

4.3.2. Testing the 1 year bill and stock market correlation

Table 7. Residual tests for 1 year correlation

	Total period		1982M01-1994M09		1994M09-2009M03	
	Probability	Reject/ Do not reject H_0	Probability	Reject/ Do not reject H_0	Probability	Reject/ Do not reject H_0
Dickey-Fuller	0.0002	Reject H_0	-	-	-	-
White's test	0.3882	Do not reject H_0	0.6384	Do not reject H_0	0.5626	Do not reject H_0
Breusch- Godfrey	0.0000	Reject H_0	0.3086	Do not reject H_0	0.0000	Reject H_0
Jarque-Bera	0.1487	Do not reject H_0	2.3351	Do not reject H_0	0.3038	Do not reject H_0
Ramsey RESET	0.6924	Do not reject H_0	0.7722	Do not reject H_0	0.0071	Reject H_0
Chow-breakpoint test	0.0024	Reject H_0	-	-	-	-

Testing the properties of the correlation for the 1 year bill and stock market index for the total period the assumption about no autocorrelation did not hold. Other than that, the data for the total period fulfilled all criteria.

Then moving on to the two subsamples, we found high correlation for the 10 year return and 3 month return for the first sub sample (see Appendix 2) and therefore excluded these two variables from the regression. Thereafter no assumptions were violated for the first period and for the second one, starting October 1994, we once again discovered signs of autocorrelation. Moreover, for this last subsample the regression equation cannot be said to be linear since the null hypothesis is rejected.

4.3.3. Testing the 3 month bill and stock market correlation

Table 8. Residual tests for 3 month correlation

	Total period	
	Probability	Reject/ Do not reject H_0
Dickey-Fuller	0.0000	Reject H_0
White's test	0.2350	Do not reject H_0
Breusch- Godfrey	0.0002	Reject H_0
Jarque-Bera	0.4163	Do not reject H_0
Ramsey RESET	0.0121	Reject H_0
Chow-breakpoint test	0.1606	Do not reject H_0

For the 3 month bill and stock market correlation we only reject the null hypotheses of no autocorrelation and that the regression equation is linear. For residual testing and the covariance matrix please see appendix 3.

4.4. Remark about not included variables

Comparing the results for the correlation series to the retrieved models included below, one realizes that some significant variables are excluded. The exclusions are caused by their, compared to the other variables in the model, relatively high standard errors. This procedure is supported by that the presence of serial correlation, as in some of the series, causes an underestimation of the standard errors (Brooks, 2008). Thus we exclude variables that have too high standard errors, in order to be able to do valid and reliable interferences.

4.5. Regression for 10 year note and stock market

First we ran the regression on the correlation between the 10 year note and the stock market index.

Table 9. Regression on correlation between 10 year note and stock market

Coeficients Standard Errors	total period 1982M01 - 2009M03	sub period 1 1982M01 - 1994M09	sub period 2 1994M10 - 2009M03
10 year note return	-1,12* 0,66	-1,17** 0,57	-1,42* 0,84
1 year bill return	-0,54 0,44	-	-0,57 0,53
3 month bill return	0,18** 0,07	-	0,35*** 0,11
Business cycle	0,02 0,09	0,05 0,06	0,02 0,14
Business cycle (-10)	-0,19*** 0,05	-0,05 0,05	-0,21* 0,12
Federal funds rate return	0,05 0,12	-0,22** 0,09	0,24* 0,14
Federal funds rate return (-4)	-0,31*** 0,10	-0,24* 0,14	-0,39** 0,15
Inflation	-0,34 8,75	-20,48** 9,94	-1,96 12,83
S&P 500 return	-0,64 0,46	-1,74*** 0,56	0,23 0,66
Variance 10 year note	195,70 166,01	-1797,70*** 445,20	202,95 253,07
Variance 1 year bill	81,90*** 31,01	882,53** 384,50	73,01* 39,21
Variance 3 month bill	-0,42 0,33	-247,01 420,38	-0,31 0,33
Variance S&P 500	26,08 71,14	14,90 103,85	308,79 213,19
Volume	2,18*** 0,24	-0,81 1,12	2,88*** 0,00
Intercept	-0,39*** 0,11	-0,22** 0,11	-0,58** 0,23
R^2 Adjusted R^2	0,49 0,46	0,26 0,19	0,41 0,36

significant on the*** 1%; ** 5%; * 10% level,
for t-statistics see appendix 6

The regression on the correlation between 10 year note and stock market for the total period led to a model with an adjusted R^2 of 46.3%, thus nearly 50% of the correlation between the two series can be explained by the OLS-regression. It turned out that not all variables are of significant importance. Together with a significant intercept, significant variables are the 3

month bill return, the ten periods lagged business cycle, the four periods lagged federal funds rate return, the variance of the 1 year bill, and the stock market trading volume. Among these, only the variable for the 1 year bill variance seems problematic, because of the relatively high standard error. Lags for example for the inflation variable did not give significant results, except for the 11 month lag. We decided to not include it, due to a very high standard error and a high correlation with the business cycle and the federal funds rate.

When running the regression on the first sub period it estimated a model with an adjusted R^2 of 18.7%. Thus the regresses can explain nearly 20% of the correlation between the two series. Among those not all are significant and there are different significant variables than for the total period and the second sub period. Besides a significant intercept, significant variables are the 10 year note return, the federal funds rate return, the inflation, the S&P 500 return the variance of the 10 year note and the variance of the 1 year bill. Among these, the variables for the 10 year note variance, the 1 year bill variance and the inflation seem problematic, because of their relatively high standard errors.

The regression on the second sub period provided a model with an adjusted R^2 of 35.8%. Hence the explanatory variables account for circa 40% of the correlation between the two series. Significant variables are for the second sub sample the intercept, the 3 months bill return, the four periods lagged federal funds rate return and the trading volume of the S&P 500. As for the first sub period, lagging of different variables such as inflation did not yield significant variables or explanatory power improvements.

4.5.1. Total period analysis

Taking the significant variables into account we retrieved the following model for the total period of the 10 year note and stock market correlation series:

$$10y - corr = -0.39 + 0.18 * 3\,month\ bill\ return - 0.19 * business\ cycle(-10) - 0.31 * Federal\ Funds\ Rate\ Return(-4) + 2.18 * Volume + \varepsilon_{10y}$$

Here it is shown that the $10y - corr$ variable is negatively related to the ten periods lagged business cycle and the four periods lagged federal funds rate return variable. On the other hand it is positively related to the market trading volume and the 3 month bill return. The significance of the lagged business cycle and federal funds rate return variables can be explained by the fact that the market needs some time to realize if there is an up- or downturn

in the economy, meaning that a time lag is necessary for taking in the real intention and extension of the actions of the Federal Reserve. Regarding the negative signs of the coefficients, the federal funds rate return is in line with the flight into quality theory. Indicating that in case of a rise in the rate the bond markets become more attractive. A lowering of the rate is usually done in times of bad economic conditions to motivate a turn around. This is taken as a good sign for both markets, thus it usually marks the starting point for an upturn where previous empirical findings have shown a positive, or at least a less negative relationship. An interpretation for the negative sign of the ten periods lagged business cycle can only be given taking the positive sign of the insignificant non-lagged business cycle variable into account. If the economy was turning up ten months ago, then there are some investors feeling uncomfortable in the stock market and turning to the bond markets in order to protect their gains. The same idea works vice-versa, that if there ten periods ago was a downturn, then investors might start investing again and thereby setting the starting point for a new upturn. Here the declining correlation in a current market downturn is in line with the flight into quality and the increasing correlation in an upturn is supported by empirical findings. The trading volume covers, as stated earlier, the activity in the stock market. The positive sign is then reasonable, motivated by that in case of a declining trading volume on the stock market the investors shift to other markets and in this case to the bond market. Regarding the significance of the 3 month bill return variable, its positive coefficient is in line with the flight into quality, as well as with findings of previous studies. The fact that this is the only variable that is significant, might be explained by the fact, that the 3 month bill market is the most active and thus its return reflects economic changes earlier than the other two bond markets.

The insignificance of the inflation variable can be caused by the inclusion of the federal funds rate return. The federal funds rate is set by the Federal Reserve in order to fight inflation and to give stimulus to the economy, thus movements in this variable capture those of the inflation rate. This argument leads to the conclusion, that our result is in line with former studies that found the inflation to be significant. The implication of this is that inflation (federal funds rate) is causing the market supervisors to respond to changes, which in turn of a higher federal funds rate will increase the return on the treasury securities and thus make them more attractive compared to the stock market. If inflation is successfully fought then the federal funds rate will be lowered to stimulate investments and hence cause improving economic

conditions, which means less negative correlation between the treasury securities and the stock market.

As stated above, the trading volume variable captures part of the changes in the volatility of the markets, thereby it can turn out that only one of them will be significant. Hence our result is again in line with previous studies.

4.5.2. First sub period analysis

For the first sub period the following model, only including significant elements, was retrieved:

$$10y - corr = -0.22 - 1.17 * 10y\ note\ return - 0.22 * Federal\ Funds\ Rate\ Return - 1.74 * S\&P500\ return + \varepsilon_{10y}$$

Compared to the total period there are differences in terms of significant variables. In this sub sample the 10 year note return, the federal funds rate return and the S&P 500 return turned out to be significant. The negative sign of the 10 year note return variable is reflecting the flight into quality phenomenon, which means that in case the returns on the bond market rises, investors shift their holdings to the bond market with its lower uncertainty. Regarding the federal funds rate return, the impact is the same as for the total period, with the exception that now the effect of changes in the rate is immediate instead of delayed by a time lag. The negative sign of the S&P 500 return implies that there is not only a flight into, but also a flight out of quality in times of improving market conditions. Both market return variables support the flight into quality theory. This result contradicts empirical findings, stating that in case of improving market conditions the correlation becomes less negative and might even get positive (Andersson, Krylova, & Vähämaa, 2008). The federal funds rate return supports the flight into quality theory and the empirical findings. An increase in the federal funds rate might indicate the starting point for worsening market conditions and vice-versa. This can be explained by the correlation figure for the first sub sample (Figure 1). Here one can see that before the identified breakpoint the correlation is mainly negative. Thus supporting a strong believe in the flight into quality theory among investors, with only little disturbance.

The correlation is moving towards zero when both the treasury security and the stock market decreases, which might indicate that the investors are leaving both markets and not just

shifting their investments from one market to the other. This is then following the flight into quality theory and previous empirical findings.

In contrast to the total period there is no volatility measure of any importance, which indicates, that uncertainty measures were less regarded for portfolio and investment decisions.

4.5.3. Second sub period analysis

The regression for the period starting in 1994-10 provided the following model:

$$10y - corr = -0.58 + 0.35 * 3m\ bill\ return - 0.39 * Federal\ Funds\ Rate\ Return(-4) + 2.88 * Volume + \varepsilon_{10y}$$

Here it turned out that the four periods lagged federal funds rate return is again significant with a negative sign. Additionally we found the 3 months bill return and the trading volume to be significant with a positive sign. Where the signs for the volume and the lagged federal funds rate return are as expected according to the flight into quality theorem, as explained above. The positive coefficient for the 3 months bill return is in line with theory and empirical findings, stating that the correlation increases in case of improving market conditions. This is also supported by the calculations for the second sub period, where the correlation is positive on average. The four period lag of the federal funds rate return is also reasonable according to the prior findings. Mainly because in a more volatile environment the market participants seem to need some time to evaluate the actions of the central bank and thereafter act, hence causing a time delay.

4.6. Regression for 1 year bill and stock market

Moving on to the correlation between the 1 year bill and the stock market, the results for the total period and subsample multiple regressions are given below.

Table 10. Regression on correlation between 1 year bill and stock market

Coeficients Standard Errors	total period 1982M01 - 2009M03	sub period 1 1982M01 - 1994M09	sub period 2 1994M10 - 2009M03
10 year note return	-0,57 0,56	-	-0,82 0,74
1 year bill return	-0,53 0,38	-0,99** 0,44	-0,49 0,45
3 month bill return	0,08 0,06	-	0,21** 0,09
Business cycle	0,03 0,08	-0,01 0,09	0,11 0,11
Business cycle (-2)	-0,15** 0,07	-0,04 0,06	-0,27*** 0,08
Federal funds rate return	0,11 0,12	-0,06 0,09	0,27** 0,13
Federal funds rate return (-4)	-0,20** 0,09	-0,21** 0,11	-0,17 0,11
Inflation	-2,17 8,17	-18,21 12,21	-0,14 10,66
S&P 500 return	-0,88* 0,46	-0,84 0,68	-0,58 0,68
Variance 10 year note	106,01 117,18	-2037,13*** 461,83	153,44 209,46
Variance 1 year bill	49,76** 23,32	427,62 305,00	24,97 33,15
Variance 3 month bill	-0,53** 0,25	-135,20 131,65	-0,43* 0,26
Variance S&P 500	74,35 77,19	175,15** 74,68	359,41* 185,04
Volume	1,61*** 0,20	0,69 1,06	2,15*** 0,41
Intercept	-0,26*** 0,08	-0,10 0,10	-0,40*** 0,14
R^2 Adjusted R^2	0,38 0,35	0,25 0,19	-0,40 0,29

significant on the*** 1%; ** 5%; * 10% level,
for t-statistics see appendix 6

The OLS-regression of the correlation between 1 year bill and stock market for the total period led to a model with an adjusted R^2 of 34.9%. Compared to the regression on the total period for the 10 year correlation series we found very similar results. Besides a significant intercept, again significant variables are the two periods lagged business cycle, the four

periods lagged federal funds rate return, the variance of the 1 year bill and the stock market trading volume. Moreover, for this correlation series the variance for the 3 months bill was significant as well. Among these, only the variable for the 1 year bill variance seems problematic, because of the relatively high standard error. Again, lagging the inflation variable did not yield significant results.

For the first sub period the retrieved model has an adjusted R^2 of 19.3%. Thus it has an explanatory power of circa 20%. Here the intercept is insignificant and it is only the 1 year bill return, the variance of the 10 year note and the variance of the S&P 500 being significant. However, the variables for the 10 year note variance and the S&P 500 variance seem problematic because of their high standard errors.

With an adjusted R^2 of 29.1% the OLS-regression for the second period provided a model that can explain about 30% of the correlation between the two series. As before not all incorporated variables passed the significance hurdle and again there are different variables significant than for the total period and the first sub period. This time there is the significant intercept, 3 months bill return, two periods lagged business cycle, the federal funds rate and the trading volume of the S&P 500. All the significant variables have low standard errors, and thus none has to be excluded.

4.6.1. Total period analysis

The OLS-regression for the correlation between the one year bill and the stock market yielded the following equation for the total period:

$$1y - corr = -0.26 - 0.15 * business\ cycle(-2) - 0.20 * Federal\ Funds\ Rate\ Return(-4) - 0.53 * Variance\ 3m\ bill + 1.61 * Volume + \varepsilon_{1y}$$

The results are quite similar to those for the 10 year note and stock market correlation. There are again significant lagged business cycle and lagged federal funds rate return variables, as well as the positively related trading volume variable. Additionally there is the variable of the three months bill return with a negative sign. Differences compared to the previous examination is that the correlation variable reacts much faster to changes in the underlying economy, since the business cycle variable is only lagged twice in this regression. Another difference between the 1 year correlation series and the 10 year correlation series is that an

increase in risk in the treasury securities market with the shortest maturity also causes a strengthening of the negative correlation, namely the 3 month variance variable. This market is supposed to be the more active one, due to the fact that especially the rates can react much faster to macroeconomic changes. The market for longer maturity securities, such as one or ten years might react slower, due to the fact that short term shocks usually disappear over longer periods. The lower explanatory power compared to the 10 year examination can be explained by the fact that this correlation series does not follow the time trend of the highly significant trading volume variable as close as the 10 year series did (See figure 1, 2 and 4 in previous chapter).

Analyzing the coefficients and especially their signs in the theoretical context yields that all are in line with the flight into quality theory.

4.6.2. First sub period analysis

The significant results for the first sub period of this correlation series provided the following model:

$$1y - corr = -0.99 * 1y\ bill\ return - 0.21 * Federal\ Funds\ Rate\ Return(-4) + \varepsilon_{1y}$$

The sign of the one year bill return coefficient as well as the one for the four periods lagged federal funds rate return are reasonable in the context of the flight into quality theory. Compared to the previous models, the low adjusted R^2 indicates that the relationship between the stock market and the one year bill is driven by other factors that are not being captured by our regression. Another explanation could be that the flight into quality, even though it is supported by the coefficient of the significant variable, is more easily spotted on the 10 year treasury note market.

Due to an insignificant intercept the properties of this model might not be reliable enough to make valid interferences and the explanatory power of the model is insignificant.

4.6.3. Second sub period analysis

The second sub period is described by a model that looks very similar to the one for the total period, with approximately the same explanatory power as indicated by the similar adjusted R^2.

$$1y - corr = -0.40 + 0.21 * 3m\ bill\ return - 0.27 * business\ cycle(-2) + 0.27 * Federal\ Funds\ Rate\ Return + 2.15 * Volume + \varepsilon_{1y}$$

The two periods lagged business cycle and the trading volume are comparable in terms of sign and dimension of the coefficients. Furthermore, as stated above, they are reasonable in the theoretical context.

Even though the equations look similar there are still important differences between the two. Differences occur in terms of the 3 months bill return, the non-lagged federal funds rate return variable and the non-appearance of the 3 months bill variance. The coefficient sign of the 3 month bill return variable is in line with the flight into quality theory, indicating that higher returns in the bond market lead to a portfolio re-allocation towards this market. The positive coefficient of the federal funds rate return variable is in line with previous studies, if market participants interpret it as a sign of improved market conditions. To fight inflation, which is increasing in good economic conditions, the federal funds rate is expected to rise. This is reasonable in the context of other previous studies that have found that the sign of the correlation can change in economic up-turns.

Explanation for the co-movement of the correlation series and the non-lagged federal funds rate return can either be provided by proactive steering actions of the central bank or improved data processing of the market participants, leading to faster decision making.

4.7. Regression for 3month bill and stock market

We also ran the multivariable regression for the correlation between the 3 month bill and the S&P 500 stock market index, and the result from this is included in the table below.

Table 11. Regression on correlation between 3 month bill and stock market

Coeficients Standard Errors	total period 1982M01 - 2009M03
10 year note return	-0,23 0,43
1 year bill return	-0,41 0,30
3 month bill return	0,05 0,06
Business cycle	-0,03 0,05
Federal funds rate return	0,07 0,07
Federal funds rate return (-4)	-0,21*** 0,06
Inflation	1,88 7,40
S&P 500 return	-0,40 0,40
Variance 10 year note	-82,29 59,96
Variance 1 year bill	29,68* 16,87
Variance 3 month bill	-0,24 0,16
Variance S&P 500	126,92* 72,40
Volume	0,82*** 0,16
Intercept	-0,16** 0,06
R^2 Adjusted R^2	0,20 0,17

significant on the*** 1%; ** 5%; * 10% level,
for t-statistics see appendix 6

Finally running the regression of the correlation between 3 months bill and stock market for the total period, we retrieved a model with an adjusted R^2 of 16.6%. As for the prior total period regressions, there is a significant intercept and the four periods lagged federal funds rate return and the stock market trading volume are significant, too. Due to low standard errors, none of them is seen as problematic. Other variables or their lags did either not pass

the significance hurdle, or had very high standard errors and high correlation with other explanatory variables. Hence they are not taken into account.

Since the 3 month bill correlation series does not have a significant breakpoint (0.160), this series will not be divided into subsamples.

4.7.1. Total period analysis

As stated above, the correlation series of the 3 months bill and the stock market has no significant breakpoint. Thus there is only the total period of the regression to analyze, which turned out to be the following:

$$3m - corr = -0.16 - 0.21 * Federal\ Funds\ Rate\ Return(-4) + 0.82 * Volume + \varepsilon_{3m}$$

The 3 month bill and stock market correlation regression was the model with the lowest explanatory power. This can be explained by that this correlation series does not follow the trading volume time trend as the other two models, see figure 1, 2, 3, 4 and table 4 earlier in the chapter.

Regarding the two significant coefficients both are in line with the flight into quality theory. The four periods lagged federal funds rate return reflects the idea that the markets need some time to adjust to the new macroeconomic framework provided by the Federal Reserve. The volume is again significant, as for the two other total period correlation series.

4.8. Quarterly correlation regressions

Applying the method to quarterly data, to see if the analysis still holds, we found very similar results compared to the monthly examination.

Again we found the trading volume to be the most important variable for the problem, because of the time trend it carries. Besides this the lagged business cycle and the lagged federal funds rate are of similar importance. Moreover, there are also some of the market returns and market variances of importance, but this changes from series to series. Thus we consider the three factors mentioned before of highest importance in terms of explaining the movements in the particular correlation series.

Regarding the coefficients of the significant variables, they are also comparable in terms of sign and dimension. In case it is significant, the trading volume always has a positive

coefficient. The coefficients for the lagged business cycle and the lagged federal funds rate return are constantly negative. As stated for the monthly analysis, the realization of the different coefficients can be interpreted in line with the flight into quality theory, as well as with previous empirical findings.

All results can be found in Appendix 4, however worth noting here is that the only problem occurred in terms of serial correlation, where the Breusch-Godfrey test found serial correlation in the 1 year bond-stock correlation and the 10 year bond-stock correlation. Taking this into account, we do not assign importance to variables with too high standard errors.

Regarding the overall analysis, the results of the quarterly examination support the findings from the monthly.

4.9. Yearly correlation regressions

Moreover, we also performed the correlation analysis for the three series on a yearly basis, which also did provide results that are in line with those of the monthly examination. For results please see appendix 5.

As for the other two examinations we again found the trading volume to be of highest importance in terms of explaining the movement of the correlation in the three series. Apart from the one year series, the one year lagged business cycle variable was also significantly important. The three month model has additional significant return variables, namely the 10 year note and the 3 month bill return. For the 10 year series, we also retrieved a significant inflation variable. Even though it has a relatively high standard error, there was no sign of serial correlation or heteroscedasticity. Thus we think it can be trusted and used for reliable interference.

The most important difference compared to the other two examinations is that the federal funds rate return, whether lagged or not, turned out to be insignificant for all three series.

Regarding the signs of the coefficients, we retrieved comparable results for the trading volume, but changing signs for the lagged business cycle variable. The return variables both had negative coefficients.

For the 3 month bill – stock correlation, we retrieved negative return variable coefficients and a positive coefficient for the lagged business cycle variable, where the negative coefficients provide evidence for the run into quality in times of improving bond market conditions. Those are either caused by an overall economy improvement or by bad stock market conditions. In times of decreasing bond market returns the sign either indicates a leave from all markets by the investors, or a swing towards the stock market depending on the economic conditions. The sign of the lagged business cycle variable support the run into quality theory in times of market downturns, and the empirical findings of rising correlation in times of economy upturns.

Among the three significant variables we found the signs of the coefficients for the trading volume and the inflation variables to be in line with the run into quality theory. The negative sign for the business cycle variable can be interpreted as the inverse of the current business environment. This way it is in line with both the empirical findings and the flight into quality.

Regarding the monthly analysis, the outcome of the yearly examination support the results found previously.

4.10. Comparison of the three correlation series

A comparison over the three series leads to the conclusion that the trading volume, the federal funds rate and the business cycle are of great importance for the relationship between the stock and the particular bond markets. The federal funds rate return and the business cycle usually appear with a time delay. This can be explained by the fact that the market participants need some time to either realize the current state of the economy and its impact on the markets or to evaluate the actions and intentions by the central bank.

The importance of the trading volume across the three series can be explained by the co-movement of trading volume and the three correlation series over time. All four variables carry a similar time trend, which makes the volume variable the most important for this examination. Increasing volume indicates improving economical conditions, meaning that investors can benefit from being on the capital markets regardless whether they are informed or not.

The unimportance of market return measures for portfolio decisions explains the insignificance of those variables. Especially institutional investors are more worried about the risk than the return. They intend to maximize return, given a certain risk level. Thus the return is usually not the main reason for portfolio decisions, which in turn help explain the low and insignificant importance of the market return variables. However, there can be periods of overall low market uncertainty, where institutional investors also just follow the markets with the highest returns. The findings indicate that it is only for the sub periods that the impacts of the different return variables are significant, and that they thus level each other out for the total period.

The highest explanatory power is retrieved for the 10 year note and stock market total period correlation series for the monthly results. Here close to 50% of the correlation is explained by the significant variables included. A possible explanation for this is that the 10 year note is traded over a noteworthy longer time period than the other two treasury securities, and therefore responds to several movements in most of the explanatory variables. The 3 month correlation did not yield a very high explanatory power, which is because the model used is not the most suitable for this type of data. The property of the data indicates that an autoregressive model might have been more appropriate.

One implication of the study is that portfolio managers can use trends in the stock market volume for estimating the correlation between their treasury security and stock market positions. Announcements by the Federal Reserve should be considered by investors due to their impact on the relationship between the stock and treasury securities markets. The information from the National Bureau of Economic Research (NBER) for the business cycle can be used as an indicator whether trends and the correlation is estimated correctly in relationship to each other.

The major findings in this thesis support the theory about flight into quality. Long term investors and managers concerned about the risk level should support their decisions based on this, thus the correlation is important. Currently there is a positive correlation and thus you should see increasing importance of short selling in the markets. If following the flight into quality theory then more bonds should be issued in times of economic uncertainty, due to the increased demand. The institutions issuing the information necessary for the variables gain importance in terms of investment decisions. Referring to our objective it has been shown that

macroeconomic factors have a significant impact on portfolio choice when it comes to the correlation between treasury securities and the stock market.

5. Conclusions

The purpose of the thesis is to retrieve the correlation between treasury securities and the stock market and find significant variables to explain this relationship. The most important variables for the correlation were found to be the volume traded, the federal funds rate and the business cycle. Portfolio managers and investors can then use the information in those variables when trading and taking positions on the treasury securities and the stock markets. Finding the highest explanatory power for the 10 year monthly correlation model is backed up by the fact that the variables included are not so sensitive to shocks or short term movements. They are more based on the underlying macroeconomic factors and thus best reflected in an examination between the stock market and the treasury securities market with the longest maturity.

All the findings in this study support the flight into quality postulate. Further, the empirical findings for improving market conditions are also supported. Thus the findings of the study are linked to previous studies and theory. Moreover, the purpose of the thesis is fulfilled by the finding of the significant variables explaining the correlation between the three treasury securities of different maturities and the stock market.

To further study the correlation alternative approaches can be taken. When studying the plot of the volume traded one can see that an autoregressive model might be of better use and it is therefore of interest to see if this model is more suitable in finding significant explanatory variables. Yet another idea would be to divide the original sample into more subsamples, perhaps using another factor to find the breakpoints, but the daily data would have been necessary in order to retrieve large enough subsamples to be able to make valid inferences. What is also interesting is to try to find more significant explanatory variables, to see if one could increase the explanatory power of the multiple regressions. Variables to include could be exchange rates of importance to the U.S. economy or some kind of distress variable. Even though a lot of prior researches have shown that there are no major differences between different markets of different countries, taking the approach of this study and apply it to other countries to see if this would yield another result would be interesting.

6. References

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Appendix 1.

The correlation for the 10 year treasury note and the stock market yielded the following results for the tests applied:

Correlation matrix, total period

Covariance Correlation	10 y note return	1 y bill return	3 m bill return	Business cycle	F.f. rate return	Inflation	S&P 500 return	Variance 10 y note	Variance 1 y bill	Variance 3 m bill	Variance S&P 500	Volume
10 year note return	0.003139											
	1.000000											
1 year bill return	0.003907	0.009107										
	0.730675	1.000000										
3 month bill return	0.007171	0.016416	0.069311									
	0.486126	0.653407	1.000000									
Business cycle	0.001394	0.007611	0.024164	0.107361								
	0.075934	0.243417	0.280115	1.000000								
Federal funds rate return	0.000245	0.006173	0.006769	0.011677	0.045238							
	0.020561	0.304138	0.120887	0.167552	1.000000							
Inflation	3.65E-05	6.89E-05	0.000331	4.19E-05	6.93E-05	6.86E-06						
	0.249026	0.275684	0.479952	0.048859	0.124373	1.000000						
S&P 500 return	-0.000123	0.000259	0.001486	0.002520	-0.000214	-2.99E-06	0.002038					
	-0.048638	0.060120	0.125042	0.170370	-0.022272	-0.025319	1.000000					
Variance 10 year note	-1.20E-06	-5.75E-06	-2.37E-05	-2.98E-05	-8.85E-06	-1.23E-07	-1.64E-06	4.53E-08				
	-0.100202	-0.283115	-0.422581	-0.426511	-0.195474	-0.221370	-0.170963	1.000000				
Variance 1 year bill	-4.04E-06	-3.06E-05	-0.000106	-0.000113	-6.65E-05	-6.29E-07	-1.02E-05	1.15E-07	7.29E-07			
	-0.084510	-0.375477	-0.473210	-0.404965	-0.366191	-0.281270	-0.265513	0.635190	1.000000			
Variance 3 month bill	-0.001179	-0.004038	-0.013913	-0.007078	-0.003965	-6.85E-05	-0.000454	8.50E-06	4.09E-05	0.006575		
	-0.259423	-0.521815	-0.651775	-0.266402	-0.229907	-0.322398	-0.124129	0.492293	0.590984	1.000000		
Variance S&P 500	-3.24E-06	-1.03E-05	-3.67E-05	-2.44E-05	-1.81E-05	-2.17E-07	-5.77E-06	3.17E-08	1.43E-07	8.69E-06	8.47E-08	
	-0.198667	-0.370579	-0.478970	-0.256005	-0.291762	-0.284307	-0.439177	0.511352	0.576548	0.368350	1.000000	
Volume	10.47748	-31.40456	-122.8599	-180.4895	-67.47468	-3.165184	-44.27716	0.509799	1.770607	65.23112	0.248653	1.15E+08
	0.017408	-0.030635	-0.043442	-0.051277	-0.029531	-0.112520	-0.091308	0.222912	0.193037	0.074888	0.079534	1.000000

10 year note and stock market residual explanatory variables correlation, total period

Residual	Correlation	Covariance
Residual	1.000000	0.092807
10 year note return	8.29E-17	1.42E-18
1 year bill return	-1.03E-18	-3.01E-20
3 month bill return	2.72E-17	2.21E-18
Business cycle	1.13E-16	1.02E-17
Business cycle (-10)	-9.32E-17	-8.31E-18
Federal funds rate return	8.32E-18	5.43E-19
Federal funds rate return (-4)	5.81E-17	3.54E-18
Inflation	-2.24E-16	-1.76E-19
S&P 500 return	1.11E-16	1.51E-18
Variance 10 year note	-9.47E-17	-6.22E-21
Variance 1 year bill	-1.25E-16	-3.29E-20
Variance 3 month bill	-4.48E-17	-1.12E-18
Variance S&P 500	5.11E-17	4.60E-21
Volume	3.80E-16	1.23E-12

Correlation matrix, 1982-01 to 1994-09

Covariance Correlation	10 y note return	1 y bill return	3 m bill return	Business cycle	F.f. rate return	Inflation	S&P 500 return	Variance 10 y note	Variance 1 y bill	Variance 3 m bill	Variance S&P 500	Volume
10 year note return	0.001866 1.000000											
1 year bill return	0.002084 0.830319	0.003376 1.000000										
3 month bill return	0.001446 0.559679	0.002933 0.844011	0.003578 1.000000									
Business cycle	0.001040 0.076593	0.002160 0.118285	0.003772 0.200670	0.098765 1.000000								
Federal funds rate return	0.000852 0.114574	0.001831 0.183128	0.002115 0.205523	0.002390 0.044189	0.029609 1.000000							
Inflation	1.72E-05 0.187958	1.48E-05 0.119983	1.14E-05 0.090434	-0.000118 -0.177646	-2.03E-05 -0.055704	4.48E-06 1.000000						
S&P 500 return	-0.000655 -0.343818	-0.000464 -0.181186	0.000109 0.041212	0.000747 0.053909	-0.001335 -0.175833	-1.59E-05 -0.170515	0.001947 1.000000					
Variance 10 year note	-2.92E-07 -0.112245	-3.46E-07 -0.098830	-4.63E-07 -0.128610	-2.38E-07 -0.012575	-6.14E-07 -0.059255	-1.87E-08 -0.146812	-4.97E-07 -0.187313	3.62E-09 1.000000				
Variance 1 year bill	-1.27E-06 -0.228797	-2.06E-06 -0.276209	-2.46E-06 -0.319314	-5.40E-06 -0.133559	-3.37E-06 -0.152081	-1.89E-08 -0.069535	-4.55E-07 -0.080179	5.53E-09 0.714252	1.65E-08 1.000000			
Variance 3 month bill	-1.80E-06 -0.153856	-2.69E-06 -0.170839	-4.64E-06 -0.286535	-2.89E-05 -0.339492	-4.25E-06 -0.091201	-2.28E-08 -0.039842	-8.51E-07 -0.071212	8.49E-09 0.521100	2.62E-08 0.753509	7.33E-08 1.000000		
Variance S&P 500	-1.90E-06 -0.145519	-3.85E-06 -0.219631	-5.14E-06 -0.284868	-1.43E-06 -0.015126	-5.66E-06 -0.108970	8.05E-10 0.001262	-6.07E-06 -0.456373	9.43E-09 0.519485	1.80E-08 0.464755	3.19E-08 0.390733	9.10E-08 1.000000	
Volume	10.84565 0.117199	11.27702 0.090601	6.897677 0.053829	153.7052 0.228305	11.83448 0.032104	-0.443998 -0.097942	-4.602700 -0.048697	0.000122 0.000945	-0.001828 -0.006632	-0.121252 -0.209053	-0.044475 -0.068828	4589264. 1.000000

10 year note and stock market residual explanatory variables correlation, 1982-01 to 1994-09

Residual	Correlation	Covariance
Residual	1.000000	0.045949
10 year note return	-7.15E-17	-6.54E-19
Business cycle	3.33E-15	1.64E-16
Business cycle (-10)	1.65E-15	1.15E-16
Federal funds rate return	5.56E-18	2.07E-19
Federal funds rate return (-4)	-1.07E-16	-3.95E-18
Inflation	1.29E-15	5.42E-19
S&P 500 return	1.62E-16	1.50E-18
Variance 10 year note	8.85E-16	1.06E-20
Variance 1 year bill	6.83E-16	1.43E-20
Variance 3 month bill	4.43E-16	1.33E-20
Variance S&P 500	1.71E-16	1.14E-20
Volume	1.95E-15	8.51E-13

Correlation matrix, 1994-10 to 2009-03

Covariance Correlation	10 y note return	1 y bill return	3 m bill return	Business cycle	F.f. rate return	Inflation	S&P 500 return	Variance 10 y note	Variance 1 y bill	Variance 3 m bill	Variance S&P 500	Volume
10 year note return	0.004257											
	1.000000											
1 year bill return	0.005502	0.014111										
	0.709865	1.000000										
3 month bill return	0.012170	0.028116	0.126411									
	0.524630	0.665697	1.000000									
Business cycle	0.001687	0.012320	0.041712	0.114711								
	0.076340	0.306213	0.346395	1.000000								
Federal funds rate return	-0.000301	0.009933	0.010600	0.019701	0.058884							
	-0.019014	0.344598	0.122866	0.239711	1.000000							
Inflation	5.27E-05	0.000113	0.000595	0.000173	0.000142	8.53E-06						
	0.276724	0.324846	0.572699	0.175227	0.199847	1.000000						
S&P 500 return	0.000340	0.000873	0.002597	0.004024	0.000735	5.91E-06	0.002103					
	0.113668	0.160214	0.159252	0.259041	0.066002	0.044122	1.000000					
Variance 10 year note	-1.89E-06	-1.00E-05	-4.20E-05	-5.45E-05	-1.53E-05	-1.63E-07	-2.34E-06	7.54E-08				
	-0.105228	-0.307441	-0.429740	-0.586332	-0.229518	-0.202943	-0.186024	1.000000				
Variance 1 year bill	-6.17E-06	-5.43E-05	-0.000191	-0.000205	-0.000120	-1.01E-06	-1.79E-05	1.93E-07	1.30E-06			
	-0.083026	-0.401037	-0.472535	-0.530577	-0.432837	-0.303246	-0.343001	0.615698	1.000000			
Variance 3 month bill	-0.002200	-0.007525	-0.025869	-0.013126	-0.007345	-0.000122	-0.000814	1.51E-05	7.44E-05	0.012248		
	-0.304671	-0.572369	-0.657438	-0.350192	-0.273514	-0.377135	-0.160318	0.497525	0.589924	1.000000		
Variance S&P 500	-4.37E-06	-1.57E-05	-6.34E-05	-4.40E-05	-2.86E-05	-3.81E-07	-5.35E-06	4.79E-08	2.44E-07	1.59E-05	7.75E-08	
	-0.240480	-0.475254	-0.640191	-0.466941	-0.422820	-0.469149	-0.418831	0.627085	0.768041	0.515527	1.000000	
Volume	26.60261	6.258057	101.7842	-289.7542	-10.90715	2.771824	-30.61942	-0.080702	0.246214	-10.31162	-0.015509	48832967
	0.058345	0.007539	0.040967	-0.122425	-0.006432	0.135844	-0.095539	-0.042053	0.030930	-0.013333	-0.007971	1.000000

10 year note and stock market residual explanatory variables correlation, 1994-10 to 2009-03

Residual	Correlation	Covariance
Residual	1.000000	0.116415
10 year note return	6.78E-17	1.51E-18
1 year bill return	2.60E-17	1.05E-18
3 month bill return	1.00E-16	1.21E-17
Business cycle	4.28E-17	4.95E-18
Business cycle (-10)	-2.19E-15	-1.97E-16
Federal funds rate return	7.10E-17	5.88E-18
Federal funds rate return (-4)	-7.03E-19	-5.28E-20
Inflation	-2.57E-16	-2.56E-19
S&P 500 return	-7.07E-17	-1.11E-18
Variance 10 year note	-5.68E-16	-5.33E-20
Variance 1 year bill	-2.52E-16	-9.80E-20
Variance 3 month bill	-7.79E-17	-2.94E-18
Variance S&P 500	-3.18E-16	-3.02E-20
Volume	-1.14E-15	-2.71E-12

Appendix 2.

The results retrieved for the 1 year note and stock market correlation are displayed in the tables below.

Correlation matrix, total period

Covariance Correlation	10 y note return	1 y bill return	3 m bill return	Business cycle	F.f. rate return	Inflation	S&P 500 return	Variance 10 y note	Variance 1 y bill	Variance 3 m bill	Variance S&P 500	Volume
10 year note return	0.003139											
	1.000000											
1 year bill return	0.003907	0.009107										
	0.730675	1.000000										
3 month bill return	0.007171	0.016416	0.069311									
	0.486126	0.653407	1.000000									
Business cycle	0.001394	0.007611	0.024164	0.107361								
	0.075934	0.243417	0.280115	1.000000								
Federal funds rate return	0.000245	0.006173	0.006769	0.011677	0.045238							
	0.020561	0.304138	0.120887	0.167552	1.000000							
Inflation	3.65E-05	6.89E-05	0.000331	4.19E-05	6.93E-05	6.86E-06						
	0.249026	0.275684	0.479952	0.048859	0.124373	1.000000						
S&P 500 return	-0.000123	0.000259	0.001486	0.002520	-0.000214	-2.99E-06	0.002038					
	-0.048638	0.060120	0.125042	0.170370	-0.022272	-0.025319	1.000000					
Variance 10 year note	-1.20E-06	-5.75E-06	-2.37E-05	-2.98E-05	-8.85E-06	-1.23E-07	-1.64E-06	4.53E-08				
	-0.100202	-0.283115	-0.422581	-0.426511	-0.195474	-0.221370	-0.170963	1.000000				
Variance 1 year bill	-4.04E-06	-3.06E-05	-0.000106	-0.000113	-6.65E-05	-6.29E-07	-1.02E-05	1.15E-07	7.29E-07			
	-0.084510	-0.375477	-0.473210	-0.404965	-0.366191	-0.281270	-0.265513	0.635190	1.000000			
Variance 3 month bill	-0.001179	-0.004038	-0.013913	-0.007078	-0.003965	-6.85E-05	-0.000454	8.50E-06	4.09E-05	0.006575		
	-0.259423	-0.521815	-0.651775	-0.266402	-0.229907	-0.322398	-0.124129	0.492293	0.590984	1.000000		
Variance S&P 500	-3.24E-06	-1.03E-05	-3.67E-05	-2.44E-05	-1.81E-05	-2.17E-07	-5.77E-06	3.17E-08	1.43E-07	8.69E-06	8.47E-08	
	-0.198667	-0.370579	-0.478970	-0.256005	-0.291762	-0.284307	-0.439177	0.511352	0.576548	0.368350	1.000000	
Volume	10.47748	-31.40456	-122.8599	-180.4895	-67.47468	-3.165184	-44.27716	0.509799	1.770607	65.23112	0.248653	1.15E+08
	0.017408	-0.030635	-0.043442	-0.051277	-0.029531	-0.112520	-0.091308	0.222912	0.193037	0.074888	0.079534	1.000000

1 year bill and stock market residual explanatory variables correlation, total period

Residual	Correlation	Covariance
Residual	1.000000	0.085063
10 year note return	3.85E-17	6.32E-19
1 year bill return	7.96E-17	2.22E-18
3 month bill return	7.83E-17	6.05E-18
Business cycle	-1.66E-16	-1.52E-17
Business cycle (-2)	-3.44E-16	-3.15E-17
Federal funds rate return	6.10E-17	3.80E-18
Federal funds rate return (-4)	-7.13E-18	-4.13E-19
Inflation	9.23E-19	7.08E-22
S&P 500 return	1.06E-17	1.40E-19
Variance 10 year note	-8.59E-17	-5.37E-21
Variance 1 year bill	-4.58E-17	-1.15E-20
Variance 3 month bill	-6.41E-17	-1.53E-18
Variance S&P 500	-1.22E-16	-1.04E-20
Volume	-3.87E-16	-1.21E-12

Correlation matrix, 1982-01 to 1994-09

Covariance Correlation	10 y note return	1 y bill return	3 m bill return	Business cycle	F.f. rate return	Inflation	S&P 500 return	Variance 10 y note	Variance 1 y bill	Variance 3 m bill	Variance S&P 500	Volume
10 year note return	0.001866 1.000000											
1 year bill return	0.002084 0.830319	0.003376 1.000000										
3 month bill return	0.001446 0.559679	0.002933 0.844011	0.003578 1.000000									
Business cycle	0.001040 0.076593	0.002160 0.118285	0.003772 0.200670	0.098765 1.000000								
Federal funds rate return	0.000852 0.114574	0.001831 0.183128	0.002115 0.205523	0.002390 0.044189	0.029609 1.000000							
Inflation	1.72E-05 0.187958	1.48E-05 0.119983	1.14E-05 0.090434	-0.000118 -0.177646	-2.03E-05 -0.055704	4.48E-06 1.000000						
S&P 500 return	-0.000655 -0.343818	-0.000464 -0.181186	0.000109 0.041212	0.000747 0.053909	-0.001335 -0.175833	-1.59E-05 -0.170515	0.001947 1.000000					
Variance 10 year note	-2.92E-07 -0.112245	-3.46E-07 -0.098830	-4.63E-07 -0.128610	-2.38E-07 -0.012575	-6.14E-07 -0.059255	-1.87E-08 -0.146812	-4.97E-07 -0.187313	3.62E-09 1.000000				
Variance 1 year bill	-1.27E-06 -0.228797	-2.06E-06 -0.276209	-2.46E-06 -0.319314	-5.40E-06 -0.133559	-3.37E-06 -0.152081	-1.89E-08 -0.069535	-4.55E-07 -0.080179	5.53E-09 0.714252	1.65E-08 1.000000			
Variance 3 month bill	-1.80E-06 -0.153856	-2.69E-06 -0.170839	-4.64E-06 -0.286535	-2.89E-05 -0.339492	-4.25E-06 -0.091201	-2.28E-08 -0.039842	-8.51E-07 -0.071212	8.49E-09 0.521100	2.62E-08 0.753509	7.33E-08 1.000000		
Variance S&P 500	-1.90E-06 -0.145519	-3.85E-06 -0.219631	-5.14E-06 -0.284868	-1.43E-06 -0.015126	-5.66E-06 -0.108970	8.05E-10 0.001262	-6.07E-06 -0.456373	9.43E-09 0.519485	1.80E-08 0.464755	3.19E-08 0.390733	9.10E-08 1.000000	
Volume	10.84565 0.117199	11.27702 0.090601	6.897677 0.053829	153.7052 0.228305	11.83448 0.032104	-0.443998 -0.097942	-4.602700 -0.048697	0.000122 0.000945	-0.001828 -0.006632	-0.121252 -0.209053	-0.044475 -0.068828	4589264. 1.000000

1 year bill and stock market residual explanatory variables correlation, 1982-01 to 1994-09

Residual	Correlation	Covariance
Residual	1.000000	0.046588
1 year bill return	-3.25E-17	-4.08E-19
Business cycle	-2.02E-16	-1.23E-17
Business cycle (-2)	5.86E-16	3.81E-17
Federal funds rate return	-5.09E-18	-1.90E-19
Federal funds rate return (-4)	-1.87E-17	-6.87E-19
Inflation	1.05E-16	4.83E-20
S&P 500 return	5.41E-18	5.15E-20
Variance 10 year note	-3.59E-17	-4.68E-22
Variance 1 year bill	2.03E-16	5.64E-21
Variance 3 month bill	1.55E-16	8.33E-21
Variance S&P 500	2.72E-18	1.80E-22
Volume	-2.48E-16	-1.13E-13

Correlation matrix, 1994-10 to 2009-03

Covariance Correlation	10 y note return	1 y bill return	3 m bill return	Business cycle	F.f. rate return	Inflation	S&P 500 return	Variance 10 y note	Variance 1 y bill	Variance 3 m bill	Variance S&P 500	Volume
10 year note return	0.004257											
	1.000000											
1 year bill return	0.005502	0.014111										
	0.709865	1.000000										
3 month bill return	0.012170	0.028116	0.126411									
	0.524630	0.665697	1.000000									
Business cycle	0.001687	0.012320	0.041712	0.114711								
	0.076340	0.306213	0.346395	1.000000								
Federal funds rate return	-0.000301	0.009933	0.010600	0.019701	0.058884							
	-0.019014	0.344598	0.122866	0.239711	1.000000							
Inflation	5.27E-05	0.000113	0.000595	0.000173	0.000142	8.53E-06						
	0.276724	0.324846	0.572699	0.175227	0.199847	1.000000						
S&P 500 return	0.000340	0.000873	0.002597	0.004024	0.000735	5.91E-06	0.002103					
	0.113668	0.160214	0.159252	0.259041	0.066002	0.044122	1.000000					
Variance 10 year note	-1.89E-06	-1.00E-05	-4.20E-05	-5.45E-05	-1.53E-05	-1.63E-07	-2.34E-06	7.54E-08				
	-0.105228	-0.307441	-0.429740	-0.586332	-0.229518	-0.202943	-0.186024	1.000000				
Variance 1 year bill	-6.17E-06	-5.43E-05	-0.000191	-0.000205	-0.000120	-1.01E-06	-1.79E-05	1.93E-07	1.30E-06			
	-0.083026	-0.401037	-0.472535	-0.530577	-0.432837	-0.303246	-0.343001	0.615698	1.000000			
Variance 3 month bill	-0.002200	-0.007525	-0.025869	-0.013126	-0.007345	-0.000122	-0.000814	1.51E-05	7.44E-05	0.012248		
	-0.304671	-0.572369	-0.657438	-0.350192	-0.273514	-0.377135	-0.160318	0.497525	0.589924	1.000000		
Variance S&P 500	-4.37E-06	-1.57E-05	-6.34E-05	-4.40E-05	-2.86E-05	-3.81E-07	-5.35E-06	4.79E-08	2.44E-07	1.59E-05	7.75E-08	
	-0.240480	-0.475254	-0.640191	-0.466941	-0.422820	-0.469149	-0.418831	0.627085	0.768041	0.515527	1.000000	
Volume	26.60261	6.258057	101.7842	-289.7542	-10.90715	2.771824	-30.61942	-0.080702	0.246214	-10.31162	-0.015509	48832967
	0.058345	0.007539	0.040967	-0.122425	-0.006432	0.135844	-0.095539	-0.042053	0.030930	-0.013333	-0.007971	1.000000

1 year bill and stock market residual explanatory variables correlation, 1994-10 to 2009-03

Residual	Correlation	Covariance
Residual	1.000000	0.101597
10 year note return	1.08E-16	2.25E-18
1 year bill return	1.17E-16	4.42E-18
3 month bill return	1.08E-16	1.22E-17
Business cycle	6.48E-17	7.00E-18
Business cycle (-2)	-1.27E-15	-1.32E-16
Federal funds rate return	7.07E-17	5.47E-18
Federal funds rate return (-4)	1.65E-17	1.16E-18
Inflation	-3.30E-16	-3.07E-19
S&P 500 return	4.88E-17	7.13E-19
Variance 10 year note	-6.62E-16	-5.79E-20
Variance 1 year bill	-2.27E-16	-8.24E-20
Variance 3 month bill	-1.25E-16	-4.41E-18
Variance S&P 500	-4.16E-16	-3.70E-20
Volume	-1.00E-15	-2.23E-12

Appendix 3.

The 3 month bill and stock market correlation outputs are given in tables below.

Correlation matrix, total period

Covariance Correlation	10 y note return	1 y bill return	3 m bill return	Business cycle	F.f. rate return	Inflation	S&P 500 return	Variance 10 y note	Variance 1 y bill	Variance 3 m bill	Variance S&P 500	Volume
10 year note return	0.003139											
	1.000000											
1 year bill return	0.003907	0.009107										
	0.730675	1.000000										
3 month bill return	0.007171	0.016416	0.069311									
	0.486126	0.653407	1.000000									
Business cycle	0.001394	0.007611	0.024164	0.107361								
	0.075934	0.243417	0.280115	1.000000								
Federal funds rate return	0.000245	0.006173	0.006769	0.011677	0.045238							
	0.020561	0.304138	0.120887	0.167552	1.000000							
Inflation	3.65E-05	6.89E-05	0.000331	4.19E-05	6.93E-05	6.86E-06						
	0.249026	0.275684	0.479952	0.048859	0.124373	1.000000						
S&P 500 return	-0.000123	0.000259	0.001486	0.002520	-0.000214	-2.99E-06	0.002038					
	-0.048638	0.060120	0.125042	0.170370	-0.022272	-0.025319	1.000000					
Variance 10 year note	-1.20E-06	-5.75E-06	-2.37E-05	-2.98E-05	-8.85E-06	-1.23E-07	-1.64E-06	4.53E-08				
	-0.100202	-0.283115	-0.422581	-0.426511	-0.195474	-0.221370	-0.170963	1.000000				
Variance 1 year bill	-4.04E-06	-3.06E-05	-0.000106	-0.000113	-6.65E-05	-6.29E-07	-1.02E-05	1.15E-07	7.29E-07			
	-0.084510	-0.375477	-0.473210	-0.404965	-0.366191	-0.281270	-0.265513	0.635190	1.000000			
Variance 3 month bill	-0.001179	-0.004038	-0.013913	-0.007078	-0.003965	-6.85E-05	-0.000454	8.50E-06	4.09E-05	0.006575		
	-0.259423	-0.521815	-0.651775	-0.266402	-0.229907	-0.322398	-0.124129	0.492293	0.590984	1.000000		
Variance S&P 500	-3.24E-06	-1.03E-05	-3.67E-05	-2.44E-05	-1.81E-05	-2.17E-07	-5.77E-06	3.17E-08	1.43E-07	8.69E-06	8.47E-08	
	-0.198667	-0.370579	-0.478970	-0.256005	-0.291762	-0.284307	-0.439177	0.511352	0.576548	0.368350	1.000000	
Volume	10.47748	-31.40456	-122.8599	-180.4895	-67.47468	-3.165184	-44.27716	0.509799	1.770607	65.23112	0.248653	1.15E+08
	0.017408	-0.030635	-0.043442	-0.051277	-0.029531	-0.112520	-0.091308	0.222912	0.193037	0.074888	0.079534	1.000000

3 month bill and stock market residual explanatory variables correlation, total period

Residual	Correlation	Covariance
Residual	1.000000	0.059082
10 year note return	-3.05E-18	-4.18E-20
1 year bill return	3.61E-17	8.40E-19
3 month bill return	2.30E-17	1.48E-18
Business cycle	-3.43E-16	-2.62E-17
Federal funds rate return	2.87E-17	1.49E-18
Federal funds rate return (-4)	9.17E-18	4.43E-19
Inflation	-8.22E-17	-5.26E-20
S&P 500 return	-2.12E-17	-2.32E-19
Variance 10 year note	-1.34E-16	-6.99E-21
Variance 1 year bill	8.26E-18	1.73E-21
Variance 3 month bill	-4.25E-19	-8.43E-21
Variance S&P 500	-7.20E-17	-5.13E-21
Volume	-3.68E-16	-9.58E-13

Appendix 4.

The treasury securities and stock market correlation outputs for the quarterly data are given in tables below.

Correlation matrix, total period

Covariance Correlation	10 y note return	1 y bill return	3 m bill return	Business cycle	Business cycle(-2)	F.f. rate return	F.f. rate return(-2)	Inflation	S&P 500 return	Variance 10 y note	Variance 1 y bill	Variance 3 m bill	Variance S&P 500	Volume
10 year note return	0.011208 1.000000													
1 year bill return	0.019214 0.807344	0.050535 1.000000												
3 month bill return	0.041626 0.582969	0.124738 0.822712	0.454895 1.000000											
Business cycle	0.004090 0.122433	0.024517 0.345621	0.076172 0.357906	0.099572 1.000000										
Business cycle(-2)	0.004953 0.148268	0.017824 0.251269	0.063760 0.299588	0.043497 0.436842	0.099572 1.000000									
Federal funds rate return	0.015697 0.431929	0.051535 0.667820	0.183360 0.791960	0.040011 0.369377	0.027858 0.257182	0.117839 1.000000								
Federal funds rate return(-2)	-0.002099 -0.086106	0.000361 0.006972	0.002321 0.014947	0.009567 0.131688	0.018174 0.250164	-0.003601 -0.045559	0.053004 1.000000							
Inflation	0.000288 0.455997	0.000718 0.534868	0.002688 0.667706	0.000259 0.137303	0.000595 0.315754	0.001130 0.551329	0.000115 0.083881	3.56E-05 1.000000						
S&P 500 return	0.001941 0.222687	0.005826 0.314687	0.018832 0.339051	0.006563 0.252543	0.002350 0.090449	0.004342 0.153589	0.001096 0.057782	3.70E-05 0.075270	0.006782 1.000000					
Variance 10 year note	-2.28E-06 -0.109038	-1.24E-05 -0.278750	-5.73E-05 -0.430007	-3.15E-05 -0.505659	-2.4E-05 -0.38282	-2.54E-05 -0.375129	-4.74E-06 -0.104296	-3.67E-07 -0.311353	-6.22E-06 -0.382166	3.90E-08 1.000000				
Variance 1 year bill	-2.74E-05 -0.376742	-9.57E-05 -0.620031	-0.000355 -0.767227	-0.000119 -0.547682	-8.6E-05 -0.39768	-0.000140 -0.593571	-2.36E-05 -0.148973	-2.06E-06 -0.503610	-2.30E-05 -0.406226	9.99E-08 0.736469	4.72E-07 1.000000			
Variance 3 month bill	-0.002684 -0.427938	-0.008520 -0.639794	-0.035662 -0.892641	-0.007288 -0.389893	-0.00714 -0.38215	-0.013817 -0.679492	-0.000546 -0.040056	-0.000204 -0.578107	-0.001752 -0.359196	6.17E-06 0.527476	3.43E-05 0.843606	0.00351 1.00000		
Variance S&P 500	-1.03E-05 -0.423491	-2.89E-05 -0.559536	-0.000110 -0.705780	-2.54E-05 -0.349738	-2.3E-05 -0.31651	-4.60E-05 -0.582312	-1.89E-06 -0.035704	-6.42E-07 -0.467078	-1.10E-05 -0.582793	2.78E-08 0.611137	1.07E-07 0.674955	9.6E-06 0.70639	5.3E-08 1.0000	
Volume	24.70080 0.021930	-81.03863 -0.033883	-417.6603 -0.058205	-406.5518 -0.121099	133.6420 0.039808	-160.7592 -0.044017	17.63108 0.007198	-7.922674 -0.124741	-164.0820 -0.187275	0.521393 0.248053	1.796279 0.245849	68.1413 0.10813	0.2455 0.1005	1.1E+08 1.00000

	Coefficients	Std errors		
10 year note return	-0.72	0.206021	R^2	0.619549
Business cycle	0.10	0.084181	Adjusted R^2	0.579918
Business cycle (-10)	-0.08	0.059600		
Federal funds rate return (-2)	-0.19	0.090153		
Inflation	10.23	5.070946		
S&P 500 return	-0.48	0.344309		
Variance 10 year note	284.89	106.9495		
Variance 1 year bill	85.72	50.91806		
Variance S&P 500	26.15	117.6282		
Volume	2.18	0.275		
Intercept	-0.66	0.120686		

Correlation between 10 year note and S&P 500, total period

	Null hypothesis	Probability	Reject/ Do not reject H_0
White's test	There is no heteroscedasticity	0.8090	Do not reject H_0
Breusch- Godfrey	There is no autocorrelation	0.0002	Reject H_0
Jarque-Bera	The residuals are normally distributed	0.286935	Do not reject H_0
Ramsey RESET	The regression equation is linear	0.5829	Do not reject H_0

10 year note and stock market residual explanatory variables correlation, total period

Residual	Correlation	Covariance
Residual	1.000000	0.053713
10 year note return	1.39E-16	3.40E-18
Business cycle	-2.13E-15	-1.56E-16
Business cycle (-2)	-6.07E-16	-4.44E-17
Federal funds rate return	-0.053052	-0.004221
Federal funds rate return (-2)	3.26E-17	1.74E-18
Inflation	-2.43E-16	-3.36E-19
S&P 500 return	-2.64E-16	-5.04E-18
Variance 10 year note	-2.90E-16	-1.33E-20
Variance 1 year bill	-4.38E-16	-6.97E-20
Variance S&P 500	-2.86E-16	-1.53E-20
Volume	-8.26E-16	-2.04E-12

	Coefficients	Std errors		
10 year note return	-0.37	0.384329	R^2	0.627069
1 year bill return	-0.30	0.316399	Adjusted R^2	0.569695
3 month bill return	0.22	0.066940		
Business cycle	0.01	0.073859		
Business cycle (-2)	-0.20	0.063048		
Federal funds rate return	-0.20	0.100779		
Federal funds rate return (-3)	0.12	0.088777		
Inflation	4.34	3.803255		
S&P 500 return	-0.51	0.318450		
Variance 10 year note	-1 69.46	116.4740		
Variance 1 year bill	2 40.00	93.63670		
Variance 3 month bill	-1.82	0.940126		
Variance S&P 500	282.02	181.4 742		
Volume	1.52	0.213		
Intercept	-0.24	0.111044		

Correlation between 1 year bill and S&P 500, total period

	Null hypothesis	Probability	Reject/ Do not reject H_0
White's test	There is no heteroscedasticity	0.6874	Do not reject H_0
Breusch- Godfrey	There is no autocorrelation	0.0087	Reject H_0
Jarque-Bera	The residuals are normally distributed	0.277988	Do not reject H_0
Ramsey RESET	The regression equation is linear	0.1750	Do not reject H_0

1 year bill and stock market residual explanatory variables correlation, total period

Residual	Correlation	Covariance
Residual	1.000000	0.036108
10 year note return	-1.16E-16	-2.31E-18
1 year bill return	-1.14E-16	-4.84E-18
3 month bill return	-1.79E-16	-2.30E-17
Business cycle	2.57E-16	1.49E-17
Business cycle (-2)	6.56E-16	3.80E-17
Federal funds rate return	-4.10E-16	-2.69E-17
Federal funds rate return (-3)	-3.13E-17	-1.37E-18
Inflation	1.10E-15	1.25E-18
S&P 500 return	1.58E-16	2.47E-18
Variance 10 year note	6.07E-16	2.29E-20
Variance 1 year bill	1.99E-16	2.61E-20
Variance 3 month bill	1.32E-16	1.50E-18
Variance S&P 500	2.16E-16	9.50E-21
Volume	4.21E-16	8.49E-13

Regression between 3 month bill and S&P 500, total period

	Coefficients	Std errors		
1 year bill return	-0.17	0.105275	R^2	0.371226
Business cycle	-0.03	0.059518	Adjusted R^2	0.298420
Business cycle (-2)	-0.05	0.090178		
Federal funds rate return	-0.03	0.057181		
Federal funds rate return (-2)	-0.03	0.074175		
Inflation	2.67	3 504 117		
S&P 500 return	-0.10	0.281762		
Variance 10 year note	-101.57	99.69516		
Variance 3 month bill	-1.03	0.462897		
Variance S&P 500	363.68	99.81118		
Volume	0.90	0.1710		
Intercept	-0.16	0.116494		

Correlation between 3 month bill and S&P 500, total period

	Null hypothesis	Probability	Reject/ Do not reject H_0
White's test	**There is no heteroscedasticity**	0.9394	Do not reject H_0
Breusch- Godfrey	There is no autocorrelation	0.1732	Do not reject H_0
Jarque-Bera	The residuals are normally distributed	0.5880	Do not reject H_0
Ramsey RESET	The regression equation is linear	0.1152	Do not reject H_0

3 month bill and stock market residual explanatory variables correlation, total period

Residual	Correlation	Covariance
Residual	1.000000	0.025996
1 year bill return	3.84E-17	1.39E-18
Business cycle	6.45E-16	3.28E-17
Business cycle(-2)	5.18E-16	2.63E-17
Federal funds rate return	9.35E-17	5.18E-18
Federal funds rate return (-2)	-9.05E-18	-3.36E-19
Inflation	2.20E-16	2.12E-19
S&P 500 return	7.87E-17	1.04E-18
Variance 10 year note	-1.62E-16	7.87E-17
Variance 3 month bill	-5.41E-17	-5.17E-19
Variance S&P 500	5.37E-17	1.99E-21
Volume	5.92E-16	1.02E-12

Appendix 5.

The treasury securities and stock market correlation outputs for the yearly data are given below.

Correlation matrix, total period

Covariance Correlation	10 y note return	1 y bill return	3 m bill return	Business cycle	Business cycle(-2)	F.f. rate return	F.f. rate return(-2)	Inflation	S&P 500 return	Variance 10 y note	Variance 1 y bill	Variance 3 m bill	Variance S&P 500	Volume
10 year note return	0.041335 1.000000													
1 year bill return	0.082232 0.740743	0.298145 1.000000												
3 month bill return	0.188941 0.591491	0.763408 0.889859	2.468560 1.000000											
Business cycle	0.009634 0.150776	0.087491 0.509857	0.285160 0.577517	0.098765 1.000000										
Business cycle(-2)	-0.006903 -0.108040	-0.014339 -0.083558	-0.049712 -0.100678	0.024691 0.250000	0.098765 1.000000									
Federal funds rate return	0.067144 0.460633	0.348197 0.889445	1.015820 0.901785	0.138833 0.616165	-0.007924 -0.035166	0.514025 1.000000								
Federal funds rate return(-2)	-0.016213 -0.111584	-0.013689 -0.035080	0.043058 0.038346	0.103647 0.461466	0.148911 0.662997	0.034431 0.067196	0.510771 1.000000							
Inflation	0.000727 0.283553	0.002746 0.398837	0.009232 0.465982	0.002286 0.576821	0.000563 0.142068	0.003519 0.389262	0.002085 0.231356	0.000159 1.000000						
S&P 500 return	0.008505 0.237164	0.046887 0.486822	0.166234 0.599828	0.034910 0.629756	0.015694 0.283104	0.072527 0.573502	0.047355 0.375649	0.000563 0.252951	0.031113 1.000000					
Variance 10 year note	3.55E-06 0.056636	-1.27E-05 -0.075800	-9.96E-05 -0.205918	-7.13E-05 -0.737103	-5.09E-05 -0.526170	-4.51E-05 -0.204069	-0.000177 -0.806169	-1.91E-06 -0.492241	-2.36E-05 -0.434955	9.48E-08 1.000000				
Variance 1 year bill	-4.68E-05 -0.363960	-0.000217 -0.628364	-0.000824 -0.829900	-0.000151 -0.757778	-3.95E-05 -0.198697	-0.000330 -0.728374	-0.000201 -0.444719	-4.79E-06 -0.601073	-7.52E-05 -0.674370	1.26E-07 0.648014	4.00E-07 1.000000			
Variance 3 month bill	-0.003997 -0.488023	-0.016047 -0.729530	-0.060106 -0.949652	-0.007858 -0.620674	3.04E-05 0.002398	-0.022818 -0.790031	-0.005577 -0.193715	-0.000252 -0.496865	-0.004521 -0.636243	4.88E-06 0.393619	2.31E-05 0.906366	0.0016 1.0000		
Variance S&P 500	-5.06E-06 -0.147090	-3.79E-05 -0.410688	-0.000148 -0.557488	-3.95E-05 -0.742515	-2.06E-05 -0.387089	-7.28E-05 -0.600241	-7.66E-05 -0.633799	-9.84E-07 -0.461276	-1.98E-05 -0.662970	4.10E-08 0.787586	8.40E-08 0.785176	4.6E-06 0.6700	2.9E-08 1.0000	
Volume	-207.3359 -0.098270	-956.9531 -0.168881	-3479.957 -0.213430	-951.4109 -0.291722	125.2844 0.038415	-1262.973 -0.169748	256.9005 0.034638	-50.04534 -0.382431	-612.8748 -0.334814	0.666089 0.208426	2.119602 0.323026	98.262 0.2350	0.4079 0.2323	1.08E+08 1.000000

Regression between 10 year note and S&P 500, total period

	Coefficients	Std errors		
10 year Return	-0.30	0.342414	R^2	0.846969
1 year Return	-0.10	0.116407	Adjusted R^2	0.734746
Business Cycle	0.08	0.261178		
Business Cycle(-1)	-0.22	0.086967		
Federal Funds Rate Return(-1)	-0.10	0.075467		
Inflation	3.30	1.498301		
S&P 500 Return	0.03	0.216024		
10 year Variance	115.44	225.5566		
1 year Variance	130.34	132.0126		
S&P 500 Variance	-198.50	470.4461		
Volume	2.33	0.3400		
Intercept	-0.55	0.318827		

Correlation between 10 year note and S&P 500, total period

	Null hypothesis	Probability	Reject/ Do not reject H_0
White's test	There is no heteroscedasticity	0.2547	Do not reject H_0
Breusch- Godfrey	There is no autocorrelation	0.6794	Do not reject H0
Jarque-Bera	The residuals are normally distributed	0.8705	Do not reject H_0
Ramsey RESET	The regression equation is linear	0.3717	Do not reject H_0

10 year note and stock market residual explanatory variables correlation, total period

Residual	Correlation	Covariance
Residual	1.000000	0.017723
10 year Return	1.12E-16	3.02E-18
1 year Return	1.53E-17	1.11E-18
Business Cycle	-1.14E-15	-4.78E-17
Business Cycle(-1)	8.48E-16	3.55E-17
Federal Funds Rate Return(-1)	1.36E-16	1.29E-17
Inflation	5.55E-17	9.32E-20
S&P 500 Return	-2.03E-16	-4.78E-18
10 year Variance	-1.60E-16	-6.58E-21
1 year Variance	-3.00E-16	-2.52E-20
S&P 500 Variance	-6.14E-17	-1.38E-21
Volume	8.32E-17	1.15E-13

Regression between 1 year bill and S&P 500, total period

	Coefficients	Std errors		
10 year Return	-0.22	0.308256	R^2	0.815268
1 year Return	-0.19	0.125243	Adjusted R^2	0.679798
Business Cycle	0.05	0.214511		
Business Cycle(-1)	-0.07	0.062281		
Federal Funds Rate Return(-1)	-0.11	0.066561		
Inflation	2.09	1.122011		
S&P 500 Return	0.004	0.185566		
10 Year Variance	138.73	213.3045		
1 Year Variance	3.47	115.9236		
S&P 500 Variance	-104.00	380.6052		
Volume	1.75	0.2690		
Intercept	-0.45	0.259221		

Correlation between 1 year bill and S&P 500, total period

	Null hypothesis	Probability	Reject/ Do not reject H_0
White's test	There is no heteroscedasticity	0.7732	Do not reject H_0
Breusch- Godfrey	There is no autocorrelation	0.7081	Do not reject H0
Jarque-Bera	The residuals are normally distributed	0.6862	Do not reject H_0
Ramsey RESET	The regression equation is linear	0.1737	Do not reject H_0

1 year bill and stock market residual explanatory variables correlation, total period

Residual	Correlation	Covariance
Residual	1.000000	0.013597
10 year Return	2.67E-16	6.32E-18
1 year Return	2.91E-18	1.85E-19
Business Cycle	-1.29E-15	-4.74E-17
Business Cycle(-1)	6.56E-16	2.40E-17
Federal Funds Rate Return(-1)	-5.90E-17	-4.92E-18
Inflation	3.49E-16	5.14E-19
S&P 500 Return	-2.25E-16	-4.62E-18
10 Year Variance	3.19E-18	1.15E-22
1 Year Variance	1.76E-16	1.30E-20
S&P 500 Variance	2.62E-16	5.16E-21
Volume	2.09E-16	2.53E-13

Regression between 3 month bill and S&P 500, total period

	Coefficients	Std errors		
10 year Return	-0.20	0.095903	R^2	0.371226
3 months Return	-0.15	0.049829	Adjusted R^2	0.298420
Business Cycle	0.11	0.073616		
Business Cycle(-1)	0.09	0.040593		
Federal Funds Rate Return	-0.09	0.056429		
Inflation	1.29	1.608263		
S&P 500 Return	0.06	0.141434		
10 year Variance	-35.79	155.3316		
3 months Variance	-5.98	1.570972		
S&P 500 Variance	524.30	184.6428		
Volume	0.94	0.1190		
Intercept	-0.48	0.093276		

Correlation between 3 month bill and S&P 500, total period

	Null hypothesis	Probability	Reject/ Do not reject H_0
White's test	There is no heteroscedasticity	0.8495	Do not reject H_0
Breusch- Godfrey	There is no autocorrelation	0.0530	Do not reject H_0
Jarque-Bera	The residuals are normally distributed	0.8279	Do not reject H_0
Ramsey RESET	The regression equation is linear	0.6594	Do not reject H_0

3 month bill and stock market residual explanatory variables correlation, total period

Residual	Correlation	Covariance
Residual	1.000000	0.003840
10 year Return	1.38E-16	1.73E-18
3 months Return	-7.88E-16	-7.67E-17
Business Cycle	-3.36E-15	-6.54E-17
Business Cycle(-1)	-1.93E-16	-3.75E-18
Federal Funds Rate Return	1.56E-16	6.91E-18
Inflation	-1.55E-15	-1.21E-18
S&P 500 Return	-2.67E-16	-2.92E-18
10 year Variance	3.02E-16	5.76E-21
3 months Variance	1.58E-16	3.95E-19
S&P 500 Variance	6.17E-16	6.47E-21
Volume	1.56E-15	1.00E-12

Appendix 6.

T-statistics for 10 year correlation

	total period	first sub period	second sub period
10 year note return	-1.700865	-2.048168	-1.687769
1 year bill return	-1.237198		-1.077095
3 month bill return	2.462173		3.051993
Business cycle	0.163467	0.881025	0.133567
Business cycle (-2)	-3.552387	-1.001683	-1.789845
Federal funds rate return	0.412621	-2.436788	1.749476
Federal funds rate return (-4)	-3.173723	-1.746590	-2.589975
Inflation	-0.038852	-2.059526	-0.152719
S&P 500 return	-1.392253	-3.130388	0.352062
Variance 10 year note	1.178825	-4.037917	0.801959
Variance 1 year bill	2.641191	2.295268	1.861895
Variance 3 month bill	-1.286441	-0.587583	-0.952836
Variance S&P 500	0.366552	0.143428	1.448424
Volume	9.291924	-0.724528	6.438501
Intercept	-3.463662	-2.054927	-2.555742

T-statistics for 1 year correlation

	total period	first sub period	second sub period
10 year note return	-0.1011082		-1.107928
1 year bill return	-1.383404	-2.249430	-1.073999
3 month bill return	1.204555		2.401984
Business cycle	0.446986	-0.060000	0.972869
Business cycle (-2)	-2.153194	-0.623077	-3.555456
Federal funds rate return	0.952498	-0.640163	2.114365
Federal funds rate return (-4)	-2.316489	-2.017730	-1.501970
Inflation	-0.266065	-1.491041	-0.012921
S&P 500 return	-1.911460	-1.233739	-0.853457
Variance 10 year note	0.904654	-4.410981	0.732541
Variance 1 year bill	2.133390	1.402019	0.753280
Variance 3 month bill	-2.128537	-1.026965	-1.658666
Variance S&P 500	0.963267	2.345224	1.942315
Volume	7.960936	0.652980	5.209387
Intercept	-3.139527	-1.070803	-2.856313

T-statistics for 3 month correlation

	total period
10 year note return	-0.532810
1 year bill return	-1.377387
3 month bill return	0.809900
Business cycle	-0.575776
Federal funds rate return	1.033935
Federal funds rate return (-4)	-3.655287
Inflation	0.254493
S&P 500 return	-1.000339
Variance 10 year note	-1.372290
Variance 1 year bill	1.758710
Variance 3 month bill	-1.462756
Variance S&P 500	1.753160
Volume	5.119213
Intercept	-2.403218