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του

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ΘΕΜΑ

"Implied Volatility, Risk Reversal and the Stock- Bond Return Relation"

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1. ABSTRACT

In this project the time-variation in the co-movements between daily stock and Treasury bond returns over 1986-2005 was studied. The main task was to examine whether variation in stock bond return dynamics can be linked to the implied volatility (IV) from equity index options and to the detrended stock turnover (DTVR). From our regressions it was found out that the Implied Volatility and the detrended stock turnover are both negatively associated with the future correlation between stock and bond returns. Furthermore, it was found out that bond returns tend to be relatively high during days when Implied Volatility increases. The above findings have implications for understanding that times of high stock market uncertainty are also times with the relative attractiveness of stocks and bonds. Therefore, there is a positive effect of implied volatility of stocks on expected bond returns, since investors switch to bonds.

2. INTRODUCTION

Option prices reflect both economic and uncertainty and market perceptions about the balance of risks. Implied Volatility is often used by market participants as one measure of economic uncertainty and risk reversal as one measure of the balance of risks, which reflects expectations of the direction of the market. The main aim of the project is to investigate the role of the implied volatility and risk reversal in the correlation between bond and stock returns. A number of studies have found evidence of time variation in the correlation between stocks and bonds. Although, this correlation is positive but small on average, there are times when stocks and bonds are highly correlated and times when this correlation becomes negative. Recent examples are the South-East Asian Crisis in 1997, the Russian crisis in 1998 and the last recession 2001-2003, when stock and bond markets moved in opposite directions.

The main hypothesis, which was investigated in this project, is whether there is a flight-to-quality effect in bond returns. The later was found out that it holds truth and furthermore it was proved there was a positive effect of implied volatility of stocks on expected bond returns. Since implied stock volatility is negatively related to expected stock returns, the existence of a flight-to-quality implies a negative effect of stock implied volatility on the conditional correlation between bond and stock returns. The hypothesis above was tested empirically by estimating the correlation between stock and bond returns, conditional on implied stock market volatility.

The data selected for the project was over the period 1986-2005 since the Chicago Board Option Exchange's Volatility Index was first reported in 1986. Furthermore according to the OECD Economic Outlet the inflation in USA was modest over the specific period. The stock market crash took place in October

1987; therefore the sample is divided into sub periods in order to avoid the impact of the crash for the whole sample. The sub period samples were:

12/86 to 6/93 (1st sub period)

7/93 to 12/00 (2nd sub period)

1/01 to 12/05 (3rd sub period)

12/86 to 12/00 (4th sub period)

The project is carried out over the daily return horizon since: a) the model of Kodres and Pritsker (2002) is valid for short periods of time, b) the work of Fleming, Kirby & Ostdiek (1998) applies for short time and c) significant stock market changes occur over a trading day.

The project is organized as follows. Sections 2 and 3 provide additional background and related literature, respectively. Section 4 presents the asset allocation models. Section 5 presents the data. Sections 6, 7 and 8 examine the stock bond return dynamics jointly with VIX and stock turnover. Finally, conclusions are drawn in section 9.

3. BACKGROUND

This project aims at investigating the role of implied volatility and stock turnover in the correlation between stock and bond returns and more specifically for periods of time where this correlation is negative. A number of studies have found that there is evidence of time variation in the correlation between stocks and bonds and although this correlation is positive but small on average there are times when this correlation becomes negative.

In this project data over the1986 to 2005 period is examined in daily and monthly basis, since the Chicago Board Option Exchange's Volatility Index (VIX) is first reported in 1986. Furthermore during this period of time the inflation is modest.

Stock market crashes are social phenomena where external economic events combine with crowd behavior and psychology in a positive feedback loop that drives investors to sell. Generally speaking, crashes usually occur under the following conditions: a prolonged period of rising stock prices and economic optimism, a market where P/E ratios exceed long-term averages, and extensive use of margin debt and leverage by market participants.

There is no numerically-specific definition of a crash but the term commonly applies to steep double-digit percentage losses in a stock market index over a period of several days. Crashes are often distinguished from bear markets by panic selling and abrupt, dramatic price declines.

Figure A, shows the substantial time series variation in the stock-bond returns. The time-series of 22-trading-day correlations between stock and bond returns over t to t+21 days.

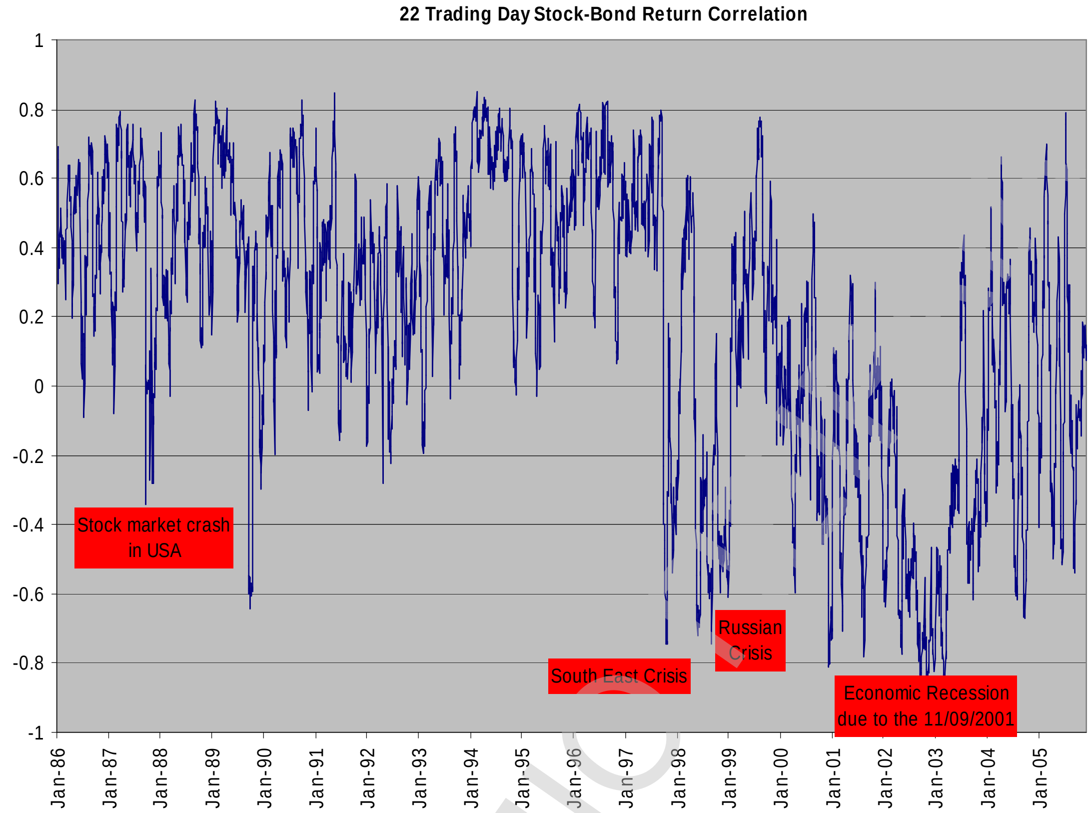

Figure A

From the figure above it can be seen that although the time variation in stock bond returns is positive over the majority of the sample, the stock-bond markets have moved in the opposite directions during the South East crisis in 1997, the Russian crisis in 1998 and the last recession 2001-2003 due to the 9th September of 2001.

Respectively the stock bond return correlation for monthly data can be seen below in Figure B.

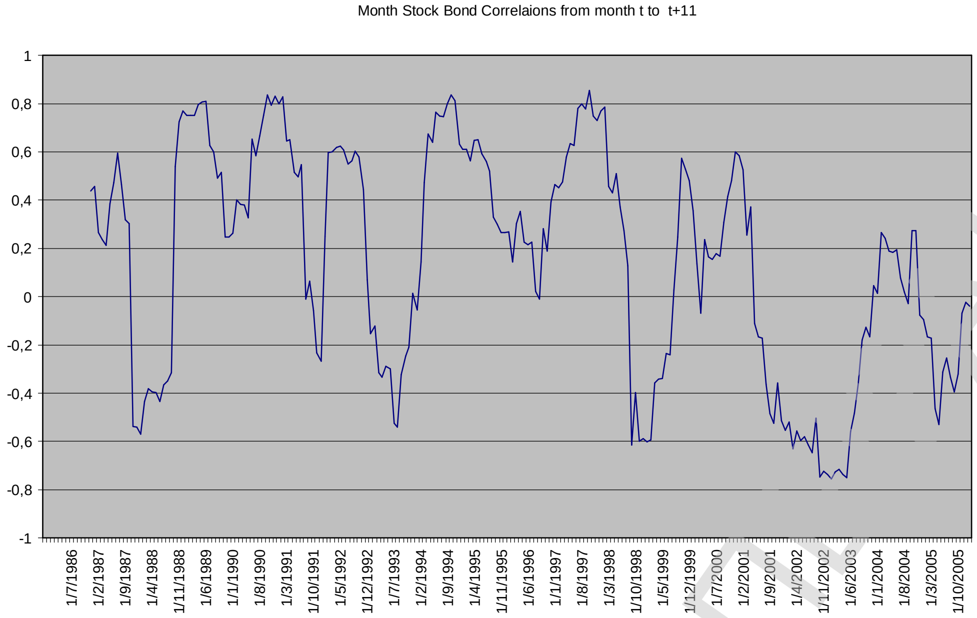

Figure B

On the monthly sample the sample displays similar results to the daily sample. Figure C and Figure D illustrate the CBOE's Volatility index (VIX) in daily and monthly sample respectively. Existing literature suggests that the information in implied volatility provides the best volatility forecast and subsumes the volatility information from historical returns shocks. Furthermore VIX is considered a reflection of market volatility, since it reflects a broad section of stocks.

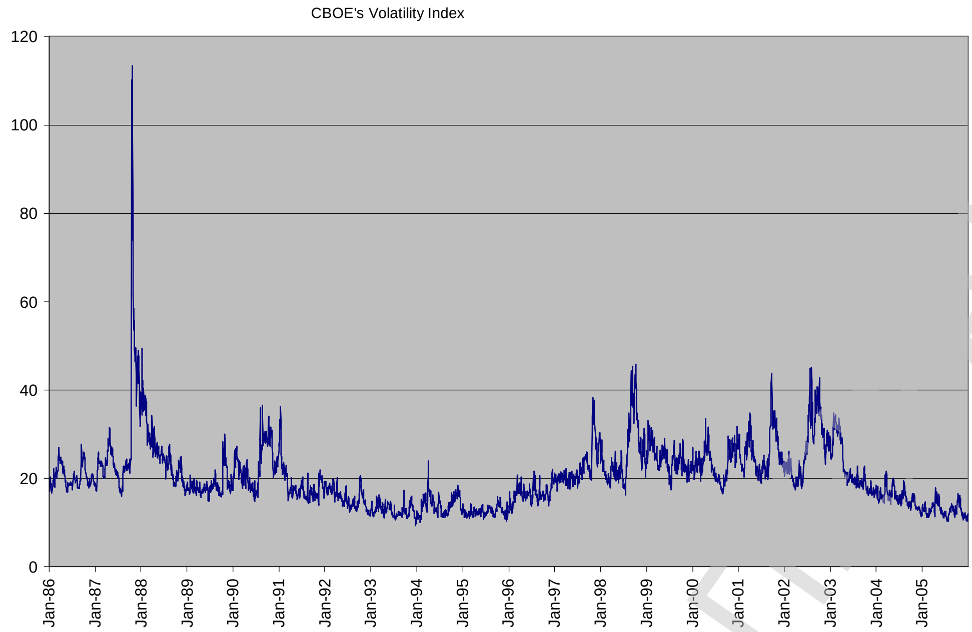

Figure C

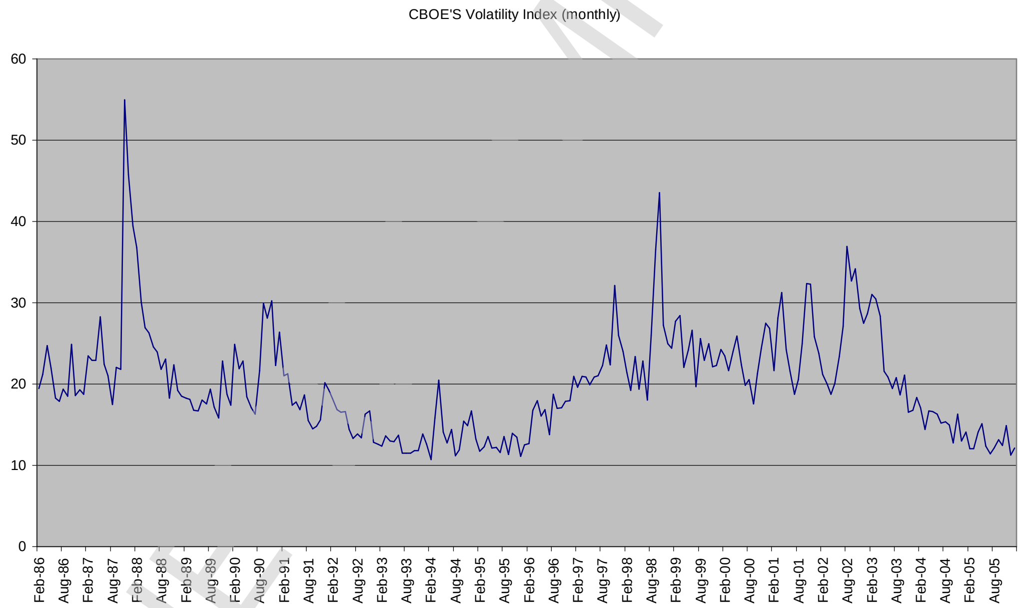

Figure D

From Figures C and D it is apparent that VIX moves in opposite direction with the correlation of bond-stock returns. For instance periods of high VIX seems to be associated with the corresponding negative correlation of bond-stock return. Finally, daily and monthly trading volume samples are derived from Data Stream (TOTMKUS) where trading volume is defined as shares traded over shares outstanding.

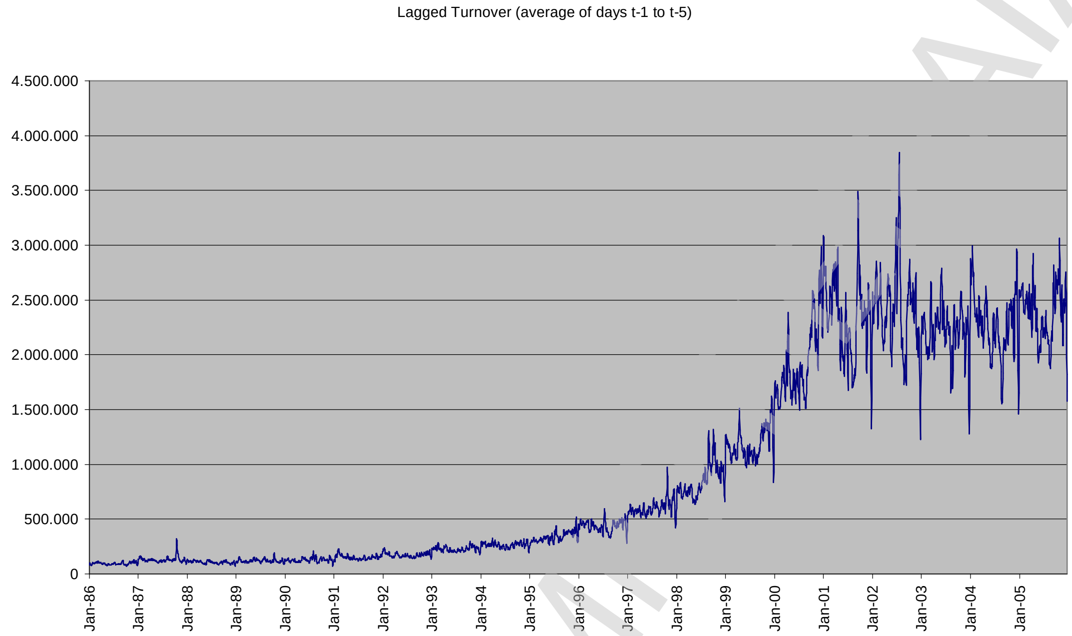

Figure E

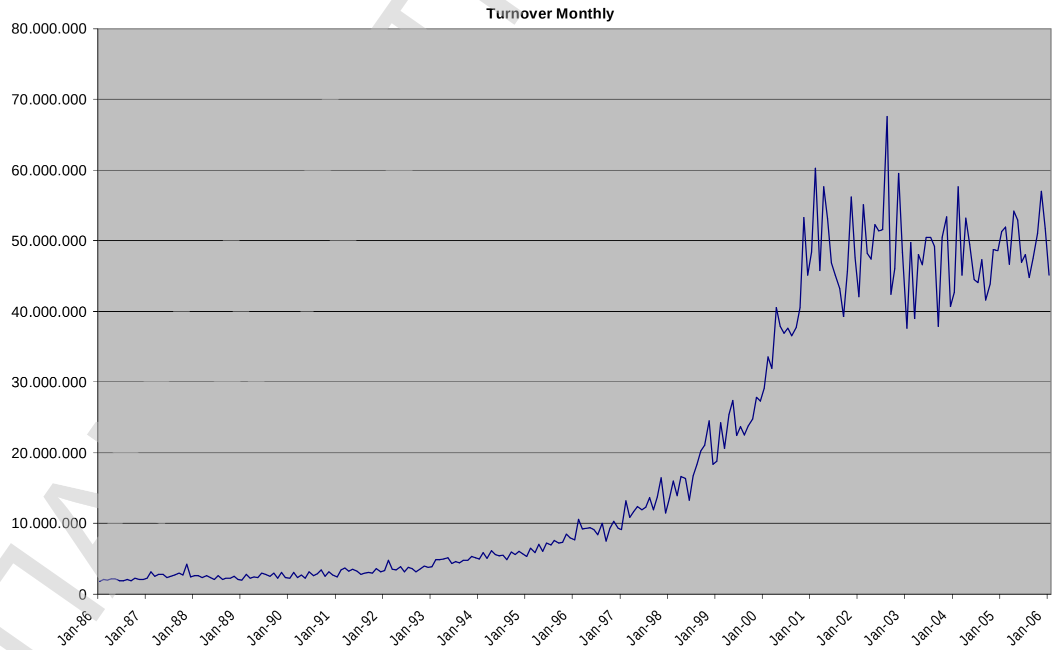

Figure F

Figure E illustrates the average turnover of firms over days t-1 to t-5. There is an obvious increase of the volume on the later years. In addition, the variance of turnover seems to increase with its level during the later years. The growth of turnover in the late Figure F illustrates the average turnover of firms over days t-1 to t-5 on a monthly basis.

Finally, the abnormal stock turnover is considered. Existing literature has suggested that turnover may be informative about the dispersion in beliefs across investors, since daily volume trading is a signal for high frequency shifts in demand. Additionally numerous papers have documented the fact that high stock market volume is associated with volatile returns and that volume tends to be higher when stock prices are increasing than when prices are falling. The de-trended turnover measure in the spirit of Campell, Grossman and Wang (1993) is formed as follows:

$$DTVR_{t-1} = [\tfrac{1}{5}\sum_{i=1}^{5}\ln(TVR_{t-i})] - [\tfrac{1}{245}\sum_{i=6}^{250}\ln(TVR_{t-i})]$$

Where TVR_t is the average turnover of the firms that comprise in a day t for the data which was selected from the Data Stream and the corresponding time series of $DTVR_{t-1}$ is presented in Figure G.

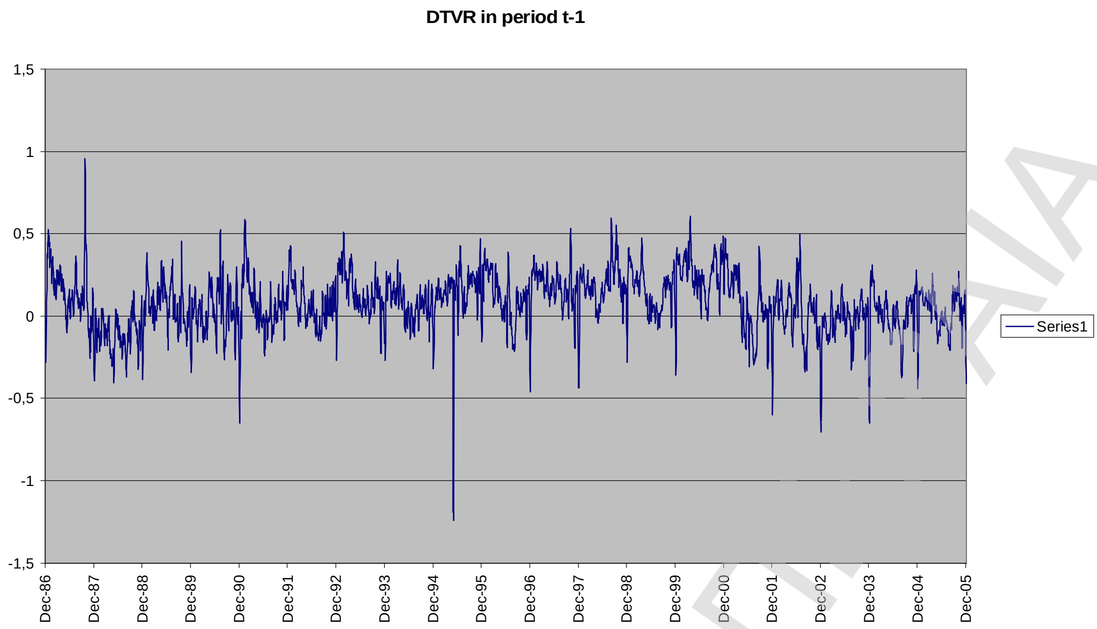

Figure G

The detrended volume, which is plotted in Figure: G shows no trends of in mean or variance, but it does show considerable persistence.

In order to illustrate more thoroughly the results of the stock-bond returns and examine the periods where the correlation of the stock-bond returns is negative the following samples are considered:

A. Subperiod 1/86-6/93

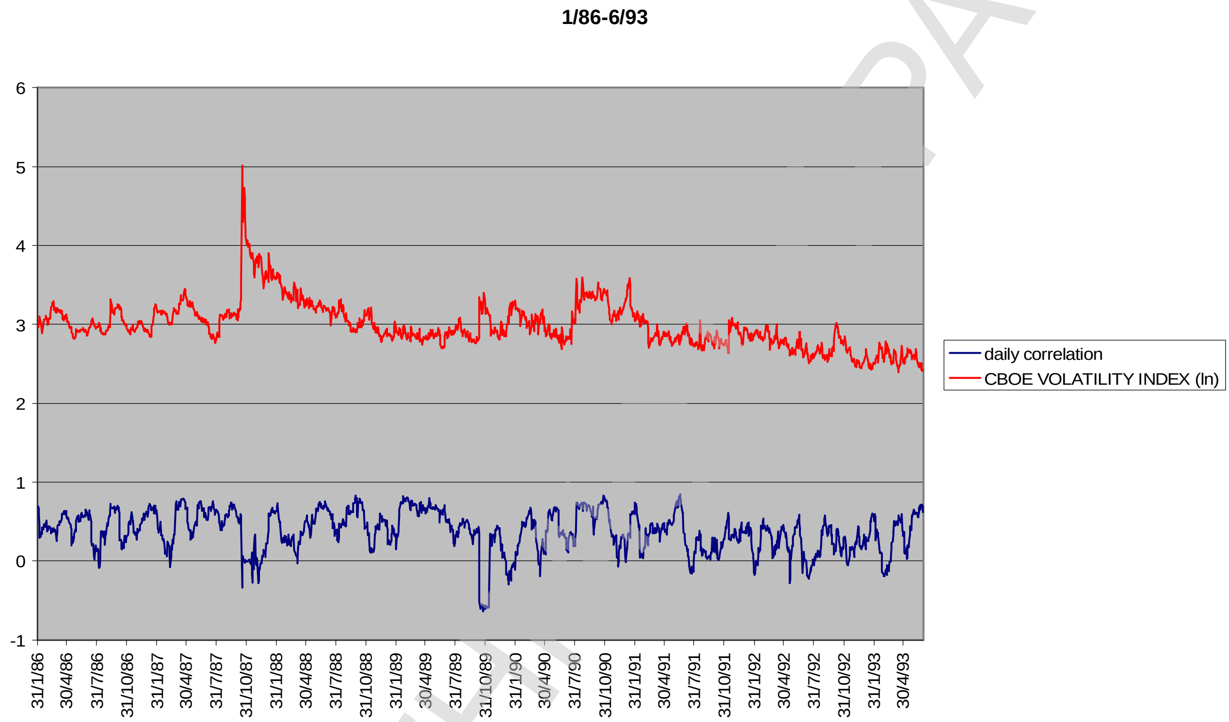

Figure: G

In this period of time it very clear from the diagram that the correlation of stock bond returns and the VIX exhibit a substantial variation over the year 1987. They move in opposite directions due to the October 1987 stock market crash. The crash was an extreme event since it was the largest percentage change in market value in over 29.000 days accompanied by a period of high volatility. Therefore, negative returns lead to larger increases in volatility than do positive returns.

The crash on October 19 1987, a date that is also known as Black Monday, was the day the day that Dow Jones Industrials Average plummeted 580 points, losing 22,6% of its value in a day. Furthermore, the S&P 500 dropped

20,4%. The NASDAQ Composite lost only 11.3% not because of restraint on the part of sellers but because the NASDAQ market system failed

The Crash was the greatest single-day loss that Wall Street had ever suffered in continuous trading up to that point. Between the start of trading on October 14th to the close on October 19, the Dow Jones Industrial Average lost 760 points, a decline of over 31 percent. The 1987 Crash was a worldwide phenomenon. The FTSE 100 Index lost 10.8% on that Monday and a further 12.2% the following day. The most affected was Hong Kong with a drop of 45.8%.

Finally, no definitive conclusions have been reached on the reasons behind the 1987 Crash. The stocks had been in a multi-year bull run and market P/E ratios in the U.S. were above the post-war average. The analysts have also tried to look for external triggering events such as psychological feedback loops and herd behavior. Apart from the general worries of stock market overvaluation, blame for the collapse has been apportioned to such factors as prior news of worsening economic indicators, program trading and portfolio insurance and derivatives.

B. Superiod 7/1993-12/2000

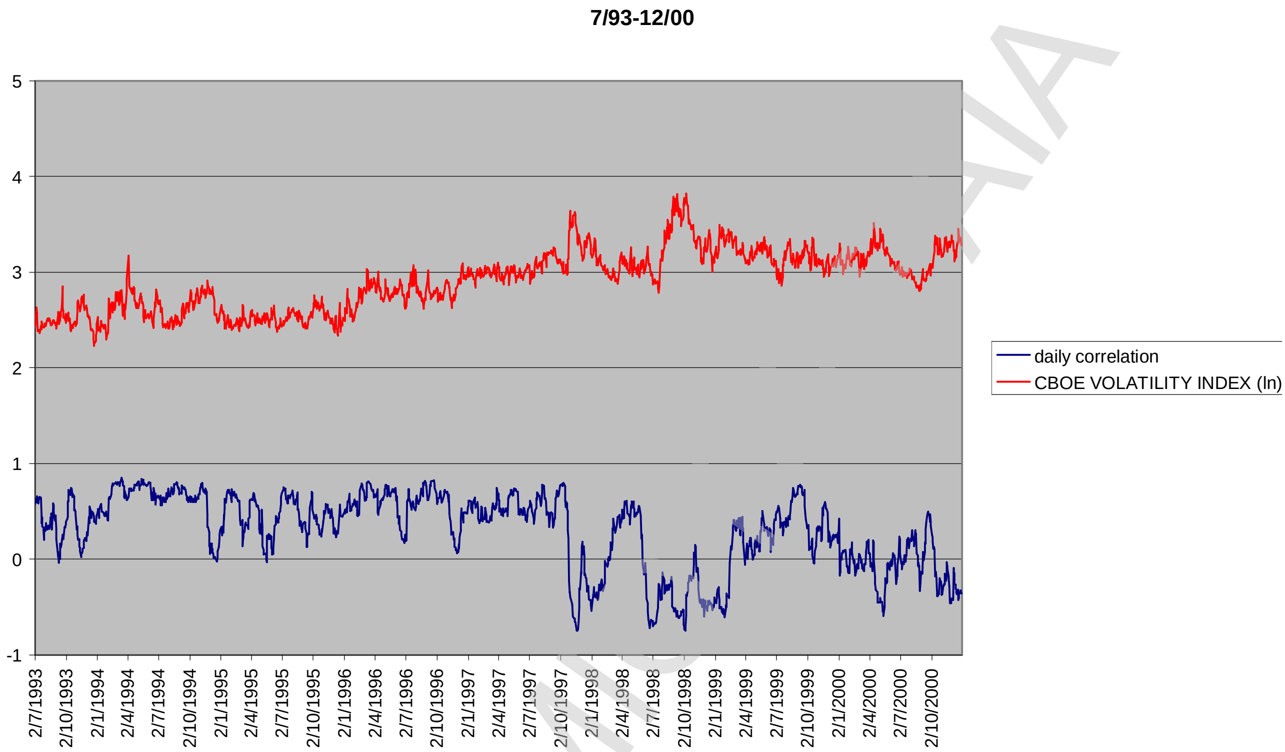

Figure: H

The correlation of stock-bond returns exhibits a negative correlation with the VIX in the years 1997 and 1998. This is due to the The East Asian financial crisis that started in July 1997 in Thailand and affected currencies, stock markets and other asset prices in several Asian countries. The global recession of 1998 which started with the Asian financial crisis, exacerbated Russia's financial crisis. Given the ensuing decline in world commodity prices, countries heavily dependent on the export of raw materials, such as oil, were among those most severely hit.

Although the "East Asian" crisis originated in East Asia, its effects rippled throughout the globe and caused a global financial crisis, with major effects felt as widely as Russia and Brazil, as investors lost confidence in emerging markets.

The East Asian Financial Crisis was a period of economic unrest that started in July 1997 in Thailand and South Korea with the financial collapse of KIA, and affected stock markets, currencies and other asset prices in several Asian countries. It is also commonly referred to as the East Asian currency crisis or locally as the IMF crisis. There is general consensus on the existence of a crisis and its consequences, but what is less clear are the causes of the crisis, its scope and resolution.

Thailand, South Korea and Indonesia were the countries most affected by the crisis. Philippines, Hong Kong and Malaysia were also hit by the slump. Mainland China, Vietnam and Singapore were relatively unaffected. Japan was not affected much by this crisis but was going through its own long-term economic difficulties. However, all nations mentioned above saw their currencies dip significantly relative to the American Dollar, though the harder hit nations saw extended currency losses. Among the countries affected, South Korea was hit hardest.

Whatever the disputed causes, the Asian crisis started in mid-1997 and affected currencies, stock markets, and other asset prices of several Southeast Asian economies. Triggered by events in Latin America, particularly after the Mexican peso crisis of 1994, Western investors lost confidence in securities in East Asia and began to pull money out, creating a domino effect.

C. Superiod 2001-12/2005

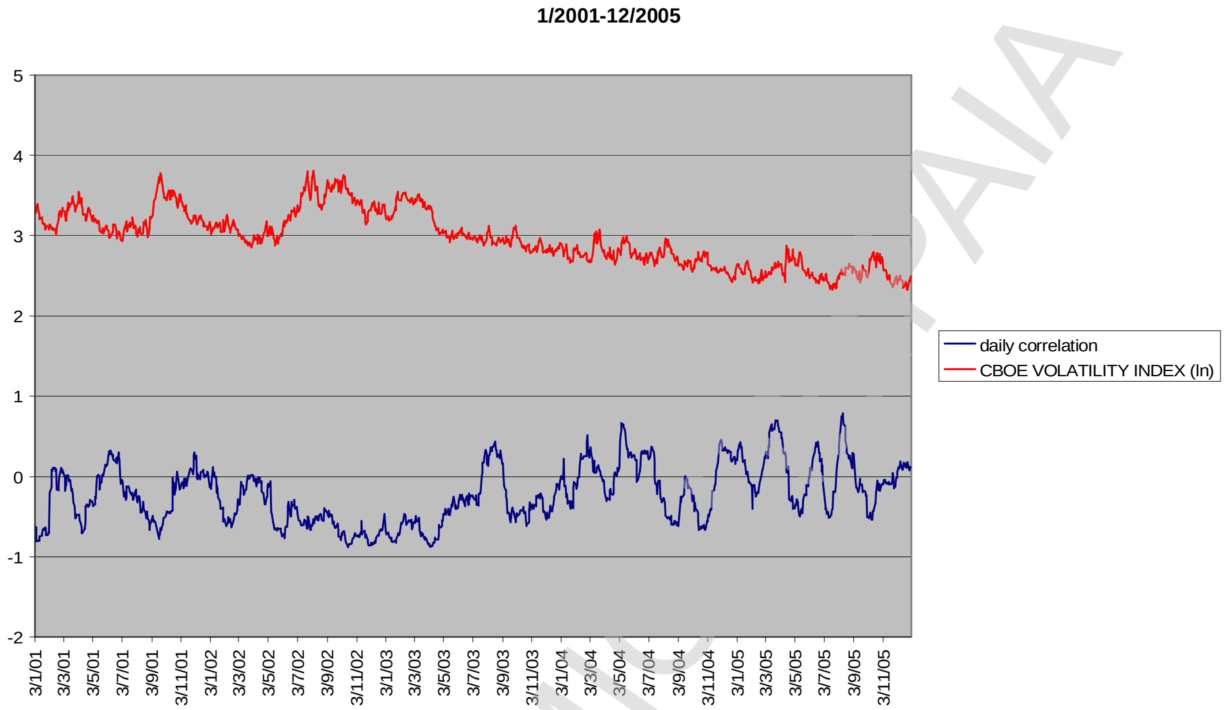

Figure :J

The correlation of stock-bond returns exhibits a negative correlation with the VIX in the year 2001. This is due to the September 11th 2001 and the collapse of the World Trade Center. The VIX reflects the pulse of the financial markets whereas the sustained periods of negative correlation between stock and bond returns depicts the high stock market uncertainty.

Using the stock market as a benchmark, the recession began in March 2000 when the NASDAQ index crashed following the collapse of the Dot-com Bubble. The Dow Jones Industrial Average was relatively unscathed by the NASDAQ's crash until the September 11, 2001 terrorist attacks, after which the Dow Jones Industrial Average suffered its worst one-day point loss and biggest one-week losses in history. The market rebounded, only to crash more once in the final two quarters of 2002. Finally, in the final three quarters of 2003, the market finally rebounded permanently, agreeing with the unemployment statistics that the recession lasted from 2001 through 2003.

4. RELATED LITERATURE

The correlation of stock and bond returns is a major factor in investors' diversification and asset allocation decisions. Over the long run the correlation between stock bond returns is positive but low and the reason is described by Campell and Ammer (1993). However, a number of studies have found evidence of substantial time variation in the correlation of stock-bond returns. Furthermore there are short periods of time that the correlation between stock bond returns is negative, (Fleming, Kirby & Ostdiek 2002, Li 2002, Hartmann, Straetmans & Devries 2001).

Based on the findings of the paper (Campell & Ammer, 1993), the only common component in both assets is the news about real interest rates. Increases in long run expected inflation tend to drive the stock market up and the bond market down. However, in our project the sample selected is 1986-2005 and the inflation has relatively little variability over the whole sample. Nonetheless, it can be noticed sizable time-variation in correlation of the stock-bond returns, including periods of negative correlation. (Figure A).

Single bond or stock market crashes are relatively rare events, but the conditional probabilities of having a crash in a market given that one occurred in another market are markedly higher, showing the relevance of joint crises or contagion, (Hartmann, Straetmans & Devries 2001). On the same paper, it was suggested that simultaneous crashes in stock markets are about two times more likely than in bond markets.

Therefore, other pricing influences are considered such as cross market hedging influences, Kodres and Pritsker (2002). In their paper, a rational expectations model of financial market is introduced and it provides an explanation for the cross-sectional and time series pattern of financial contagion. This contagion of the model is defined as a price movement in one market resulting from a shock in another market. Their results shed light on the reason that contagion is more likely to appear during times of financial and exchange rate crises and during times of the absence of public news. More specifically, the investors respond to shocks in one market by optimally readjusting their portfolios in other markets, hence transmitting the shocks and generating the financial contagion.

Generally, there is evidence that investors tend to be more uncertain about the future growth rate of the economy during recessions therefore it is accompanied with a higher volatility of stock returns. Veronesi (1999) suggests a model that explains the investors' behavior regarding uncertainty, and how the later may greatly impact the volatility of stock returns. In other words, the willingness of investors to hedge against changes in their level of uncertainty makes the price of the assets more sensitive to news in good times than in bad times. More analytically, when investors believe that times are good, a bad piece of news decreases future expected dividends and increases the investors' uncertainty. Once the uncertainty arises, the risk-averse investors want to be compensated for bearing more risk and they will require an additional discount on the price of the asset and that will result in the decrease of the assets. On the other hand when investors believe that times are bad, a good piece of news will raise their expectation of future dividend but simultaneously it will raise their uncertainty, therefore the price of the assets will increase.

During periods of high uncertainty (over both inflation and earnings growth), investors' expectations tend to react more swiftly to news, affecting both variances and covariances of asset returns, thus affecting the volatility of assets (David & Veronesi 2004). Their empirical results show that their constructing measures of uncertainty about future inflation and future earning growth are statistically significant in forecasting future variances and covariances of stock-bond returns. With the use of these uncertainty measures, about half the variation in the volatility of Treasury bond returns and the covariance of stock-bond returns can be predicted for the following year or two.

In another study of Veronesi (2004), the unconditional and conditional properties of asset returns are explained through the concepts of "belief dependent" and "aversion to state-uncertainty". The "belief dependent" utility function is depended on the subjective belief on an underlying partially observable state of nature, whereas the aversion to the wider subjective distribution on the underling state is the "aversion to state-uncertainty". His empirical results suggest that aversion to state uncertainty will yield to higher expected returns and volatility but lower interest rates.

It is suggested that the economic-uncertainty is positively related to the implied volatility from options, (David, Veronesi 2002). Their results show that the implied volatility is higher in times investors are more uncertain about the state of earnings growth.

Furthermore, the results in the paper of Kodres and Pritsker (2002) shed light on the cross-market hedging influences. A 'flight to quality' refers to the movement where the investors are worried about the safety of their portfolios, therefore they re-adjust their portfolios to include more safe assets and fewer risky assets. Furthermore by saying 'flight to quality' in the market, it is meant that a crash in stock markets accompanied by a boom in government bond markets.

In the project, two measures of stock market uncertainty are used for the empirical work: a) the Chicago Board Option Exchange' Volatility Index (VIX) and b) an abnormal stock turnover.

a) The lagged implied volatility index is used to measure the changes in perceived stock market risk and uncertainty. The VIX is considered to be an objective, observable and dynamic measure of stock market uncertainty. The information in VIX provides the best volatility forecast and subsumes volatility information from historical return shocks. Further studies, examine the information in implied volatility and in 5-minute intra-day returns and they reinforce that the implied volatility provide better information about future volatility (Blair, Poon and Taylor 2001; Christensen and Prabhala, 1998; and Fleming, 1998). According to the paper of Fleming, Ostdiek and Whaley (1995), the VIX index represents the implied Volatility of an at the money option on the S&P 100 index with 22 trading days to expiration. The CBOE's VIX is the result of the weighted average of the implied volatilities of eight options, calls and puts at the two strike prices closest to the money and the nearest expirations.

b) The stock turnover contains information about the dispersion in beliefs across the investors and it also related to their assets' allocation. Trading volume is the reflection of the process through which information is incorporated into stock prices and moreover volatility is very sensitive to new information. Furthermore, Veronesi argued that periods with economic uncertainty are also likely to be periods with higher dispersion in beliefs across the investors.

5. ASSET ALLOCATION MODELS

The asset allocation is the practice of dividing resources among different categories such as stocks, bonds, mutual funds, investment partnerships, real estate, cash equivalents and private equity. An investor can lessen risk because each asset class has a different correlation to the others. For instance when stocks rise, bonds often fall. There an asset allocation model determines the amount of an investor's total portfolio placed into each class. The asset allocation models are designed to reflect the personal goals and risk tolerance of the investor. Additionally, individual asset classes can be sub-divided into sectors. Thus if the asset allocation model calls for 40% of the total portfolio to be invested in stocks, the portfolio manager may recommend different allocations within the field of stocks, such as recommending a certain percentage in large-cap, mid-cap, banking, manufacturing, etc.

Furthermore, the asset allocation model is determined by need. Every person depending on his/her needs invests in different asset categories according to what his/her objectives are. For example, young corporate employees are more interested in building wealth, since they can afford to ignore market fluctuations and they do not depend upon their investments to meet their daily living expenses. (A portfolio heavily concentrated in stocks, under reasonable market conditions, is the best option for these types of investors). On the other hand, elderly people who own an amount of money with no other source of income want to place a significant portion of their wealth in fixed income obligations that will generate a steady source of retirement income for the remainder of their lives.

Most of the asset allocation models fall somewhere between four objectives: preservation of capital, income, balanced, or growth.

Preservation of Capital Model

The preservation of capital model is designed for investors who expect to use their cash within the following year and do not wish to risk losing even a small percentage of principal value for the possibility of capital gains. This particular type of allocation model is usually chosen by investors who plan on paying for something in the immediate future, such as purchasing a house or acquiring a business. Furthermore, the preservation of capital model portfolios are usually composed by cash and cash equivalents. Finally, the biggest danger is that the return earned may not keep pace with inflation, eroding purchasing power in real terms.

Income Model

The income model portfolios are designed to generate income for their owners often consist of investment-grade, fixed income obligations of large, profitable corporations, real estate, treasury notes, and, to a lesser extent, shares of blue chip companies with regular dividend payments. The typical income-oriented investor is one that is nearing retirement whose need for cash in hand for living expenses is of primary importance.

Balanced Model

The balanced model is a model which is between the income and growth asset allocation model. The balanced portfolio is considered to be the best option not for financial reasons, but for emotional by most people. The balances model portfolios attempt to strike a compromise between long-term growth and current income. Therefore, the balanced portfolios tend to divide assets between medium-term investment-grade fixed income obligations and shares of common stocks in leading corporations, many of which may pay cash dividends.

Growth Model

The growth asset allocation model is designed for those that are just beginning their careers and are interested in building long-term wealth. The investors are likely to increase their position each year by depositing additional funds. The assets are not required to generate current income because usually the owners are actively employed, living off their salaries for the day to day expenses. Usually, growth model portfolios (sometimes even up to one hundred percent) invest in stocks.

Regarding to the models above, it can be easily understood that investors who are actively engaged in an asset allocation strategy will find that their needs change as they move through the various stages of life. Therefore it is commonly recommended by their professional money managers to switch over a portion of their assets to a different model several years prior to major life changes.

6. DATA DESCRIPTION AND STATISTICS

The daily bond returns are derived from the US Treasury Benchmark bond 10 Years. One of the main reasons that 10 year Treasury bonds are examined as opposed to securities with longer maturities is due to Fleming's paper (1997). Based on the later paper, the10 year securities and the 30 year securities are 17% and 3% respectively of the total trading. The daily stock returns are taken from the DataStream and represent the US Market – Price Index (TOTMKUS).

The total number of observations is 4798 after the merger of the stock-bond returns. The merger was necessary since there were days in our data that there was not available yield for the bonds (such as Federal Bank Holidays), while stock market was still open.

Furthermore, the daily horizon was chosen for various reasons. It has been noticed that sizable changes in stock market uncertainty may occur intraday. Additionally, it seems feasible that the attractiveness of bonds, relative to stocks may experience significant changes within a single day. Thirdly, the use of daily data has been suggested by prior studies and it provides many more observations for our econometric estimation.

6.1. Variation in 22-trading day stock-bond return correlations.: with variation in VIX Level.

The distribution of forward looking correlation of stock bond returns formed from daily data over days t to t+21, following a given value of VIX_{t-1}. For the estimation of the correlations, it is assumed that the expected daily stock and bond returns are zero. Applying this method, extreme returns are prevented. The correlation of $r_{S,B}$ between the Stock and bond returns with expected daily values m_S & m_B respectively and standard deviations s_S & s_B is defined as:

$$r_{S,B} = \frac{\mathrm{cov}(S,B)}{s_S s_B} = \frac{E((S-m_S)(B-m_B))}{s_S s_B},$$

but the covariance can be also written as:

$$\mathrm{cov}(S,B) = E((S-m_S)(B-m_B)) = E(S,S) - m_S m_B$$

and since m_S & m_B are assumed to be zeros then the correlation is:

$$r_{S,B} = \frac{E(SB)}{s_S s_B}.$$

By substituting the corresponding values in excel worksheets the empirical results are shown in the table below. We estimate these measures for a rolling 22-trading day period, instead of a traditional one-month period, as this allows us to capture sizable changes in stock market liquidity that may occur over a trading day and secondly with the 22 consecutive trading day period we get enough observations to study the return dynamics.

Furthermore the 22 trading day period is selected since this horizon corresponds to the maturity of the VIX index.

VIX Criterion	**Observations**	**Proportion of correlations <0**	**Average correlation**
All	N=5046	29,28%	0,19883
VIX<20%	N=2818	18,99%	0,16755
VIX>25%	N=945	53,76%	-0,0105
VIX>30%	N=388	63,63%	-0,00123
VIX>35%	N=178	60,67%	-0,0034
VIX>40%	N=76	57,89%	-0,000078

Table A

In the Table A, it can be seen that the forward looking correlations between stock-bond returns vary negatively and substantially with the VIX level. Expected returns change over time as the investors' level of uncertainty changes. The investors rationally anticipate that during periods of high uncertainty their expectations of future cash flows tend to react more swiftly to news. The predictable higher sensitivity to news tends to increase the asset price volatility, against which risk-averse investors are willing to hedge. The reaction of prices to news tends to be high in good times and low in bad times. Therefore, the volatility of percentage returns tends to be higher in bad times than in good times and it is maximized during periods of highest uncertainty. Thus, when VIX_{t-1} is less than 20%, then there is 18,9% chance of observing a subsequent negative correlation between stock and bond returns over the next month. However, when VIX_{t-1} is greater than 25%, then there is 53,7% chance of observing a subsequent negative correlation between stock and bond returns over the next month (days t to t+21).

Secondly, for the sample of our project it was a found that bond returns tend to be relatively high during periods when VIX increases. The results are shown in the table B, below:

VIX Criterion	**Observations**	**Average daily bond returns**
All	N=5046	0,00643%
VIX>25%	N=945	0,00598%
VIX>30%	N=388	0,07393%
VIX>35%	N=178	0,14319%
VIX>40%	N=76	0,29923%

Table B

The average daily 10 year bond returns are 0,0064%, however the average daily bond returns are 0,074% when the VIX>30% and 0,14% when the VIX>35%. Thus, our results reinforce the theory of "Flight to quality". During periods with high stock market uncertainty, investors frequently revise their estimate of the relative attractiveness of stocks versus bonds. Hence, the investors switch to bonds which are regarded as a save haven. Bond prices increases as a result of the increased demand therefore bond prices increase.

6.2. Variation in 22-trading day stock-bond return correlations.: with variation in Detrended Stock Turnover

Cambell, Grossman and Wang (1993) on their paper investigated the relationship between aggregate stock market trading volume and the serial correlation of daily stock returns. Their model implies that if there is a high volume, the subsequent return reversal will result in a high volatility, therefore that the trading volume and subsequent volatility are positively related. Their model was based on the phenomenon in which some investors desire to sell stock for exogenous reasons, other investors who are risk averse utility maximizers, are willing to accommodate the selling pressure thus resulting in a certain trading volume, but they demand a reward in the form of a lower stock price and a higher expected stock return in the future.

The relation of the detrended stock turnover with the subsequent 22 trading day stock-bond correlation is summarized on table B below. The DTVR criterion refers to the percentile range of the detrended stock turnover $DTVR_{t-1}$, which is derived from the equation below:

$$DTVR_{t-1} = [\tfrac{1}{5}\sum_{i=1}^{5}\ln(TVR_{t-i})] - [\tfrac{1}{245}\sum_{i=6}^{250}\ln(TVR_{t-i})]$$

where TVR_t is the average turnover of the firms that comprise in a day t for the data which was selected from the Data Stream. The distribution of forward looking correlation of stock bond returns formed from daily data over days t to t+21, following a given value of $DTVR_{t-1}$. For the estimation of the correlations, it is assumed that the expected daily stock and bond returns are zero. Applying this method, extreme returns are prevented.

DTVR Criterion	**Observations**	**Proportion of correlations <0**	**Average correlation**
All	N=4798	31%	0,3078
95th to 100th percentile	N=239	15,06%	0,0188
90th to 100th percentile	N=479	7,52%	0,0428
75th to 100th percentile	N=1199	7,01%	0,1007
0th to 25th percentile	N=3599	38,71%	0,0842

Table C

In the Table C, it can be seen that these forward looking correlations between stock-bond returns are not consistent negatively with the $DTVR_{t-1}$ criterion. For the upper 95th percentile of the DTVR criterion there is a 15% chance of observing a subsequent negative correlation between stock-bond returns. The rest of the results do not satisfy the theory of the hypothesis, since when the DTVR criterion is on the 0th – 25th percentile, there is a 38,7% chance of observing a negative correlation between the stock-bond returns. Therefore, the paper (Campell, Grossman and Wang (1993)) we were based on to examine whether the stock turnover is negatively correlated with the future correlation of stock-bond returns, does not hold truth for the data sample we have chosen. Their model is not robust for the stock turnover of our project, since in our turnover we examine the whole sample of the index. In their model they consider the lagged stock turnover $DTVR_{t-1}$, which represents the turnover of the largest size based firms on their market capitalization. However, the data that is used for the implementation of the project the turnover does not represent only the large size firms but the overall.

7. THE STOCK BOND RELATION AND IMPLIED VOLATILITY

The VIX index represents the implied Volatility of an at the money option on the S&P 100 index with 22 trading days to expiration, (paper of Fleming, Ostdiek and Whaley (1995)). The CBOE's VIX is the result of the weighted average of the implied volatilities of eight options, calls and puts at the two strike prices closest to the money and the nearest expirations. The CBOE's Volatility index (VIX) is also referred to as a market Fear Index.

In order to estimate the variation of stock-bond returns relation with the lagged VIX the regression below is considered:

$$B = (a_0 + a_1 \ln(VIX_{t-1}) + a_2 CV_{t-1})S + v_t \quad \text{(I)}$$

Where B are the daily 10 year T-bond returns

S are the daily stock returns

$\ln(VIX_{t-1})$ in the lagged natural log of the implied volatility,

CV_{t-1} is the correlation of stock-bond returns from period t-1 to t-22

v_t is the residual &

$a_{0,} a_1 \& a_2$ are the estimated coefficients.

The regressions are estimated by OLS and the T- statistics are in the brackets. The t-statistic tests if a coefficient is zero (that if the variable does not belong in the regression) and it is the ratio of the coefficient to its standard error. If the t-statistics exceeds one in magnitude it is at least two thirds likely that the true value of the coefficient is not zero and if the t-statistic exceeds two in magnitude it is at least 95% likely the coefficient is not zero.

	12/86-12/05	12/86-12/00	12/86-06/93	07/93-12/00	1/01-12/05
a_0	0,031 (5,218)	0,081 (12,213)	0,118 (11,99)	0,053 (5,93)	-0,123 (-11,956)
R^2	0,556%	3,9%	7,79%	17,59%	10,22%

Panel A: Restrict $a_1 \& a_2 = 0$

In the Panel A, we substitute in the equation (I) $a_1 \& a_2 = 0$, so that the variation of stock and bond returns can be examined. The results indicate that there is positive relation between the stock and bond returns except for the subperiod of 1/01-12/05. Due to the September 11th events and the collapse of the World Trade Center Building for a long period of time the returns of stocks and bonds were moving in opposite directions.

	12/86-12/05	12/86-12/00	12/86-06/93	07/93-12/00	1/01-12/05
a_0	0,465 (10,413)	0,5612 (11,66)	0,396 (6,515)	1,637 (17,98)	0,302 (2,943)
a_1	-0,134 (-9,814)	-0,146 (-10,086)	-0,081 (-4,624)	-0,498 (-17,47)	-0,1209 (-4,145)
R^2	2,5%	6,51%	8,9%	15,03%	11,13%

Panel B: Restrict $a_2 = 0$

For the Panel B, the assumption that the $a_2 = 0$, was made for the equation (I). In this case, it is found that the stock bond return relation varies negatively with the lagged VIX throughout the period.

	12/86-12/05	12/86-12/00	12/86-06/93	07/93-12/00	1/01-12/05
a_0	0,184 (4,166)	0,1202 (2,525)	0,002 (0,031)	0,379 (3,066)	-0,258 (-2,225)
a_1	-0,046 (-3,492)	-0,025 (-1,794)	0,014 (0,775)	-0,103 (-2.658)	0,09 (2,35)
a_2	0,295 (22,58)	0,396 (25,466)	0,383 (15,322)	0,366 (14,27)	0,369 (9,269)
R^2	11,87%	20,61%	20,02%	23,06%	16,85%

Panel C

In Panel C, we investigate whether information from the lagged VIX remains important when jointly including information from lagged stock bond correlations, estimated from recent stock-bond returns. it can be seen that in 3 of the 5 subperiods the estimated a_1 is negative and statistically significant. The estimated a_2 coefficients are positive and significant for all the different periods. Thus the negative relation between lagged VIX and stock-bond co-movements remains reliably evident, even when directly considering the information from recent stock bond return correlations.

8. THE STOCK BOND RELATION AND STOCK TURNOVER

In order to estimate the variation of stock-bond returns relation with the lagged detrended stock turnover the regression below is considered:

$$B = (a_0 + a_1 DTVR_{t-1} + a_2 CV_{t-1})S + v_t \quad \text{(II)}$$

Where B are the daily 10 year T-bond returns

S are the daily stock returns

$DTVR_{t-1}$ in the lagged detrended stock turnover,

CV_{t-1} is the correlation of stock-bond returns from period t-1 to t-22

v_t is the residual &

$a_{0,} a_1 \& a_2$ are the estimated coefficients.

The regressions are estimated by OLS and the T- statistics are in the brackets. The t-statistic tests if a coefficient is zero (that if the variable does not belong in the regression) and it is the ratio of the coefficient to its standard error. If the t-statistics exceeds one in magnitude it is at least two thirds likely that the true value of the coefficient is not zero and if the t-statistic exceeds two in magnitude it is at least 95% likely the coefficient is not zero.

	12/86-12/05	**12/86-12/00**	**12/86-06/93**	**07/93-12/00**	**1/01-12/05**
a_0	0,031 (5,218)	0,081 (12,213)	0,118 (11,99)	0,053 (5,923)	-0,123 (-11,95)
R^2	0,556%	3,9%	7,79%	17,59%	10,21%

Panel D: Restrict $a_1 \& a_2 = 0$

In the Panel D we substitute in the equation (I) $a_1 \& a_2 = 0$, so that the variation of stock and bond returns can be examined. The results indicate that there is positive relation between the stock and bond returns except for the subperiod of 1/01-12/05.

	12/86-12/05	**12/86-12/00**	**12/86-06/93**	**07/93-12/00**	**1/01-12/05**
a_0	0,465 (10,413)	0,136 (15,900)	15,53 (13,63)	0,143 (9,732)	-0,125 (-11,513)
a_1	-0,134 (-9,814)	-0,296 (-9,993)	-0,228 (-6,285)	-0,419 (-7,658)	0,069 (1,256)
R^2	2,5%	6,47%	9,89%	4,62%	10,28%

Panel E: Restrict $a_2 = 0$

In the Panel E, the results on the variation of the equation (II) are reported with only the $DTVR_{t-1}$ information since we make the assumption $a_2 = 0$. In this case, it is found that the stock bond return relation varies negatively with the lagged VIX for the samples of our experiment. The only exception is the subperiod of 1/01-12/05.

	12/86-12/05	**12/86-12/00**	**12/86-06/93**	**07/93-12/00**	**1/01-12/05**
a_0	0,184 (4,166)	0,051 (5,937)	0,063 (5,032)	1,136 (10,01)	0,006 (0,3962)
a_1	-0,046 (-3,492)	-0,074 (-2,605)	-0,065 (-1,795)	-0,342 (-9,608)	0,139 (2,584)
a_2	0,295 (22,58)	0,393 (25,588)	0,363 (14,75)	0,176 (7,76)	0,322 (10,18)

R^2	11,87%	20,69%	20,14%	17,5%	16,92%

Panel F

In the Panel F, reports the results in the case that CV_{t-1} is the lagged correlation of stock-bond returns for the period t-1 to t-22. The estimated coefficients of a_1 remain negative and statistically significant for the whole sample and for 3 of the sub periods. The estimated coefficient of a_2 remains positive and significant for the all the periods.

9. CONCLUSIONS

In this project the time variation in the co-movements between stock bond returns was studied and potential links to stock market uncertainty was explored. Implied Volatilities form equity index options, daily Treasury bond returns and stock market returns were examined for the period of 1986 to 2005.

The time series variation that is apparent in the stock-bond return relation can not be the result of changes in inflation expectations, since the inflation during the sample of the project is modest. Reinforcing earlier papers, it is found that the correlation of a daily stock and bond return tends to be sizably positive following low uncertainty periods and modestly negative following high uncertainty.

David and Veronesi (2002) demonstrated that the uncertainty about inflation and firm earnings explain some of the changes in the variances and co variances of stock-bond returns. Empirical results indicate that the major trends in stock-bond correlations are determined primarily by uncertainty about expected inflation whereas the unexpected inflation and the real interest rate are significant to a lesser degree. (Li, 2002).

Our empirical investigations uncover striking results. We found out that the level of VIX and the detrended stock turnover are both negatively associated with the future correlation between stock and bond returns.

Secondly, we found out that bond returns tend to be relatively high during periods when VIX increases.

Overall, the findings suggest that stock market uncertainty has cross-market pricing influences that play an important role in joint stock-bond price formation. In addition, our findings suggest that implied volatility and stock turnover may prove useful for financial applications that need to understand and predict stock and bond market co-movements.

Periods with high stock uncertainty are also times with higher volatility in the relative attractiveness of stocks versus bonds. Therefore, higher stock market uncertainty suggests higher probability of a negative stock bond return correlation in the near future.

Finally, times of high stock market uncertainty are also times of stock market declines. In such times it has been noticed that there is “flight to quality”. Furthermore, during times when volatility is expected to increase, investors should increase their bond holdings relative to their equities.

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