



LOUVAIN
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LOUVAIN SCHOOL OF MANAGEMENT

**CORRELATION BETWEEN BOND MARKET AND STOCK MARKET RETURNS:
EMPIRICAL ANALYSIS FROM THE AMERICAN AND GERMAN MARKETS**

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Research Master's Thesis submitted by
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With a view of getting the degree
Master 120 in Business Engineering

ACADEMIC YEAR 2015-2016

Abstract

Using monthly stock and bond returns data in the past twenty years for both the United States and Germany, this master's thesis investigates the time-varying correlation between the two main asset classes. Emphasis is placed on the evolution of this relationship during periods of market turmoil; characterized by the "flight-to-quality" phenomenon. The empirical results indicate that crisis episodes, stock market uncertainty (as measured by the VIX and the VDAX) and globalization affect negatively the stock-bond correlation. By contrast, the term spread has a positive impact on both relationships. The TED spread and oil prices, for their part, only influence the American interaction. This research is motivated by its critical implications for asset allocation, portfolio optimization and risk management.

Acknowledgements

Foremost, I wish to express my gratitude to my supervisor, Pr. Léonardo Iania, for his patience, availability and guidance throughout this year.

Special thanks to my reader Pr. Emmanuel Van Rillaer for his willingness and precious help; Arnaud Delaunay, financial analyst at Leleux Associated Brokers and Xavier Servais, financial analyst at Delande et Cie. for their help, time and valuable advice all along this master's thesis. Their knowledge on financial markets was a great help for this report. I would also like to thank Arnaud Monseur for its availability and aid.

I express my gratitude to my parents, Ernest Lambert and Bénédicte Nyssen and my grandparents, Hubert Nyssen and Anne-Marie François for their support through all these years.

Last but not least, my sincere thanks go to my friends, particularly to Héléne Warnier for her support and to Daniel Paige for his reading and editing.

Table of contents

Chapter 2: Literature review	3
2.1. Time-varying stock-bond correlation	3
2.2. Macroeconomic determinants of the stock-bond correlation	4
2.2.1. Business cycle	4
2.2.2. Major crisis episodes	5
2.2.3. Flight-to-quality or decoupling phenomenon.....	9
2.2.4. Globalization	11
2.2.5. Stock market uncertainty: the VIX index.....	12
2.2.6. TED spread.....	13
2.2.7. Default risk spread	14
2.2.8. Term spread.....	15
2.2.9. Economic indicators	17
2.2.9.1. Short term interest rate and inflation	17
2.2.9.2. Purchasing Managers' Index (PMI)	22
2.2.9.3. Industrial production.....	24
2.2.9.4. Consumer Confidence	24
2.2.10. Oil price.....	26
2.2.11. Gold price	27
2.3. Summary of the literature review	28
Chapter 3: Data collection and stock-bond correlation calculations.....	29
Chapter 4: Crisis periods.....	32
4.1. The different types of crisis	32
4.2. Criteria's used to determine the crisis periods.....	33
4.2.1. Stock market value (S&P500 index and DAX index): "CRISIS_B"	34
4.2.2. Gross Domestic Product Value (GDP): "CRISIS_GDP"	35
4.2.3. The LIBOR-OIS spread: "CRISIS_LO"	36
4.2.3.1. LIBOR	36
4.2.3.2. Overnight Index Swap (OIS).....	37
4.2.3.3. LIBOR-OIS spread	37
4.2.4. Index volatility (VIX index and VDAX index): "CRISIS_V"	39

4.3. Crisis variables	40
Chapter 5: Correlation between American and German stock (bond) returns: “- “Globalization”	40
5.1. Correlation between American and German stock returns.....	41
5.2. Correlation between American and German 10-year bond returns	41
Chapter 6: Macroeconomic variables.....	42
6.1. Stock market uncertainty	47
6.2. TED spread	47
6.3. Default risk spread.....	48
6.4. Term spread	48
6.5. Economic indicators	49
6.5.1. Short term interest rate	49
6.5.1.1. Short Term Interest Rate (3-month bond yield)	49
6.5.1.2. Key interest rates provided by the Central Banks	50
6.5.2. Inflation	51
6.5.3. Business conditions	51
6.5.4. Industrial Production	52
6.5.5. Consumer Confidence	53
6.5. Oil price	54
6.6. Gold price.....	55
6.7. Summary of the macroeconomic variables	56
Chapter 7: Non-stationary variables and Augmented Dickey-Fuller (ADF) Test	57
Chapter 8: Regression models.....	58
8.1. Lagged dependant variables	60
8.2. Independent variables	60
Chapter 9: Regression results	61
9.1. Regression results for Model 1	61
9.1.1. The United States	61
9.1.2. Germany	63
9.2. Regression results for Model 2.....	64
9.2.1. Regression results for Model 2 with CRISIS_G	64
9.2.1.1. The United States.....	64

9.2.1.2.	Germany	64
9.2.2.	Regression results for Model 2 with CRISIS_V	65
9.2.2.1.	The United States.....	65
9.2.2.2.	Germany	65
9.3.	Regression results for Model 3	66
9.3.1.	Regression results for Model 3 with CRISIS_G.....	66
9.3.1.1.	The United States	66
9.3.1.2.	Germany.....	67
9.3.2.	Regression results for Model 3 with CRISIS_V.....	67
9.3.2.1.	The United States	67
9.3.2.2.	Germany.....	68
Chapter 10: Tests carried out on the various regressions.		69
10.1.	Tools to determine the presence of residual series correlation : correlograms and Q-statistics	69
10.2.	Tools to determine the presence of ARCH	69
10.2.1.	Correlograms of squared residuals	69
10.2.2.	Engle's ARCH test	70
Chapter 11: Evaluation of the models		70
11.1.	Adjusted R ²	70
11.2.	Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC)..	71
11.3.	Results.....	72
Chapter 12: Conclusion		73
12.1.	Summary of the empirical results	73
12.1.1.	Stock-bond correlation	73
12.1.2.	Crisis and macroeconomic variables.....	74
12.2.	Implications for asset allocation	75
12.2.1.	Portfolio diversification.....	75
12.2.2.	Warning indicators	75
12.3.	Limitations	76
12.3.1.	Sample period.....	76
12.3.2.	Geographic location	76
12.3.3.	Difficulty to find equivalent indicators	76

12.3.4. Data frequency	77
Bibliography	79
Appendices	85

Chapter 1: Introduction

Over the past decades, the analysis of the correlation between stock and bond returns has been an inescapable topic in financial markets since the sign of this relationship plays a pivotal role for asset allocation, portfolio optimization and risk management. Bond returns provide fixed incomes whereas returns on stocks reward investors for taking risk. Therefore, in a dynamic environment, investors can diversify their risk by choosing a portfolio including these two asset classes and by adjusting their proportions (Li (2002), Ilmanen (2003), Aslanidis and Christiansen (2011), Hong et al. (2011), Asgharian et al. (2015)). The recent crisis episodes have proven that investors need to be extremely attentive to the market changes and deeply understand the various factors that could influence the correlation. This is the main reason that led me to conduct this research.

Although it has not always been the case, literature reaches an agreement regarding the time-varying nature of the stock-bond correlation. However, despite the impressive amount of research that has been carried out, no consensus has been reached about the exact drivers of the correlation between the two main asset classes. The relationship should be on average positive since both markets are exposed to similar macroeconomic conditions such as the inflation rate, the economic growth and the real interest rate (Chiang et al. (2014)). Moreover, the literature suggests that the stock-bond correlation presents a slightly positive value over long periods of time. Nonetheless, in periods of market turmoil or weak economic conditions, this trend tends to reverse and sustained periods of negative correlation can be observed (Andersson et al. (2004), Johnson et al. (2013), Acosta-Gonzales et al. (2015)). Some researchers such as Gulko (2002), Baur (2006) and Baele et al. (2014) affirm that these negative episodes coincide with the “flight-to-quality” phenomenon; characterized by a movement of funds from risky assets to safer assets.

The goal of this master’s thesis is to get a grasp on the complex and dynamic relationship between stock and ten-year bond returns. In order to do so, the monthly stock-bond relationship is studied over time and across two developed countries: the United States and Germany. Two different nations are chosen in order to compare the findings. This report tries to determine the sign and the amplitude of the stock-bond correlation over the past two decades and to discover the macroeconomic variables having a positive/negative impact on

the relationship. A particular attention is given to crisis episodes and their impact on the stock-bond correlation.

The S&P500 index, DAX index and ten-year government bonds are employed to determine the monthly stock-bond correlations. The results obtained are analysed over time in order to figure out the sign and amplitude of these two relationships. Then, two dummies variables are created for each country to identify the impact of the crisis episodes on the correlation between stock and bond returns. The first one resumes the information contained in the stock market value, the gross domestic product value and the Libor-OIS spread. The second one is based, for its part, on the stock market uncertainty. Various macroeconomic indicators are also selected from the literature. Next, the effect of these macroeconomic variables/crisis indicators is estimated through three lagged dependent variable models. These models allow one to determine the sign and the impact of the diverse indicators.

The remainder of this master thesis is organized as follows. Chapter 2 provides an overview of the existing literature on the stock-bond correlation. The various macroeconomic variables that could have an impact on the relationship are also presented in this chapter. Chapter 3 and chapter 4 describe the data collection, stock-bond correlation calculations and crisis episodes. Chapter 5 represents the globalization, while a description of the macroeconomic variables over the sample period is available in chapter 6. Chapter 7 explains the Augmented Dickey Fuller test and its applications. Then chapters 8 and 9 exhibit the three lagged dependent variable models and the regression outputs. In chapter 10, different tests are carried out on the results. Chapter 11 evaluates the quality of the models. Finally, chapter 12 provides a summary of the discoveries, their implications for asset allocation and the limitations of this research.

Chapter 2: Literature review

During the past decades, the financial world has paid attention to the correlation between stock and bond returns. The pioneers of this subject are Fama and Schwert (1977), Keim and Stambought (1986) and Campbell and Schiller (1987) (cited in Baeker et al. (2011)). They are followed by a large number of authors, trying to resolve the mystery of the stock-bond correlation.

Since bonds and stocks are the two main asset classes of investment portfolios, the sign of this association plays a pivotal role for asset allocation decisions, portfolio optimization and risk management (Li (2002), Ilmanen (2003), Aslanidis and Christiansen (2011), Hong et al. (2011), Asgharian et al. (2015)).

2.1. Time-varying stock-bond correlation

Although it has not always been the case, the literature reaches an agreement on the time-varying nature of the stock-bond correlation (Campbell (1987), Gulko (2002), Engle and Sheppard (2002), Ilmanen (2003), Connollu et al. (2004), Jones and Wilson (2004) and Li (2004)).

Recently, Johnson et al. (2013) highlight the fact that from 1927 to 2012, the correlation between the S&P500 and the long-term Treasuries has changed signs 29 times, and ranged from -93% to + 86%. Using data from the United States and Germany, Andersson et al. (2004) show that, even if the relation in both countries is positive most of the time, this one can change from positive to negative in a very short period of time. This point of view is supported by Ilmanen (2003) adding that the positive co-movements between stock and bond returns occasionally dipped below zero for extended periods.

To name but a few, Li (2002), Andersson et al. (2004) and Yang et al. (2008) affirm that taking into account the time-varying nature of the stock-bond correlation allows to improve asset allocation and risk management strategies.

Even though several macroeconomic factors can possibly influence this relation; the different authors didn't reach a consensus about the drivers of the time-varying correlation.

2.2. Macroeconomic determinants of the stock-bond correlation

2.2.1. Business cycle

“The business cycle is the fluctuation in economic activity that an economy experienced over a period of time. A business cycle is basically defined in terms of periods of expansions and recessions” (Investopedia.com (2016)).

Schwert (1989) shows that business cycle can explain much of the time variation series as well as the stock market volatility.

During periods of good economic prospects, the correlation between stock and bond returns is positive whereas, in crisis period, this relation becomes negative. Stock markets and bond markets are exposed to similar macroeconomic conditions (inflation rate, real interest rate and economic growth), leading to a positive correlation between the two asset classes. In tranquil times, bond and stock prices tend to increase and therefore drive a positive relation. However, during periods of crisis or high uncertainty, the relation turns negative (Chiang et al. (2014)).

According to Andersson et al. (2004), Boyd et al. (2005) and Andersen et al. (2007), the cash flows effect may dominate during recessions, while the discount rate effect may be more important during expansions. The latter case leads to a positive relation whereas the former one induces a lower, perhaps negative correlation.

Stocks tend to outperform bonds during business cycle expansions whereas bonds are likely to surpass stocks during contractions. Bonds have higher average returns in contractions than in expansions, while the reverse is true for stocks (Ilmanen (2003)). See figure 1.1: Business cycle: stock and bond returns.

Andersson et al. (2004) notice that the stock-bond correlation tends to be negative in period of stock market crashes. Hong (2011) agrees with this hypothesis and adds that during periods of recession, the spread of returns between stock and bond is expected to be lower.

Business cycle: stock and bond returns

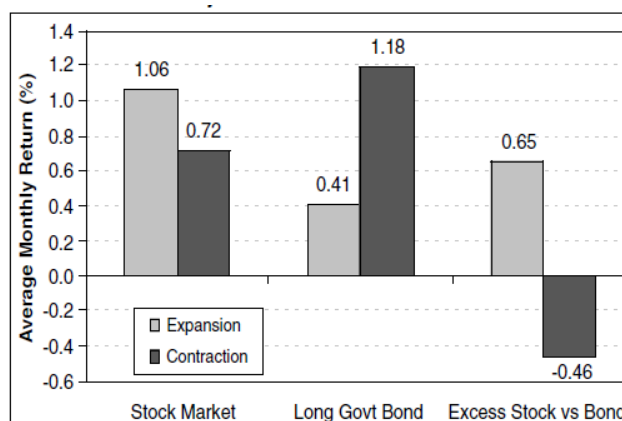


Figure 1.1 – Ilmanen (2003)

By contrast, Jensen and Mercer (2003) affirm that the stock-bond correlation is lower during expansions than during recessions. However, this difference is only significant for small cap stocks.

The “flight-to-quality” phenomenon, explained in *Section 2.2.3*, is one possible explanation of the negative correlation observed during times of uncertainty, high volatility and crisis periods.

2.2.2. Major crisis episodes

The past decades have been marked by different crises. The broad lines of the most important ones are presented in this section.

Asian financial crisis – 1997

The Asian financial crisis, also called “Asian Contagion” started in Thailand in July 1997 with the collapse of the Thai bath. The main cause of this crisis is the lack of foreign exchange reserves to support the Thai bath pegs to the US dollar.

“A currency peg is a country or government’s exchange-rate policy of pegging the central bank’s rate of exchange to another country’s currency. It allows importers and exporters to know exactly what kind of exchange rate they can expect for their transactions, simplifying trade” (Investopedia.com (2016)).

Overinvestments as well as high levels of foreign debts constitute the underlying causes of this crash. As the crisis spread, most of Southeast Asia and Japan saw a devaluation of their currencies and stock markets. Despite the intervention of the International Monetary Fund and the World Bank to limit the damages, other areas such as the United States and Europe were touched by this turmoil.

(Miller (1998), investopedia.com (2016), financial times (2016))

Russian crisis – 1998

A decreasing productivity, a chronic fiscal deficit and the wish to maintain high fixed exchange rate between the Ruble and foreign currencies triggered the crisis that hit Russia in 1998.

The Asian crisis of 1997, as well as the declining demand of crude oil also affected the Russian foreign exchange reserves.

In the mid-1990s, the Russian government issued short-term bonds called GKO. Many banks and investors were attracted by these juicy negotiable debt securities.

However, on the 17th August 1998, the Russian government had defaulted on its debt, leading to a brutal devaluation of its currency and a huge “flight-to-quality” phenomenon.

On its turn, this course to safety affected the hedge fund Long Term Capital Management (LTCM); an important hedge fund management firm using high financial leverage and complex risk management techniques. LTCM was fooled because it ignored the warning signs preceding this crisis. Indeed, when the financial markets started to enter in a period of turmoil, LTCM was sure that the situation would rapidly reverse. It decided to take a large position in the market by holding an important quantity of GKO. When Russia announced its debt default, LTCM lost a huge amount of money.

Other areas, such as the United States and Europe were affected by this crisis.

(Edwards (1999), Investopedia (2016), Financial Times (2016))

Turkish crisis – 2000

Throughout the 1990s, the Turkish government didn't own the financial funds to support a meaningful economic growth. This country was suffering from an important budget deficit. Hence, it decided to manage this issue by selling an important quantity of high interest government bonds. However, the competitiveness of the country started to decline. The investors escaped the country and the balance of payment broke down rapidly. The crisis started on the 20th November 2000, in the middle of an ambitious plan, destined to reduce the high inflation affecting the country. The help of the International Monetary Fund was not enough to save this nation. A second aid plan was put in place by the United States.

(Macovei (2009))

Argentine crisis – 1998-2002

The Argentinian government chose to use the “currency board”, linked to the US dollar in order to stabilize the economy suffering from high inflation. This dangerous system, the Russian and Asian crises and the burst of the dotcom bubble are the main causes of this Great

Depression. It caused a widespread unemployment, rapid political changes, the default on the country's foreign debt and the end of the peso's fixed exchange rate to the US dollar, which led to a dramatic fall of the currency.

(Murphy et al. (2003), investopedia.com (2016)).

Explosion of the dotcom bubble – 2000-2002

“The dotcom bubble is a rapid rise in equity markets fuelled by investments in internet-based companies. During the dotcom bubble of the late 1990s, the value of equity markets grew exponentially, with the technology-dominated Nasdaq index rising from under 1,000 to 5,000 between 1995 and 2000” (Investopedia.com (2016)).

This bubble started to explode in 2000 when it was highlighted that internet-based companies were not as prosperous as expected. Some of them were suffering from huge losses. Hearing this news, investors became afraid and sold their stocks, leading to a market crash.

(Ofek & Richardson (2003), investopedia.com (2016))

Brazilian crisis – 2002

Before the presidential elections (27th October 2002), Brazilian debt holders were afraid that Luiz Inacio da Solva would adopt a moratorium on the government bonds. Over the year, the spread between the Brazilian bonds, issued in dollars and the American government bonds widened. As a result, the implicit default level of the country was 100%. The International Monetary Fund brought 30 billion dollars. This bubble stopped once it was clear that the new president would not go into a financial adventurism.

(Cardim de Carvalho & Pires de Souza (2011))

Subprime crisis: explosion of the housing bubble and global crisis - 2007-2009

A subprime is a mortgage loan granted to American households that not meet the required conditions to take out regular credit. The assurance of these loans is based on the increasing value of the property. Indeed, since the year 2000, a housing bubble was observed in the United States, characterized by a rapid rise in property values.

In the 2000s, the financial securities generated by assembling these mortgage credits attracted a lot of investors. In a context of very low rates and liquidities, they were looking for higher returns on investment.

However, the households' debt reached its limits after some years. The real estate prices peaked before collapsing; they experienced their highest decline for more than a century in the middle of 2006.

A large number of households were not able to honour their monthly reimbursements. The real estates of insolvent borrowers were seized, which maintained the falling house prices.

Banks, for their part, suffered from the depreciation of the asset-backed securities and booked asset depreciations every semester. The subprimes' dissemination through the securitization had installed an atmosphere of mistrust and banks no longer wanted to lend money to each other.

The majority of countries were affected by the 2008 crisis because the subprimes were owned by more than just the American financial institutions. Indeed, European banks had also invested in these juicy investments and recorded losses. In order to re-establish their solvency ratio, they restrained the credit access, which had consequences on the real economy; the households reduced their consumption and the companies had more difficulties investing. The trading and economic connections between countries made the rest of the decline.

(Bartnick (2015), Bianco (2008))

European sovereign debt crisis- 2009-2014

In order to revive the economy and save their banks after the subprime crisis, governments injected liquidities, and to do so, accumulated important debts. The Great Recession of 2008-2012, the real property market crisis and fiscal policies constitute other causes of this crisis.

The European sovereign debt crisis started at the end of 2009, when some peripheral Eurozone countries were incapable to refinance their government debt. They needed the assistance of third-party institutions such as the European Central Bank, the European Financial Stability Facility and the International Monetary Fund. After Greece in 2009, Ireland required a bailout in November 2010, followed by Portugal in May 2011. Italy, Spain and Cyprus were also in trouble; the two latter asked assistance in June 2012.

In 2009, the new Greek government announced that the budget deficit of the country was underreported. This lack of transparency initiated a climate of fear in the euro zone and investors were less willing to lend money to high indebted European countries. They decided

to increase their interest rates, which complicated the financing of these countries' budget deficits.

Thanks to various financial reforms, domestic austerity measures and other unique economic factors, Ireland, Portugal and Spain recovered and exited of their bailout program in 2014. Although these good news have reduced the concerns about the European markets, the indebtedness of some countries are still high today and carefully monitored by investors and institutions.

(Investopedia.com (2016), Financial Times (2016))

Russian crisis – 2014

This crisis is caused by a lack of confidence in the Russian economy. This decreasing confidence stemmed from two majors sources: the fall of the oil price in 2014 and the international economic sanctions imposed on Russia after the annexation of Crimea.

(Investopedia.com (2016)).

China market crash - 2015

Having started on the 12th June 2015, this crash was the consequence of a financial bubble started in November 2014. In one month, the Shanghai stock exchange lost a third of its value and the borrowing capacity of the registered companies was highly reduced. In a bit of ricochet effect, this market crash affected the USA stock exchange.

(Investopedia.com (2016))

These important crises have more than probably affected the two countries studied in this master thesis. Since the correlation between stock and bond returns is negative in periods of market turmoil, these dates should be characterized by a declining or a negative stock-bond correlation.

2.2.3. Flight-to-quality or decoupling phenomenon

“Flight-to-quality is the action of the investors moving their capital away from riskier investments to the safest possible investment vehicles. This flight is usually caused by uncertainty in the financial or international markets” (Investopedia.com (2016))

According to Acosta Gonzales (2015), investors consider government bonds as instruments to diversify their portfolios in period of high volatility and decreasing stock market levels. This hypothesis is supported by Hong (2011), adding that bond markets represent a hedge during time of stock markets weakening.

Investors tend to become more risk averse when stock markets present some difficulties and prefer move funds from the stock market to the less risky bond market (Hartmann et al. (2001), Baur and Lucey (2009) and Hakkio and Keeto (2009)). The opposite phenomenon (the movement of funds from bonds to stocks when stock market is rising), called “flight-from-quality” is generally observed after the crisis. These two flows lead to a negative correlation between stock and bond returns. However, when the crisis had passed, the stock-bond correlation reverts to positive. (Gulko (2002), Connolly et al. (2005), Andersson et al. (2008) and Baur and Lucey (2009)).

Baele et al. (2014) add that most of flight-to-safety events are country-specific. Indeed only less than 25% of them are characterized as global. The authors’ results show that flight-to-safety events coincide with decreases in consumer sentiment indicators and rises of the VIX and the TED spread.

Hong (2014), Christiansen and Rinaldo (2007), Zhou Zang (2009) and Baur and Lucey (2009) have, for their part, documented that “flight-to-quality” and cross-country stock market contagion occur at the same time.

“Contagion is the spread of market changes or disturbances from one regional market to others. Contagion can refer to the diffusion of either economic booms or economic crises throughout a geographic region” (Investopedia.com (2016)).

According to Baur (2010), the cross-country co-movements determine the international diversification benefits. However, during periods of crisis, one can notice an increased stock correlation between the different countries, leading to a reduction of this diversification (Baig and Goldfajn (1999), Forbes and Rigobon (2002)). The hypothesis is that in order to compensate for lower gain, investors rebalance their portfolios by selling off stocks in favour of bonds. When the co-movement among the same type of assets is high (low), the stock-bond correlation is low (high).

2.2.4. Globalization

Over time, international diversification has attracted the attention of many researchers. Indeed, the 18th century development of mutual funds in Holland relied on the benefits of diversification through holding of international securities. Henry Lowenfeld's (1902) carries out a quantitative analysis on international diversification and affirms that better performance can be reached by dividing the capital in equal proportion across a number of geographical regions. Grubel (1968) notices that US investors could have attained better risk and return opportunities by holding foreign stocks in the 1959-1966 period. Levy and Sarnat (1970), on their turn, study international correlation and show the benefits from investing in both developed and developing equity markets between 1951 and 1967.

According to Goetzmann (2001), the correlations of major equity markets change considerably over time with peaks in the late 19th century, the Great Depression and the late 20th century. Therefore, the diversification benefits from global investments are not constant through time and are currently low compared to the rest of the capital market history.

The variation in the average correlation across markets and the variation in the investment opportunity set are the two components of the diversification benefits. The two last decades have experienced a remarkable increase of the opportunity set as well as a surge of the major markets correlations. The development of emerging capital markets has driven the benefits of this international diversification.

The other periods, as the two decades after the World War II, were characterised by a risk reduction coming from lower correlation between the major international markets. Periods of globalization provide benefits, but also drawbacks for international investors since they increase the opportunity set. However, diversification relies more and more on investments in emerging markets.

During the last decades, the reduction in trading costs, the superior accessibility to global stock and bond markets and the integration of markets have brought an increased integration of international capital markets. This globalization leads to higher international stock market correlations and lower potential gain from international diversification (Finnerty and Schneeweis (1979), Cochran and Mansur (1991), Kasa (1992), Longin and Solnik (1995), Eun et al. (2002, 2008), Goetzmann et al. (2005) and Baur (2010)).

This hypothesis is supported by Hong et al. (2011) that analyse the contemporaneous correlation between stock returns in eight countries (the US, Japan, the UK, Germany, Canada, China, Mexico and Singapore). Their results show a positive and relatively large correlation between each pair of countries. A similar pattern is detected for bonds. This highlights the co-movements among stock market indices and among bond market indices: stock returns tend to move in the same direction over time and so do bond returns. This integration implies lower benefits across similar asset classes, inducing investors to rebalance their portfolios.

This effect is accentuated in recession periods. Indeed when a crisis occurs, the cross-country correlations increase due to the contagion effect. Therefore, investors decide to move their funds from stocks to bonds (“flight-to-quality” phenomenon) in order to compensate the lower gain from the international diversification. These fund movements lead to a decline in the stock-bond correlation.

2.2.5. Stock market uncertainty: the VIX index

When the stock market uncertainty increases, the correlation between stock and bond returns tends to decrease, due to the “flight-to-quality” phenomenon (Connolly et al., and Kim et al., Andersson et al. (2004)).

The long-run stock volatility tends to be large when the general economic conditions are weak (Asgharian et al. (2015)).

Chiang et al. (2014) declare that this uncertainty can be measured by the VIX, which displays the expected market volatility from an external influence.

VIX

The Chicago Board Options Exchange (CBOE) website defines the VIX as follows:

“The CBOE Volatility Index (VIX) is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices. Since its introduction in 1993, VIX has been considered by many to be the world's premier barometer of investor sentiment and market volatility”.

“The VIX (CBOE volatility index) is the ticker symbol for the Chicago Board Options Exchange (CBOE) Volatility Index, which shows the market’s expectation of 30-days volatility. It is constructed using the volatilities of a wide range of S&P500 index options. This volatility is meant to be forward looking and is calculated from both calls and puts. The VIX is a widely used measure of market risk and is often referred to as “the investor fear gauge” (Investopedia.com (2016)).

When Banerjee et al. (2007) consider the VIX as a price factor having a significant power to predict stock returns, Hakkio and Keeton (2009) attest its power to capture uncertainty arising from fundamentals or unexpected shifts in investor behaviour.

Whaley (2009) highlights the considerable increase of the VIX during market turmoil, reflecting the market phenomenon that if expected market volatility increases (decreases), a higher (lower) rate of return is desired by the investors, which leads to the decline (rising) of the stocks prices.

Aslanidis and Christiansen (2011), for their part, consider the VIX as one of the most influential transition variable for determining the regime of the stock-bond correlation. They affirm that the stock-bond correlation is more likely to be negative when the VIX is larger, due to the “flight-to-quality” phenomenon. Indeed, when uncertainty increases, investors tend to move their funds from risky asset to safer assets.

2.2.6. TED spread

“The TED spread is the difference between the three-month London Interbank Offered Rate T-bill rate (LIBOR) for a particular currency (country) and the corresponding three-month T-bill interest rate” (Baele et al. (2014)).

Formula:

$$\begin{aligned} & \textit{TED spread} \\ & = (3 - \textit{month London Interbank Offered Rate (LIBOR)}) - (3 - \textit{month bill interest rate}) \end{aligned}$$

The Federal Reserve Bank of St Louis (2016) defines the LIBOR as follows:

“The London Interbank Offered Rate is the average interest rate at which leading banks borrow funds of a sizeable amount from other banks in the London market. Libor is the most widely used “benchmark” or reference rate for short term interest rates”.

“The London interbank offer rate (Libor) is the rate at which banks indicate they are willing to lend to other banks for a specified term of the loan” (Thornton (2009)).

The TED spread being a short term indicator of the default risk in financial markets; a widening of this one signifies that the lenders feel an increased risk of default on interbank loans. Therefore, interbank lenders either ask higher interest rate or move their funds from risky assets to safe assets (“flight-to-quality” phenomenon); leading to a negative stock-bond correlation (Chiang et al. (2014)). Baele and al. (2014) confirm that flight-to-safety episodes coincide with increases in the TED spread.

The liquidity risk is also highlighted by this spread. Indeed, an increase of the TED spread caused by a short-run liquidity crisis leads to a negative correlation between the stock and bond returns, reflecting a “flight-to-liquidity” phenomenon. This is what happened during the 2008 crisis (Chiang et al. (2014)).

Although the relation between the TED spread and the stock-bond correlation is negative in periods of market turmoil, the sign of this one reverses during periods of low inflation and stable availability of liquidity (Chiang et al. (2014)).

2.2.7. Default risk spread

“The default risk spread is calculated as the difference in the annualized yields of Moody’s Baa and Aaa-rated bonds” (Chiang et al. (2014)).

According to Chen et al. (1986) and Fama and French (1993), the premium that uncertainty commands in the bond market is measured by this spread.

Other authors, such as Dichev (1998) or Campbell et al. (2008) demonstrate that this yield spread is negatively correlated with the S&P500 index. Indeed a small spread reflects better market sentiment, leading to an increase in stock price. On the contrary, a deterioration in the financial health of the borrowing firms or an increase in compensation for liquidity risk tends to increase the default spread (Avramov (2002), Houweling et al. (2005)). When this spread starts to widen, market participants perceive that the future economy is becoming less promising. Hence, risk adverse investors decide to reduce their stock holdings, leading to a decrease in stock prices. This finding is consistent with the “flight-to-quality” phenomenon: larger default risk encourages investors to move their funds from risky instruments to safer

assets. Therefore, the default risk spread seems to have a negative impact on the stock-bond correlation in the long run (Chiang et al. (2014)).

Aghasharian et al. (2015) highlight in their study that the default spread has a positive impact on the long-run stock-bond correlation.

According to Vassalou and Xing (2004), much information included in the default spread is independent to the default risk. Indeed, 85% of this spread is considered as a reward for the bearing systematic risk.

“The systematic risk is the risk inherent to the entire market or an entire market segment. Systematic risk, also known as “undiversifiable risk,” “volatility” or “market risk,” affects the overall market, not just a particular stock or industry. This type of risk is both unpredictable and impossible to completely avoid” (Investopedia.com (2016)).

Being mainly composed of systematic risk, the default spread should affect the stock and bond returns in a same way, leading to a positive stock-bond correlation.

2.2.8. Term spread

“The term spread is computed as the first difference of the yield spread between 10-year Treasury bond and 3-month Treasury bill” (Asgharian et al. (2015)).

According to a great number of authors such as Dueker (1997, 2005), Moneta (2005), Wright (2006) and Rosenberg and Maurer (2008), the term spread is a good predictor of recessions (Wheelock and Wohar (2009)).

This spread represents the slope of the yield curve.

“The yield curve is a graphical representation of the relationship between the yields and maturities of different bonds of similar quality, currency denomination and risk (usually government bonds)” (Financial times (2016)).

See figure 1.2: Regular yield curve

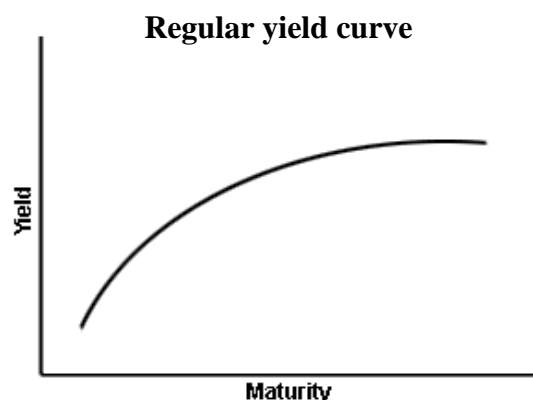


Figure 1.2- Investopedia.com (2016)

The yield on long-term securities being typically superior to otherwise comparable short-term securities, the yield curve (i.e., the plot of the yield on otherwise comparable securities of different maturities) is typically upward sloping. However, analysts notice that a sharp decline in the slope or an inversion of the yield curve is observed before most recessions (short term yields rising above those on long-term securities).

Therefore, a declining or negative term spread generally predicts periods of market turmoil (Wheelock and Wohar (2009)).

See figure 1.3: US term spread and recessions.

The expected excess returns on long-term bonds are time-varying and this variation is positively associated with movements in the yield spread. The counter cyclical time variation in bond risk is proxied by the yield spread (Fama and French (1989)).

Viceira (2007)'s results show that the bond risk increases when the yield spread widens. However, when the bond market risk increases,

bonds have to pay higher yields in order to attract investors. Since bond yields and discounted rate of the equity market move in the same direction, higher bond yields lead bond and stock prices to go down, leading to a positive stock-bond correlation (Chiang et al. (2014)).

Asgharian et al. (2015), for their part, try to determine the impact of certain macro-finance variables, reflecting the current state of economy, on the stock-bond correlation. The variables measuring the bond volatility include the term spread. The results show that the term spread has a positive influence on the long-run bond volatility. However, the long-run correlation between stock and bond returns is not influenced by the same variables than the long-run stock and bond volatility. Indeed, the term spread is not significant for the long-run stock-bond correlation.

Aslanidis and Christiansen (2011) affirm that the yield spread is one of the most important transition variables for determining the stock-bond correlation. According to them, this

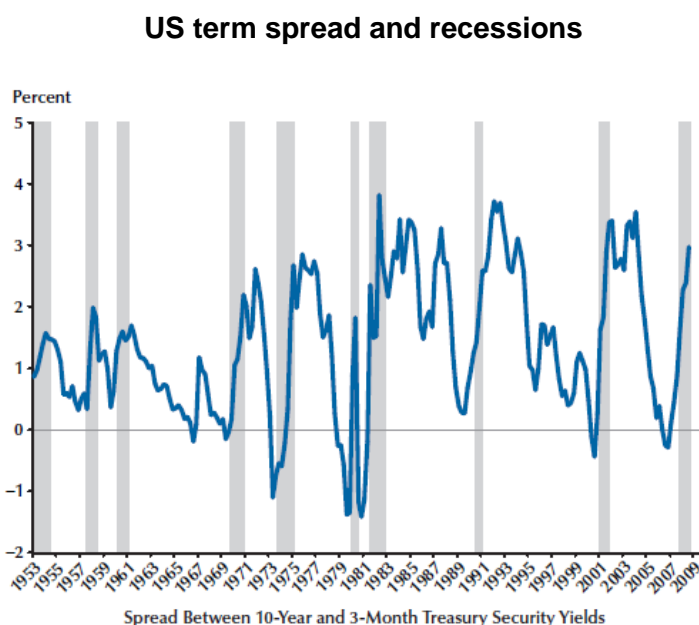


Figure 1.3 – Wheelock and Wolar (2009). The continued line represents the term spread whereas the shaded areas denote recessions.

correlation is more likely to be positive when the yield spread is large. Estrella and Trubin (2006) and Wright (2006) note that the term spread is a good predictor of the state of the macroeconomy; large spreads tend to imply future expansions (Aslanidis and Christiansen (2011)).

2.2.9. Economic indicators

In this master thesis, the short term interest rate, the inflation, the purchasing managers' index, the industrial production and the consumer confidence are employed to determine the economic situation of a country.

2.2.9.1. Short term interest rate and inflation

Definitions of interest rate and inflation

"Interest rate is the amount charged, expressed as a percentage of principal, by a lender to a borrower for the use of assets" (Investopedia.com (2016)).

"Inflation is the rate at which the general level of price for goods and services is rising and, consequently, the purchasing power of currency is falling" (Investopedia.com (2016)).

Link between interest rate and inflation (Fisher (1930))

Formula: $(1 + \text{nominal interest rate}) = (1 + \text{real interest rate}) * (1 + \text{inflation rate})$

The nominal interest rate can be approximated as the sum of the real interest rate and the inflation rate.

In theory, the real interest rate is assumed to be stable over time, meaning that the nominal interest rate reflects the expected inflation rate. Therefore, we can expect the correlation between the nominal interest rate and the inflation rate to be strongly positive.

Although this assumption is rejected in the reality (the real interest rate is actually time-varying), this relationship highlights the fact that the effects of the short term interest rate and the inflation on the stock-bond correlation should be similar.

Interest rate and economy

When interest rates are lower, consumers are able to borrow money cheaply, which increases their purchasing power. This increased consumption leads to economic growth and eventually to a rise of inflation. By contrast, when interest rates are higher, consumers tend to save more and spend less, leading to a slowdown of the economy and a decrease of inflation. *See figure 1.4: Interest rate and inflation.*



Figure 1.4- investopedia.com (2016)

Eight times each year, the Federal Open Market Committee of the US Federal Reserve reviews economic and financial conditions and decides on monetary policy. The short-term interest rate targets are determined during these meetings. The Federal Reserve analyses several economic indicators such as the Consumer Price Index and the Produce Price Index and establishes the appropriated interest rates targets. Having the role to keep the economy in balance, the Fed decides to increase the short-term interest rate to limit the future inflation or, on the contrary, to decrease the short-term interest rate to spur the economic growth.

Inflation is not the only factor influencing the Fed's decisions on interest rates. For example, during a financial crisis, the Fed can decrease interest rates to provide liquidity to US financial market in order to prevent a market meltdown (Investopedia.com (2016)).

Unfortunately, this mechanism is not always efficient. Indeed, since the 2008 crisis, the Fed has considerably decreased the interest rates in order to support the economy and increase the level of inflation, but the economic situation doesn't seem very prosperous. This is why additional unconventional measures like the QE (Quantitative Easing) were implemented.

Interest rate impact on the stock-bond correlation:

According to Asgharian et al. (2015), the short rate has a positive impact on the stock-bond correlation. These results are in line with the research of Aslanidis and Christiansen (2001), affirming that the stock-bond correlation is more likely positive if the short term interest rates are high.

This idea is also supported by Viceira (2007) showing the ability of the short rate to forecast positively the covariance between stock and bond returns, adding that the short term nominal interest rate is considered as a proxy for inflation and economic uncertainty.

Li (2002) affirms that the co-movements between stock and bond returns are increased by the real interest rate uncertainty. D'Addona and Kind (2006) analyse the stock-bond correlation in G-7 countries and find that the volatility of the real interest rate increases this correlation.

However, Asgharian et al. (2015) and Baele and al. (2010) explain the difficulty to predict the impact of the short interest rate on stock and bond returns. This complexity comes from the fact that the interest rate is linked to the inflation, and inflation is likely to affect both the cash flows and the discount rate.

Inflation impact on the stock-bond correlation:

Although the inflation is one of the most influential transition variable for determining the regime of the stock-bond correlation, its impact on this relation is still undetermined since this factor is likely to affect both the cash flow and the discount rate (Asgharian et al. (2015), Baele and al. (2010)).

A) Bond price

As explained before, inflation rate and interest rate are linked. Therefore, inflation can affect the bond price's discount rate through the interest rate. Since the coupons are constant over time, the bond price's cash flows are negatively affected by an increase of the interest rate, which can be caused by an increase in expected inflation. Therefore, inflation and bond price are negatively correlated, via the impact of inflation on the level of interest rates.

Formula bond price:

$$Bond\ Price = \sum_{t=1}^n \frac{Coupon}{(1 + interest\ rate_t)^t}$$

B) Stock Price

The effect of inflation on stock prices is more difficult to determine. Indeed, the discount rate involves a risk premium and generally, the dividends are also influenced by inflation.

“The risk premium is the additional return an investor expects from holding a risky asset rather than a riskless one” (Financial Times (2016)).

The correlation between the risk premium and the interest rate is weak since the risk premium is influenced by many other factors such as the exchange rate, commodities prices, changes in taxes, market sentiment,... This implies that the risk premium and the interest rate can move either in the same direction or in the opposite direction.

Concerning the impact of inflation on dividends, it is important to determine the source of the inflation. According to its nature (for example: a decision of the company to increase the prices or an oil shock), inflation can have a positive or a negative impact on the profitability of the company, and so on its dividends.

Formula stock price (according to DDM):

$$Stock\ Price = \sum_{t=1}^T \frac{Dividend_t}{(1 + (risk\ premium_t + interest\ rate_t))^t}$$

The effect of inflation on the stock-bond correlation depends on the relative discount rate and cash flow effects.

Authors' research

According to Imanen (2003), the correlation between the inflation and the stock-bond correlation is positive. The author proposes the following explanation:

When the inflation level is high, stock and bond volatilities are dominated by common discount rate changes, leading to a positive stock-bond correlation. However, during periods of low but positive inflation, discount rates are relatively stable and the volatilities are dominated by growth uncertainty, inducing a lower stock-bond correlation. Finally, deflation has a positive impact on equity risk premium and a negative impact on bond risk premium, making the stock-bond correlation negative.

Andersson et al. (2004) reason in the same way by explaining that an increase in expected inflation represents bad news for bond markets since it raises the discount rates. However, the impact of this rise on stock prices is ambiguous because the discount rates and the expected future cash flows are likely to be affected. They also find that periods of negative stock-bond correlation coincide with the lowest levels of inflation expectations, while during periods of high inflation, stock and bond prices are going in the same direction.

According to Li (2002), the correlation between stock and bond returns tends to increase with the expected inflation uncertainty. He reveals that greater concerns about the future inflation lead to higher co-movements.

Since this uncertainty is positively related to the inflation level (Ball and Cecchetti (1990)), periods of high uncertainty coincides with periods of high inflation level. Li (2002) adds that when the inflation risk is high, asset returns tend to be more volatile, encouraging investors to diversify their portfolio. Unfortunately, during this kind of period, the stock-bond correlations are high and few diversification opportunities are available.

By contrast, d'Addona and Kind (2004) indicate that inflation shocks and volatility tend to decouple the correlation between stocks and bonds in G-7 countries. This hypothesis is also supported by Campbell and Ammer (1993) who demonstrate that expected inflation as well as changes in the long-run expected inflation tend to drive the bond market down and the stock market up.

Yang et al. (2008), discover, for their part, that higher inflation rates tend to be followed by higher stock-bond correlation.

The inflation is generally measured as the log difference of the consumer price index (CPI).

“The consumer price index (CPI) is a measure that examines the weighted average of prices of a basket of consumer goods and services, such as transportation, food and medical care. The CPI is calculated by taking price changes for each item in the predetermined basket of goods and averaging them; the goods are weighted according to their importance”
(Investopedia.com (2016))

2.2.9.2. Purchasing Managers' Index (PMI)

“The purchasing manager index (PMI) is an indicator of the economic health of the manufacturing sector. The PMI index is based on five major indicators: new orders, inventory levels, production, supplier deliveries and the employment environment” (Investopedia.com (2016)).

Joseph et al. (2011) affirm that this index is subjective, being based on the reports of manufacturing companies' managers. Indeed, more than 400 purchasing managers, chosen for their geographic and industry diversification benefits complete the survey necessary to determine the PMI (Investopedia.com (2016)).

Harris (1991)¹, Koenig (2002)², Lindsey & Pasvur (2005)³, Raedels (1990)⁴ and Peleaz (2003)⁵ (cited in Cho (2006)) for their part, use the following definition:

“Purchasing managers' index is a monthly seasonally adjusted weighted composite diffusion index of five indicators of economic activities in the manufacturing sector”.

Since 1982, the weights attributed to each indicator are the following (Danny I.Cho (2006), Joseph et al. (2011)):

See figure 1.5: Weight of each indicator in the PMI calculation.

- 30% for new orders (from customers; higher or lower)
- 25% for production (higher or lower)
- 20% for employment (increase or decrease)
- 15% for supplier deliveries (slower or faster)
- 10% for inventories (increase or decrease)

Weight of each indicator in the PMI calculation

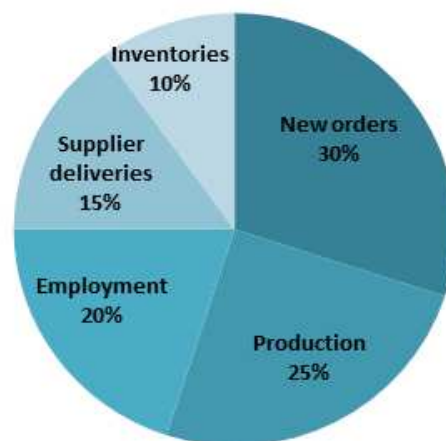


Figure 1.5 – Danny I.Cho (2006), Joseph et al. (2011)

¹ Harris, E.S. (1991). Tracking the Economy With the Purchasing Managers' Index. *Quarterly Review Federal Reserve Bank of New York*, 16(3), 61-69.

² Koenig, E.F. (2002). Using the Purchasing Managers' Index to Assess the Economy's Strength and the Likely Direction of Monetary Policy. *Federal Reserve Bank of Dallas Economic and Financial Policy Review*, 1(6), 1-14.

³ Lindsey, M.D., Pavur, R.J. (2005). As the PMI Turns: A Tool for Supply Chain Managers. *Journal of Supply Chain Management*, 41, 30-39.

⁴ Raedels, A. (1990). Forecasting the NAPM Purchasing Managers' Index. *International Journal of Purchasing and Materials Management*, 26(4), 34-39.

⁵ Peleaz, R.F. (2003). A Reassessment of the Purchasing Managers' Index. *Business Economics*, 38(4), 35-41.

These specific weights were chosen in order to maximize the correlation between the PMI and the real Gross Domestic Product (GDP) growth (Torda (1985), Bretz (1990), Kauffman (1999), Lindsey and Pavur (2005)).

Here is the formula used to obtain the PMI:

$$PMI = 0,3 * (I_{Order}) + 0,25 * (I_{Prod}) + 0,2 * (I_{Employ}) + 0,15 * (I_{Supply}) + 0,1 * I_{Inventory}$$

Where I_{Order} is the Index of New Orders, I_{Prod} is the Index of Production, I_{Employ} is the Index of Employment, I_{Supply} is the Index of Supplier Deliveries and $I_{Inventory}$ is the Index of Inventories.

The purchasing managers' index ranges from 0 to 100 with 50 as the critical value. A PMI score equal or higher to 50 indicates growth in the industry. If the manufacturing sector is increasing, the general economy should expand as well. A PMI below 50 forecasts bad news for the economy and means that recession could be just around the corner (Joseph et al. (2011) and Investopedia.com (2016)).

See figure 1.6: Meanings of the PMI scores.

This index, released on the first business day of each month, presents a large number of advantages.

Indeed, it is recognized by many practitioners and economists to be a timely, reliable and valuable near-term indicator of the economic activity in spite of the decrease in the manufacturing importance (Danny I. Cho (2006)).

It is also a good predictor of the real gross domestic product (GDP) and the growth rate (Joseph et al. (2011), Investopedia.com (2016)). Although the manufacturing is not the main component of the total gross domestic product (GDP), recessions tend to begin and end in this particular industry (Investopedia.com (2016)).

Harris (1991), Dasgupta and Lahiri (1992, 1993), Kauffman (1999), Koenig (2002) and Lindsey and Pavur (2005) demonstrate the ability of the Price Managers' Index to warn changes in economic trend and to furnish early clues on the turning point of business cycle.

The PMI presents also some disadvantages as its subjective nature in its data collection compared to other indicators, the fact that it only covers the manufacturing sector and the

Meanings of the PMI scores

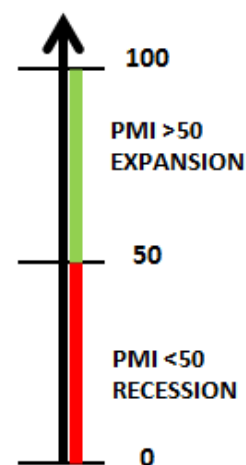


Figure 1.6 – Joseph et al. (2011), Investopedia.com (2016)

unaccounted economic impact of analysed firms in survey responses (Joseph et al (2011); Investopedia.com (2016)).

Since the correlation between stock and bond returns is positive during expansions and negative during recessions; this one should be positive when the PMI is superior or equal to 50 and negative when the PMI is inferior to 50.

2.2.9.3. Industrial production

“Industrial production figures are based on the monthly raw volume of goods produced by industrial firms such as factories, mines and electric utilities in the United States” (Investopedia.com (2016)).

Combined with some capacity utilization figures, the industrial production provides information about the overall economic activity and the gross domestic product (GDP) (Investopedia.com (2016)).

Asgharian et al. (2015) examine the impact of certain macro-finance variables, reflecting the current state of economy, on the stock-bond correlation. They find that the industrial production has a significant and positive impact on the correlation between stock and bond returns. This result indicates that the long-run correlation between stock and bond returns tends to be small/negative when the economy is weak and reinforces the “flight-to-quality” phenomenon.

2.2.9.4. Consumer Confidence

“Consumer confidence, measured by the Consumer Confidence Index (CCI), is defined as the degree of optimism on the state of the economy that consumers are expressing through their activities of saving and spending” (Investopedia.com (2016)).

This index, calculated for the first time in 1985, is released every month by the Conference Board.

Consumer spending, forming from 50 to 75% of the gross domestic product (GDP) is the key component of any developed economy. Optimistic consumers tend to purchase more goods and services, which stimulates the whole economy. When the consumer confidence is high, the market can move higher because investors are more willing to purchase equities. However, when confidence is trending down, consumers prefer save money, indicating that

the economy faces some difficulties (The Conference Board website (2016), Investopedia.com (2016)).

Historically, the consumer confidence index followed well the business cycle.

Every month, 5 000 households complete a survey (composed of five questions) designed to measure the relative financial health, spending power and confidence of the average consumer. The data are available by age, income and region. Consumers' opinions on current conditions represent 40% of the index whereas the remaining 60% is devoted to future economic expectations (Investopedia.com (2016)).

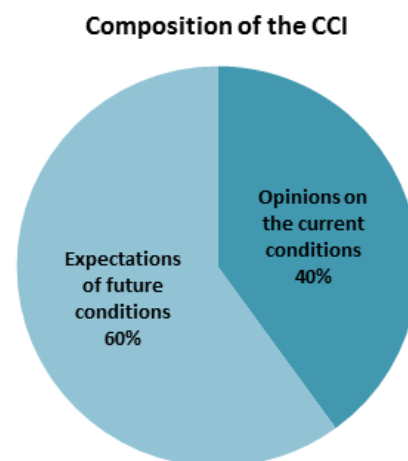


Figure 1.7 – Investopedia.com (2016)

See figure 1.7: Composition of the CCI

Because of its small sample size and its subjective nature, economists prefer analyse the consumer confidence trend over several months. While an index change inferior to 5% is generally considered as negligible, a shift equal or superior to 5% usually indicates a modification in the economy's direction (Investopedia.com (2016))

Responding only after the overall economy has already changed; consumer confidence is considered as a lagging indicator by the economists. Consumers needing time to respond to economic events, this index doesn't predict the future but provides information about what has happened and if it can be expected to continue (Ferrer et al. (2016)).

The consumer sentiment, component of the consumer confidence index, is released each month by the University of Michigan.

Asgharian et al. (2015) study how the stock-bond correlation is influenced by certain macro-finance variables reflecting the current state of economy. They notice that the Consumer Confidence (measure by the Consumer Confidence Index) has a significant and positive influence on the long-run stock-bond correlation.

Baele et al. (2014) examine flight-to-safety episodes in different countries and note that these episodes coincide with declines in consumer sentiment indicators. To carry out their research, these authors use the Baker and Wurgler sentiment indicator, the Michigan Consumer Sentiment Index (to measure the sentiment in the US), the IFO Business Climate Indicator (to

measure the sentiment in Germany) and the country-specific OECD consumer confidence indicators.

Given that periods of flight-to-quality are characterized by a negative stock-bond correlation, one can affirm that Consumer Sentiment Indicators influence positively the correlation between stock and bond returns.

2.2.10. Oil price

By its increasing importance in the global economy, oil has attracted the attention of many authors, trying to explain the relationship between oil and financial markets. A great literature exists on the impact of oil price changes on equity valuation. Although most of the research concludes that oil price have an impact on stock price, the sign of this relationship is still debated.

Hamilton (1986) examines the relation between oil prices and GDP growth for the period 1948-1972 and establishes that oil price shocks were contributing factors to recession in the US. Kaul and Seyhun (1990); Huang et al. (1996) and Sadorsky (1999) indicate that both oil price and its volatility have a negative impact on stock returns. Papapetrou (2001); Hong, Torous and Valkanov (2007) find a negative correlation between these two assets in advanced economies.

The effects of different structural shocks of oil price changes on stock returns attract the attention of Apergis and Miller (2009). However, their results show that the magnitude of these shocks (supply shocks, global and idiosyncratic demand shocks) is very small.

Conrad et al. (2012), for their part, study the long-run correlation between crude oil and stock prices for the period 1993-2011. Their results show a positive correlation during recessions and recovery periods and a negative correlation during periods of strong economic growth.

Vo (2011)'s results exhibit that the correlation between oil prices and S&P500 index rises with the volatility in the market. A volatility jump is observed in 2008, leading to an increased correlation between these two assets. This situation reveals that oil and stock prices behave more similarly in the last few years, meaning that crude oil is no longer a safe-haven (Turhan (2014)). For Ravazzolo (2013), the correlation between oil and stock prices fluctuates around zero and becomes positive since mid-2008.

Nicolau (2011), for his part, investigate the relation between the Dow Jones Industrial Average (stocks) and the CRB Commodity Index (oil and other commodities). A strong negative correlation is observed until December 2003 (US's invasion of Iraq), followed by a shift to highly positive levels.

Using daily data from 1983 to 2006, Gogineni (2007) finds a weak correlation between the US stock market and daily oil price changes. If the market expects an expansion, oil and stock prices are likely to rise and, if the market decides a recession is coming, assets prices are likely to decrease. In other words, oil prices have a positive impact on stock prices, if oil price shocks are driven by the aggregate demand, but a negative effect if they reflect changes in supply. The returns of industries that do not use much oil are also sensitive to oil price changes.

Park (2008) demonstrates the significant impact of oil price shocks on real stock returns in the US and 13 European countries between 1986 and 2005. This author finds that oil price shocks represent 6% of the volatility in real stock returns. He also adds that Norway being an oil exporter, its real stocks returns are positively impacted by oil price increases.

According to Nicolau (2011), the correlation between oil and bond prices is negative. An increase in oil price is generally followed by a rise in interest rates (due to the inflationary pressure), leading to a drop in bond prices (Turhan et al. (2014)). Ciner et al. (2013) identifies a low negative association between oil and bond prices.

An increased demand or a lower supply can both drive a surge in oil prices. The former predicts good economic prospects, leading to a positive correlation between stock and bond returns. However, the latter means a rise of production costs for the industries, leading to a negative stock-bond correlation.

2.2.11. Gold price

The relation of US, UK and German stock and bond returns with gold returns is analysed by Baur and Lucey (2010). Their results show that, on average, gold is considered as a hedge against stocks and as a safe haven when stock market conditions become more extreme. Bond markets, for their part, are viewed as a hedge for equity market (at least, on average). Gold is not all the time a safe-haven for stocks; it takes this role only when it is needed the most, namely in extreme stock market shocks.

“A hedge is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio on average” whereas *“A safe haven is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil”* (Baur and Lucey (2010)).

However, gold is a safe-haven for a relatively short period of time. This time constraint is due to the fact that gold is also a hedge for stocks, so, when stock prices start to increase after the extreme negative shock, the gold price falls.

It is important to notice that gold is not a safe-haven for bonds in any market.

Since the gold price increases in periods of market turmoil and decreases in times of good economic prospects, the relation between the gold price and the stock-bond correlation should be negative.

2.3. Summary of the literature review

Although the stock-bond correlation is positive most of the time, this one can change from positive to negative in a very short period of time, due to its time-varying nature. Good economic prospects are generally associated with a positive correlation whereas the relation becomes negative during periods of market turmoil and recessions. Therefore, the different periods of crises are likely to be marked by a declining or a negative stock-bond correlation. The “flight-to-quality” phenomenon is the most plausible explanation of the negative correlation observed during periods of weak economic conditions.

The correlation between stock and bond returns is influenced by a large number of macroeconomic factors. While term spread, purchasing managers’ index, industrial production, short term interest rate and consumer confidence have a positive impact on the stock-bond correlation; the globalization, stock market uncertainty (measured by the VIX), TED spread and gold price affect negatively the relationship.

Finally, the result of some other factors such as the default risk spread, oil price or inflation is still undetermined.

Chapter 3: Data collection and stock-bond correlation calculations

Stock and bond returns

The empirical analysis in this master thesis is performed using monthly data on stock and bond returns. The data, extracted from Bloomberg, covers two advanced markets: the United States and Germany. The period studied, including 241 observations, starts on the 2nd January 1996 and ends on the 31st January 2016. It was chosen because some important crises occurred during this time.

The daily stock returns are computed as the log difference of the daily stock prices; namely the S&P500 index for the United States and the DAX index for Germany.

$$r_{stock,d} = \ln \frac{Stock\ price_d}{Stock\ price_{d-1}}$$

Daily bond returns, for their part, are determined by using the following formula:

$$r_{bond,d} \cong -yield_d + yield_{d-1}$$

(Formula provided by professor Léonardo Iania)

The long term (10-year) government yields employed to calculate the bond returns are the USGG10YR index for the United States and the GDBR10 index for Germany.

Correlation between stock and ten-year government bond returns

The monthly correlations are calculated as followed:

$$correlation(r_{stock,t}; r_{bond,t}) = correlation \left(\begin{pmatrix} r_{stock, \text{ day 1 of month } t} \\ r_{stock, \text{ day 2 of month } t} \\ \vdots \\ r_{stock, \text{ day 30 of month } t} \end{pmatrix}; \begin{pmatrix} r_{bond, \text{ day 1 of month } t} \\ r_{bond, \text{ day 2 of month } t} \\ \vdots \\ r_{bond, \text{ day 30 of month } t} \end{pmatrix} \right)$$

where:

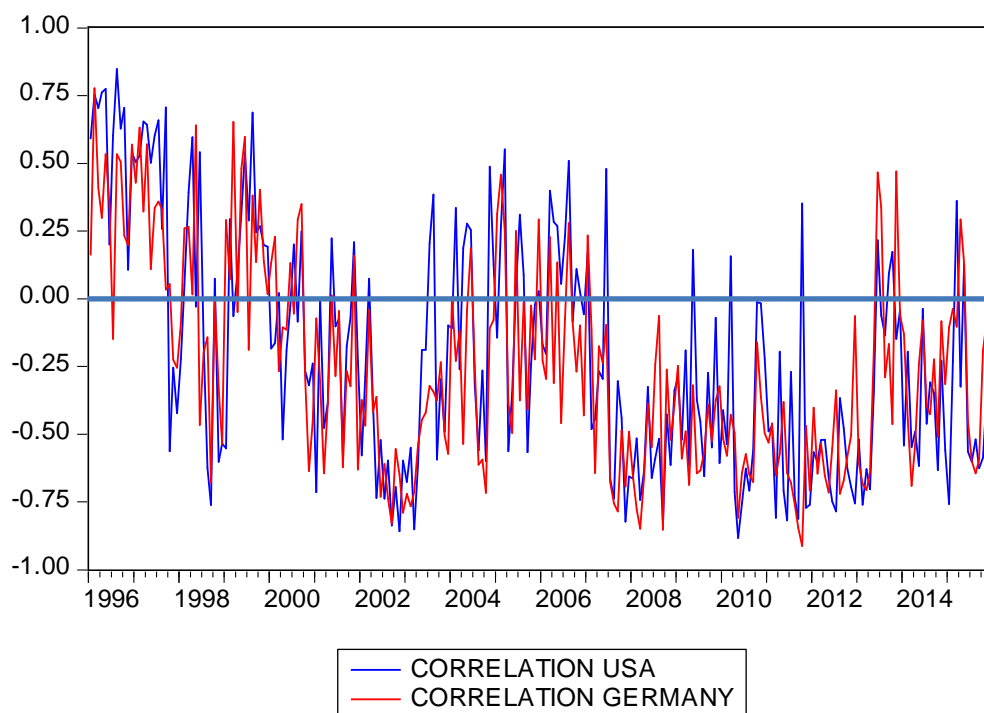
$r_{stock,t}$: stock return at time t (expressed in month).

$r_{bond,t}$: bond return at time t (expressed in month).

(Formula provided by professor Léonardo Iania)

The representation of the correlation between stock and 10-year bond returns over time is provided in the *figure 2* below.

Figure 2: Correlation between stock and 10-year bond returns over time in the United States and Germany



The time-varying nature of the stock-bond correlations, well represented on this graph by periods of negative and positive correlations; illustrates the agreement reached by the literature (Campbell (1987), Gulko (2002), Engle and Sheppard (2003), Iilmanen (2003), Connollu et al. (2004), Jones and Wilson (2004) and Li (2004)).

Since 1997, the correlations in both countries tend to be mainly negative, due to the diverse crisis periods. Some huge declines from positive to negative are observed around 1997, 1998, 2000, 2007 and 2011. These decreasing relations correspond to the “flight-to-quality” phenomenon, generally perceived during periods of market turmoil and explained in *section 2.2.3*. The first and the second switches correspond to the Asian and the Russian crises. The large negative correlation between 2000 and 2003 coincides, for its part, to the burst of the dotcom bubble. The next extensive negative relation is associated with the subprime crisis. Since then, the correlation is most of the time negative, reflecting the other crisis episodes, as well as the difficulty of the economy to recover.

The stock-bond correlations of the two countries tend to follow the same trend and are correlated at 0,73. This high relationship between the United States and Germany is in line with the research of many authors such as Andersson et al. (2004), Baur et al. (2006), Chiang et al. (2015) and Acosta-Gonzales et al. (2015).

Over the sample period, the correlation between stock and bond returns is mainly negative with an average value of -0,20 and -0,25 for the United States and Germany, respectively. The medians are, for their part, equal to -0,26 and -0,31.

Therefore, the hypothesis claiming a positive stock-bond relationship over long periods of time is rejected by these numbers.

However, this negative correlation is consistent with the research of Acosta-Gonzales et al. (2015), declaring:

“... from the beginning of the second period (2 October 1997) to the present, this behaviour changed and most of the time the stock-bond correlation has remained negative ... “ (Acosta-Gonzales et al (2005), p.4)

To name but a few, other authors, such as Andersson et al. (2004), Baur et al. (2006), Ilmanen et al. (2013) and Chiang et al. (2015) also notice this negative tendency.

Hong et al. (2011) highlight the fact that globalization reduces the benefits of diversification across similar asset classes and encourages investors to rebalance their portfolios. This rebalancing leads, on its turn, to a negative correlation between stock and bond returns.

Studying trends in the stock-bond correlation, Ohmi and Okimoto (2016) show that the declining effects of diversification across countries as well as the increasing “flight-to-quality” phenomenon are the two main reasons of the negative relationship observed during the last decades.

These results suggest that our sample period could be too short to highlight the positive stock-bond correlation generally observed over long period of time. The increasing globalization and the different crises that occurred during the two past decades have driven investors to diversify their portfolio. This portfolio rebalancing lead to a negative correlation between stock and bond returns.

The standard deviation, measuring the dispersion of the correlation around the mean, is equal to +0,44 for the United States and to +0,39 for Germany; meaning that the correlation is more volatile in the former country. The relationships range from -0,88 to +0,85 in the United States and from -0,91 to +0,78 in Germany.

These findings are in line with the past literature, asserting great variations in the stock-bond correlation (Johnson et al. (2013), Li (2002), Andersson et al. (2004), Ilmanen (2003), Yang et al. (2008)).

The separated graphs for the United States and Germany, as well as more descriptive statistics are provided in the *Appendix 1*.

Chapter 4: Crisis periods

In order to determine the impact of the different crises on the American and German stock-bond correlations, two dummy variables are created for each country. These ones are equal to “1” in periods of crisis and to “0” otherwise. The methodology, as well as the different criteria’s selected to delineate the periods of market turmoil are developed in this section.

4.1. The different types of crisis

Financial crisis and economic crisis

“A financial crisis is a situation in which the value of financial institutions or assets drops rapidly. A financial crisis is often associated with a panic or a run on the banks, in which investors sell off assets and withdraw money from saving accounts.” (Investopedia.com (2016)).

Therefore, a financial crisis is generally amplified by investors’ behaviour. Other situations, such as stock market crashes or bursting of financial bubbles are called “financial crises”. If no measures are taken, a financial crisis can rapidly turn into an economic crisis. Indeed, the financial crisis tends to drive the economy away from its equilibrium. The outputs, measured by the GDP, start to decline. An economic crisis commonly takes the form of a recession or a depression (Mishkin (1992), Frankel (2010), Babecky et al. (2014))

Currency crisis

A currency crisis occurs when a country's central banks does not have sufficient foreign exchange reserves to maintain the country's desired exchange rate. Currency crises are often associated with financial, economic or debt crisis (Babecky (2014)).

Debt crisis

A country suffers from a debt crisis when it experiences massive public debts. It meets some difficulties to refinance its government debt and needs the assistance of third-party institutions (Investopedia.com (2016), Financial Times (2016)).

Note:

During periods of market turmoil, banks are less willing to lend money to each other and demand early repayment of loans and other financial instruments (Thornton (2009), Cui (2016), Financial Times (2016)).

4.2. Criteria's used to determine the crisis periods

In this master thesis, four criteria's are employed to determine the various periods of market turmoil. It is important to notice that although some indicators better highlight a specific type of crisis, they can also, in a lesser extent, display the other types of crisis.

The stock market value (S&P500 index and DAX index)

This factor mainly indicates the periods of financial crisis or the burst of financial bubble. However, the other types of crisis can be felt on the stock market value.

The value of the Gross Domestic Product (GDP)

This factor illustrates the different periods of recession. As explained in *section 4.2.2*, economic crises are most of the time associated with recession periods.

The LIBOR-OIS spread

Reflecting the willingness of banks to lend money to each other, this indicator provides information about the health of the banking system.

The volatility index (VIX index and VDAX index)

All crisis episodes are characterized by an important increase of stock market uncertainty.

4.2.1. Stock market value (S&P500 index and DAX index): “CRISIS_B”

Economists, journalists and more widely the investors’ community consider that a stock market is bearish when the spread between the last highest point and the new lowest point is superior to 20% (Information provided by Arnaud Delaunay, financial analyst at Leleux Associated Brokers).

Since the stock market is generally bearish in period of market turmoil, this criterion is used to establish precisely the dates at which a country is affected by a crisis. Therefore, a dummy variable called “CRISIS_B” is created for each country. These ones are equal to “1” in periods of bearish stock market and to “0” otherwise. These two variables are available in *Table 6*.

The United States

On the graph of the S&P500 index (available in *Appendix 2*), four bearish periods can be observed. Their starting and ending dates, as well as their amplitudes are provided in *table 1* below. The two columns in the centre indicate the difference between the highest and the lowest values of the bearish periods and the difference between the closing values (of the starting and ending dates). The detailed calculations are available in *Appendix 3*.

Table 1: Crisis periods highlighted by bearish trends in the United States (CRISIS_B)

Starting and ending dates	Amplitude 1 (highest ---- lowest)	Amplitude 2 (closing ---- closing)	>20%?
July 1998 – October 1998	(-) 22%	(-) 2%	Yes
March 2000 – October 2002	(-) 51%	(-) 41%	Yes
October 2007 – March 2009	(-) 58%	(-) 49%	Yes
May 2011- October 2011	(-) 22%	(-) 7%	Yes

Germany

The same process is applied for Germany. On the graph of the DAX index (available in *Appendix 4*), six bearish periods are noticed. Their starting and ending dates, as well as their amplitudes are provided in *table 2* below. The detailed calculations are provided in *Appendix 5*.

Table 2: Crisis periods highlighted by bearish trends in Germany (CRISIS_B)

Starting and ending dates	Amplitude 1 (highest ---- lowest)	Amplitude 2 (closing ----- closing)	>20%?
July 1997 – October 1997	(-) 22%	(-) 16%	Yes
July 1998 – October 1998	(-) 38%	(-) 20%	Yes
March 2000 – March 2003	(-) 73%	(-) 68%	Yes
July 2007 – March 2009	(-) 56%	(-) 46%	Yes
June 2011 – September 2011	(-) 35%	(-) 25%	Yes
April 2015- January 2016	(-) 25%	(-) 15%	Yes

Over the sample period, four (six) bearish periods can be observed in the United States (Germany).

4.2.2. Gross Domestic Product Value (GDP): “CRISIS_GDP”

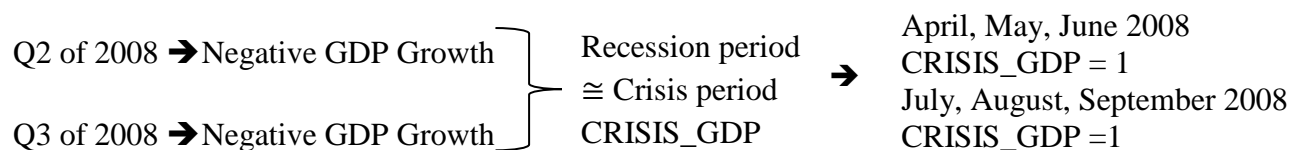
Although recessions constitute a normal part of the business cycle, their onset can be triggered by a crisis event. Therefore, this characteristic can be used in order to determine the various periods of market turmoil.

“A recession is a significant decline in activity across the economy, lasting longer than a few months. It is visible in industrial production, employment, real income and wholesale-retail trade” (Investopedia.com (2016)).

The Gross Domestic Product (GDP) is the technical indicator of recessions. Indeed, a country is considered “in recession” when it presents two consecutive quarters of negative economic growth. Among the numerous factors leading to recession, inflation is the most important one. When this variable increases, individuals and companies tend to reduce their expenses, leading to a decrease of GDP. More details about the GDP (definition, characteristics, ...) are provided in *Appendix 6* (Investopedia.com (2016)).

Considering recessions as a proxy of crisis periods, a dummy variable, called “CRISIS_GDP” is created for each country. These two variables are available in *Table 6*. The quarterly data are transformed into monthly data by assuming that the sign of the quarterly GDP growth can be applied to the corresponding months (Babecky et al. (2014)).

Example:



It is important to notice that this variable does not highlight all types of crises. It mainly reveals the economic and global crises, having an impact on the consumers' and companies' expenditures (Frankel (2010)).

Two (three) recession periods are exhibited by the GDP growth indicator in the United States (Germany).

Table 3: Crisis periods highlighted by the GDP growth indicator in the United States and Germany (CRISIS_GDP)

Country	Crisis periods
<i>The United States</i>	From January 2008 to March 2008
	From July 2008 to June 2009
<i>Germany</i>	From October 2002 to March 2003
	From April 2008 to March 2009
	From October 2012 to March 2013

4.2.3. The LIBOR-OIS spread: “CRISIS_LO”

The LIBOR-OIS spread is the difference between the London Interbank Offered Rate T-bill Rate (LIBOR) and the Overnight Index Swap (OIS) (Thornton (2016)).

4.2.3.1. LIBOR

“The London Interbank Offered Rate is the average interest rate at which leading banks borrow funds of a sizeable amount from other banks in the London market. Libor is the most widely used “benchmark” or reference rate for short term interest rates” (Federal Reserve Bank of St Louis (2016)).

Thornton (2009) defines the LIBOR as follows:

“The London interbank offer rate (Libor) is the rate at which banks indicate they are willing to lend to other banks for a specified term of the loan”.

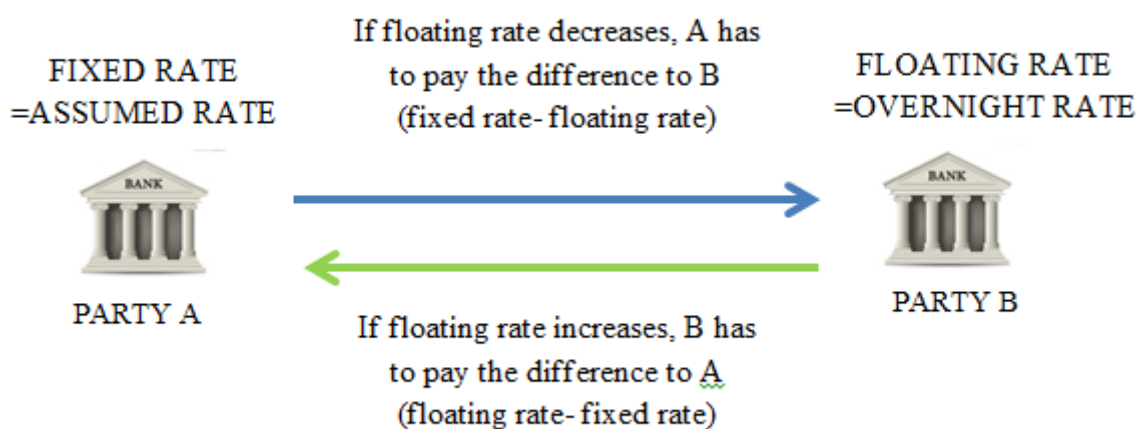
4.2.3.2. Overnight Index Swap (OIS)

“An overnight index swap is an interest rate swap involving the overnight rate being exchanged for a fixed interest rate. An overnight index swap uses an overnight rate index, such as the Federal Funds Rate, as the underlying for its floating leg, while the fixed leg would be set at an assumed rate’ (Investopedia.com (2016)).

The Federal Funds Rate corresponds to the interest rate at which a depository institution lends funds maintained at the Federal Reserve to another institution overnight (Federal Reserve Bank of Saint Louis (2016)).

Since no principals are exchanged, the risk of default on the OIS market is very little. It is only at the maturity of the contract that funds are exchanged. One party pays the net interest obligation (the difference between the floating and the fixed interest rates) to the other (Thornton (2009)). See figure 3: Overnight Index Swap.

Figure 3: Overnight Index Swap



Being considered as good indicators of the interbank credit markets, Overnight Index Swaps are popular among financial institutions. They are also less risky than other traditional interest rate spreads (Thornton (2016), Investopedia.com (2016)).

4.2.3.3. LIBOR-OIS spread

Measuring the willingness of banks to lend to each other, the LIBOR-OIS spread is considered as an indicator of the health of the banking system (Sengupta and Tam (2008)).

This idea is supported by Thornton (2009), affirming:

“ ... *The term LIBOR-OIS is assumed to be a measure of the health of banks because it reflects what banks believe is the risk of default associated with lending to other banks ...* “ (Thornton (2009), p. 1).

A higher spread indicates a decreased lending willingness by major banks, whereas a lower spread is an indication of higher liquidity in the market (Investopedia.com (2016)).

The LIBOR-OIS, remaining a fear barometer of market illiquidity, is considered as a key measure of credit risk in the banking sector. It reflects the changes in risk premiums, which tend to rise in periods of market turmoil and recessions (Thornton (2009)).

Historically, the value of this spread remains around 10-15 basis points. However, when the environment becomes uncertain (for example, during a crisis period), the gap increases dramatically. This characteristic can be used to determine the periods of market turmoil (Sengupta and Tam (2008), Thornton (2009)).

For Germany, this spread is calculated as the difference between the EURIBOR and the OIS. The overnight rate index is the Euro OverNight Index Average (EONIA), which is equivalent to the Federal Funds Rate.

Considering the LIBOR-OIS spread as an indicator of crisis, a dummy variable “CRISIS_LO” is created for both countries. This variable is equal to “1” when the LIBOR-OIS spread is superior to 20 and to “0”, otherwise. More details about these two variables are provided in *Table 6*.

The LIBOR-OIS spread is only available since December 2001, reducing the number of observations from 218 to 175. The EURIBOR-OIS spread is, for its part, available since February 1999, lowering the number of observation to 204.

As one can see on the *table 4* below, banks were less willing to lend money to each other during three (two) periods in the United States (Germany).

Although this indicator can be helpful to determine periods of recessions or crisis, it is important to notice that its first role is to highlight the health of the banking system. After a crisis has passed, banks are sometimes still reluctant to lend money to each other. Therefore, the crisis periods displayed by this indicator tend to be longer than they really are.

Table 4: Crisis periods highlighted by the LIBOR-OIS spread and the EURIBOR-OIS spread (CRISIS_LO)

Country	Period of “uncertain environment”
<i>The United States</i>	From August 2007 to July 2009
	From August 2011 to September 2002
	From December 2015 to January 2016
<i>Germany</i>	From August 1999 to November 1999
	From August 2007 to August 2012

4.2.4. Index volatility (VIX index and VDAX index): “CRISIS_V”

Crisis episodes are characterized by an important increase of the stock market uncertainty, measured by the VIX index (VDAX index) in the United States (Germany). This indicator, generally used to measure the market risk, is called the “investor fear gauge” since its value tends to peak when investors are concerned about the future volatility. (Banerjee et al. (2007), Whaley (2009), Investopedia.com (2016)).

The VIX index (VDAX index) can be employed to determine the different periods of market turmoil in the United States (Germany). A dummy variable, called “CRISIS_V” is created for each country. This variable is equal to “1” when the VIX (VDAX) is superior to 25; and to “0” otherwise. More information about these two variables is provided in *Table 6*.

Although the VIX (VDAX) is used as an indicator of market turmoil, it is important to notice that the stock market uncertainty can be induced by other events that crises. For example, the VIX (VDAX) has increased after the terrorist attacks of the 11th September 2001.

Table 5: Periods of crisis highlighted by the VIX index and the VDAX index (CRISIS_V)

Country	Periods of crisis
<i>The United States</i>	From October 1997 to November 1997
	From August 1998 to November 1998
	From November 2000 to April 2001
	From June 2002 to March 2003
	From January 2008 to October 2009
	From August 2011 to November 2011
<i>Germany</i>	From August 1997 to January 1998
	From June 1998 to March 1999
	From December 1999 to March 2000
	From September 2001 to December 2001
	From June 2002 to June 2003
	From September 2008 to August 2009
	From August 2011 to December 2011

4.3. Crisis variables

Since the first three variables represent different types of crisis (financial, economic, debt), a dummy variable called “CRISIS_G” is created for each country. This variable captures the information of the stock market value, the gross domestic product value and the LIBOR-OIS spread. It is equal to “1” when “CRISIS_B”, “CRISIS_GDP” or “CRISIS_LO” is equal to “1” and to “0” otherwise. Detailed information is provided in *Table 6*.

Since all crisis episodes are characterized by an important increase of stock market uncertainty, CRISIS_V is the second crisis indicator employed in this master thesis.

Chapter 5: Correlation between American and German stock (10-year bond) returns: “Globalization”

The cross country correlations between stock markets and 10-year bond markets are studied separately in order to determine the degree of globalization. These two time series are also presented in *table 6*.

5.1. Correlation between American and German stock returns

The formula employed to calculate the relationship is similar to the one used to establish the stock-bond correlation. The daily German stock prices are multiplied by the daily USD/EUR exchange rates (EURUSD BGN Currency) in order to obtain consistent results.

$$\begin{aligned} & \text{correlation} (r_{\text{American stock},t}; r_{\text{German stock},t}) \\ = & \text{correlation} \left(\begin{pmatrix} r_{\text{American stock, day 1 of month } t} \\ r_{\text{American stock, day 2 of month } t} \\ \vdots \\ r_{\text{American stock, day 30 of month } t} \end{pmatrix}; \begin{pmatrix} r_{\text{German stock, day 1 of month } t} \\ r_{\text{German stock, day 2 of month } t} \\ \vdots \\ r_{\text{German stock, day 30 of month } t} \end{pmatrix} \right) \end{aligned}$$

where:

$r_{\text{American stock},t}$: Stock return of the S&P500 index at time t (expressed in month).

$r_{\text{German stock},t}$: Stock return of the DAX index at time t (expressed in month).

The correlation between American and German stock returns is positive over the sample period, with an average value equals to 0,48. As one can observe on the graph provided in *Appendix 7*, it reaches its maximum of 0,90 in November 2011. These results are in line with the research of many authors such as Goetzmann et al. (2005), Baur (2010), Hong et al. (2011) and Ohmi and Okimoto (2016) announcing a positive and increasing correlation between same asset classes.

5.2. Correlation between American and German 10-year bond returns

The cross-country correlation is determined by using the formula presented in *section 5.1*. The “stock returns” are simply replaced by the “10-year bond returns”. The daily German bond yields are multiplied by the daily USD/EUR exchange rates (EURUSD BGN Currency) in order to obtain consistent results. The modified formula is available in *Appendix 8*.

Being in line with the research of Hong et al. (2011), the correlation observed between 10-year bond returns is positive over the sample period. The average value is equal to 0,42 and the relationship reaches its maximum in July 2014 (0,86). The standard deviation, for its part, is equal to 0,24. The graph of the correlation between American and German 10-year bond returns is provided in *Appendix 9*.

Chapter 6: Macroeconomic variables

A wide range of macroeconomic variables are selected from the literature in order to assess their impact on the stock-bond correlation. Since one goal of this master thesis is to compare their repercussions on the American and German relationships; analogous factors must be employed to ensure the rigor of the analysis (*Appendix 10*). The evolution of the comparable variables over the sample period is provided in this section.

To obtain the desired factors, some of them are transformed into the first difference. This step is also necessary in certain cases for stationarity reasons, explained in *chapter 7*. *Table 6* below provides an overview of the different variables. The first columns provide a brief description of the variable as well as the frequencies, sources and codes of the various data. The last row indicates the expected effect of the variable on the stock-bond correlation.

Table 6: Description of the variables

Factor	Country	Name of the variable	Description	Freq.	Source + code	Sign
Crisis period Stock market value	USA	CRISIS_B USA	Dummy variable: CRISIS_B=1 in periods of bearish markets and CRISIS_B=0 otherwise.	Monthly	Bloomberg S&P500 index	Negative
	Germany	CRISIS_B GERM		Monthly	Bloomberg DAX index	Negative
Crisis period Gross Domestic Product value (GDP)	USA	CRISIS_GDP USA	Dummy variable: CRISIS_GDP=1 in periods of recessions and CRISIS_GDP=0 otherwise.	Monthly	Bloomberg CQOQ index	Negative
	Germany	CRISIS_GDP GERM		Monthly	Bloomberg GRGDPPGQ index	Negative
Crisis period LIBOR-OIS spread	USA	CRISIS_LO USA	Dummy variable: CRISIS_LO=1 when the LIBOR-OIS > 20 and CRISIS_LO=0 otherwise.	Monthly	Bloomberg US0003M index – USSOC Curncy	Negative
	Germany	CRISIS_LO GERM		Monthly	Bloomberg EUR003M index – EUSWEC Curncy	Negative
Crisis period Global crisis indicator	USA	CRISIS_G USA	Dummy variable CRISIS_G=1 when CRISIS_B, CRISIS_GDP or CRISIS_LO is equal to 1 and CRISIS_G=0 otherwise // CRISIS_G=1 in periods of crisis and CRISIS_G=0 otherwise.	Monthly	Bloomberg	Negative
	Germany	CRISIS_G GERM		Monthly	Bloomberg	Negative

Crisis period Stock market uncertainty	USA	CRISIS_V USA	Dummy variable: CRISIS_V=1 when the VIX (VDAX) index > 25 and CRISIS_V=0 otherwise // CRISIS_V=1 in periods of crisis and CRISIS_V=0 otherwise	Monthly	Bloomberg VIX index	Negative
	Germany	CRISIS_V GERM		Monthly	Bloomberg VDAX index	Negative
Globalization Integration of the stock markets	USA and Germany	STOCK STOCK	Correlation between American and German stock returns	Monthly	Bloomberg S&P500 index and DAX index	Negative
Globalization Integration of the 10-year bond markets	USA and Germany	BOND BOND	Correlation between American and German 10-year bond returns	Monthly	Bloomberg USGG10YR index and GDBR10 index	Negative
Stock market uncertainty	USA	VIX	Chicago Board Options Exchange Volatility Index	Monthly	Bloomberg VIX index	Negative
	Germany	VDAX	Deutsche Borse AG DAX Volatility Index	Monthly	Bloomberg VDAX index	Negative
TED spread	USA	TED USA	First difference between the 3-month LIBOR/ EURIBOR and the corresponding 3-month bond yield	Monthly	Bloomberg US0003M index – USGG3M index	Negative
	Germany	TED GERM		Monthly	Bloomberg EUR003M index – GETB1 index	Negative

Default risk spread	USA	DEFAULT	First difference between the yields of Moody's Baa- and Aaa-rated bonds	Monthly	Bloomberg MOODCBA A index – MOODCAA A index	Undetermined
Term spread	USA	TERM USA	First difference of the yield between 10-year Treasury bond and 3-month Treasury bill	Monthly	Bloomberg USGG10YR index – USGG3M index	Positive
	Germany	TERM GERM		Monthly	Bloomberg GDBR10 index – GETB1 index	Positive
Economic indicator Short term interest rate	USA	SHORT USA	3-month bond yields	Monthly	Bloomberg USGG3M index	Undetermined or positive
	Germany	SHORT GERM		Monthly	Bloomberg GETB1 index	Undetermined or positive
Economic indicator Key interest rate provided by the Central Banks	USA	FED KEY RATE	Key interest rate provided by the Central Banks	Monthly	Bloomberg FDTR index	Undetermined or positive
	Germany	ECB KEY RATE		Monthly	Bloomberg EURR002W index	Undetermined or positive
Economic indicator Inflation	USA	INFL USA	Month-on-month log difference of the consumer price index	Monthly	Bloomberg CPI CHNG index	Undetermined
	Germany	INFL GERM		Monthly	Bloomberg GRCP20MM index	Undetermined

Economic indicator Business condition	USA	PMI	Indicator of the economic health of the manufacturing sector	Monthly	Bloomberg NAMPMI index	Positive
	Germany	IFO	Indicator of the “Germany Business Climate”	Monthly	Bloomberg GRIGPBUS index	Positive
Economic indicator Industrial production	USA	IP USA	Raw volume of goods produced by industrial firms	Monthly	Bloomberg IP index	Positive
	Germany	IP GERM		Monthly	Bloomberg GRIPI index	Positive
Economic indicator Consumer confidence	USA	Consumer Confidence USA = CC USA	Degree of optimism on the state of the economy that consumers are expressing through their activities of saving and spending	Monthly	Bloomberg CONCCONF index	Positive
		Consumer Sentiment USA = CS USA	Michigan Consumer Sentiment Index	Monthly	Bloomberg CONSSSENT index	Positive
	Germany	Consumer Confidence GERM = CC GERM	Degree of optimism on the state of the economy that consumers are expressing through their activities of saving and spending	Monthly	Bloomberg GRCCI index	Positive

Oil price		OIL	Crude oil Brent ~ Price per barrel	Monthly	Bloomberg CO1 comodty index	Undeter- mined
Gold price		GOLD	The Gold Spot Price is quoted as US\$ per Troy Ounce	Monthly	Bloomberg Xau index	Negative

6.1. Stock market uncertainty

VIX and VDAX

The VDAX index, measured in Germany is equivalent to the VIX index in the United States. On average, the volatility of the DAX is higher than the S&P500. *Table 7* below resumes the descriptive statistics for both countries. Although some differences can be observed, both indicators are characterized by identical periods of peaks and troughs. With a correlation equals to 0,86 ; the VIX and the VDAX tend to move similarly over time. The two last jumps in the indicators levels are observed in November 2008 and in September 2011. A graph with the evolution of the VIX and the VDAX over time is available in the *Appendix 11*.

Table 7: Descriptive statistics of the stock market uncertainty

Stock market uncertainty	Mean	Median	Standard Deviation	Minimum	Maximum
VIX	21,11	19,52	7,82	10,42 (January 2007)	59,89 (October 2008)
VDAX	22,47	20,73	8,53	10,87 (September 1996)	57,96 (February 2002)

6.2. TED spread

The TED spread is only available since December 1998 for Germany, reducing the number of observations from 241 to 206. This indicator presents an average of 0,43% for the United States and 0,39% for Germany. One can observe, on the graph provided in *appendix 12*, that the TED spreads for both countries tend to follow the same trend. The TED spreads peak in 2007 and 2008 and reach their maximum in September 2008, in the middle of the subprime crisis. Despite their correlation of 0,71 ; two main differences are detected; the American

spread increases in 1999 and 2000 (burst of the Dotcom bubble), whereas the German spread raises in 2011 (EU sovereign crisis).

Table 8: Descriptive Statistics of the TED spreads

TED spread	Mean	Median	Standard deviation	Minimum	Maximum
USA	0,43%	0,29%	0,42%	0,10% (August 2011)	3,15% (September 2008)
Germany	0,39%	0,24%	0,44%	-0,30% (December 2000)	2,85% (September 2008)

6.3. Default risk spread

The default risk spread, only available for the United States, is on average equal to 1,01% with a 0,44% standard deviation. The default risk peaks to 3,38% at the end of December 2008; in the middle of the global financial crisis. The difference between the yields of the Moody's Baa and Aaa-rated bonds is at its minimum in June 2014. A graph with the evolution of the default risk spread is available in *Appendix 13*.

Table 9: Descriptive Statistics of the Default risk spread

Default Risk spread	Mean	Median	Standard Deviation	Minimum	Maximum
USA	1,01%	0,90%	0,44%	0,55% (June 2014)	3,38% (December 2008)
Germany	NA	NA	NA	NA	NA

6.4. Term spread

Since the term spread averages for the United States and Germany are positive, the market expected a higher yield on the long-term securities than on the short term securities.

The term spread average is superior for the United States than for Germany, meaning that the yield difference between the long and the short term securities is superior for the former country.

Although the correlation between the term spreads is only 0,50 ; both spreads cross the zero line two times and reach their lowest point at the same time. However, as one can see on the graph in *Appendix 14*, the German term spread has a slight delay on the American one and its negative values are less extreme.

Table 10: Descriptive Statistics of the term spreads

Term spread	Mean	Median	Standard Deviation	Minimum	Maximum
USA	1,75%	1,87%	1,15%	-0,71% (December 2000)	3,68% (May 2004)
First diff	0,00%	-0,01%	0,24%	-0,93%	0,82%
Germany	1,58%	1,57%	0,83%	-0,29% (December 2000)	3,24% (May 1996)
First diff	0,00%	-0,02%	0,21%	-0,56%	1,67%

6.5. Economic indicators

6.5.1. Short term interest rate

6.5.1.1. Short Term Interest Rate (3-month bond yield)

Over the sample period, the 3-month bond yield is used to measure the short term interest rate (OCDE website (2016)). The average values in the United States and Germany are positive and equal to 2,38% and 2,06%, respectively. As one can observe on the graph provided in *Appendix 15*, the American and German interest rates were particularly affected by the burst of the dotcom bubble (2000-2002) and the 2008-crisis. Since then, the short term interest rates amount approximatively zero. Although the correlation between both interest rates is 0,82; the American interest rate movements are in advance compared to the German's ones.

Table 11: Descriptive Statistics of the short term interest rates

Short term interest rate	Mean	Median	Standard deviation	Minimum	Maximum
USA	2,38%	1,72%	2,21%	-0,0007% (December 2011)	6,35% (November 2000)
First diff	-0,02%	0,00%	0,19%	-0,90%	0,47%
Germany	2,06%	2,34%	1,59%	-0,53% (January 2016)	5,21% (December 2000)
First diff	-0,02%	0,00%	0,18%	-1,87%	0,40%

6.5.1.2. Key interest rates provided by the Central Banks

Since the commercial and/or bond market are greatly influenced by the key interest rate provided by the Federal Reserve Bank (FED) (in the United States) and the European Central Bank (ECB) (in Germany), one can affirm that the orientation given by the Central Banks constitutes the essential factor of the short term interest rate.

However the missions of these two financial institutions present some differences.

Maintaining the economic activity (in order to avoid a depression such as the one that affected the US in the 1930s) and keeping an eye on the inflation (the “ideal” objective is to retain the inflation under 2%) are both parts of the FED’s mission (Federal Reserve.gov (2016)).

In Europe, the mission of the ECB consists of defending the euro stability to prevent the inflation to run out of control (such as in Germany in 1923). Supporting the economic activity is not included in its mandate. This is why the European Central Bank acts more carefully and slowly when interest rate issues are on the table (ecb.europa.eu (2016)).

The Central Banks decide to decrease the short rates in order to boost the economy and to avoid the liquidity problem that some banks could encounter after a crisis. One can see on the graph provided in *Appendix 16* that the FED’s decisions are in advance compared to the ECB’s ones. The amplitude of the reduction is superior in the United States than in Germany. However, since 2015, the key interest rate of the ECB is inferior to the FED’s one.

During the 2008 crisis, the FED rapidly decreased its key interest rate. However, this measure was not sufficient and the financial institution added an exceptional and non-conventional measure: the quantitative easing.

“Quantitative easing is an unconventional monetary policy in which a central bank purchases government securities or other securities from the market in order to lower interest rates and increase the money supply. Quantitative easing increases the money supply by flooding financial institutions with capital in an effort to promote increased lending and liquidity. Quantitative easing is considered when short-term interest rates are at or approaching zero, and does not involve the printing of new banknotes” (Investopedia.com (2016)).

One can notice on the graph provided in *Appendix 16* that since then, the key interest rate is stable and equal to 0,5%.

Being more reticent to decrease its rate, it is only when the inflation was almost equal to zero that the ECB reduced its key rate to zero.

Table 12 : Descriptive Statistics of the key interest rates

Key interest rate	Mean	Median	Standard Deviation	Minimum	Maximum
USA	2,11%	1,25%	2,11%	0,25%	6,50%
First diff	-0,02%	0,00%	0,20%	-1,25%	0,50%
Europe	2,12%	2,00%	1,39%	0,05%	4,75%
First diff	-0,01%	0,00%	0,16%	0,50%	-0,75%

6.5.2. Inflation

With a weak correlation of 0,28 ; American and German inflations present some divergences. The average (monthly) values are positive and equal to 0,18% and 0,11% respectively. The standard deviations, for their part, amount to 0,32% and 0,29%. One can note, on the graph provided in *Appendix 17* that inflation in Germany crosses many times the zero line and exhibits some high negative values. In the United States, inflation is more stable over time; except in November 2008, when the indicator collapses to -1,80%.

Table 13: Descriptive Statistics of Inflation

Inflation	Mean	Median	Standard Deviation	Minimum	Maximum
USA	0,18%	0,20%	0,29%	-1,80% (November 2008)	1,40% (September 2005)
Germany	0,11%	0,10%	0,32%	-1,00% (January 2015)	1,10% (December 2004)
First diff	0,00%	0,00%	0,50%	-1,90%	1,90%

6.5.3. Business conditions

Purchasing Managers' index (PMI)

Over the sample period, the Purchasing Managers' Index is only available for the United States. Its average value, median and standard deviation are 52,10 ; 52,6 and 4,89 respectively.

The PMI is inferior to 50 during the five following periods: from September 1998 to December 1998; from August 2000 to February 2002, from October 2002 to June 2003, from December 2007 to July 2009 and from October 2015 to the present time. The manufacturing sector and activities are suffering during these different periods.

The lower value is observed in December 2008 whereas the highest value is observed in May 2004.

IFO

The IFO in Germany can be compared to the PMI in the United States. The critical value 100 corresponds to the survey data as of the 1st January 2005. The average value, median and standard deviation over the sample are equal to 102,33 ; 103,4 and 6,74 respectively. The lower value is observed in March 2009 and the highest value in December 2010.

Although the two indicators tend to follow the same trend, the PMI is in advance compared to the IFO.

A graph with the evolution of the PMI and the IFO over time is available in *Appendix 18*.

Table 14: Descriptive Statistics of the business climate

Business Climate	Mean	Median	Standard Deviation	Minimum	Maximum
PMI	52,10	52,60	4,89	33,10 (December 2008)	61,40 (May 2004)
IFO	102,33	103,4	6,74	83,60 (March 2009)	114,20 (December 2010)

6.5.4. Industrial Production

Although the industrial production in the United States and in Germany follows an upward trend over the sample period, a huge collapse is observed between February 2008 and September 2009. Fortunately, this decline stops in October 2009 and the industrial production starts to recover. The critical value of 100 corresponds to the survey data as of the 2012 (2010) in the United States (Germany). The mean value being inferior to 100, the industrial production is, on average, lower than it used to be in 2012 (2010). A graph with the evolution of the German industrial production and the American industrial production over time is available in the *Appendix 19*.

Table 15: Descriptive Statistics of the Industrial Production

Industrial Production	Mean	Median	Standard Deviation	Minimum	Maximum
USA	95,99	96,32	7,17	75,33 (31-01-1996)	106,67 (28-11-2014)
First diff	0,12	0,17	0,64	-4,36	1,79
Germany	96,67	93,70	8,97	79,40 (29-02-1996)	111,20 (29-01-2016)
First diff	0,12	0,20	1,39	-6,70	3,30

6.5.5. Consumer Confidence

The average values of the consumer confidence in the United States and Germany are equal to 93,29 and 92,80 ; respectively. The critical value 100 corresponds to the survey data as of the 1985. Since the average values are below this critical value, American and German consumers are on average more pessimist than they were in the past.

Although the correlation between the German and the American consumer confidence is weak (18%), this indicator displays its lowest value approximatively at the same time in both countries (2009).

It is important to notice that the consumer confidence is more volatile in the United States than in Germany.

One can see on the graph provided in *Appendix 20* that the American households were used to be optimistic before 2001. However, since then, a negative confidence has taken place and has been reinforced by the 2008-crisis. Albeit the German consumers express their pessimism in a lesser extent, their confidence is under the critical value most of the time.

The degree of optimism on the state of the economy perceived by the consumers in the United States can also be measured by the Michigan Consumer Sentiment Index. The correlation between the Michigan Consumer Sentiment Index and the Consumer Confidence Index is equal to 0,94. A graph with both indexes is provided in *Appendix 21*.

Table 16: Descriptive statistics of the consumer confidence

Consumer Confidence	Mean	Median	Standard Deviation	Minimum	Maximum
USA	93,29	95,24	28,08	25,30 (February 2009)	144,71 (May 2000)
First diff	0,00	0,16	6,17	-22,54	19,58
Germany	92,79	95,00	9,48	67,00 (April 2009)	111,00 (November 2010)

6.5. Oil price

From 1996 to 2008, oil price tends to follow an upward trend. A sharp rise is observed between 2006 and 2008 and the prices reached their maximum of 139,83\$/barrel in June 2008. A high demand from the emerging countries and particularly from China, together with heavy speculation, constitutes the main causes of this spectacular increase.

However, the financial crisis and the resulting fear of recession induce a huge decline of the raw material prices (including oil) by the end of the year 2008. Fortunately, some recovery measures (a sharp fall of the Central Banks prime rates, “quantitative easing” in the United States and in China, investment plans (Europe, Japan, China)) were put into motion in order to reverse the tendency.

Some other factors, specific to the oil sector, can also explain the large price fluctuations. Among them, one can find a more efficient use of the energy (green cars and industries); the increasing success of the renewable energies (wind turbines, photovoltaic panels); the return of oil producing countries (Libya, Iraq and later Iran), previously under embargo as well as the exploitation of new production techniques (shale oil from Canada and USA, “offshore” production in Mexico, Brazil and Africa). The increasing offer and decreasing demand resulting from these factors lead to a decline of the prices.

A graph with the evolution of oil price over time is provided in *Appendix 22*.

Table 17: Descriptive Statistics of the oil prices

Oil price	Mean	Median	Standard Deviation	Minimum	Maximum
USA and Germany	59,89\$	50,80\$	35,36\$	10,46\$ (November 1998)	139,83\$ (June 2008)
First diff	0,07\$	0,31\$	5,54\$	-32,85\$	16,42\$

6.6. Gold price

Over the sample period, the average gold price is equal to 744,34\$/ounce. The price follows an upward trend between 1996 and 2013. One can see on the graph provided in *Appendix 23* that the gold value increases sharply in 2008. This important raise translates the fact that gold is considered as a safe haven during chaotic periods.

Table 18: Descriptive Statistics of the gold prices

Gold price	Mean	Median	Standard Deviation	Minimum	Maximum
USA and Germany	744,34\$	561,55\$	475,50\$	255,68\$ (August 1999)	1825,55\$ (August 2011)
First diff	3,03\$	0,40\$	47,77\$	-201,76\$	198,5\$

6.7. Summary of the macroeconomic variables

Over the sample period, the economy is weakened by the various crises. Being affected by these periods of market turmoil, the different indicators tend to change their tendency when the situation is becoming less prosperous.

The 2008 crisis affects the diverse factors to a greater extent. Since then, one can observe the difficulty of the economy to recover. The European sovereign debt crisis is, for its part, mainly felt through the German indicators.

Therefore, the market uncertainty, measured by the VIX and the VDAX, peaks during periods of market turmoil. These times are also marked by an increase of the TED spread, as well as the Default risk spread (only available for the United States). The gold price, playing its role of safe haven, rises dramatically between 2008 and 2012.

By contrast, the inflation crosses many times the zero line and reaches some high negative values when bad news is taking shape on the horizon. The interest rate decreases dramatically during crisis episodes and amounts approximately zero since the 2008-crisis. The business conditions indicators, represented by the PMI and the IFO, fall below their critical values during periods of market turmoil. Being an indicator of recession, the term spread tends to decline before each crisis.

The consumer confidence reveals that the American and German consumers are pessimistic during the sample period.

Finally, the industrial production, following an upward trend, seems only affected by the 2008 crisis.

Generally speaking, the American and German indicators tend to follow the same tendency over the sample period.

Chapter 7: Non-stationary variables and Augmented Dickey-Fuller (ADF) Test

Since the different models (described in *chapter 8*) are estimated by using the Ordinary Least Squares (OLS) method, it is important to verify the stationarity of the dependant (stock-bond correlations) and independent variables (macroeconomic variables/crisis indicators).

“A series is said to be stationary if the mean and auto-covariances of the series do not depend on time” (EViews 9 user guide II, p. 527).

By contrast, a non-stationary series, called “integrated”, is designed by the abbreviation $I(d)$; where d is the number of unit roots contained in the series.

For example, in a simple AR(1) process, the series y_t depends on its lagged values and a random innovation, ϵ_t .

$$y_t = \rho y_{t-1} + \epsilon_t$$

If $|\rho|$ is superior or equal to one, the process has a unit root and is considered as non-stationary. In that case, the variance of y increases with time and approaches infinity.

Since the stationarity is needed to insure the non-violation of the OLS assumptions, regressions including integrated $I(d)$ variables lead to spurious regression. In such situation, the OLS results highlight a false relationship between two variables, either due to a coincidence or to the presence of a third, unseen factor. The standard errors and the t-statistics are, for their part, invalid.

(Keele and Kelly (2006), Wooldridge (2013), EViews 9 user guide II (2015))

Augmented Dickey Fuller test (ADF)

The ADF test allows to detect the presence of unit roots in a series. Assuming that the series follows an $AR(p)$ process instead of an $AR(1)$ process, it is an evolution of the Dickey Fuller test. Therefore, the right-hand side of the ADF test regression includes p lagged terms of the dependant variable y .

$$\Delta y_t = \alpha y_{t-1} + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \dots + \beta_p \Delta y_{t-p} + \epsilon_t$$

Where $\alpha = \rho - 1$.

The Augmented Dickey Fuller test tests whether the absolute value of ρ is strictly inferior to the unity. Therefore, the null and alternative hypothesises are the following:

$$\left\{ \begin{array}{l} H_0: \alpha = 0 \rightarrow |\rho| = 1 \rightarrow \text{The time series is not stationary.} \\ H_a: \alpha < 0 \rightarrow |\rho| < 1 \rightarrow \text{The time series is stationary.} \end{array} \right.$$

This test is performed on all the variables presented in this master thesis. When the null hypothesis ($|\rho| = 1$) is not rejected, the non-stationary series is transformed into its first difference, which is stationary. The different results of the ADF test are provided in *Appendix 24*. The first differences of the non-stationary variables are added in their descriptive statistics tables.

(Wooldridge (2013), EViews User Guide II (2015))

Chapter 8: Regression models

In this section, three regression models are employed in order to determine the impact of the different macroeconomic variables on the stock-bond correlation. The best model is elected on the basis of three indicators: the adjusted R-squared, the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC), explained in *chapter 10*.

Model 1

$$SB\ correlation_t = \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * Y_t + \varepsilon_t$$

Model 2

$$\begin{aligned} &SB\ correlation_t \\ &= \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_X_t \\ &+ \varepsilon_t \end{aligned}$$

Model 3

$$\begin{aligned} &SB\ correlation_t \\ &= \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_X_t \\ &+ \beta_5 * (MACRO_t * CRISIS_X_t) + \varepsilon_t \end{aligned}$$

Table 19: Description of the variables

Variable	Description
$SB\ correlation_t$	Contemporaneous correlation between stock and 10-year bond returns, calculated in <i>Chapter 3</i> .
$SB\ correlation_{t-1}$	Correlation between stock and 10-year bond returns, lagged by one period.
$SB\ correlation_{t-2}$	Correlation between stock and 10-year bond returns, lagged by two periods.
Y_t	Macroeconomic variable or crisis indicator (CRISIS_G or CRISIS_V) at time t.
$MACRO_t$	Macroeconomic variable at time t.
$CRISIS_X_t$	Dummy variable equals to “1” in period of crisis and to “0” otherwise, at time t. CRISIS_X is replaced either by CRISIS_G or by CRISIS_V.

Model 1 displays the impact of the macro-economic variable on the stock-bond correlation. It does not take into account the presence or absence of crises. According to this model, the contemporaneous stock-bond correlation is function of the past correlation, altered by new information.

Model 2 is a bit different in the sense that it takes into consideration the influence of crisis periods. Since $CRISIS_X_t$ is a dummy variable, its effect is felt at the intercept level. Indeed, β_4 coincides with a fixed increase or decrease of the stock-bond correlation (when the variable $CRISIS_X_t$ is equal to one).

The model can be re-written as followed (when $CRISIS_X_t = 1$)

$$SB\ correlation_t = (\alpha + \beta_4) + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \varepsilon_t$$

Model 3, for its part, includes an interactive dummy variable; ($MACRO_t * CRISIS_t$). This element allows to discover the effects of the macro-economic factor on the stock-bond correlation, conditionally to the presence or absence of crisis. Therefore, one can consider that the variable behaves differently in periods of crisis when β_3 and β_5 are not similar. β_5 modifies the slope of the stock-bond correlation (when the variable $CRISIS_X_t$ is equal to one).

The model can be re-written as followed (when $CRISIS_X_t = 1$)

$$\begin{aligned}
 & SB\ correlation_t \\
 &= (\alpha + \beta_4) + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + (\beta_3 + \beta_5) * MACRO_t \\
 &+ \varepsilon_t
 \end{aligned}$$

8.1. Lagged dependant variables

According to Ohmi and Okimoto (2015), the conditional correlation between stock and bond returns is highly serially correlated. However, this characteristic constitutes a violation of the various conditions necessary to employ correctly the Ordinary Least Squares (OLS) method.

“The Ordinary Least Squares (OLS) regression estimator assumes, for example, that there is no autocorrelation in the residuals” (Keele and Kelly (2005)).

In order to eliminate this residual series correlation, a lagged dependent variable is included in the right-hand side of the model. This inclusion also captures the dynamics of the stock-bond correlation. Moreover, not incorporating this lagged variable could lead to an omitted variable bias and, therefore, to inconsistent and biased OLS estimators (Keele and Kelly (2005)).

Including only the first dependent variable is not enough to remove the residual correlation. Therefore, the second lagged dependent variable is also incorporated in the various models.

The absence of ARCH and residual series correlation is controlled through three indicators, presented in *Chapter 10*.

8.2. Independent variables

The different macroeconomic variables, as well as the crisis indicators are included in the various models in order to define their impact on the stock-bond correlation.

Chapter 9: Regression results

The results of the various models are presented in this section. With very low p-values, the first and the second lagged dependent variables have a positive impact on the stock-bond correlation; both in the United States and Germany.

9.1. Regression results for Model 1

A comparative table with the American and German results is provided in *Appendix 27*. It only includes the significant crisis/macroeconomic variables and their impact on the stock-bond correlation in both countries.

9.1.1. The United States

The regression outputs of model 1 suggest that CRISIS_G, CRISIS_V, STOCK STOCK, BOND BOND, VIX, TED USA, TERM USA and OIL have a significant impact⁶ on the stock-bond correlation. A table with the results is provided in *Appendix 25*.

Crisis periods

With a p-value inferior to 0,05, the negative coefficients of CRISIS_G (-0,161673) and CRISIS_V (-0,109973) are highly significant (5% significance level). Therefore, a negative relationship exists between the crisis periods and the stock-bond correlation. According to the first indicator (CRISIS_G), the stock-bond correlation is, on average, 0,161673 more negative in periods of crisis. The second indicator (CRISIS_V) reveals that the correlation is, on average, 0,109973 inferior in periods of market turmoil. These findings are in line with the research of many authors such as Ilmanen (2003), Johnson et al. (2013), Chiang et al. (2014) and Acosta-Gonzales et al. (2015).

⁶ In this master thesis, the variables considered as “significant” are the ones presenting at least a 5% significance level. This choice is made in order to have highly precise estimations.

For a two-sided test, a factor is significant at the 1% or 5% significance level if the absolute value of the t-statistic is larger than its corresponding critical value (2,58 and 1,96; respectively). The t-value is calculated as the ratio of the estimated parameters on its standard deviation. Alternatively, a variable is significant at 1% or 5% significance level when the p-value of the estimated parameters is inferior to 0,01 or 0,05. In these cases, the null hypothesis, affirming that the estimated coefficient is equal to zero, is rejected (Wooldridge (2013)).

The negative impact of these two variables on the stock-bond correlation indicates the presence of “flight-to-quality” episodes. As explained in *section 2.2.3*, investors tend to move their funds from risky assets to safer assets in crisis periods (Gulko (2002), Baur and Lucey (2009), Hakkio and Keetp and Acosta-Gonzales (2015)).

Macroeconomic variables having a positive impact on the stock-bond correlation

TERM USA and OIL have a positive impact on the relationship between stock and bond returns. Their p-values being inferior to 0,05 (0,01); the null hypothesis of a zero coefficient can be rejected at the 5% (1%) significance level.

TERM USA

A one per cent increase in the first difference of the term spread would cause a 0,280931 rise of the stock-bond correlation. This result is consistent with the research of Viceira (2007), Wheelock and Wohar (2009), Aslanidis and Christiansen (2011) and Asgharian et al. (2015).

OIL

The coefficient of OIL illustrates a 0,008344 increase of the stock-bond correlation for a one dollar increase in the oil price first difference.

Macroeconomic variables having a negative impact on the stock-bond correlation

The p-values of STOCK STOCK, BOND BOND, VIX and TED USA indicate a highly significant negative relationship between these variables and the stock-bond correlation. All the findings are in line with the literature (*Sections 2.2.4, 2.2.5, 2.2.6*).

STOCK STOCK and BOND BOND

A one percent increase in the correlation between American and German stock (10-year bond) returns leads to a 0,273181 (0,188427) decrease of the stock-bond correlation. Hong et al. (2011) and Ohmi and Okimoto (2016) also noticed the negative impact of the globalization on the stock-bond correlation.

VIX

The correlation between stock and bond returns is reduced by 0,007782 when the VIX index is increased by one per cent. The negative effect of the stock market uncertainty on the stock-

bond correlation is due to the “flight-to-quality” phenomenon (Andersson et al. (2004), Whaley (2009), Baele et al. (2010), Asgharian et al. (2014)).

TED USA

The -0,133683 TED USA coefficient predicts a 0,133683 decrease of the correlation for a one percent increase of the TED spread.

9.1.2. Germany

In Germany, five variables (CRISIS_G, CRISIS_V, STOCK STOCK, VDAX and TERM GERM) have an impact on the stock-bond correlation. All the findings are in line with the literature. A table with the results is provided in *Appendix 26*.

Crisis periods

As for the United States, the two crisis indicators are highly significant and reveal the negative effect of the crises on the stock-bond correlation. CRISIS_G (CRISIS_V) indicates that the relationship between stock and bond returns is, on average, 0,137243 (0,103003) inferior in periods of market turmoil. The negative effect of these two variables on the correlation highlights the presence of “flight-to-quality” episodes.

Macroeconomic variables having a positive impact on the stock-bond correlation

With a p-value equals to 0,0491 ; TERM GERM is the only macroeconomic variable having a positive impact on the stock-bond correlation. When the term spread increases by one per cent, the correlation increases by 0,173481.

Macroeconomic variables having a negative impact on the stock-bond correlation

STOCK STOCK

Representing the globalization (cross-country correlation), STOCK STOCK has a negative impact on the correlation between stock and bond returns. A one percent increase in the correlation between American and German stock returns leads to a 0,430959 decrease of the stock-bond correlation.

VDAX

The p-value of VDAX (0,0059) evidences the existence of a highly significant, negative relationship between the German stock market volatility and the stock-bond correlation. When the VDAX increases by one per cent, the correlation should decrease by 0,006227.

9.2. Regression results for Model 2

Since CRISIS_G and CRISIS_V are significant in the first model, both of them are retained as adequate proxies of the crisis periods.

9.2.1. Regression results for Model 2 with CRISIS_G

Model 2 takes into account the influence of the dummy variable CRISIS_G. A comparative table with the American and German results is provided in *Appendix 30*. It includes the significant macroeconomic variables and their impact on the stock-bond correlation in both countries.

9.2.1.1. The United States

As one can see on the table provided in *Appendix 28*, the crisis indicator (CRISIS_G) is highly significant in all the regressions. Indeed, its p-value is inferior to 0,01 in each of them. Since CRISIS_G has an impact on the intercept level; a fixed decrease of the stock-bond correlation can be expected in crisis periods.

STOCK STOCK, BOND BOND, TERM USA and OIL remain significant, with a p-value inferior to 0,05. As expected, the value of their coefficients stays approximatively the same.

9.2.1.2. Germany

As for the United States, CRISIS_G has a significant, negative impact in all the regressions.

With a p-value inferior to 0,05, STOCK STOCK and TERM GERM stay significant in this second model. As expected, their coefficients are roughly similar to the ones provided by the model 1.

A table with the regression outputs is available in *Appendix 29*.

9.2.2. Regression results for Model 2 with CRISIS_V

Model 2 takes into account the influence of the dummy variable CRISIS_V. Since this indicator is created on the basis of the VIX index and the VDAX index (see *Section 4.2.4*), these two macroeconomic variables are not included in order to avoid inconsistent results.

A comparative table with the American and German outputs is provided in *Appendix 33*. It includes the significant macroeconomic variables and their impact on the stock-bond correlation in both countries.

9.2.2.1. The United States

The crisis indicator is significant in six regressions on thirteen (46%). CRISIS_V is significant for BOND BOND, TERM USA, INFLATION USA, PMI, IP USA and GOLD. Therefore, a fixed decrease of the stock-bond correlation can be expected in periods of market turmoil for the regressions including these variables.

The p-value of STOCK STOCK, BOND BOND, TED USA, TERM USA and OIL indicates that the null hypothesis can be rejected at a 5% significance level. Therefore, as in model 1, these variables have an impact on the stock-bond correlation. As expected, the value of their coefficients stays approximately the same.

The table with the regression outputs is available in *Appendix 31*.

9.2.2.2. Germany

By contrast to the United States, CRISIS_V is highly significant and negative in all the regressions in Germany.

Two variables (STOCK STOCK and TERM GERM) remain significant in this model. As expected, their coefficients are roughly similar to the ones provided by the model 1.

A table with the regression outputs is available in *Appendix 32*.

9.3. Regression results for Model 3

Model 3 contains an interactive dummy variable. As for Model 2, CRISIS_G and CRISIS_V are retained as adequate proxies of the crisis periods.

9.3.1. Regression results for Model 3 with CRISIS_G

9.3.1.1. The United States

As one can see on the table provided in *Appendix 34*, the coefficients of TED USA and FED KEY RATE, as well as their corresponding interactive dummies (TED*CRISIS_G) and (FED KEY RATE* CRISIS_G) are significant, meaning that the effect of these two variables on the stock-bond correlation varies in periods of market turmoil.

Since the interactive dummy tends to modify the slope of the stock-bond correlation (when the crisis indicator is equal to one), model 3 can be re-written as followed:

$$\begin{aligned}
 &SB\ correlation_t \\
 &= (\alpha + \beta_4) + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + (\beta_3 + \beta_5) \\
 &* MACRO_t + \varepsilon_t
 \end{aligned}$$

Therefore, in periods of crisis, the impact of TED USA and FED KEY I RATE on the stock-bond correlation is equal to the sum of β_3 and β_5 .

TED USA

In periods of market turmoil, when the TED spread increases by one percent, the relationship between stock and bond returns decreases by 0,073872 (-0,501408+0,427536).

FED KEY RATE

When the crisis indicator is equal to one, a one per cent increase of FED KEY INTEREST RATE would cause a 0,021772 (0,777627-0,799399) decrease of the correlation between stock and bond returns.

With a p-value inferior to 0,05, STOCK STOCK and TERM USA have a negative impact on the stock-bond correlation. However, since their corresponding interactive dummies are not significant, one cannot conclude that these factors have a different impact on the stock-bond correlation during crisis periods.

9.3.1.2. Germany

In this model, no interactive dummy is significant at the 5% or 1% level.

A table with the regression outputs is available in *Appendix 35*.

With a p-value inferior to 0,05, STOCK STOCK, TERM GERMANY and IFO have an impact on the stock-bond correlation. However, since their corresponding interactive dummies are not significant, one cannot conclude that the impact of these three macroeconomic variables on the stock-bond correlation varies in period of market turmoil.

9.3.2. Regression results for Model 3 with CRISIS_V

Model 3 takes into account the influence of the dummy variable CRISIS_V. Since this indicator is created on the basis of the VIX index and the VDAX index (see *Section 4.2.4*), these two macroeconomic variables are not included in order to avoid inconsistent results.

9.3.2.1. The United States

As one can see on the table provided in *Appendix 36*, the coefficients of TED USA, DEFAULT and SHORT USA, as well as their corresponding interactive dummies (TED USA* CRISIS_V), (DEFAULT*CRISIS_V) and (SHORT USA*CRISIS_V) are significant, meaning that the effect of these three variables on the stock-bond correlation varies in periods of market turmoil. Their impact are therefore equals to the sum of β_3 and β_5 , depending on the model.

TED USA

In period of market turmoil, when the TED spread increases by one per cent, the relationship between stock and bond returns decreases by 0,045773 (-0,331259+0,285486).

DEFAULT USA

When the crisis indicator is equal to one, a one per cent increase of the default risk spread would lead to a 0,037778(-0,400009+0,437787) increase of the stock-bond correlation.

SHORT USA

When CRISIS_V is equal to one, a one percent increase of the short interest rate would cause a 0,116522 (0,393785-0,510307) decrease of the stock-bond correlation.

With a p-value equals to 0,05, STOCK STOCK, BOND BOND, TERM USA and FED KEY RATE have a negative impact on the stock-bond correlation. However, since their corresponding interactive dummies are not significant, one cannot conclude that these variables have a different impact on the stock-bond relationship during crisis periods

9.3.2.2. Germany

In this model, no interactive dummy is significant at the 5% or 1% level.

A table with the regression outputs is available in *Appendix 37*.

With a p-value inferior to 0,05, STOCK STOCK and CC GERM have a negative impact on the correlation. However, since their corresponding interactive dummies are not significant, one cannot conclude that these two variables have a different impact on the stock-bond relationship during periods of market turmoil.

Chapter 10: Tests carried out on the various regressions.

10.1. Tools to determine the presence of residual series correlation : correlograms and Q-statistics

In order to test whether the inclusion of the lagged dependent variables is able to eradicate the residual series correlation, the correlograms and Q-statistics of the different regressions are observed and analysed.

The correlograms present the autocorrelation and partial autocorrelation of the residuals, as well as the Ljung Q-statistics for high-order serial correlation.

“ If there is no serial correlation in the residuals, the autocorrelations and partial autocorrelations at all lags should be nearly zero, and all Q-statistics should be insignificant with large p-values” (HIS (2015), p.96)

Results

For all the regressions, the null hypothesis, stating the absence of autocorrelation, cannot be rejected. This finding suggests that incorporating the first and the second lagged dependent variables is sufficient to completely eliminate the autocorrelation. An example is available in *Appendix 38*.

10.2. Tools to determine the presence of ARCH

Two different tools are employed in order to confirm the absence of ARCH in the residuals: the correlograms of squared residuals and the Engle's ARCH test.

10.2.1. Correlograms of squared residuals

The correlograms exhibit the autocorrelations and partial autocorrelations of the squared residuals up to any stated number of lags. The Ljung-Box Q-statistics are also calculated for the corresponding lags. These indicators can be employed to determine the presence of autoregressive conditional heteroscedasticity (ARCH) in the residuals.

“If there is no ARCH in the residuals, the autocorrelations and partial autocorrelation should be zero at all lags and the Q-statistics should be not significant” (HIS (2015)).

An example is available in *Appendix 39*.

10.2.2. Engle's ARCH test

Although ARCH in itself does not invalidate the OLS inferences, ignoring its effects may result in loss of efficiency. The ARCH test regresses the squared residuals on the lagged squared residuals and a constant. The null hypothesis states the absence of heteroscedasticity and autocorrelation effects in the regression's error term.

The Engle's (1982) Lagrange Multiplier test allows to determine the presence of ARCH. Following a χ^2 distribution, this statistic is computed as the number of observations times the R-squared from the test regression.

(HIS (2015)).

Results

The results of Engle's ARCH test (provided in *Appendix 40*), as well as a correlograms do not reject the null hypothesis, stating the absence of ARCH in the various regressions. This finding suggests that including the first and the second lagged dependent variables is sufficient to entirely eliminate the Autoregressive Conditional Heteroscedasticity.

Chapter 11: Evaluation of the models

As revealed before, the best model is elected on the basis of three indicators: the adjusted R-squared, the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). All the results are provided in *Appendix 41*.

11.1. Adjusted R²

The R-squared measures the proportion of the variance of the dependant variable that is explained by the model.

$$R^2 = 1 - \frac{\left(\frac{SRR}{n}\right)}{\left(\frac{SST}{n}\right)}$$

Where *SRR* corresponds to the sum of squared residuals, *SST* is the total sum of squares and *n* coincides with the number of observations.

The coefficient of determination typically increases when more independent variables are included in the model. This rise is mainly due to the fact that SRR tends to fall with the presence of new regressors. The adjusted R-squared, for its part, imposes a penalty for the addition of exogenous factors which do not contribute to the explanatory power of the model.

$$\bar{R}^2 = 1 - \frac{\left(\frac{SRR}{(n-k-1)}\right)}{\left(\frac{STT}{(n-1)}\right)}$$

Where k represents the number of estimated parameters.

(Wooldridge (2013), HIS (2015))

11.2. Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC)

Measuring the relative quality of statistical models, the two indicators reward the goodness of fit but also incorporate a penalty term, rising with the number of parameters. Since the likelihood can be increased by adding exogenous factors, this penalty is present to discourage overfitting. It also allows to stay parsimonious. Therefore, the preferred model is the one with the lowest AIC/BIC.

The Bayesian Information Criterion, also called Schwartz Criterion (SC) is an alternative of the AIC that imposes a larger penalty for supplementary exogenous factors. Indeed, besides depending on the number of parameters, its sanction relies on the sample size.

AIC formula:

$$AIC = \frac{-2l}{n} + \frac{2k}{n}$$

BIC or SC formula:

$$SC = \frac{-2l}{n} + \frac{(k \log n)}{n}$$

Where l is the log likelihood, k is the number of parameters and n is the number of observations.

(Wooldridge (2013), HIS (2015))

11.3. Results

Model 2 with CRISIS_G is the best model for the United States and Germany. This choice was made by examining the Adjusted R-squared, as well as the Akaike Information Criterion and the Bayesian Information Criterion. Although the R-squared is slightly superior for some macroeconomic variables in model 3 with CRISIS_G; the AIC and BIC are undeniably lower in model 2 with CRISIS_G. The “10% significance level” variables are added in this section.

The United States:

The crisis indicator (CRISIS_G) is highly significant in all the regressions; meaning that the periods of market turmoil have a negative impact on the stock-bond correlation. With a p-value inferior to 0,05, STOCK STOCK, BOND BOND, TERM USA and OIL also affect the relationship.

The correlation between stock and bond returns is influenced by the stock market uncertainty and the TED spread. These two macroeconomic variables present a coefficient significant at the 10% significance level.

Germany:

As for the United States, CRISIS_G is highly significant in all the regressions; meaning that the stock-bond correlation is negatively influenced by the crisis periods. STOCK STOCK, and TERM GERMANY affect this correlation; with a p-value inferior to 0,05.

The stock-bond relationship is also impacted by BOND BOND and VDAX. With a p-value inferior to 0,10 ; these two macroeconomic variables have a negative impact on the stock-bond correlation (10% significance level).

Comparison between the United States and Germany

In both countries, the periods of market turmoil tend to push the stock-bond correlation into negative territory. The globalization (represented by STOCK STOCK and BOND BOND) as well as the stock market uncertainty (described by VIX and VDAX) affects negatively the relationship. On the contrary, the correlation is positively influenced by the term spread.

The TED spread and the oil prices, for their part, only affect the American stock-bond correlation.

Chapter 12: Conclusion

The purpose of this master's thesis is to better understand the changing and complex correlation between stock and ten-year government bond returns. The monthly relationship between the two main asset classes is studied over time and across two different countries: the United States and Germany. Emphasis is placed on the evolution of this correlation during periods of market turmoil; characterized by the "flight-to-quality" phenomenon. Therefore, the sample period (1996-2016), including the 2008 global crisis, is particularly relevant. This research is motivated by the desire to get a grasp on the correlation dynamics in order to improve asset allocation and risk management strategies. Another objective of this report is to determine the various macroeconomic factors having an impact on the stock-bond correlation. In order to do so, three lagged dependent variable models are compared and evaluated for each country. This chapter is divided in three parts: summary of the empirical results, implication for asset allocation and limitations.

12.1. Summary of the empirical results

12.1.1. Stock-bond correlation

Over the sample period, the correlation between stock and ten-year bond returns is mainly negative, with an average value of -0,20 and -0,25 for the United States and Germany, respectively. These findings contradict the hypothesis claiming a positive relationship over long period of time. However, several authors such as Andersson et al. (2004), Baur et al. (2006), Ilmanen et al. (2013) and Ohmi & Okimoto (2016) also notice this tendency. The negative results are principally due to the fact that the correlation tends to reverse from positive to negative in periods of weak economic conditions. Some huge declines, corresponding to "flight-to-quality" episodes can be observed at the beginning of the various crises. This fund movement from risky assets to safer assets is amplified by the globalization, reducing the benefits of diversification across similar asset classes and encouraging investors to rebalance their portfolios (Hong et al. (2011), Ohmi & Okimoto (2016)). The globalization, computed as the correlation between American and German stock (bond) returns, is positive over the sample period, with an average value of 0,48 (0,42).

Being correlated at 0,73, the stock-bond correlation in both countries tends to follow the same trend; meaning that similar factors could affect the relationship in different countries. This finding could reject the assumption that the dynamics of the stock-bond correlation are

country specific. However, deeper research has to be carried out before reaching this conclusion.

The correlation between stock and bond returns is very unstable and ranges from -0,88 (-0,91) to +0,85 (+0,78) for the United States (Germany). These results are in line with the research of Baele et al. (2010) and Johnson et al. (2013).

12.1.2. Crisis and macroeconomic variables

In order to determine the effect of the different crises on the American and German stock-bond correlations, two dummy variables are created for each country. The first one captures the information of three crisis indicators, namely the stock market value (S&P500 index and DAX index), the gross domestic product value (GDP) and the Libor-OIS spread. The second one is, for its part, based on the VIX index and the VDAX index.

A wide range of macroeconomic variables are selected from the literature to assess their impact on the relationship between stock and bond returns. Since one goal of this report is to compare their repercussions on the American and German correlations; analogous factors are employed to ensure the rigor of the analysis.

Three different models are developed in this master thesis. Each of them includes the first and the second lagged dependent variables. This incorporation allows the eradication of the residual series correlation. Model 2 with CRISIS_G is the best model for the United States and Germany. This choice is made by examining the adjusted R-squared as well as the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). Adding an interactive dummy variable or using the other crisis indicator (CRISIS_V) does not improve the quality of the model.

For both countries, CRISIS_G is highly significant in all the regressions; meaning that the crisis periods have a negative impact on the stock-bond relationship. The globalization (measured as the correlation between American and German stock (bond) returns) and the stock market uncertainty (represented by the VIX and the VDAX indexes) push down the stock-bond correlations and suggest the presence of the “flight-to-quality” phenomenon in periods of market turmoil. By contrast, the term spread influences positively the relationship in both countries.

The TED spread and the oil prices only affect the American stock-bond correlation. The former (latter) has a negative (positive) impact on the relationship.

12.2. Implications for asset allocation

12.2.1. Portfolio diversification

“Asset allocation and risk management strategies that assume a constant relationship between stock and bond returns may be improved by properly taking into account the observed time-variation in the correlation between these two assets” (Andersson et al. (2004), p.2)

This affirmation is supported by many authors such as Li (2002), Chiang et al. (2014) and Acosta-Gonzales et al. (2015).

Our results suggest that, over the sample period, American and German investors who would have held a diversified portfolio, composed of stocks and ten-year government bonds, would have seen a reduction of their risk with a minimal impact on their returns. Indeed, the variance formula of the Modern Portfolio Theory (Markowitz (1952)) reveals that a negative stock-bond correlation decreases the portfolio risk (Beyhaghi & Hawley (2013), Mangram (2013)).

12.2.2. Warning indicators

Investors must react quickly to the evolution of the correlation between stock and ten-year bond returns and adjust their portfolios in response to several factors. As the VIX and the VDAX represent the market's expectation volatility, these two indicators should be closely monitored. The stock-bond correlation tends to be negative in periods of high market uncertainty. Therefore, investors can put their money into bonds and benefit from diversification when the markets become more volatile. American and German investors should also keep an eye on the term spread and the components of the crisis indicator (CRISIS_G). The TED spread, as well as the oil prices should be controlled in the United States.

Since the globalization tends to reduce the benefits of investing abroad, foreign markets are not considered anymore as a good solution to avoid the various crisis episodes. In consequence, when the situation becomes less prosperous, investors move their funds from risky assets to safer assets (flight-to-quality phenomenon). Accordingly, holding a portfolio with ten-year government bonds could be more profitable than buying foreign equities.

Finally, past correlations, particularly the first and the second lags, contained valuable information regarding the future correlation between stock and bond returns.

12.3. Limitations

The sample period, the geographic location, the difficulty to find equivalent indicators and the data frequency are the four limitations identified in this master thesis. This section provides more information about each of them.

12.3.1. Sample period

The first limitation of this master thesis resides in the time period studied. Covering twenty years, the empirical research starts in January 1996 and ends in January 2016. This limited range does not allow to determine the sign of the stock-bond correlation over longer periods of time. Being characterized by many crisis episodes, the sample is nonetheless adequate for the purpose of this report.

12.3.2. Geographic location

Although Germany constitutes a critical pillar of the Eurozone, other countries situated in this area could react differently to the macroeconomic factors and therefore present divergent results. More generally, the geographical scope of this study (the United States and Germany) does not allow to extrapolate the findings on other markets such as the Asian or the South American ones. The developing countries could also exhibit different outputs. Hence, one can wonder whether the dynamics of the stock-bond correlation are applicable to all the countries. Chiang et al. (2014) as well as Acosta-Gonzales (2015) studies the correlations in various developed countries and reach the conclusion that the relationships tend to follow the same trend.

12.3.3. Difficulty to find equivalent indicators

In order to compare the different factors affecting the stock-bond correlations in the United States and Germany, analogous indicators have to be found to guarantee the rigor of the analysis. However, some divergences, including the starting dates, can exist between these various factors. For example, the default spread is only available in the United States and the German Purchasing Managers' Index (PMI) only starts in 2013.

12.3.4. Data frequency

The last limitation of this master thesis concerns the frequency of the data. This research investigates the impact of the monthly macroeconomic/crisis indicators on the monthly stock-bond correlation. It could be interesting to test whether the daily, weekly, quarterly and yearly data provide the same results.

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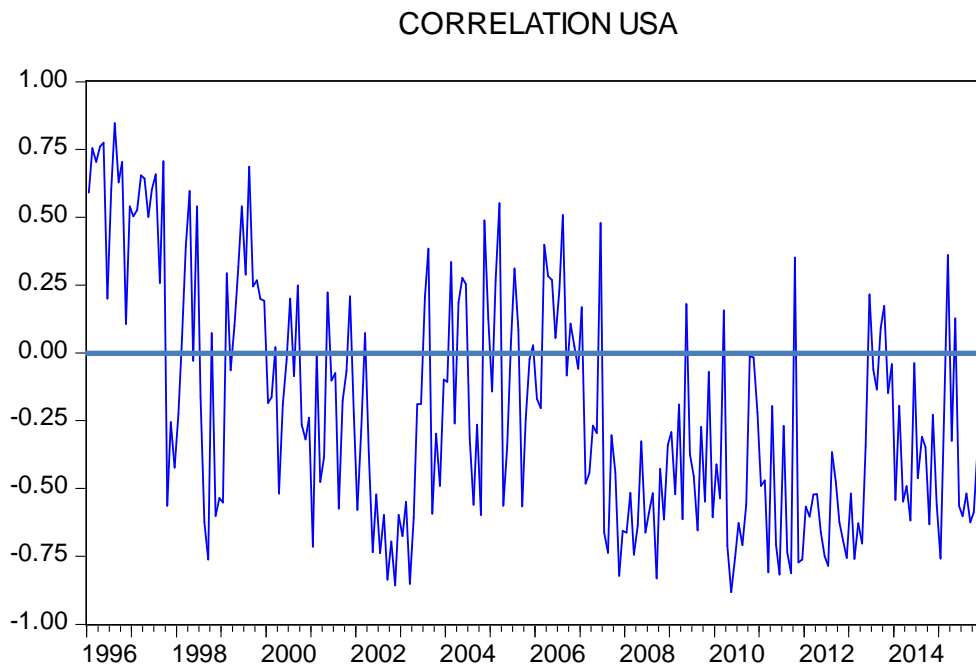
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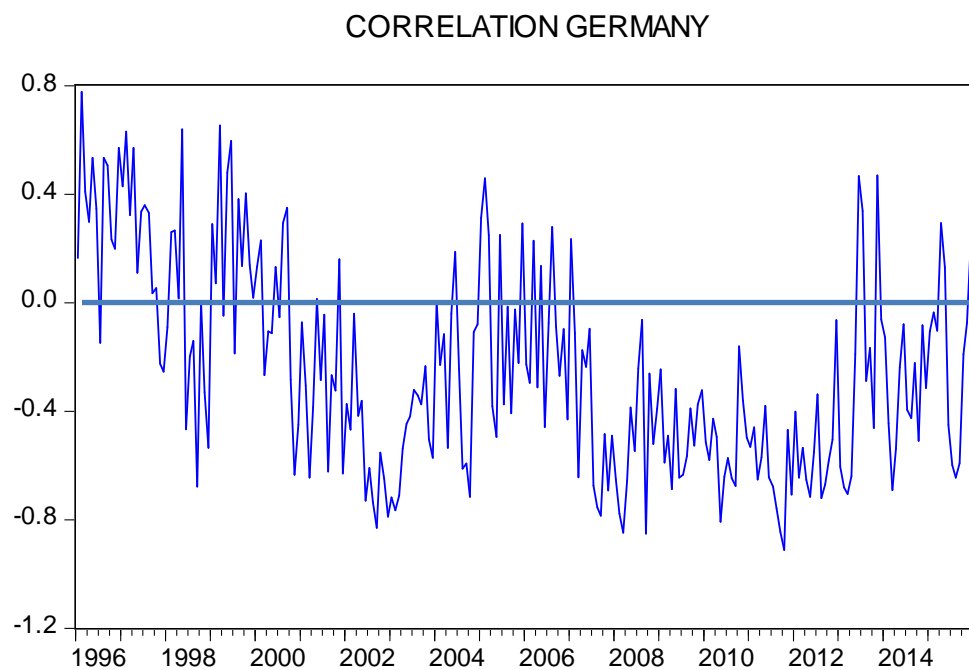
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Appendices

Appendix 1.1: Graph of the correlation between stock and 10-year bond returns over time for the United States.



Appendix 1.2: Graph of the correlation between stock and 10-year bond returns over time for Germany.



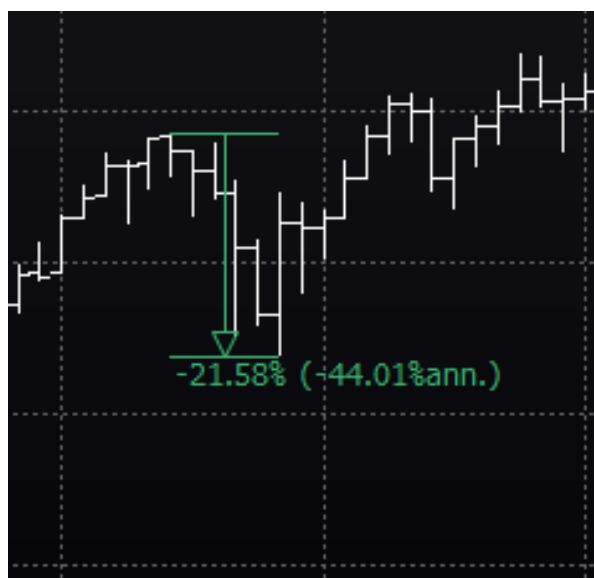
Appendix 1.3: Descriptive Statistics of the correlation between stock and 10-year bond returns in the United States and Germany.

	CORRELATION_GERMANY	CORRELATION_USA
Mean	-0.245636	-0.204036
Median	-0.311358	-0.264609
Maximum	0.776898	0.847911
Minimum	-0.911588	-0.882134
Std. Dev.	0.383278	0.435656
Skewness	0.532046	0.513412
Kurtosis	2.379308	2.244457
Jarque-Bera	15.23874	16.31982
Probability	0.000491	0.000286
Sum	-59.19829	-49.17274
Sum Sq. Dev.	35.25641	45.55113
Observations	241	241

Appendix 2: Graph of the S&P500 index (periods of bearish stock market).

The various periods of bearish market are represented on this graph. The difference between the highest value and the lowest value, expressed in per cent, is indicated next to the corresponding bearish market period. Some zooms are proposed below.





Appendix 3: Detailed calculations to determine precisely the bearish market periods in the United States (CRISIS_B).

Crisis periods	Starting date characteristics		Ending date characteristics		Difference 1	Difference 2
<i>Periods of bearish markets</i>	<i>Highest value</i>	<i>Closing value</i>	<i>Lowest value</i>	<i>Closing Value</i>	<i>(lowest value - highest value) / highest value</i>	<i>(closing value end - closing value start) / closing value start</i>
July 1998 – October 1008	1190,00\$	1120,67\$	923,32\$	1098,67\$	(-) 22 %	(-) 2%
March 2000 – October 2002	1552,87\$	1498,58\$	768,63\$	885,76\$	(-) 51%	(-) 41%
October 2007 – March 2009	1576,09\$	1549,38\$	666,79\$	797,87\$	(-) 58%	(-) 49%
May 2011- October 2011	1370, 58\$	1345,20\$	1074,77\$	1253,30\$	(-) 22%	(-) 7%

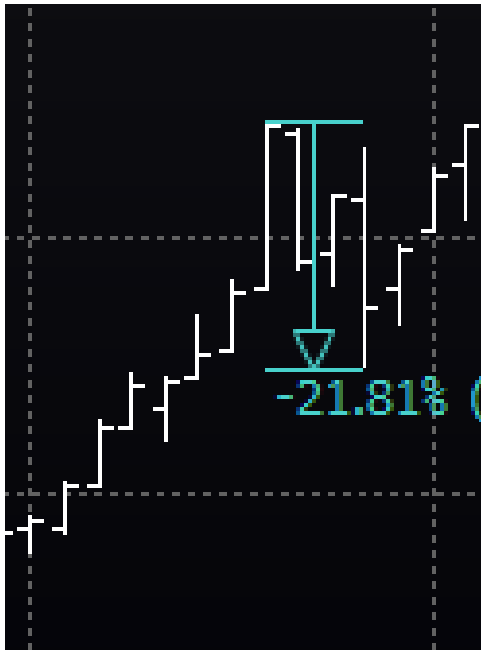
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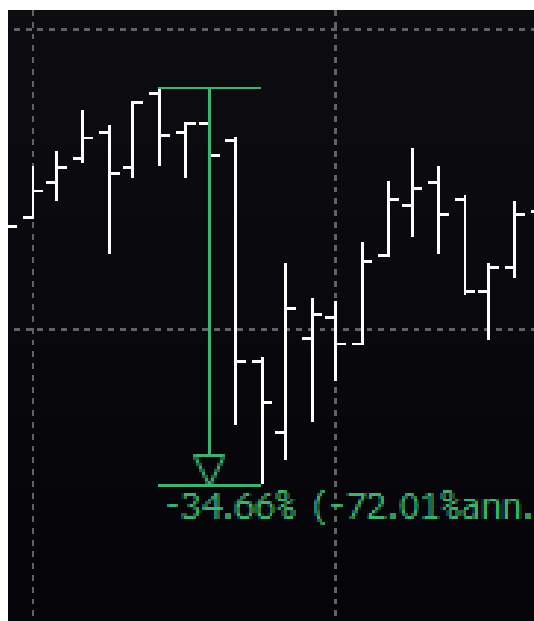
- Column 1: Periods during which the S&P500 market is bearish.
- Column 2: Highest value measured at the starting date (highest value of the highest value).
- Column 3: Closing value measured at the starting date (closing value of the highest value).
- Column 4: Lowest value measured at the ending date (lowest value of the lowest value).
- Column 5: Closing value measured at the ending date (closing value of the lowest value).
- Column 6: Difference (in %) between the highest value (column 2) and the lowest value (column 4).
- Column 7: Difference (in %) between the closing values of the starting and ending dates (columns 3 and 5).

Appendix 4: Graph of the DAX index (periods of bearish stock market).

The various periods of bearish market are represented on this graph. The difference between the highest value and the lowest value, expressed in per cent, is indicated next to the corresponding bearish market period. Some zooms are proposed below.







Appendix 5: Detailed calculations to determine precisely the bearish market periods in Germany (CRISIS_B).

Crisis periods	Starting date characteristics		Ending date characteristics		Difference 1	Difference 2
	Highest value	Closing value	Lowest value	Closing Value		
<i>Periods of bearish markets</i>					<i>(lowest value - highest value) / highest value</i>	<i>(closing value end - closing value start) / closing value start</i>
July 1997 – October 1997	4459,89€	4438,98€	3487,24€	3726,69€	(-) 22%	(-) 16%
July 1998 – October 1998	6217,83€	5873,92€	3833,71€	4671,12€	(-) 38%	(-) 20%
March 2000 – March 2003	8136,16€	7599,39€	2188,75€	2423,87€	(-) 73%	(-) 68%
July 2007 – March 2009	8151,57€	7584,14€	3588,89€	4084,76€	(-) 56%	(-) 46%
June 2011- September 2011	7600,41€	7293,69€	4965,80€	5502,02€	(-) 35%	(-) 25%
April 2015- January 2016	12390,75€	11454,38€	9314,57€	9798,11€	(-) 25%	(-) 15%

Description of the table

- Column 1: Periods during which the VDAX market is bearish.
- Column 2: Highest value measured at the starting date (highest value of the highest value).
- Column 3: Closing value measured at the starting date (closing value of the highest value).
- Column 4: Lowest value measured at the ending date (lowest value of the lowest value).
- Column 5: Closing value measured at the ending date (closing value of the lowest value).
- Column 6: Difference (in %) between the highest value (column 2) and the lowest value (column 4).
- Column 7: Difference (in %) between the closing values of the starting and ending dates (columns 3 and 5).

Appendix 6: Information about the Gross Domestic Product (GDP).

“GDP is the sum of the market values of all final goods and services produced in a country (that is, domestically) during a specific period using that country’s resources, regardless of the ownership of the resources” (Yamarone (2012)).

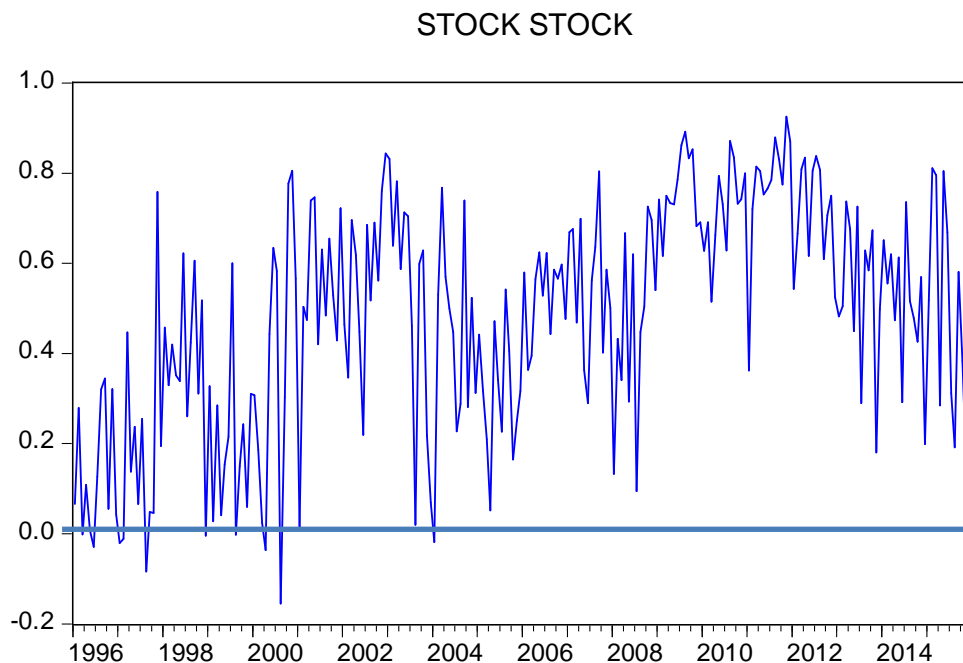
The formula used to calculate the GDP is the following:

$$GDP = C + G + I + (X - M)$$

Where C is the personal consumption expenditures, G is the government consumption expenditures and the gross investment, I is the gross private domestic investment, and (X-M) is the net export value of goods and services (exports minus imports) (Yamarone (2012)).

The gross domestic product is recognized by the economists, politicians and policy makers as the broadest and the most comprehensive indicator available of a country’s overall economic condition. The GDP report is accompanied by information about the corporate profits, personal income and consumption expenditures, national income and inflation. By comparing the changes in the GDP’s components and subcomponents with changes that happened in the past, economists can infer the direction of the future economy (Yamarone (2012)).

Appendix 7: Graph of the correlation between American and German stock returns.



Appendix 8: Formula employed to calculate the cross-country correlation between 10-year bond returns.

$$\text{correlation} (r_{\text{American bond},t}; r_{\text{German bond},t})$$

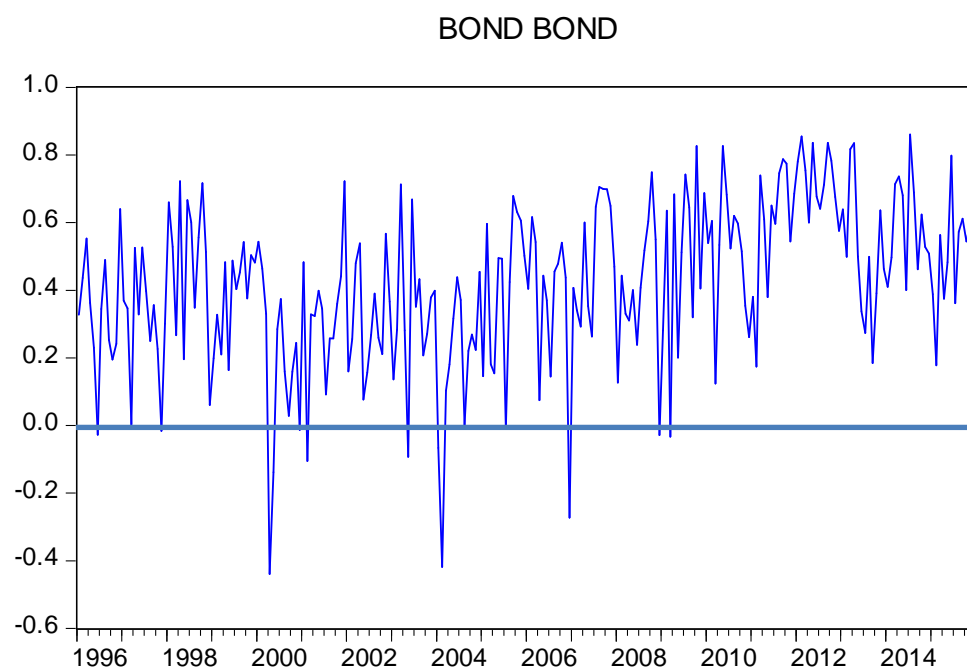
$$= \text{correlation} \left(\begin{pmatrix} r_{\text{American bond, day 1 of month } t} \\ r_{\text{American bond, day 2 of month } t} \\ \vdots \\ r_{\text{American bond, day 30 of month } t} \end{pmatrix}; \begin{pmatrix} r_{\text{German bond, day 1 of month } t} \\ r_{\text{German bond, day 2 of month } t} \\ \vdots \\ r_{\text{German bond, day 30 of month } t} \end{pmatrix} \right)$$

where:

$r_{\text{American bond},t}$: 10-year bond returns at time t (expressed in month), calculated from the USGG10YR index.

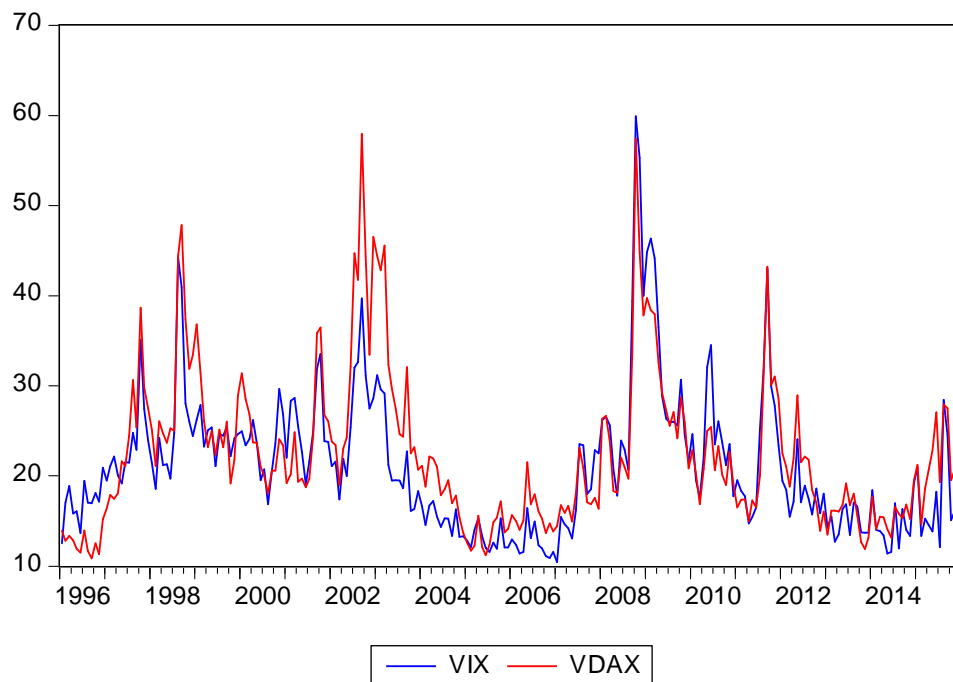
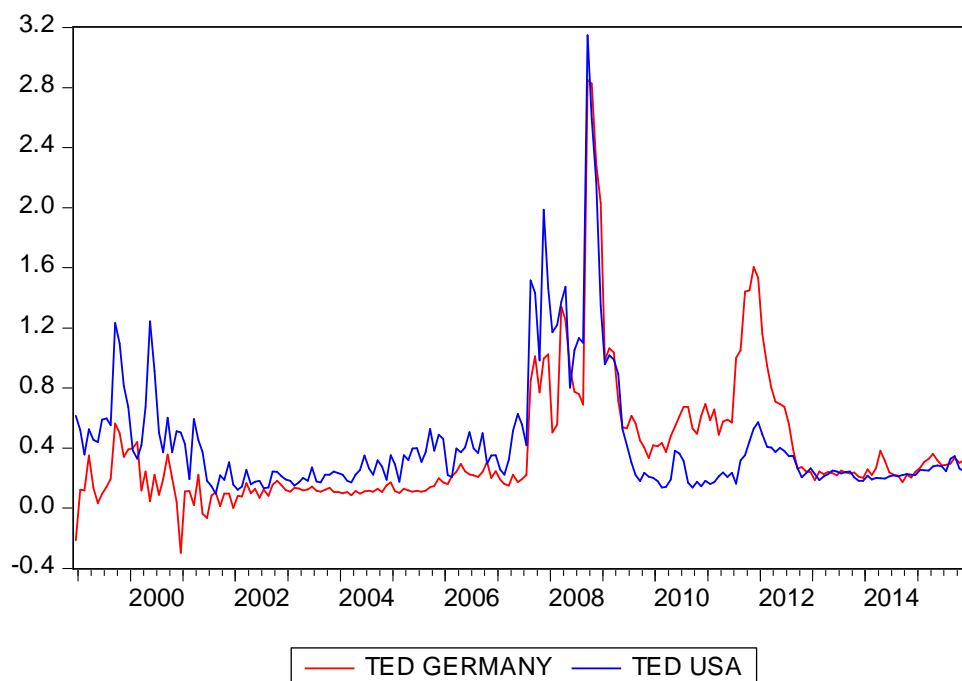
$r_{\text{German bond},t}$: 10-year bond returns at time t (expressed in month), calculated from the GDBR10 index.

Appendix 9: Graph of the correlation between American and German ten-year government bond returns.

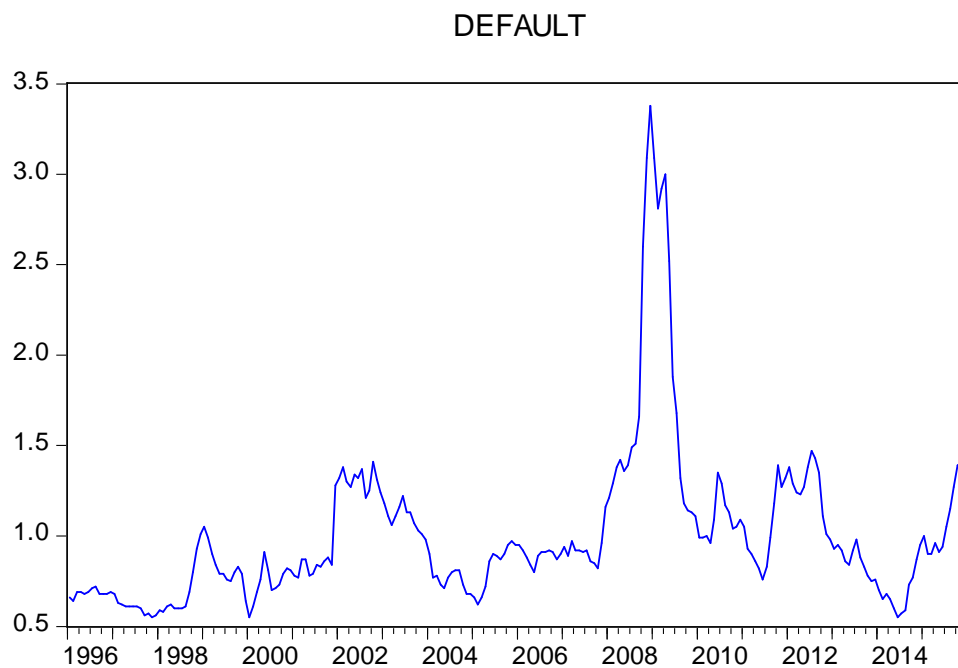


Appendix 10: Table with the analogous variables for the United States and Germany.

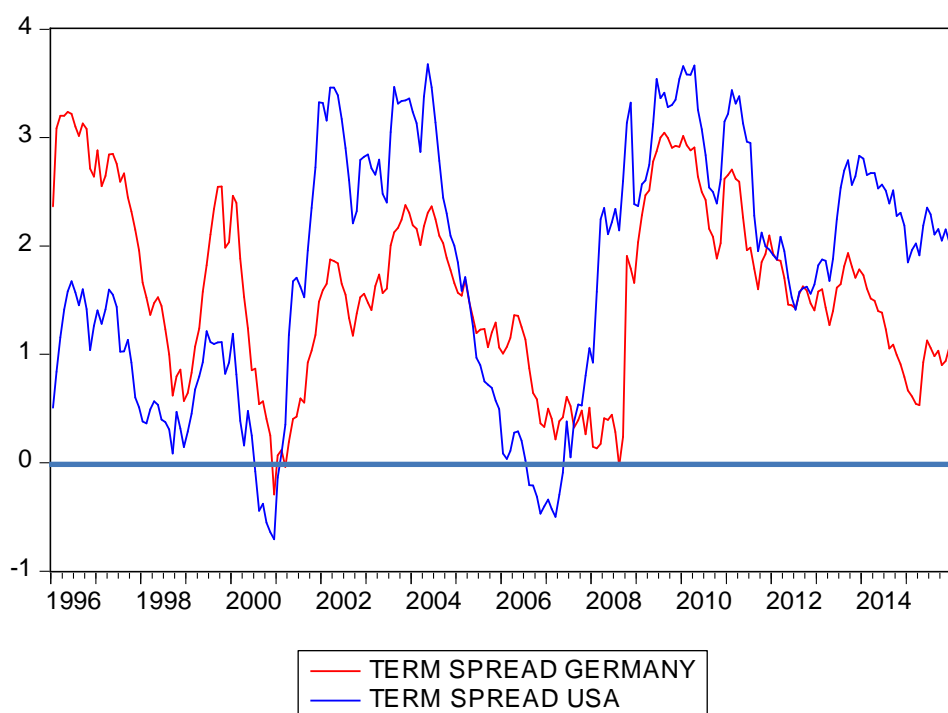
The United States	Germany
Dummy variable of crisis periods in the USA: CRISIS_G	Dummy variable of crisis periods in Germany: CRISIS_G
Dummy variable of crisis periods in the USA: CRISIS_V	Dummy variable of crisis periods in Germany: CRISIS_V
VIX	VDAX
Purchasing Managers' Index	IFO
Consumer Confidence	Consumer Confidence
Consumer Sentiment	
Industrial Production	Industrial Production
Inflation Rate	Inflation Rate
Short term interest rate	Short term interest rate
FED key interest rate	ECB key interest rate
TED spread	TED spread
Term spread	Term spread
Default risk spread	Non available
Oil price	
Gold price	
Correlation between German and American stock returns = Globalization	
Correlation between German and American 10-year bond returns = Globalization	

Appendix 11: Evolution of the VIX and the VDAX over the sample period.**Appendix 12: Evolution of the TED spread over the sample period in the United States and Germany.**

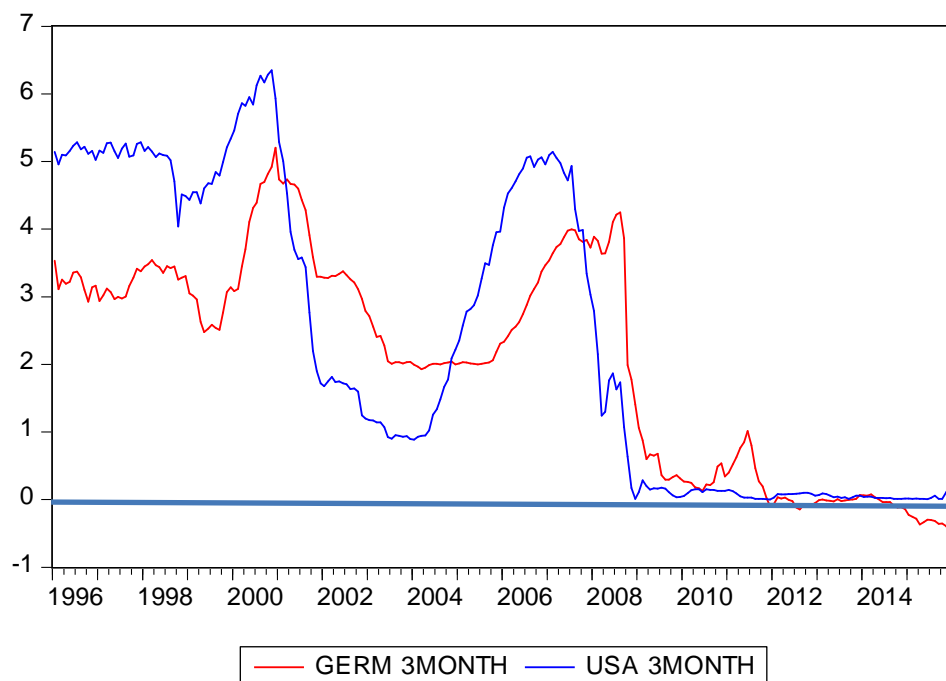
Appendix 13: Evolution of the Default risk spread over the sample period in the United States.



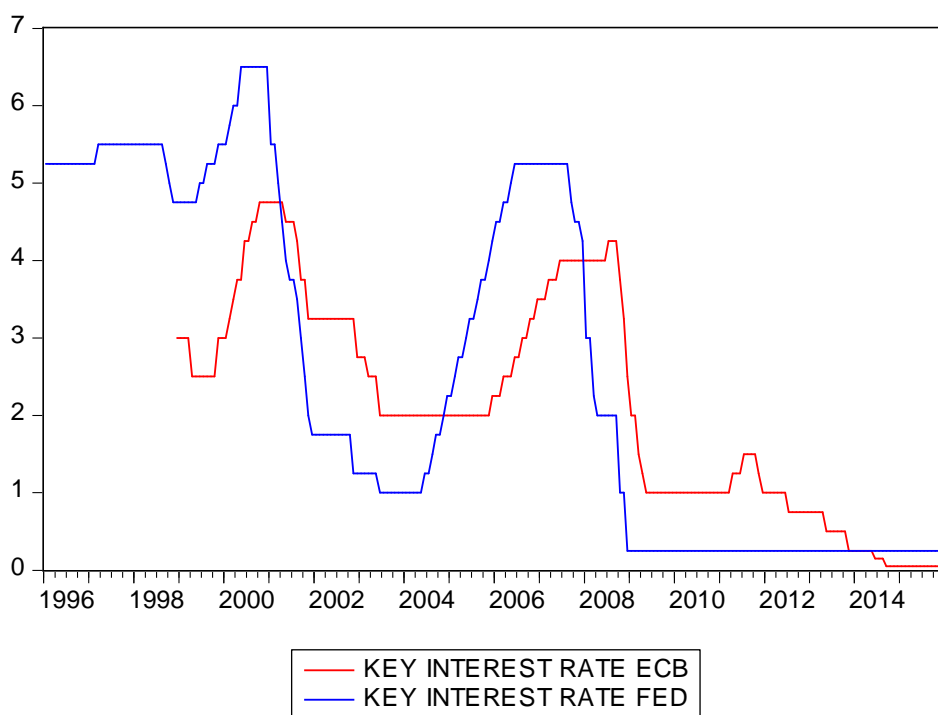
Appendix 14: Evolution of the TERM spread over the sample period in the United States and Germany.



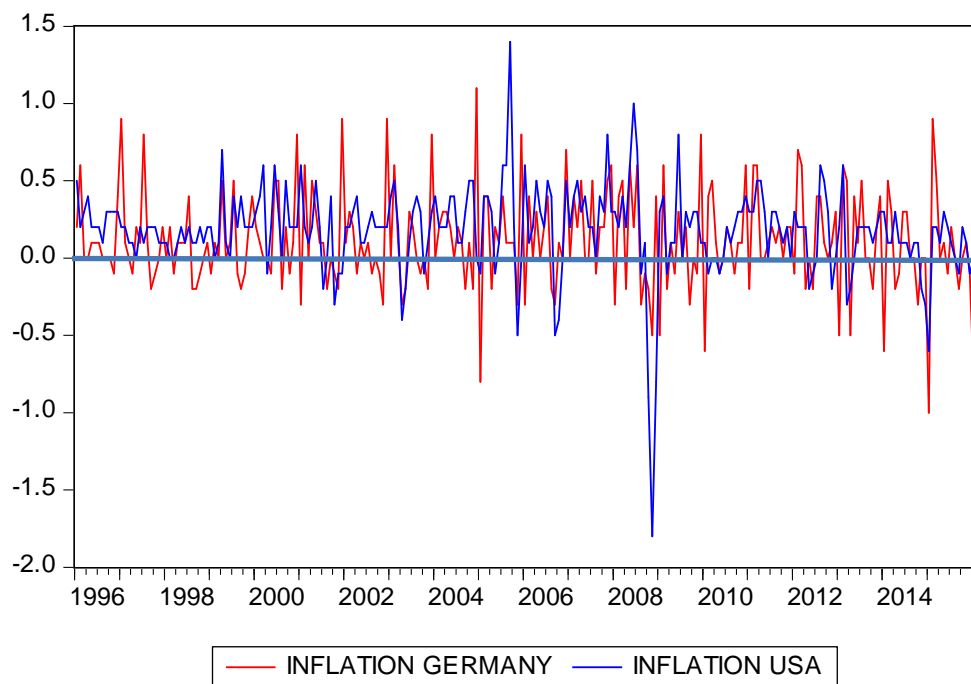
Appendix 15: Evolution of the short term interest rates over the sample period in the United States and Germany.



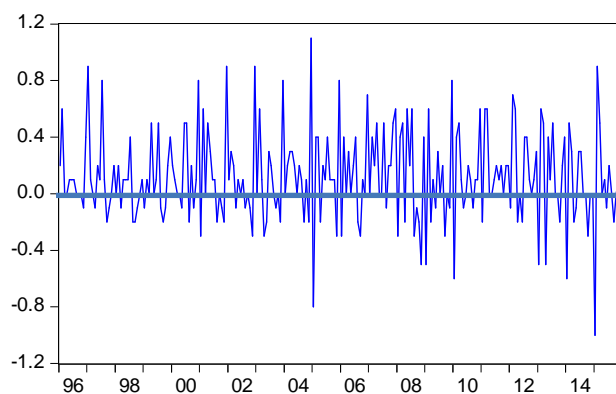
Appendix 16: Evolution of the key interest rates over the sample period in the United States and Europe.



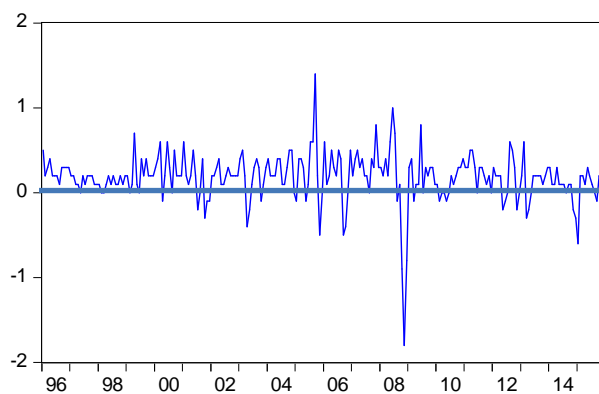
Appendix 17: Evolution of the inflation over the sample period in the United States and Germany.

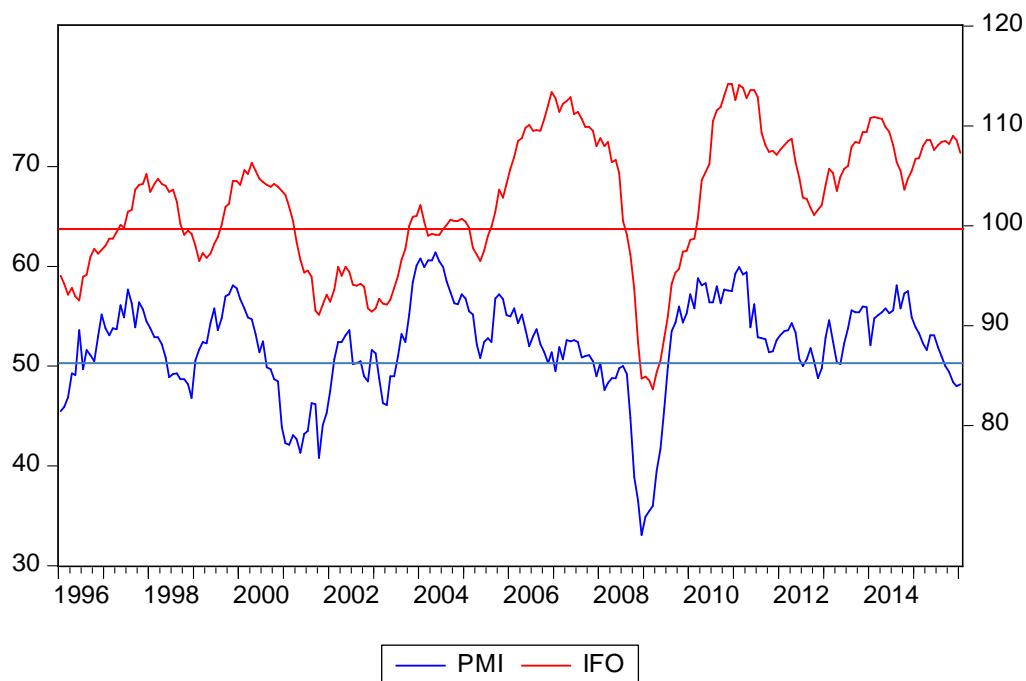
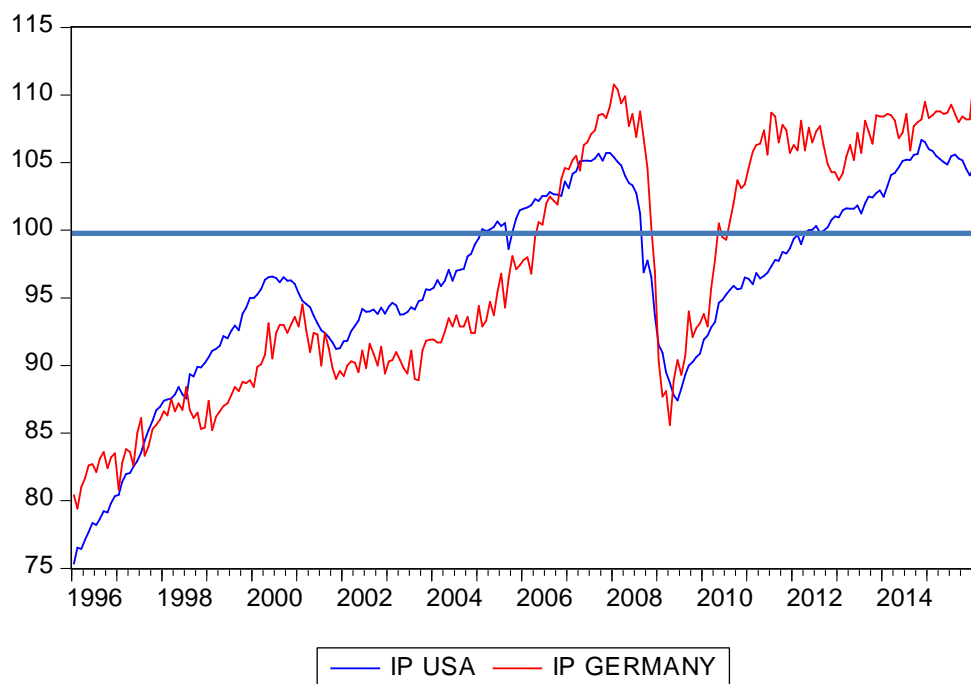


INFLATION GERMANY

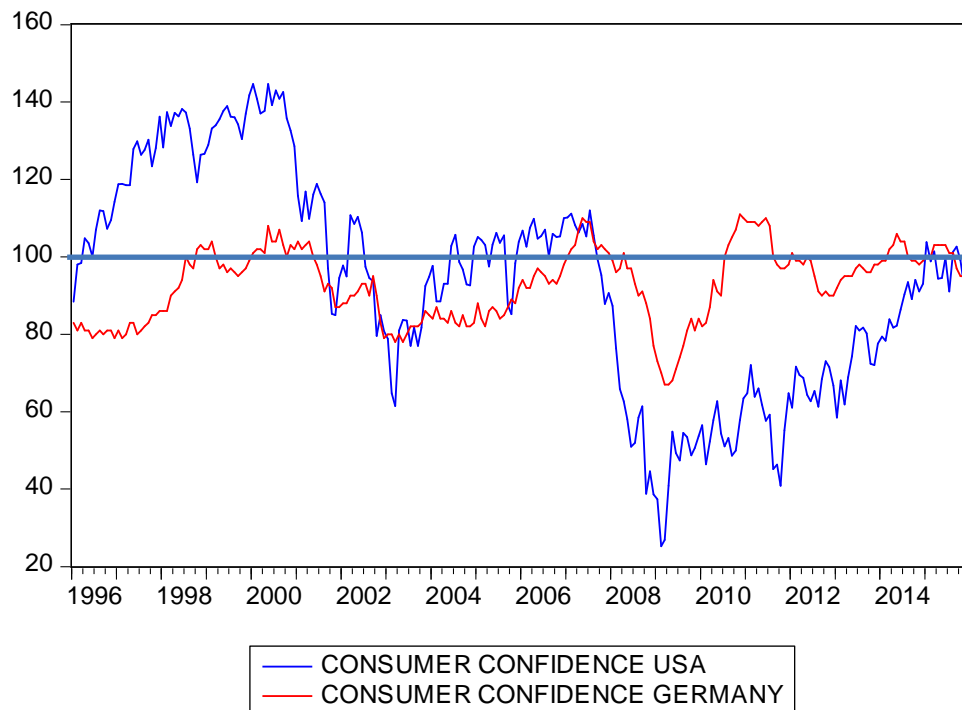


INFLATION USA

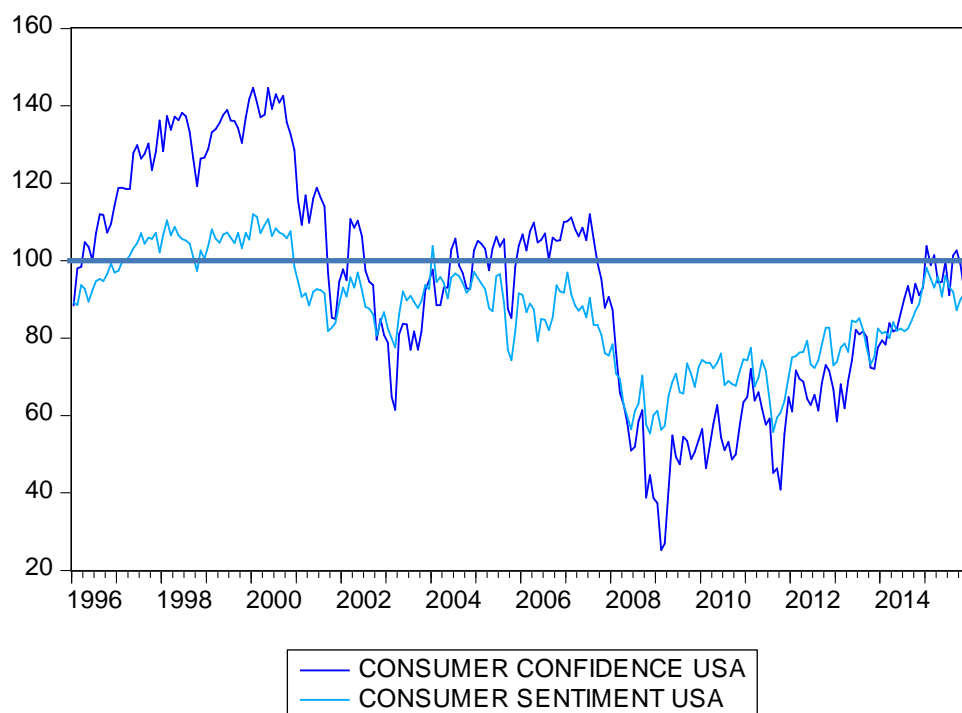


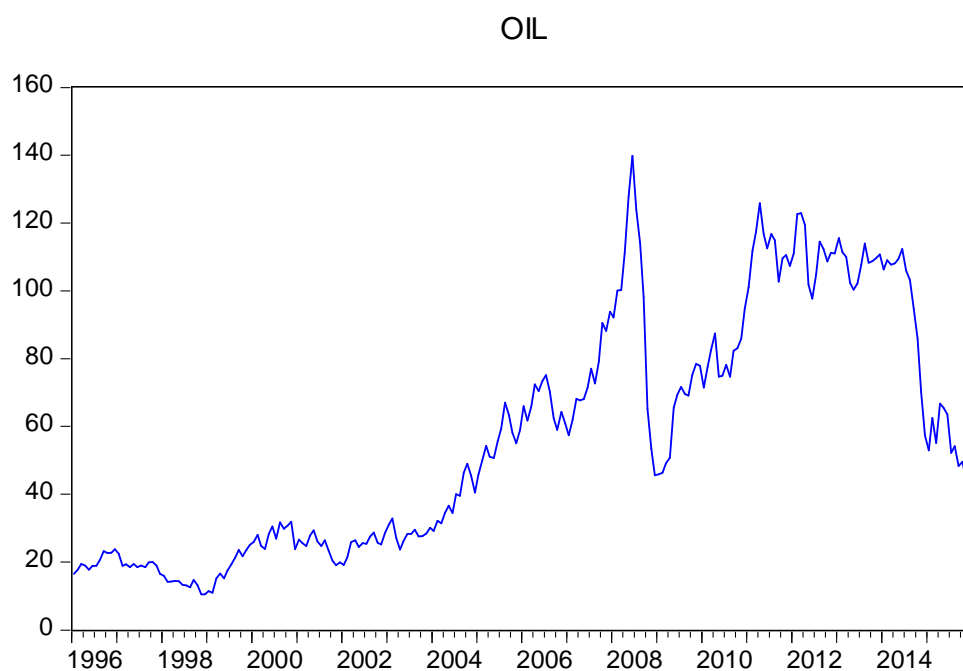
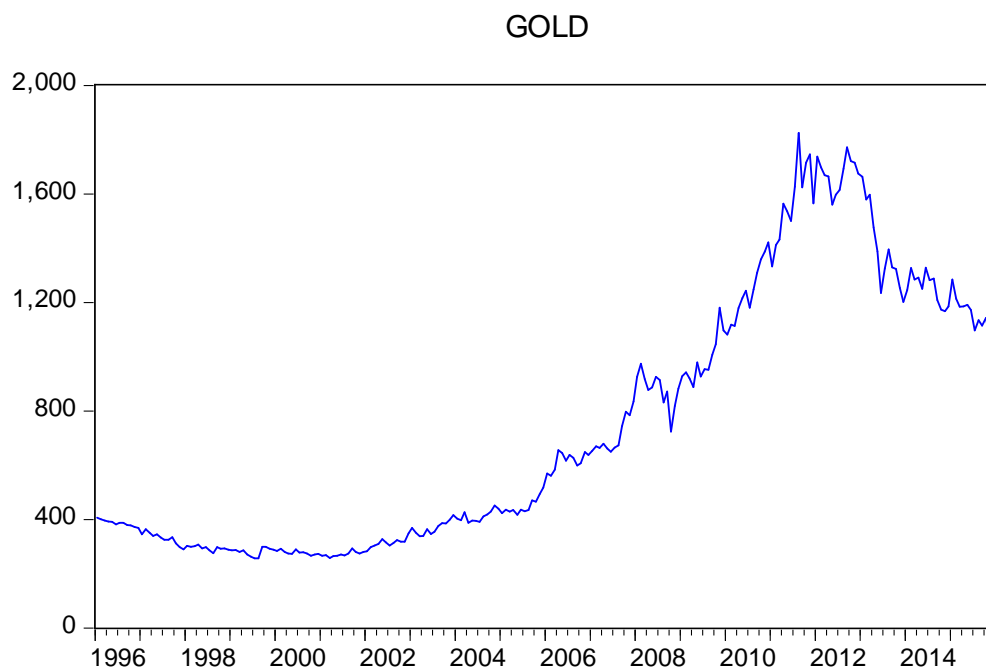
Appendix 18: Evolution of the PMI and the IFO over the sample period.**Appendix 19: Evolution of the Industrial Production over the sample period in the United States and Germany.**

Appendix 20: Evolution of the Consumer Confidence over time in the United States and Germany.



Appendix 21: Evolution of the Consumer Confidence Index and the Michigan Consumer Sentiment Index over time.



Appendix 22: Evolution of oil prices over the sample period.**Appendix 23: Evolution of gold prices over the sample period.**

Appendix 24: Augmented Dickey Fuller Test Statistics.

The ADF Test is performed in EViews

Null hypothesis: VARIABLE has a unit root.

Variable	t-Statistic	Prob.*
CORRELATION USA STOCK 10BOND	(-) 5,323335	0,0000
CORRELATION GERMANY STOCK 10BOND	(-) 5,237144	0,0000
CRISIS_G USA	-5,045081	0,0000
CRISIS_G GERMANY	-3,602156	0,0064
CRISIS_V USA	(-) 7,664934	0,0000
CRISIS_V GERMANY	(-) 5,238086	0,0000
STOCK STOCK	(-) 3,268758	0,0175
BOND BOND	(-) 5,467477	0,0000
VIX	(-) 4, 847222	0,0001
VDAX	(-) 4,625351	0,0002
TED USA	(-) 4,257015	0,0007
TED GERM	(-) 3,826333	0,0031
DEFAULT	(-) 4,580372	0,0068
TERM USA	(-) 2, 267360	0,1835
FIRST DIFFERENCE	(-) 11,45494	0,0000
TERM GERM	(-) 2,839249	0,0544
FIRST DIFFERENCE	(-) 15,12322	0,0000
SHORT USA	(-) 1,596843	0,4826
FIRST DIFFERENCE	(-) 5,250813	0,0000
SHORT GERM	(-) 0,742321	0,8326
FIRST DIFFERENCE	(-) 10, 63566	0,0000
FED KEY RATE	(-) 1,985900	0,2930
FIRST DIFFERENCE	(-) 4,142417	0,0010
ECB KEY RATE	(-) 1,577734	0,4921
FIRST DIFFERENCE	(-) 4,730854	0,0001
INFL USA	(-) 10, 35600	0,0000
INFL GERM	(-) 2,728288	0,0708
FIRST DIFFERENCE	(-) 12,96252	0,0000
PMI	(-) 2,945438	0,0418
IFO	(-) 3,702242	0,0046
IP USA	(-) 2,585730	0,0973
FIRST DIFFERENCE	(-) 5,023546	0,0000
IP GERM	(-) 1,517607	0,5231
FIRST DIFFERENCE	(-) 10,32897	0,0000
CC USA	(-) 1,693907	0,4331
FIRST DIFFERENCE	(-) 20,25965	0,0000
CC GERM	(-) 3,152816	0,0242
CS USA	(-) 2,301639	0,1723
FIRST DIFFERENCE	(-) 27,60118	0,0000

OIL	(-) 1,775362	0,3922
FIRST DIFFERENCE	(-) 20,27237	0,0000
GOLD	(-) 0,622878	0,8618
FIRST DIFFERENCE	(-) 11,65160	0,0000

-* Mackinnon (1996) one-side p-values.

Appendix 25: Regression outputs: Model 1 for the United States.

$$SB\ correlation_t = \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * Y_t + \varepsilon_t$$

Variables	α	β_1	β_2	β_3	Adjusted R ²
CRISIS_G	-0,013758 (0,6225)	0,350754** (0,0000)	0,268054** (0,0000)	-0,161673** (0,0007)	0,440001
CRISIS_V	-0,047492 (0,0625)	0,395615** (0,0000)	0,277943** (0,0000)	-0,109973* (0,0381)	0,422592
STOCK STOCK	0,049355 (0,2936)	0,364348** (0,0000)	0,257870** (0,0000)	-0,273181** (0,0050)	0,431355
BOND BOND	0,008096 (0,8518)	0,408694** (0,0000)	0,271597** (0,0000)	-0,188427* (0,0430)	0,422089
VIX	0,092159 (0,1299)	0,393475** (0,0000)	0,281358** (0,0000)	-0,007782** (0,0052)	0,431186
TED USA	-0,080681* (0,0146)	0,329058** (0,0000)	0,202796** (0,0034)	-0,133683* (0,0126)	0,276431
DEFAULT	0,010862 (0,8407)	0,397978** (0,0000)	0,270595** (0,0000)	-0,083938 (0,1164)	0,418054
TERM USA	-0,065079** (0,0062)	0,415854** (0,0000)	0,301160** (0,0000)	0,289833** (0,0009)	0,438970
SHORT USA	-0,065848** (0,0065)	0,398832** (0,0000)	0,290543** (0,0000)	0,188475 (0,1059)	0,418426
FED KEY RATE	-0,121421** (0,0001)	0,358791** (0,0000)	0,211965** (0,0023)	0,183535 (0,0962)	0,274503
INFL USA	-0,070392* (0,0135)	0,414701** (0,0000)	0,292778** (0,0000)	0,025512 (0,7344)	0,412193
PMI	-0,133273 (0,5733)	0,415943** (0,0000)	0,290685** (0,0000)	0,001290 (0,7729)	0,412113
IP USA	-0,066012** (0,0086)	0,417283** (0,0000)	0,291290** (0,0000)	0,003573 (0,9170)	0,411932
CC USA	-0,066956** (0,0058)	0,404060** (0,0000)	0,298016** (0,0000)	0,004924 (0,1630)	0,416765
OIL	-0,066902** (0,0055)	0,403851** (0,0000)	0,301424** (0,0000)	0,008344* (0,0300)	0,423594
GOLD	-0,065947** (0,0065)	0,415227** (0,0000)	0,301096** (0,0000)	0,000642 (0,1517)	0,417036

*/** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

Appendix 26: Regression outputs: Model 1 for Germany.

$$SB\ correlation_t = \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * Y_t + \varepsilon_t$$

Variable	α	β_1	β_2	β_3	Adjusted R ²
CRISIS_G	-0,034306 (0,1780)	0,365627** (0,0000)	0,254613** (0,0001)	-0,137243** (0,0012)	0,449569
CRISIS_V	-0,049711* (0,0439)	0,402270** (0,0000)	0,294808** (0,0000)	-0,103003* (0,0129)	0,439290
STOCK STOCK	0,092607* (0,0184)	0,327714** (0,0000)	0,216923** (0,0004)	-0,430959** (0,0000)	0,482351
BOND BOND	-0,025722 (0,5001)	0,408509** (0,0000)	0,287662** (0,0000)	-0,126889 (0,1168)	0,430334
VDAX	0,055985 (0,2815)	0,385308** (0,0000)	0,290119** (0,0000)	-0,006227** (0,0059)	0,442622
TED GERM	-0,096162** (0,0058)	0,407986** (0,0000)	0,239848** (0,0005)	-0,040078 (0,3899)	0,326769
TERM GERM	-0,071836** (0,0018)	0,420901** (0,0000)	0,299146** (0,0000)	0,173481* (0,0491)	0,433751
SHORT GERM	-0,073598** (0,0015)	0,421273** (0,0000)	0,299637** (0,0000)	-0,031561 (0,7725)	0,424532
ECB KEY RATE	-0,113479** (0,0001)	0,404318** (0,0000)	0,248534** (0,0004)	-0,043201 (0,7381)	0,321811
INFLATION GERM	-0,074193** (0,0013)	0,422695** (0,0000)	0,294836** (0,0000)	-0,040639 (0,2477)	0,427252
IFO	0,092007 (0,7456)	0,416860** (0,0000)	0,299458** (0,0000)	-0,001624 (0,5575)	0,425170
IP GERM	-0,075794** (0,0011)	0,417724** (0,0000)	0,297545** (0,0000)	0,009616 (0,4729)	0,425590
CC GERM	0,039951 (0,8278)	0,415842** (0,0000)	0,298267** (0,0000)	-0,001235 (0,5325)	0,425282
OIL	-0,073858** (0,0014)	0,415256** (0,0000)	0,303128** (0,0000)	0,001634 (0,6275)	0,424904
GOLD	-0,072815** (0,0016)	0,415203** (0,0000)	0,299926** (0,0000)	-0,000578 (0,1363)	0,429749

** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

Appendix 27: Summary of the significant macroeconomic variables in the United States and Germany (Model 1).

The United States		Germany	
<i>Variable</i>	<i>Impact</i>	<i>Variable</i>	<i>Impact</i>
CRISIS_G	Negative	CRISIS_G	Negative
CRISIS_V	Negative	CRISIS_V	Negative
TERM USA	Positive	TERM GERM	Positive
OIL	Positive	STOCK STOCK	Negative
STOCK STOCK	Negative	VDAX	Negative
BOND BOND	Negative		
VIX	Negative		
TED USA	Negative		

Appendix 28: Regression outputs: Model 2 with CRISIS_G for the United States.

SB correlation_t

$$= \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_G_t + \varepsilon_t$$

Variable	α	β_1	β_2	β_3	β_4	Adjusted R ²
STOCK STOCK	0,073057 (0,1198)	0,315924** (0,0000)	0,242874** (0,0001)	-0,221567* (0,0223)	-0,142169** (0,0030)	0,450047
BOND BOND	0,060859 (0,1770)	0,341865** (0,0000)	0,246717** (0,0001)	-0,190799* (0,0360)	-0,162496** (0,0006)	0,448095
VIX	0,082658 (0,1695)	0,347127** (0,0000)	0,265060** (0,0000)	-0,005236 (0,0710)	-0,162416** (0,0006)	0,448095
TED USA	-0,044781 (0,1965)	0,281845** (0,0001)	0,187073** (0,0061)	-0,098578 (0,0674)	-0,136807** (0,0047)	0,301462
DEFAULT	-0,036503 (0,5134)	0,304468** (0,0000)	0,190290** (0,0056)	-0,037315 (0,4833)	-0,140685** (0,0041)	0,289962
TERM USA	-0,006272 (0,8175)	0,340024** (0,0000)	0,274490** (0,0000)	0,331442** (0,0001)	-0,184124** (0,0001)	0,472610
SHORT USA	-0,016963 (0,5515)	0,347551** (0,0000)	0,268703** (0,0000)	0,072808 (0,5452)	-0,152224** (0,0024)	0,438489
FED KEY RATE	-0,074061* (0,0301)	0,307366** (0,0000)	0,199403** (0,0036)	0,091930 (0,4166)	-0,135905** (0,0060)	0,298234
INFLATION USA	-0,017418 (0,5833)	0,349154** (0,0000)	0,268260** (0,0000)	0,017993 (0,8068)	-0,161327** (0,0007)	0,437752
PMI	0,372127 (0,1650)	0,342976** (0,0000)	0,272960** (0,0000)	-0,007115 (0,1478)	-0,197084** (0,0002)	0,442632
IP USA	-0,008053 (0,7850)	0,347648** (0,0000)	0,274452** (0,0000)	-0,020758 (0,5443)	-0,167653** (0,0006)	0,438493
CONSUMER CONFIDENCE USA	-0,016563 (0,5548)	0,342448** (0,0000)	0,273077** (0,0000)	0,003868 (0,2648)	-0,156817** (0,0011)	0,440595
OIL	-0,015565 (0,5746)	0,337978** (0,0000)	0,276937** (0,0000)	0,008232* (0,0286)	-0,160781** (0,0007)	0,449035
GOLD	-0,014349 (0,6068)	0,348816** (0,0000)	0,276591** (0,0000)	0,000642 (0,1428)	-0,161661** (0,0007)	0,442757

*/** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

Appendix 29: Regression outputs: Model 2 with CRISIS_G for Germany.

$SB\ correlation_t$

$$= \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_G_t + \varepsilon_t$$

Variable	α	β_1	β_2	β_3	β_4	Adjusted R ²
STOCK	0,110993** (0,0049)	0,293093** (0,0000)	0,187457** (0,0022)	-0,397515** (0,0000)	-0,108742** (0,0077)	0,495702
BOND	0,017068 (0,6655)	0,354665** (0,0000)	0,241010** (0,0001)	-0,134092 (0,0907)	-0,139175** (0,0010)	0,453950
VDAX	0,048606 (0,3449)	0,352668** (0,0000)	0,256345** (0,0000)	-0,004336 (0,0650)	-0,111307* (0,0118)	0,455220
TED	-0,077719* (0,0249)	0,354214** (0,0000)	0,189649** (0,0062)	0,002795 (0,9534)	-0,136438** (0,0028)	0,353074
TERM	-0,032002 (0,2062)	0,368011** (0,0000)	0,253479** (0,0000)	0,176871* (0,0406)	-0,138256** (0,0010)	0,457054
SHORT	-0,033523 (0,1895)	0,370470** (0,0000)	0,253628** (0,0001)	-0,055063 (0,6075)	-0,138677** (0,0011)	0,447841
ECB KEY	-0,076439* (0,0135)	0,352067** (0,0000)	0,198412** (0,0047)	-0,068054 (0,5912)	-0,135792** (0,0020)	0,350632
INFL	-0,034838 (0,1713)	0,370190** (0,0000)	0,249890** (0,0001)	-0,039152 (0,2826)	-0,136679** (0,0012)	0,449943
IFO	0,352917 (0,2192)	0,357684** (0,0000)	0,249309** (0,0001)	-0,003756 (0,1761)	-0,149994** (0,0005)	0,451533
IP GERM	-0,035960 (0,1635)	0,366001** (0,0000)	0,253762** (0,0001)	0,005668 (0,6674)	-0,135560** (0,0014)	0,447654
CC GERM	0,069520 (0,6996)	0,363646** (0,0000)	0,253229** (0,0001)	-0,001129 (0,5606)	-0,136832** (0,0012)	0,448038
OIL	-0,034160 (0,1805)	0,361873** (0,0000)	0,258184** (0,0000)	0,001945 (0,5557)	-0,137950** (0,0011)	0,448038
GOLD	-0,034292 (0,1774)	0,364139** (0,0000)	0,255605** (0,0000)	-0,000512 (0,1782)	-0,134225** (0,0015)	0,313136

*/** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

Appendix 30: Summary of the significant macroeconomic variables in the United States and Germany (Model 2 with CRISIS_G).

The United States		Germany	
<i>Variables</i>	<i>Impact</i>	<i>Variables</i>	<i>Impact</i>
STOCK STOCK	Negative	STOCK STOCK	Negative
BOND BOND	Negative	TERM GERM	Positive
TERM USA	Positive		
OIL	Positive		

Appendix 31: Regression outputs: Model 2 with CRISIS_V the United States

SB correlation_t

$$= \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_V_t + \varepsilon_t$$

Variable	α	β_1	β_2	β_3	β_4	Adjusted R ²
STOCK STOCK	0,060037 (0,2024)	0,347329** (0,0000)	0,246284** (0,0001)	-0,259990** (0,0073)	-0,099843 (0,0569)	0,437726
BOND BOND	0,040247 (0,3709)	0,382544** (0,0000)	0,251480** (0,0001)	-0,218141* (0,0192)	-0,126595* (0,0171)	0,433588
TED USA	-0,077923* (0,0190)	0,322562** (0,0000)	0,195722** (0,0050)	-0,122978* (0,0257)	-0,046120 (0,4102)	0,275275
DEFAULT	-0,002805 (0,9589)	0,387107** (0,0000)	0,266594** (0,0000)	-0,052378 (0,3543)	-0,092279 (0,1012)	0,422251
TERM USA	-0,046175 (0,0638)	0,393025** (0,0000)	0,285914** (0,0000)	0,296650** (0,0006)	-0,116313* (0,0250)	0,448564
SHORT USA	-0,050570* (0,0294)	0,386209** (0,0000)	0,278792** (0,0000)	0,130634 (0,2798)	-0,093115 (0,0916)	0,423018
FED KEY RATE	-0,111586** (0,0003)	0,346207** (0,0000)	0,201563** (0,0039)	0,147693 (0,1923)	-0,074216 (0,1867)	0,277248
INFL USA	-0,050245 (0,0925)	0,394470** (0,0000)	0,278162** (0,0000)	0,013342 (0,8586)	-0,109227* (0,0405)	0,420203
PMI	0,090405 (0,7253)	0,395785** (0,0000)	0,280125** (0,0000)	-0,002583 (0,5902)	-0,121650* (0,0341)	0,420844
IP USA	-0,046708 (0,0782)	0,395380** (0,0000)	0,279186** (0,0000)	-0,003754 (0,9127)	0,110574* (0,0385)	0,420154
CC USA	-0,050331* (0,0497)	0,387585** (0,0000)	0,283434** (0,0000)	0,003751 (0,2926)	-0,099990 (0,0632)	0,422868
OIL	-0,050678* (0,0460)	0,385648** (0,0000)	0,287474** (0,0000)	0,007591* (0,0482)	-0,099004 (0,0615)	0,429734
GOLD	-0,046759 (0,0656)	0,391671** (0,0000)	0,286651** (0,0000)	0,000741 (0,0972)	-0,118658* (0,0255)	0,426917

*/** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

Appendix 32: Regression outputs: Model 2 with CRISIS_V for Germany.

*SB correlation*_t

$$= \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_V_t + \varepsilon_t$$

Variable	α	β_1	β_2	β_3	β_4	Adjusted R ²
STOCK STOCK	0,110888** (0,0053)	0,315219** (0,0000)	0,214074** (0,0004)	-0,421569** (0,0000)	-0,093638* (0,0176)	0,492530
BOND BOND	-0,001752 (0,9641)	0,392632** (0,0000)	0,282571** (0,0000)	-0,126606 (0,1135)	-0,102911* (0,0127)	0,442901
TED GERM	-0,085236* (0,0143)	0,391228** (0,0000)	0,229413** (0,0008)	-0,023449 (0,6154)	-0,103161* (0,0238)	0,340577
TERM GERM	-0,044690 (0,0683)	0,403659** (0,0000)	0,293301** (0,0000)	0,202963* (0,0207)	-0,114597** (0,0057)	0,449659
SHORT GERM	-0,045958 (0,0650)	0,411789** (0,0000)	0,293088** (0,0000)	-0,117212 (0,2972)	-0,115676** (0,0075)	0,439508
ECB KEY RATE	-0,089100** (0,0031)	0,384391** (0,0000)	0,245094** (0,0004)	-0,159621 (0,2341)	-0,131045** (0,0063)	0,343697
INFL GERM	-0,050036* (0,0424)	0,406801** (0,0000)	0,289631** (0,0000)	-0,041188 (0,2626)	-0,103278* (0,0127)	0,439912
IFO	0,508500 (0,1026)	0,392675** (0,0000)	0,291563** (0,0000)	-0,005389 (0,0725)	-0,136691** (0,0027)	0,444622
IP GERM	-0,051019* (0,0423)	0,402414** (0,0000)	0,293945** (0,0000)	0,003909 (0,7716)	-0,100860* (0,0168)	0,437097
CC GERM	0,198390 (0,2969)	0,395023** (0,0000)	0,290517** (0,0000)	-0,002658 (0,1886)	-0,117312** (0,0062)	0,441047
OIL	-0,049952* (0,0436)	0,401293** (0,0000)	0,296082** (0,0000)	0,000627 (0,8517)	-0,102053* (0,0147)	0,436978
GOLD	-0,048961* (0,0466)	0,399511** (0,0000)	0,294850** (0,0000)	-0,000563 (0,1422)	-0,102065* (0,0136)	0,442064

*/** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

Appendix 33: Summary of the significant macroeconomic variables in the United States and Germany (Model 2 with CRISIS_V).

The United States		Germany	
<i>Variables</i>	<i>Impact</i>	<i>Variables</i>	<i>Impact</i>
STOCK STOCK	Negative	STOCK STOCK	Negative
BOND BOND	Negative	TERM GERM	Positive
TED USA	Negative		
TERM USA	Positive		
OIL	Positive		

Appendix 34: Regression outputs: Model 3 with CRISIS_G the United States.

$SB\ correlation_t$

$$= \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_G_t + \beta_5 * (MACRO_t * CRISIS_G_t) + \varepsilon_t$$

Variable	α	β_1	β_2	β_3	β_4	β_5	Adjusted R ²
STOCK STOCK	0,107681 (0,0508)	0,310484** (0,0000)	0,233874** (0,0002)	-0,308933* (0,0109)	-0,264834* (0,0191)	0,226969 (0,2290)	0,451113
BOND BOND	0,070163 (0,2324)	0,342091** (0,0000)	0,246195** (0,0001)	-0,214091 (0,1023)	-0,181005* (0,0416)	-0,043729 (0,8043)	0,445873
VIX	0,109522 (0,2727)	0,348542** (0,0000)	0,264036** (0,0000)	-0,006690 (0,1981)	-0,174578 (0,2014)	0,002113 (0,7356)	0,443297
TED USA	0,054214 (0,3722)	0,283247** (0,0001)	0,176218** (0,0094)	-0,501408* (0,0180)	-0,252598** (0,0010)	0,427536* (0,0490)	0,311575
DEFAU LT	0,197440 (0,2323)	0,284972** (0,0001)	0,172748* (0,0127)	-0,303923 (0,1015)	-0,413367* (0,0283)	0,285763 (0,1331)	0,294434
TERM USA	-0,001774 (0,9479)	0,332906** (0,0000)	0,279074** (0,0000)	0,529610** (0,0001)	-0,185092** (0,0001)	-0,322382 (0,0621)	0,478219
SHORT USA	-0,017778 (0,5550)	0,347457** (0,0000)	0,268614** (0,0000)	0,091519 (0,7161)	-0,152041** (0,0025)	-0,024314 (0,9323)	0,436096
FED KEY RATE	-0,115089** (0,0022)	0,297652** (0,0000)	0,176868** (0,0092)	0,777627** (0,0076)	-0,118412* (0,0159)	-0,799399* (0,0106)	0,317710
INFL USA	-0,022864 (0,5350)	0,349080** (0,0000)	0,267173** (0,0000)	0,044735 (0,7030)	0,153715** (0,0048)	-0,044027 (0,7696)	0,435547
PMI	0,270354 (0,5733)	0,342608** (0,0000)	0,274140** (0,0000)	-0,005237 (0,5536)	-0,053380 (0,9247)	-0,002720 (0,7982)	0,440397
IP USA	-0,023200 (0,4743)	0,344994** (0,0000)	0,275284** (0,0000)	0,037423 (0,5453)	-0,154983** (0,0019)	-0,083106 (0,2596)	0,439156
CC USA	-0,018632 (0,5094)	0,340217** (0,0000)	0,275718** (0,0000)	0,006831 (0,2145)	-0,156534** (0,0011)	-0,004901 (0,4872)	0,439360
OIL	-0,014866 (0,5930)	0,339161** (0,0000)	0,277362** (0,0000)	0,005552 (0,3891)	-0,160629** (0,0007)	0,004039 (0,6092)	0,447292
GOLD	-0,014426 (0,6059)	0,349084** (0,0000)	0,276360** (0,0000)	0,000691 (0,4199)	-0,161401** (0,0007)	-6,72e ⁻⁰⁵ (0,9462)	0,440376

*/** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

Appendix 35: Regression outputs: Model 3 with CRISIS_G for Germany.*SB correlation_t*

$$= \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_G_t + \beta_5 * (MACRO_t * CRISIS_G_t) + \varepsilon_t$$

Variable	α	β_1	β_2	β_3	β_4	β_5	Adjusted R ²
STOCK STOCK	0,108102* (0,0267)	0,293042** (0,0000)	0,187334** (0,0023)	-0,390277** (0,0005)	-0,101263 (0,2309)	0,015169 (0,9195)	0,493560
BOND BOND	-0,010953 (0,8306)	0,357630** (0,0000)	0,233268** (0,0002)	-0,065138 (0,5630)	-0,084127 (0,2714)	-0,133881 (0,3900)	0,453346
VDAX	0,061731 (0,4749)	0,352771** (0,0000)	0,255838** (0,0000)	-0,005016 (0,2430)	-0,132109 (0,2647)	0,000967 (0,8497)	0,452966
TED GERM	-0,206498* (0,0150)	0,337527** (0,0000)	0,171960* (0,0136)	0,396910 (0,0999)	-0,015147 (0,8591)	-0,408936 (0,0956)	0,3518
TERM GERM	-0,030369 (0,2295)	0,353752** (0,0000)	0,259022** (0,0000)	0,366214* (0,0187)	-0,144057** (0,0006)	-0,275595 (0,1425)	0,459743
SHORT GERM	-0,030624 (0,2307)	0,359973** (0,0000)	0,259916** (0,0000)	-0,446801 (0,1153)	-0,140627** (0,0009)	0,458223 (0,1358)	0,450752
KEY	-0,075934* (0,0145)	0,350368** (0,0000)	0,199333** (0,0046)	-0,127881 (0,5229)	-0,135770** (0,0020)	0,082938 (0,7678)	0,347626
INFL GERM	-0,034794 (0,1728)	0,369459** (0,0000)	0,250425** (0,0001)	-0,034544 (0,4952)	-0,136803** (0,0013)	-0,009594 (0,8956)	0,447624
IFO	0,939087* (0,0474)	0,347221** (0,0000)	0,245744** (0,0001)	-0,009437* (0,0397)	-1,068732 (0,0709)	0,008907 (0,1192)	0,454901
IP GERM	-0,041680 (0,1142)	0,364607** (0,0000)	0,250956** (0,0001)	0,024490 (0,2722)	-0,132052** (0,0020)	-0,028996 (0,2951)	0,447893
CC GERM	0,444382 (0,1001)	0,354087** (0,0000)	0,246613** (0,0001)	-0,005208 (0,0753)	-0,817477* (0,0270)	0,007271 (0,0634)	0,453803
OIL	-0,034220 (0,1805)	0,360658** (0,0000)	0,257342** (0,0000)	0,003664 (0,5237)	-0,138575** (0,0011)	-0,002566 (0,7145)	0,445988
GOLD	-0,033983 (0,1804)	0,364000** (0,0000)	0,258258** (0,0000)	-0,001253 (0,0547)	-0,135894** (0,0013)	0,001124 (0,1611)	0,453770

*/** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

Appendix 36: Regression outputs: Model 3 with crisis_V for the United States.

$SB\ correlation_t$

$$= \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_V_t + \beta_5 * (MACRO_t * CRISIS_V_t) + \varepsilon_t$$

Variable	α	β_1	β_2	β_3	β_4	β_5	Adjusted R ²
STOCK	0,073447 (0,1684)	0,345231** (0,0000)	0,243556** (0,0001)	-0,290838** (0,0099)	-0,159195 (0,1914)	0,106124 (0,5889)	0,436021
BOND	0,052770 (0,3073)	0,379797** (0,0000)	0,251174** (0,0001)	-0,248416* (0,0261)	-0,167039 (0,0869)	0,096455 (0,6206)	0,431756
TED USA	-0,024114 (0,5427)	0,275698** (0,0002)	0,192610** (0,0052)	-0,331259** (0,0014)	0,171970* (0,0250)	0,285486* (0,0173)	0,292205
DEFAUL T	0,299251** (0,0039)	0,327330** (0,0000)	0,233179** (0,0002)	-0,400009** (0,0006)	-0,555906** (0,0002)	0,437787** (0,0007)	0,447781
TERM USA	-0,046177 (0,0644)	0,392979** (0,0000)	0,285993** (0,0000)	0,292888** (0,0098)	-0,116423* (0,0253)	0,008924 (0,9590)	0,446204
SHORT USA	-0,054861* (0,0381)	0,378486** (0,0000)	0,282949** (0,0000)	0,393785* (0,0221)	-0,123592* (0,0292)	-0,510307* (0,0321)	0,431878
FED KEY RATE	-0,116962** (0,0002)	0,345664** (0,0000)	0,190144** (0,0064)	0,345985* (0,0341)	-0,098004 (0,0898)	-0,376488 (0,0914)	0,284040
INFL USA	-0,058679 (0,0682)	0,393639** (0,0000)	0,279112** (0,0000)	0,056303 (0,5581)	-0,092837 (0,1096)	-0,109012 (0,4751)	0,418991
PMI	-0,250905 (0,4665)	0,394127** (0,0000)	0,282575** (0,0000)	0,003828 (0,5524)	0,599617 (0,2205)	0,014242 (0,1381)	0,423833
IP USA	-0,050903 (0,0644)	0,322969** (0,0000)	0,278679** (0,0000)	0,018421 (0,7181)	-0,108701* (0,0425)	-0,039790 (0,5575)	0,418527
CC USA	-0,052975* (0,0384)	0,391472** (0,0000)	0,283403** (0,0000)	0,008530 (0,0584)	-0,113066* (0,0369)	-0,012577 (0,0837)	0,427803
OIL	-0,050395* (0,0478)	0,385272** (0,0000)	0,283403** (0,0000)	0,006619 (0,1586)	-0,097535 (0,0667)	0,002931 (0,7181)	0,427607
GOLD	-0,046621 (0,0669)	0,390953** (0,0000)	0,288408** (0,0000)	0,000584 (0,2844)	-0,122548* (0,0227)	0,000470 (0,6180)	0,425073

*/** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

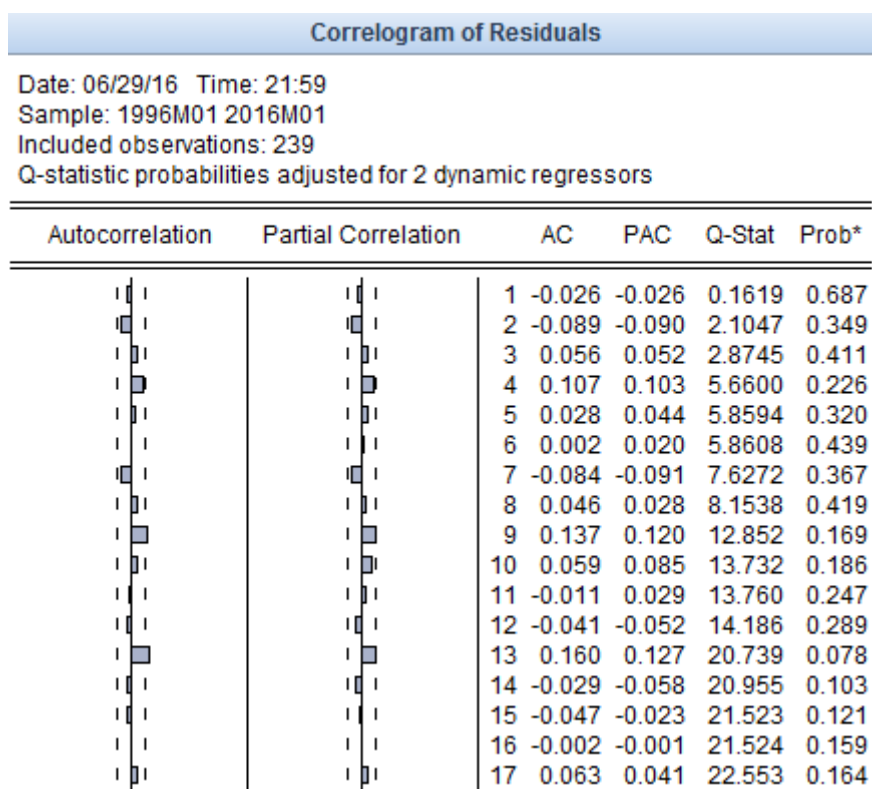
Appendix 37: Regression outputs: Model 3 with crisis_V for Germany.

$$SB\ correlation_t = \alpha + \beta_1 * SB\ correlation_{t-1} + \beta_2 * SB\ correlation_{t-2} + \beta_3 * MACRO_t + \beta_4 * CRISIS_V_t + \beta_5 * (MACRO_t * CRISIS_V_t) + \varepsilon_t$$

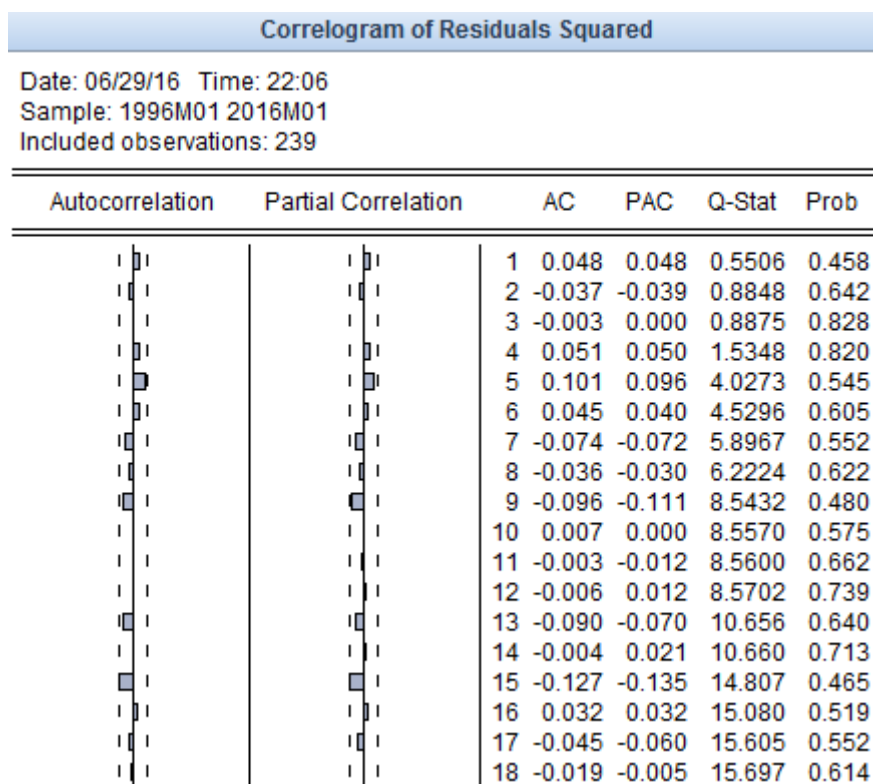
Variable	α	β_1	β_2	β_3	β_4	β_5	Adjusted R ²
STOCK STOCK	0,119414** (0,0085)	0,314417** (0,0000)	0,215967** (0,0004)	-0,439339** (0,0000)	-0,124275 (0,1557)	0,059670 (0,6946)	0,490690
BOND BOND	-0,032606 (0,4557)	0,399081** (0,0000)	0,282203** (0,0000)	-0,049354 (0,6002)	0,010960 (0,8971)	-0,262517 (0,1258)	0,446121
TED GERM	-0,096955* (0,0141)	0,392559** (0,0000)	0,231545** (0,0007)	0,008956 (0,8971)	-0,075088 (0,2372)	-0,059715 (0,5260)	0,338594
TERM GERM	-0,045231 (0,0667)	0,405785** (0,0000)	0,291439** (0,0000)	0,179773 (0,1622)	-0,114594** (0,0058)	0,042693 (0,8051)	0,447441
SHORT GERM	-0,048836 (0,0511)	0,420533** (0,0000)	0,287397** (0,0000)	0,073336 (0,7187)	-0,119920** (0,0057)	-0,274068 (0,2625)	0,440134
ECB KEY RATE	-0,091885** (0,0025)	0,390728** (0,0000)	0,237428** (0,0006)	-0,021099 (0,9165)	-0,140112** (0,0043)	-0,247147 (0,3571)	0,343206
INFL. GERM	-0,050185* (0,0406)	0,402675** (0,0000)	0,292315** (0,0000)	-0,004189 (0,9189)	-0,105285* (0,0106)	-0,173584 (0,0522)	0,446553
IFO	0,663080 (0,1077)	0,387707** (0,0000)	0,286874** (0,0000)	-0,006894 (0,0839)	-0,506029 (0,4319)	0,003661 (0,5651)	0,443031
IP GERM	-0,050763* (0,0450)	0,402739** (0,0000)	0,293328** (0,0000)	0,002810 (0,8748)	-0,100801* (0,0171)	0,002582 (0,9249)	0,434703
CC GERM	0,426383 (0,0798)	0,382437** (0,0000)	0,276600** (0,0000)	-0,005137* (0,0492)	-0,719878 (0,0749)	0,006570 (0,1334)	0,444058
OIL	-0,049724* (0,0450)	0,401144** (0,0000)	0,295158** (0,0000)	-0,000294 (0,9441)	-0,100958* (0,0163)	0,002579 (0,7123)	0,434893
GOLD	-0,048077 (0,0508)	0,395808** (0,0000)	0,298837** (0,0000)	-0,000900 (0,0730)	-0,105151* (0,0112)	0,000813 (0,2963)	0,442291

*/** indicate that the parameters is significant at 5%/1%, respectively. The values in parentheses represent the p-values of the estimates.

Appendix 38: Example of “Correlogram of the residuals and Q-statistic” (Model 2 with crisis_G: the United States)



Appendix 39: Example of “Correlogram of squared residuals” (Model 2 with crisis_G: the United States)



Appendix 40: Results of the Engle's ARCH tests.

ARCH test model 1: The United States

Variable	R ²	Prob2
CRISIS_G	1,842856	0,6057
CRISIS_V	1,248269	0,7415
STOCK STOCK	0,518335	0,9148
BOND BOND	1,791334	0,6168
VIX	1,078537	0,7823
TED USA	0,732010	0,8657
DEFAULT	2,500524	0,4752
TERM USA	0,766168	0,8575
SHORT USA	3,671598	0,2992
FED KEY RATE	2,836867	0,4175
INFLATION USA	2,659048	0,4472
PMI	2,820937	0,4201
IP USA	2,896735	0,4078
CONSUMER CONFIDENCE USA	5,007947	0,1712
OIL	2,761424	0,4299
GOLD	2,479921	0,4789

ARCH test model 1: Germany

Variable	R ²	Prob2
CRISIS_G	5,780927	0,1228
CRISIS_V	7,143993	0,0674
STOCK STOCK	3,036456	0,3860
BOND BOND	4,176620	0,2430
VDAX	6,386697	0,0942
TED GERM	4,144808	0,2462
TERM GERM	1,925524	0,5880
SHORT GERM	3,311390	0,3461
ECB KEY RATE	2,476469	0,4796
INFLATION GERM	3,206043	0,3609
IFO	3,037045	0,2833
IP GERM	4,233177	0,2374
CONSUMER CONFIDENCE GERM	3,432231	0,3297
OIL	3,366322	0,3385
GOLD	3,216976	0,3594

ARCH test model 2 with CRISIS_G: the United States

Variable	R ²	Prob2
STOCK STOCK	0,429772	0,9340
BOND BOND	0,947256	0,8140
VIX	0,904275	0,8244
TED USA	0,400032	0,9402
DEFAULT	1,104606	0,7760
TERM USA	1,391041	0,7076
SHORT USA	2,143829	0,5431
FED KEY RATE	1,474004	0,6883
INFLATION USA	1,744916	0,6270
PMI	2,244812	0,5232
IP USA	1,758277	0,6241
CONSUMER CONFIDENCE USA	2,990548	0,3931
OIL	1,706026	0,6356
GOLD	1,624167	0,6539

ARCH test model 2 with CRISIS_G: Germany

Variable	R ²	Prob2
STOCK STOCK	3,355502	0,3400
BOND BOND	6,925120	0,0743
VDAX	5,276156	0,0715
TED GERM	5,209890	0,1571
TERM GERM	4,231173	0,2376
SHORT GERM	5,664979	0,1291
ECB KEY RATE	5,192973	0,1582
INFLATION GERM	5,589126	0,1334
IFO	5,027123	0,1698
IP GERM	6,487754	0,0901
CONSUMER CONFIDENCE GERM	5,933458	0,1149
OIL	5,893229	0,1169
GOLD	5,608744	0,1323

ARCH test model 2 with CRISIS_V: the United States

Variable	R ²	Prob2
STOCK STOCK	0,115651	0,9899
BOND BOND	0,405375	0,9391
TED USA	0,631770	0,8891
DEFAULT	1,201520	0,7526
TERM USA	0,880053	0,8302
SHORT USA	1,697035	0,6376
FED KEY RATE	2,298447	0,5128
INFLATION USA	1,182776	0,7571
PMI	1,236411	0,7443
IP USA	1,228216	0,7462
CONSUMER CONFIDENCE USA	2,362583	0,5006
OIL	1,376729	0,7110
GOLD	1,134205	0,7688

ARCH test model 2 with CRISIS_V: Germany

Variable	R ²	Prob2
STOCK STOCK	4,899480	0,1793
BOND BOND	4,012562	0,1345
TED GERM	7,144988	0,0674
TERM GERM	5,362719	0,1471
SHORT GERM	7,401888	0,0601
ECB KEY RATE	5,230476	0,1557
INFLATION GERM	6,798966	0,0786
IFO	7,028299	0,0710
IP GERM	7,478219	0,0581
CONSUMER CONFIDENCE GERM	0,509363	0,4754
OIL	7,118793	0,0682
GOLD	6,949650	0,0735

ARCH test model 3 with CRISIS_G: the United States

Variable	R ²	Prob2
STOCK STOCK	0,759577	0,8591
BOND BOND	1,004246	0,8002
VIX	0,912284	0,8225
TED USA	0,770685	0,8565
DEFAULT	1,208131	0,7511
TERM USA	0,822993	0,8440
SHORT USA	2,247778	0,5226
FED KEY RATE	1,055734	0,7878
INFLATION USA	1,614617	0,6561
PMI	2,117900	0,5483
IP USA	2,278464	0,5167
CONSUMER CONFIDENCE USA	2,499791	0,4753
OIL	1,626605	0,6534
GOLD	1,647032	0,6488

ARCH test model 3 with CRISIS_G: Germany

Variable	R ²	Prob2
STOCK STOCK	3,309244	0,3464
BOND BOND	7,180523	0,0664
VDAX	5,418913	0,0666
TED GERM	3,270410	0,3518
TERM GERM	4,062195	0,2548
SHORT GERM	6,397377	0,0938
ECB KEY RATE	5,049846	0,1682
INFLATION GERM	5,608595	0,1323
IFO	4,401079	0,2213
IP GERM	7,168132	0,0667
CONSUMER CONFIDENCE GERM	6,184198	0,1030
OIL	5,546650	0,1359
GOLD	6,479637	0,0905

ARCH test model 3 with CRISIS_V: the United States

Variable	R ²	Prob2
STOCK STOCK	0,173538	0,9817
BOND BOND	0,520386	0,9144
TED USA	1,751668	0,6255
DEFAULT	1,245370	0,7421
TERM USA	0,884389	0,8292
SHORT USA	0,951240	0,8130
FED KEY RATE	1,239763	0,7435
INFLATION USA	0,987992	0,8042
PMI	0,897118	0,8261
IP USA	1,308464	0,7271
CONSUMER CONFIDENCE USA	0,863872	0,8341
OIL	1,305754	0,7278
GOLD	0,977051	0,8068

ARCH test model 3 with CRISIS_V: Germany

Variable	R ²	Prob2
STOCK STOCK	5,317825	0,1499
BOND BOND	7,299499	0,0629
TED GERM	6,639428	0,0843
TERM GERM	5,237894	0,1552
SHORT GERM	6,740937	0,0806
ECB KEY RATE	4,743856	0,1915
INFLATION GERM	6,624338	0,0849
IFO	7,022092	0,0712
IP GERM	7,300920	0,0629
CONSUMER CONFIDENCE GERM	4,586620	0,1009
OIL	7,151787	0,0672
GOLD	7,296008	0,0630

Appendix 41: Quality of the models.

Model 1: the United States

Variable	Adjusted R ²	AIC	SC
CRISIS_G	0,440001	0,586240	0,644424
CRISIS_V	0,422592	0,616855	0,675039
STOCK STOCK	0,431355	0,601562	0,659746
BOND BOND	0,422089	0,617725	0,675908
VIX	0,431186	0,601859	0,660042
TED USA	0,276431	0,538803	0,603865
DEFAULT	0,418054	0,624683	0,682866
TERM USA	0,438970	0,588079	0,646263
SHORT USA	0,418426	0,624044	0,682227
FED KEY INTEREST RATE	0,274503	0,534147	0,599432
INFLATION USA	0,412113	0,634704	0,69288
PMI	0,412113	0,634840	0,693024
IP USA	0,411932	0,635149	0,693332
CONSUMER CONFIDENCE USA	0,416765	0,626896	0,685079
OIL	0,423594	0,615118	0,673301
GOLD	0,417036	0,626432	0,684615

Model 1: Germany

Variable	Adjusted R ²	AIC	SC
CRISIS_G	0,449569	0,312530	0,370713
CRISIS_V	0,439290	0,331032	0,389216
STOCK STOCK	0,482351	0,251127	0,309311
BOND BOND	0,430334	0,346878	0,405062
VDAX	0,442622	0,325073	0,383256
TED GERMANY	0,326769	0,297903	0,362964
TERM GERMANY	0,433751	0,340863	0,399047
SHORT GERMANY	0,424532	0,357013	0,415197
ECB KEY INTEREST RATE	0,321811	0,303626	0,368911
INFLATION GERMANY	0,427252	0,352275	0,410458
IFO	0,425170	0,355903	0,414086
IP GERMANY	0,425590	0,355173	0,413356
CONSUMER CONFIDENCE GERMANY	0,425282	0,355708	0,413892
OIL	0,424904	0,356365	0,414549
GOLD	0,429749	0,347905	0,406089

Model 2 with CRISIS_G: the United States

Variable	Adjusted R ²	AIC	SC
STOCK STOCK	0,450047	0,572242	0,644972
BOND BOND	0,448095	0,575785	0,648515
VIX	0,445404	0,580649	0,653379
TED USA	0,289962	0,519402	0,600176
DEFAULT	0,265875	0,548017	0,612636
TERM USA	0,472610	0,530349	0,603078
SHORT USA	0,438489	0,593041	0,665770
FED KEY INTEREST RATE	0,298234	0,505705	0,587311
INFLATION USA	0,437752	0,594353	0,667082
PMI	0,442632	0,585635	0,658365
IP USA	0,438493	0,593034	0,665763
CONSUMER CONFIDENCE USA	0,440595	0,589283	0,662012
OIL	0,449035	0,574080	0,646810
GOLD	0,442757	0,585410	0,658140

Model 2 with CRISIS_G: Germany

Variable	Adjusted R ²	AIC	SC
STOCK STOCK	0,495702	0,229099	0,301828
BOND BOND	0,453950	0,308643	0,381372
VDAX	0,455220	0,306315	0,379044
TED GERMANY	0,353074	0,262837	0,344164
TERM GERMANY	0,457054	0,302943	0,375672
SHORT GERMANY	0,447841	0,319768	0,392497
ECB KEY INTEREST RATE	0,350632	0,265014	0,346620
INFLATION GERMANY	0,449943	0,315954	0,388683
IFO	0,419229	0,313060	0,385790
IP GERMANY	0,447654	0,320107	0,392837
CONSUMER CONFIDENCE GERMANY	0,448018	0,319448	0,392177
OIL	0,448038	0,319411	0,392141
GOLD	0,451491	0,313136	0,385866

Model 2 with crisis_V: the United States

Variable	Adjusted R ²	AIC	SC
STOCK STOCK	0,437726	0,594399	0,667129
BOND BOND	0,433588	0,601731	0,674461
TED USA	0,275275	0,545191	0,626517
DEFAULT	0,422251	0,621549	0,694278
TERM USA	0,448564	0,574935	0,647665
SHORT USA	0,423018	0,620220	0,692949
FED KEY INTEREST RATE	0,277248	0,535171	0,616777
INFLATION USA	0,420203	0,625088	0,697817
PMI	0,420844	0,623982	0,696711
IP USA	0,420154	0,625172	0,697901
CONSUMER CONFIDENCE USA	0,422868	0,620480	0,693210
OIL	0,429734	0,608513	0,681242
GOLD	0,426917	0,613439	0,686169

Model 2 with CRISIS_V: Germany

Variable	Adjusted R ²	AIC	SC
STOCK STOCK	0,492530	0,235370	0,308099
BOND BOND	0,442901	0,328676	0,401405
TED GERMANY	0,340677	0,281971	0,363297
TERM GERMANY	0,449659	0,316471	0,389201
SHORT GERMANY	0,439508	0,334747	0,407477
ECB KEY INTEREST RATE	0,343697	0,275638	0,357244
INFLATION GERMANY	0,439912	0,334027	0,406756
IFO	0,444622	0,325582	0,398311
IP GERMANY	0,437097	0,339040	0,411769
CONSUMER CONFIDENCE GERMANY	0,441047	0,331999	0,404728
OIL	0,436978	0,339251	0,411980
GOLD	0,442064	0,330177	0,402906

Model 3 with CRISIS_G: the United States

Variable	Adjusted R ²	AIC	SC
STOCK STOCK	0,451113	0,574388	0,661663
BOND BOND	0,445873	0,583889	0,671165
VIX	0,443297	0,588527	0,675802
TED USA	0,311575	0,498570	0,596162
DEFAULT	0,294434	0,517805	0,614733
TERM USA	0,478219	0,523744	0,611019
SHORT USA	0,436096	0,601378	0,688653
FED KEY INTEREST RATE	0,317710	0,482349	0,580276
INFLATION USA	0,435547	0,601378	0,718537
PMI	0,4400397	0,593722	0,710168
IP USA	0,439156	0,595937	0,719335
CONSUMER CONFIDENCE USA	0,439360	0,595574	0,703253
OIL	0,447292	0,581324	0,703596
GOLD	0,440376	0,593759	0,708013

Model 3 with CRISIS_G: Germany

Variable	Adjusted R ²	AIC	SC
STOCK STOCK	0,493560	0,237423	0,324698
BOND BOND	0,453346	0,313833	0,401108
VDAX	0,452966	0,314529	0,401804
TED GERMANY	0,358886	0,258578	0,356170
TERM GERMANY	0,459743	0,302063	0,389338
SHORT GERMANY	0,450752	0,318567	0,405843
ECB KEY INTEREST RATE	0,347626	0,274423	0,372350
INFLATION GERMANY	0,447624	0,324248	0,411523
IFO	0,454901	0,258578	0,356170
IP GERMANY	0,447893	0,323761	0,411036
CONSUMER CONFIDENCE GERMANY	0,453803	0,312998	0,400273
OIL	0,445988	0,327204	0,414479
GOLD	0,453770	0,313058	0,400333

Model 3 with CRISIS_V: the United States

Variable	Adjusted R ²	AIC	SC
STOCK STOCK	0,436021	0,601511	0,688787
BOND BOND	0,431756	0,609045	0,696321
TED USA	0,292205	0,526319	0,623910
DEFAULT	0,447781	0,580440	0,667715
TERM USA	0,446204	0,583292	0,670567
SHORT USA	0,431878	0,608830	0,696105
FED KEY INTEREST RATE	0,284040	0,530519	0,628446
INFLATION USA	0,418991	0,631262	0,718537
PMI	0,423833	0,622893	0,710168
IP USA	0,418527	0,632060	0,719335
CONSUMER CONFIDENCE USA	0,427803	0,615978	0,703253
OIL	0,427607	0,616321	0,703596
GOLD	0,425073	0,620738	0,708013

Model 3 with CRISIS_V: Germany

Variable	Adjusted R ²	AIC	SC
STOCK STOCK	0,490690	0,243075	0,330350
BOND BOND	0,446121	0,326965	0,414240
TED GERMANY	0,338594	0,289739	0,387331
TERM GERMANY	0,447441	0,324578	0,411853
SHORT GERMANY	0,440134	0,337716	0,424991
ECB KEY INTEREST RATE	0,343206	0,281175	0,379102
INFLATION GERMANY	0,446553	0,326185	0,413460
IFO	0,443031	0,332527	0,419802
IP GERMANY	0,434703	0,347370	0,434645
CONSUMER CONFIDENCE GERMANY	0,444058	0,330681	0,417956
OIL	0,434893	0,347034	0,434309
GOLD	0,442291	0,333855	0,421130