Fall 8-2015

The Effect of the Introduction of the Euro on the Stock Price Volatility in the Belgian Equity Market

Hanne Zmierczak

THE EFFECT OF THE INTRODUCTION OF THE EURO ON STOCK PRICE VOLATILITY IN THE BELGIAN EQUITY MARKET

By
Hanne Zmierczak

A THESIS

Submitted to
School of Business and Entrepreneurship
Lindenwood University

In partial fulfillment of the requirements
for the degree of

Master of Science Finance

2015

LINDENWOOD UNIVERSITY
SCHOOL OF BUSINESS AND ENTREPRENEURSHIP

Lindenwood University School of Business and Entrepreneurship

A Thesis
Entitled

THE EFFECT OF THE INTRODUCTION OF THE EURO ON STOCK PRICE VOLATILITY IN THE BELGIAN EQUITY MARKET

By

Hanne Zmierczak

We hereby certify that this Master of Science Thesis submitted by Hanne Zmierczak conforms to acceptable standards, and as such is fully adequate in scope and quality. It is therefore approved as the fulfillment of the Thesis requirements for the Degree of Master of Science in Finance.

Approved:

John Loughlin - PhD — 8/27/15
(Type Name and Degree held) — Date
Chairperson

Gaurango Banerjee - PhD — 08/27/15
(Type Name and Degree held) — Date
Committee Member

Howard Wall - PhD — 8/27/15
(Type Name and Degree held) — Date
Committee member

8/27/15
Date
Dean of the School of Business and Entrepreneurship

Lindenwood University
St. Charles, Missouri
2015

LINDENWOOD UNIVERSITY

Statement of Academic Honesty, Plagiarism, Copyright and Originality
School of Business and Entrepreneurship

Data Submission Profile

Program :	**Master of Science - Finance**
Student Lionmail Account:	hz379@lionmail.lindenwood.edu

Academic Honesty Policy:
Academic dishonesty is a serious offense to oneself and one's colleagues. Students wishing to maintain formal membership in the Lindenwood learning community must display the high level of integrity expected of all its members. According to Lindenwood University's Academic Honesty policy, names of students found guilty of cheating or plagiarizing will be sent to the Associate Provost.

Plagiarism:
Plagiarism is defined as "the presentation of someone else's ideas or words as your own. Whether deliberate or accidental, plagiarism is a serious offense" (Fowler and Aaron 680).

Each of the following is a type of plagiarism and must be avoided in all academic work:

- Copying directly from a source without quotations and source citation;
- Paraphrasing or summarizing another's idea without attribution;
- Changing a sentence's structure but copying words;
- Changing a sentence's words but copying its basic structure;
- Using audio, video or other media sources without acknowledgement;
- Submitting a paper written by another student and claiming it as your own;
- Using information obtained through interviewing an expert on the subject without attribution;
- Purchasing or downloading a paper from another source and claiming it as your own;
- Collaborating excessively on an essay with another person;
- Submitting an essay that was previously written for another class without the consent of both professors (Plagiarism Defined 1).

Copyright Policy:
It is the intent of Lindenwood University that all members of the University community comply with the provisions of the United States Copyright Law. This Copyright policy serves to uphold the University's commitment to protecting the principles of intellectual property, as well as, protect the rights of its faculty to make appropriate use of copyrighted works for acceptable educational purposes. This policy applies to all University faculty, staff, and students who wish to make use of

copyrighted works, whether in print, electronic, or other form. Implicit in this policy is the "Fair Use Act" which applies across the board to uses in the traditional classroom environment and the TEACH Act which is an exception to the "Fair Use Act" for distance learning.
Students may not distribute copies of copyrighted materials to other students. This includes such things as PowerPoint, handouts, podcasts, etc.

Research Integrity:
Research integrity is intended to maintain the accuracy of the research. All research is to be according to the university's IRB standards. Any inappropriate application to/of the research subjects, research techniques, research data or research results will not be accepted in a Thesis. This includes manipulation or fabrication of data.

STATEMENT OF ORIGINALITY: I certify that I am the author of this Thesis. Any assistance I received in its preparation is fully acknowledged and disclosed within this document. I certify that I have not violated Lindenwood Academic Policies, the above Academic Honesty Policy, Plagiarism Policy or Copyright Policy.

I understand that any violation of the above named Lindenwood University policies may result in Academic discipline. Per the Lindenwood University Graduate Catalog: "A first offense of academic dishonesty will result in a warning and a failing grade in the course. A second offense will result in expulsion from the university."

I have cited any and all sources, both print and electronic, from which I have used data, ideas, or words, either quoted or paraphrased. My cited sources are indicated within this document. I also certify that this thesis was prepared by me specifically as part of the Master of Science Thesis required by Lindenwood University and the School of Business and Entrepreneurship.

Mierczak M. 8/27/'15

Student Signature ***Date:***

Committee Comments:

ABSTRACT

THE EFFECT OF THE INTRODUCTION OF THE EURO ON STOCK PRICE VOLATILITY IN THE BELGIAN EQUITY MARKET

By:

Hanne Zmierczak

This study serves to research the effect of the introduction of the Euro as a currency on the volatility in the equity market in Belgium. It particularly looks at the Bel20 index volatility, which includes the twenty largest companies listed in the Belgian stock exchange. This study incorporates ordinary least squares regressions with a time series component. Various models with a timeframe between January 1992 and December 2013 are run. The dependent variable of this research is Bel20 volatility, while the independent variables include inflation, consumer confidence, change in industrial production, GDP growth, Euro dummy variables, and a financial crisis dummy variable. The purpose of this study is to see whether or not the introduction of the Euro had an effect on Bel20 volatility and what the sign of the relationship is if one is found. The results show that Bel20 volatility has increased with statistical significance after the introduction of the Euro.

ACKNOWLEDGEMENTS

I would like to thank everyone who helped me with the completion of this thesis. In particular, I would like to thank my parents and my sister for the support they provided during my journey to the United States. My sincere thanks also goes to my thesis committee, Dr. Banerjee, Dr. Loughlin, and Dr. Wall for guiding me through this process and being available to me when I needed them. I thank Abdullah Almatroodi for always being supportive, my friends who were there for me when I needed them, and all my professors at Lindenwood University without whom I would not have gotten to this point.

Table of Contents

CHAPTER ONE

INTRODUCTION

1.1 Overview

The determinants of stock price volatility have been extensively studied. However, little research that focuses on stock price volatility and the introduction of the Euro as a currency has been performed. This study serves to explain the relationship between several macroeconomic determinants of stock price volatility, which will be the independent variables, and stock price volatility, the dependent variable, before and after the introduction of the Euro. The research will focus on looking at this relationship in the Belgian equity market, and more specifically at the Bel20 stock index. Belgium was among the first eleven countries to adopt the Euro as a currency.

1.2 The European Union, European Monetary Union, and the Introduction of the Euro

The introduction of the Euro was a process with different steps which took 48 years to complete. The predecessor of the European Union (EU), The European Coal and Steel Community (ECSC) was founded in 1951 and was signed by six countries, including Belgium. The goal was to develop better relations, both politically and economically. It focused on setting up a common market for the coal and steel industry. Other countries joined after the European Atomic Energy Community (EURATOM) and the European Economic Community (EEC) were introduced.

After the fall of the Berlin Wall in 1989, the Maastricht Treaty was signed in 1992, which officially marked the establishment of the EU. There would be a common market for goods, money, people, and services and increased cooperation between all member countries. The next step was pursuing the introduction of a common currency. In 1998, eleven countries, one of which was Belgium agreed to adopt the Euro as a currency and the European Monetary Union (EMU) was established. Only one year later, in 1999, the Euro was introduced to be the single currency of the members of the EMU. There was a transition period until 2002, when the European Central Bank (ECB) circulated Euro coins and bills. This research will look at data between 1992 and 2013, while accounting for the different steps related to the full immersion of the Euro. It will look at stock price volatility before 1999, between 1999 and 2002, and after 2002.

1.3 Bel20

The Bel20 is a Belgian stock index that includes the twenty largest companies listed on the Belgian stock exchange. It is part of Euronext Brussels. The index was introduced on March 18th 1991 and started at 1,000. The twenty companies that were included in the index at its introduction were Barco, Bekaert, CBR, Delhaize, Electrabel, Fortis, GBL, Generale Bank, Gevaert, GIB, PetroFina, Recitel pref., Royale Belge, Soc. Générale Belg., Sofina, Solvay, Tessenderlo, Tractebel, UCB, and Umicore. Every year, on the first trading day of March, the index is revised; companies are replaced by others that are now among the twenty largest in Belgium. In 2013, only seven of the original twenty stocks remain in the index while the others were replaced by new companies. On

December 31st 2013, the Bel20 was listed at 2,923.82 basis points. This study will focus on the Bel20 because it is a good reflector of the entire Belgian stock market.

1.4 Stock Price Volatility and Macroeconomic Determinants

Stock price volatility is the relative change in stock prices. Bollerslev, Engle, and Wooldridge (1998) found that stock price volatility affects the cost of capital, the overall health of the economy, and allocation efficiency. Both Harvey (1994) and Solnik (1993) saw that when stock market volatility is predictable, there are many implications for portfolio allocation. That research called for studies on the determinants of stock volatility. Many have examined the influence of stock price volatility on different factors. Errunza (1998) researched the macroeconomic determinants of stock price volatility and looked at money supply, consumer price index, and industrial production. Davis and Kutan (2003) found evidence of a relationship between volatility and inflation and output. Engle and Rangel (2008) saw that inflation, GDP growth, and short-term interest rates are important macroeconomic factors that influence volatility. Kurtz, Jin, and Motolese (2005) found that market expectations also had a significant effect on volatility. Limited research has been conducted to study the effects of different factors that affect volatility and the introduction of the Euro. Moorhead and Brooks (2013) studied the effect of the Euro as a single currency on asymmetric stock market returns volatility, but this differs from the determinants of stock market volatility. This leads to the importance of the outcomes of this research; if traders, companies, and policymakers understand the

differences in the weight of the determinants of stock price volatility before and after the introduction of the Euro, they can use this information for decision-making.

1.5 Expectations

It would be expected that stock market volatility decreased after the introduction of the Euro as a common currency because information costs and transaction costs lowered. This is confirmed in a study by Chou, R. Y., Wu, C., & Yang (2012). Although the free flow of goods, money, people, and services was allowed by the EU before the Euro, having a common currency made everything much easier again. A study conducted by Hardouvelis, Malliaropulos, and Priestley (2006) said that the introduction of the euro as a single currency also eliminated intra-European currency risk. Although one would expect the volatility to diminish after 1999 and again after 2002, there is still a need to research how the values for the different factors that affect volatility change.

1.6 Research questions

The main research question of this study is whether or not there is an effect of the introduction of the Euro on the macroeconomic factors that determine stock price volatility in the Belgian equity market. By finding an answer to this question, this research serves to eliminate the knowledge gap as no studies on this subject have been conducted until now. To my knowledge, the only research that has been done on this topic is a paper by Chou, Wu, and Yang (2012) on the Euro's impacts on the smooth transition dynamics of stock market volatilities. However, this research focused on

France, Germany, Spain, and Italy, while my research will focus on Belgium only. Also, my research will differ from the research by Chou, Wu, and Yang (2012) in that I will focus on only the macroeconomic determinants of stock price volatility. Various determinants of stock volatility have been explored as well as the effects of the introduction of the Euro on stock market returns. This study will specifically focus on stock price volatility and the establishment of the Euro. It will look at the monthly data for the years 1992 to 2013. Different regressions, which are explained in Chapter 3, will be run to account for the differences between periods.

1.7 Scope and Limitations of the Study

Although it would be interesting to research the differences between all countries that are part of the Eurozone, this study aims to introduce the topic. For that reason, Belgium was chosen and the analysis will have a narrow focus. This means that it will be hard to draw conclusions for other EMU countries, although there will be a general idea. Also, the Bel20 was chosen due to the availability of data. The Bel20 has the necessary index data available, but the research would still implicate more about the entire common stock market in Belgium because the macroeconomic determinants' data would be the same for the entire country.

One of the limitations of the study is that for some of the macroeconomic determinants' data, such as GDP, there is only quarterly information available. However, the research will look at the Bel20's monthly volatility to maximize the population size. Another limitation is that some of the quarterly GDP data, in particular the data from the

early years, is estimated by the Organization for Economic Co-operation and Development (OECD) because no actual Belgian GDP data is available. A third limitation of this study is that it is difficult to account for the fact that the companies that are part of the Bel20 change every year, what might affect the index' basis points and thus volatility. A last limitation is the effect of the latest financial crisis of 2007. It is difficult to estimate when this crisis started influencing the Belgian stock markets and when the crisis stopped having an effect. However, this research will try to eliminate the effect of the financial crisis as much as possible by creating dummy variables for the years and months that fell within the time period of the crisis, as well as creating different models that account for the crisis.

CHAPTER TWO

LITERATURE REVIEW

2.1 Implications for Portfolio Allocation

It is important for investors to have information about returns so that they can estimate future returns. Multiple studies have been performed on optimal portfolio allocation and could be used by investors for decision-making purposes. If one would like to invest in the Bel20, this in no different; one should have all available information to make optimal investment decisions. Bollerslev, Engle, and Wooldridge (1988) researched the capital asset pricing model with time-varying covariances. They found that the risk premium of a stock is better explained by the implied market's covariances, rather than the stock's covariance. They also came to the conclusion that information regarding innovation in consumption explains part of the return on assets. First, this means that to know more about the expected return of a stock in the Bel20, an investor should look at the entire Bel20 and the covariances of its stocks rather than the covariance in the stock the investor is interested in. This implies that with the introduction of the euro, an investor should look at the entire Bel20's volatility in order to make a decision about his investment. The volatility is predicted to decrease for all stocks and this information can be used to gain expectations about one particular stock. Second, because the introduction of the Euro can be seen as an innovation in medium of exchange, it will partly explain the return on the Bel20.

Solnik (1993) studied the performance of international asset allocation strategies using condition information. Using three different approaches, he found that if an investor has dynamic asset allocation strategies, the performance is superior. Also, the study lead to the conclusion that on major stock markets expected returns have predictable time-varying components. This implicates that over time, the Bel20 presents components that can be predicted. Even though the introduction of the Euro might have some unknown effect on the Belgian index, some factors are still predictable and decisions can be made about investing in Belgian stocks. Also, Solnik's (1993) research alludes to the fact that an investor should use a dynamic asset allocation strategy and not only invest in the Bel20, no matter what the studies regarding the return of stocks with lower volatility say.

Harvey (1994) researched how a portfolio can be enhanced using emerging markets and market condition information. He found that if investors use market condition information to predict returns on their investments, they have returns that are twice as large as traditional benchmarks. The most important finding pertaining to this research is that the opportunity set in an active portfolio strategy has become larger, specifically that at a lower volatility one can gain higher expected returns. As mentioned in Chapter 1, one would expect volatility to decrease after the introduction of the Euro. Harvey's (1994) research implicates that even though the volatility of the Bel20 might decrease, one can still have a higher expected return by using an active portfolio strategy. For investors this means that they should not have to hold back on investing in Belgium.

2.2 Determinants of Stock Market Volatility

For this research it is important to know what exactly determines the volatility of stocks. Once this is known, a model can be set up to compare these influencers before and after the introduction of the Euro. There are many determinants of stock price volatility that have been studied. The determinants of common stock returns volatility was studied by Cohen, Ness, Okuda, Schwartz, and Whitcomb (1976). They took into consideration that the variance of stock market returns is different from stock to stock, depends on the exchange you look at, and differs from country to country. They came to the conclusion that the determinants of returns variance are share price and the floating supply of a companies' shares. It was also shown that financial economies of scale can be realized as firms grow. This research is important for my study because the fact that returns volatility differs between stocks should be considered. My model will look at the Bel20, but not at the individual stocks that the index includes. Thus, my research will not be able to infer a conclusion about different individual stocks.

One of the pioneers who performed research on the factors related to stock market volatility is Schwert. Schwert (1989) looks at why stock market volatility changes over time. The author looks at many different variables and related them with changes in stock market volatility. These variables include real and nominal macroeconomic volatility, economic activity, financial leverage, and stock trading activity. Schwert (1989) concludes that economies are more volatile during recessions, financial leverage affects stock volatility, share trading volume growth has a positive effect on volatility, and there is weak evidence that macroeconomic volatility helps predict stock return volatility,. The

implications for my research are that macroeconomic volatility should be left out, however, it might be useful to use other macroeconomic variables in my model. Also, because financial leverage and share trading volume affect volatility, it is important to consider these variables in my research.

Research by Liljeblom and Stenius (1997) focused on the macroeconomic volatility and the stock market volatility in Finland. They came up with results that are significantly stronger than those of the research done on US data. Their conclusion was that stock market volatility is a predictor for macroeconomic volatility and, the other way around, that macroeconomic volatility is a predictor for stock market volatility. This might be due to an outside factor. They found that one-sixth to two-thirds of aggregate stock volatility is related to macroeconomic volatility and that there is a negative relationship between increases in trading volume and stock market volatility. These results have important implications for this research because it indicates that the determinants of stock market volatility differ in different countries. Also, it indicates that it is important to consider macroeconomic volatility when making a model for stock market volatility in the Bel20.

Errunza and Hogan (1998) also look at the macroeconomic determinants of stock market volatility. They focus particularly on Europe because they find that the time variation in stock market volatility is significantly affected by the variability of real macroeconomic or monetary factors, which is not the case for the US. In the study, industrial production (a proxy for real activity), money supply, and inflation are used as macroeconomic factors. This differs from the study by Engle, Ghysels, and Sohn (2013)

in that money supply is used. The research suggests that incorporating macroeconomic information can improve return volatility predictions in many European equity markets. However, the results indicate that in the case of Belgium, macroeconomic determinants do not increase forecastability. In my research I will see if using slightly different macroeconomic variables changes these results. Also, because the study by Errunza and Hogan (1998) was performed in 1998, the results might differ after the introduction of the Euro.

An article by Binder and Merges (2001) examines the stock market volatility and its economic factors. The article states that volatility is a function of price level uncertainty, the ratio of expected profits to expected revenues for the economy, the equity risk premium, and the risk-free interest rate. The initial tests used in the research find that the mentioned economic factors explain 50 percent of the monthly changes in volatility. It also discusses the fact that during financial crises there are changes in the ratio of expected profits to expected revenues, which means that there will be changes in market volatility. For my research, the study by Binder and Merges (2001) is important because it states which factors explain stock market volatility. My research will focus on macroeconomic factors and will likely explain less that 50 percent of monthly stock market volatility changes because the macroeconomic factors used by Binder and Merges (2001) explain that much.

Contrary to the research performed by Errunza and Hogan (1998) and Engle, Ghysels, and Sohn (2013), Davis and Kutan (2003) find that macroeconomic volatility has a weak predictive power for volatility and returns in the stock market. They used

inflation and real output as proxies for macroeconomic volatility. The goal of this research was to study whether inflation and output were good predictors of stock returns and volatility by looking at international markets. The reason for the research was that other studies did not look at real output and inflation together as exogenous variables when looking at the relationship between macroeconomic factors and stock return volatility. From this, I can conclude that my research should not focus on only the variables inflation and real output. If I would only use Belgian data for those variables, it is likely that my model would have a low predictive power of stock market volatility.

Kurtz, Jin, and Motolese (2005) looked at the determinants of stock market volatility and risk premia. They treat market beliefs as the main explanation of market volatility. It is believed that individual forecasts of future market states of belief are comparable to predictions of future stock prices. Kurtz, Jin, and Motolese (2005) prepared a simple model regarding market expectations and found that it matched the empirical record of stock prices. The research concludes that market beliefs are mainly driven by overconfidence of agents and asymmetry in the amount of times bull or bear states occur. From this research one can take away that market expectations of agents significantly influence a stock's volatility. This should be no different for the Bel20. My research will take the state of belief towards the Bel20 market into account by including consumer confidence data. I will look at whether market expectations in Belgium were significantly different before and after the introduction of the Euro or not through the use of various models, which will be explained in Chapter 3.

Engle and Rangel (2006) developed their own model for equity volatility. They used macroeconomic effects and time-series dynamics. The macroeconomic factors used included GDP, inflation and short-term interest rates. These three factors will be considered when setting up the model for my research as I will focus on the macroeconomic determinants of stock price volatility. The study by Engle and Rangel (2008) is extensive and detailed. It is one of the few that has been done that specifically pertains to equity price volatility, rather than equity return volatility on which more research has been performed.

Research conducted by Giovannini, Grasso, Lanza, and Manera (2006) looked to identify the forces that drive stock returns and their associated volatilities. The study focused on oil companies and the most important takeaway pertaining to my research is that when plotting the Dynamic Conditional Correlation Model against time, the companies in the Euro area see a positive jump in the DCC at the first half of 2001. This was followed by a higher level of correlation. The Bel20 contains stocks from oil companies and some association could be made with the mentioned study. The research by Giovannini, Grasso, Lanza, and Manera (2006) could lead to a prediction of a higher correlation in the returns on stock prices and their financial risk factors after the introduction of the Euro.

The determinants of stock return comovements were also researched by Baele, Bekaert, and Inghelbrecht (2010). This study focused on data from the US. The authors came to the conclusion that interest rates, inflation, the output gap, cash flow growth, risk aversion, uncertainty about inflation, and output and liquidity proxies determined the

comovements of stock and bond returns. However, macroeconomic factors do not explain much about the comovements of the returns. Other factors, and mainly the liquidity proxies play a more important role. Individually, the variance premium is important in explaining stock return volatility. The primary item to take away from this is that I should not focus on the return volatility of stocks and bonds because the economic factors explain little about their comovements. It is however important to think about the variance premium that explains stock return volatility.

Engle, Ghysels, and Sohn (2013) looked at the macroeconomic fundamentals and stock market volatility. The results show that inflation and industrial production growth drive long-term volatility. This means that including economic fundamentals in models for volatility is good in terms of long-term forecasting. The researchers also found that even for short term forecasting the macroeconomic fundamentals are important. This implies that for this research including inflation and industrial production growth could show significance regarding volatility if we would compare a short time period before the Euro and a short time period after the Euro. It also means that in the long-term, we could see that if there are differences between inflation and industrial production growth, volatility will change.

Tennant and Tracey (2014) researched financial intermediation and stock market volatility in small developing countries. Although Belgium is a developed country, it is important to see how volatility is determined worldwide so one can make conclusions pertaining to different countries. The results of the research by Tennant and Tracey (2014) illustrate that factors affecting a bank's profitability might increase stock market

volatility. The factors studies included efficiency, stringent or inconsistently applied regulations, and ill-advised financial transactions. Also, this research concludes that the effectiveness of financial intermediation impacts the volatility of a stock market and the profitability of companies. Belgium does not have to worry much about this, but there are some countries that use the Euro that might have to take this into account. That is one of the reasons why it would be difficult to create a model for the entire EMU and that it is better just to focus on one country at a time.

2.3 Models for Stock Market Volatility

In order to decide on what model to use for this research, it is important to know what models have been used and developed in other studies. Once I know this, I will be able to choose whether I want to use one of these models or use another model for my study. Early research by Bollerslev, Engle, and Wooldridge (1998) developed a capital asset pricing model with time-varying covariances. The model focuses on the possibility that agents can have common expectations about future returns, but that these expectations are not constants. Rather, they are conditional expectations. In the research, a multivariate generalized autoregressive conditional heteroscedastic process is estimated and the GARCH-M econometric model is used. Although this model would be a good model for some other research, my research specifically focuses on volatility, rather than capital asset pricing.

Solnik (1993) has been a source for many studies pertaining stock market volatility. Solnik (1993) proposes a test of the economic significance of predictable

components in conditional expected returns. For this, the author designs dynamic international allocation strategies based on a conditioning information set. Solnik (1993) uses three approaches based off the conditional risk premium model that uses the return in a period in excess of the risk-free rate and the conditioning information known. For his first approach, he includes past returns in information set. In his second approach, he models the risk premium as a function of volatility of returns. His third approach is to use information variables observable at the start of the holding period to forecast returns over the period. This research indicates the use of various models to explain expected returns. However, these models might not be optimal for my research because I will focus on volatility rather than expected returns.

Harvey (1994) is another well-known source regarding portfolio allocation. The author looks at stock market returns in emerging markets. He comes up with a model that uses conditioning information to predict emerging market returns and finds that using this portfolio strategy produces out-of-sample performance that is two times larger than the traditional benchmark. Although this research focuses on emerging markets, it might have some implications for industrialized countries. The research implicates that using conditional asset allocation strategies might be useful.

Engle and Rangel (2008) developed the Spline-Garch model for low frequency volatility. The research suggests to model equity volatilities as a combination of time series dynamics and macroeconomic effects. According to Engle and Rangel (2006), high frequency return volatility is specified to be the product of a slow-moving component, represented by an exponential spline, and a unit GARCH. On the other hand, low

frequency volatility is modeled as a function of financial variables in an unbalanced panel with a variety of dependence structures, as stated by Engle and Rangel (2008). The research indicates the importance of using panel and time-series data to model volatility and macroeconomic effects. This will be considered when choosing a method for this study.

A cross-country model for the influence of the pre-trade transparency on market liquidity and price volatility is established in a study by Lucarelli, Mazolli, and Palomba (2008). The authors create a model with simultaneous equations that relate volatility and liquidity indicators with three different pre-trade transparency dimensions. The model also uses several control variables. The research focuses both on liquidity and volatility and pre-trade transparency. This model would be useful if I looked at pre-trade transparency, but is not optimal for focusing on stock market volatility.

2.4 Expectations

An article by Bagella, Becchetti, and Hasan (2004) discusses the anticipated effects of the introduction of the Euro. It specifically focuses on exchange rate volatility, institutions and growth. The research states that two of the main effects expected after the formation of a currency union are reduced exchange rate volatility, higher heterogeneous quality of institutional rules, and fewer macroeconomic policies. Although the research does not specifically relate to stock market volatility, it is an important implication because the introduction of the Euro will decrease exchange rate volatility, which eliminates one of the risks for investors within the EMU. Also, having fewer different

macroeconomic policies across different countries will have an effect on the stock market. The research indicates that reduced exchange rate volatility, higher heterogeneous quality of institutional rules, and fewer macroeconomic policies have a significant impact on the growth rate of GDP per capita, which is one of the variables that influences stock market volatility, as discussed in Engle and Rangel (2008). When the GDP is considered in my model, this research indicates that there will be a change in the growth rate due to the introduction of the Euro.

2.5 Introduction of the Euro and Stock Markets

Some research related to the change to a common currency has been performed after the introduction of the Euro. The first study done was by Morana and Beltratti (2002) and only looks at the period when the Euro was first introduced, but no bills or coins were issued yet. The research was conducted using a three-regime Markov switching model for the variance-covariance matrix between different stock indices. The study concludes that there was an initial burst of stock market volatility in all European stock markets. However, after the burst the Spanish and Italian stock markets have stabilized. Belgium was not included in this research, which gives rise to my study. Also, it would be interesting to look at the data after 2000, when the data for the research by Morana and Beltratti (2002) was gathered.

Another study by Baele (2005) was performed in the early years after the introduction of the Euro. This research dates from before Euro bills and coins were released by the EMU. Baele (2005) looks at volatility spillover effects in European equity

markets. A shock spillover model was developed. The model takes into account the local unexpected returns in a shock specific to a country, a regional European shock, and a global shock from the US. Baele (2005) accounts for regime switches in the shock spillover parameters. The purpose of the research was not to look at the determinants of volatility before and after the Euro; it looked to relate volatility shocks in different places to the volatility in multiple equity markets. The study finds that shock spillover intensity has increased over the years. This implies that the volatility shock related to the introduction of the Euro may be felt in other countries that are not part of the EMU.

Hardouvelis, Malliaropulos, and Priestley (2006) researched the EMU and European stock market integration. The purpose of this research was to see if the introduction of the Euro had an effect on the integration of stock markets of individual Eurozone countries similar to that of the integration of money and bond markets. The authors looked at the UK, which chose not to adopt the Euro, and different other countries which chose to adopt the Euro. Evidence that linked increased integration of European stock markets in the 1990s and the formation of the EMU was found. The UK stock market showed no evidence of increase integration with the EU stock market while the countries that chose to be part of the EMU did. This research should be considered in my study because stock market integration plays an important role in the different stock markets. The Belgian stock market should be integrated in the all of the EMU countries' stock markets, which means that implications related to the Bel20 index will have an effect on other stock markets in countries that use the Euro as a currency.

Durré and Nardelli (2007) studied the volatility in the Euro area money market. The researchers looked at the pattern of the volatility of the overnight interest rates before and after the structural changes to the Eurosystem's operational framework in March 2004. Univariate and multivariate models were used. The results indicate that the volatility of overnight interest rates decreased after March 2004. These results might be considered when looking at overnight interest rates as a macroeconomic determinant of volatility. Also, my research will indicate whether the same conclusion can be made pertaining to stock market volatility rather that the volatility of overnight interest rates.

Research by Chou, Wu, and Yang (2012) focused on the Euro's impacts on the smooth transition dynamics of stock market volatilities. The authors use a GARCH model for stock market volatility. The ST-GARCH model provides evidence that it can detect underlying pattern of volatility in four European markets (France, Germany, Spain, and Italy). Also, evidence was found that before the Euro was officially introduced in 1999, volatility processes for the stock markets of the countries that are part of the EMU contain structural changes. Before the Euro was introduced the stock market volatilities increased. The transition point was around two to three years before the launch of the Euro. This research relates very closely to my study. It implicates that I can expect a change in the values of the determinants of volatility after the Euro is introduced. It also indicates that I should treat the three years before the introduction of the Euro separately to account for the structural break. Although Belgium was not among the countries used for the study by Chou, Wu, and Yang (2012), one can still relate some results to the country.

The euro conversion and return dynamics of European financial markets were studies by Grossmann, Guidici, and Simpson (2014). They used a frequency domain approach and compared the different aspects of equity market index returns over several time periods before and after the introduction of the Euro. Twelve Euro-zone countries (including Belgium), the UK, the US, and Japan were compared. The results show that right after the introduction of the Euro, there is a reduced equity market index returns volatility. However, in the long run there is an increase in volatility in the equity markets. This study gives the opposite conclusion of all other research discussed as volatility is said to increase in the long run. Although I will be looking at the determinants of volatility, this research gives interesting insights as to what direction volatility went before and after the introduction of the Euro.

Gebka and Karoglou (2013) studied the integration of the European peripheral financial markets. The authors used tests for structural breaks and return correlations stemming from multivariate stochastic volatility models. The results indicate that financial integration strengthened while awaiting the Euro, intensified even more when the EMU was created, and became larger after the 2007/2008 financial crisis. From this research, it can be concluded that financial markets became more and more intertwined as the Euro evolved. This is an important implication for the Bel20 index as it will be increasingly related to other countries' financial markets. It also leads to this research in that it is important to see how the determinants of stock market volatility, particularly the value of Euro-dummies relate to stock market volatility, rather than how a Euro-dummy would relate to financial integration.

In a study by Moorhead and Brooks (2013) the effect of the introduction of the Euro on asymmetric stock market returns volatility across the Euro-zone is examined. TARCH and APARCH models are used across four sub-periods between July 1990 and December 2006. The research finds that asymmetric volatility is different across all four sub-periods. The number of countries that show asymmetric volatility increases with the four sub-periods. Although this research deals with stock market returns volatility, the conclusion might give rise to using the models used in the study and/or following the idea of using four sub-periods and comparing them.

2.6 Implications

An article by Helisek (2011) discusses the financial crisis and the economic recession's impact on the readiness of the Czech Republic to adopt the Euro. It states that these events have delayed the introduction of the Euro in the country. However, the interconnection between the Czech economy and the economy in the Euro area is strong and increasing. The Czech Republic would benefit from the introduction of the Euro because the exchange rate volatility would decrease from 5.92% to 2.68%. Through my research, implications could be made regarding the Czech stock market volatility once the country introduces the Euro. The research by Helisek (2011) discusses the benefits from exchange rate volatility, but this is not the only thing that would change. Investors could benefit from knowing about the determinants of stock market volatility as well, and make informed decisions. The same holds for many other countries that could take on the Euro as their currency.

CHAPTER THREE

METHODOLOGY

This research focuses on data regarding the Bel20 and the Belgian economy between January 1992 and December 2013. I will use monthly data points, which means that there are 264 observations. The reason for using monthly data is that it increases the number of observations compared to quarterly or yearly data. In order to run a regression with viable results there is a need of minimum 200 data points. Daily data was not available for all variables, specifically the macroeconomic variables regarding the Belgian economy. There are no missing data. In this chapter I will outline the data I will use in the study, the method of analysis I will use, my null and alternative hypotheses, and the models used to answer my research question. I will also outline the important regression diagnostics.

3.1 Dependent Variable

The dependent variable in this research is monthly stock price volatility, based on daily values of the index, a quantitative variable. This is measured by the standard deviation of daily index values of the Bel20 within a month. The Bel20 reflects the stock prices of the 20 largest firms that are listed on the stock market, which makes it a good proxy for the stock price volatility of the entire Belgian stock market. The data is collected from the equity index data on the Bel20 provided by EconStats (EconStats, 2015).

3.2 Independent Variables

3.2.1 Inflation

The first independent variable that will be used in this research is inflation. Inflation is a quantitative variable and macroeconomic indicator. Davis and Kutan (2003) found evidence of a relationship between volatility and inflation, while Engle and Rangel (2008) saw that inflation is an important macroeconomic factor that influences volatility, which makes this variable appropriate for my research. Monthly inflation data for Belgium is retrieved from NBB.Stat, an online database for macroeconomic statistics by the National Bank of Belgium (NBB) (NBB.Stat, 2015). The inflation reflects the price changes according to the general national index of consumer prices (NICP). The change in inflation reflects the inflation of a certain month compared to the previous month.

3.2.2 Consumer Confidence Indicator

The second independent variable is the consumer confidence indicator, a macroeconomic psychological variable. Kurtz, Jin, and Motolese (2005) found that market expectations effects on volatility. The consumer confidence indicator can be used as a proxy for market expectations. The monthly data for this variable is retrieved from the NBB.Stat databases (NBB.Stat, 2015). The data is categorical with an ordinal scale and reflects a consumer survey conducted by the NBB. The consumer confidence indicator has four components including forecasts of the economic situation in Belgium, forecasts of unemployment in Belgium, forecasts of the financial situation of households,

and forecasts of savings of households. All components are expectations of individuals reflecting the next 12 months.

3.2.3 Percentage Change in Industrial Production

The third independent variable that will be used for this research is the percentage change in industrial production, a quantitative and macroeconomic variable. The proxy for this is industrial production growth, which compares the growth of a certain month to the growth of the previous period (month). Errunza (1998) researched the macroeconomic determinants of stock price volatility found that industrial production was a determinant of stock price volatility. The reason for using the percentage change in industrial production rather than the currency amount used is because I will look at my dependent variable volatility, which is also a percentage change. This makes things easier and more accurate to compare. The percentage change in industrial production data is monthly data collected from the OECD.Stat database (OECD.Stat, 2015).

3.2.4 Gross Domestic Product (GDP) Growth

GDP is the fourth independent variable is percentage change in GDP, a quantitative variable and macroeconomic determinant of stock price volatility. Engle and Rangel (2008) studied the macroeconomic factors that influence volatility, one of which was GDP growth. The data for real GDP growth is retrieved from the OECD.Stat databases (OECD.Stat, 2015). The GDP growth data stems from the growth rate compared to the previous quarter and is seasonally adjusted. The GDP was calculated

using the expenditure approach. The data for this independent variable is quarterly, due to the lack of monthly data over the entire period this research will study. This is a challenge for the research because all other variables have monthly data. However, there are still 88 quarterly data points for GDP growth, which should reflect the variable in a good manner for the length of the entire period of the study. The monthly data points for GDP growth in the study will be proxies and will be assigned to the months within a quarter by using the quarterly GDP growth. Another challenge is that the data from the first quarter of 1992 until the fourth quarter of 1994 is estimated, according to the OECD. The reason for this being that no quarterly GDP data for Belgium for that period is available. This is not necessarily a problem, but it is not exact data so it is not optimal either.

3.2.5 Dummy Variables

Some of the regressions in this study will include dummy variables for the Euro. A dummy variable has a value of either zero or one. The study will include a variable indicating whether or not the Euro was introduced already. A zero means that there was no Euro, which means that Belgium was still using the Belgian Frank for those months. A one means that the Euro was introduced already. The months from January 1992 to December 1998 will have a value of zero and the months between January 1999 and December 2013 will have a value of 1.

For a second dummy variable, a difference will be made between the months that the Euro was introduced, but the coins and bills were not yet issued and the months after

the European Central Bank (ECB) issued coins and bills. The period between January 1999 and December 2001 will receive a value of zero, while the period between January 2002 and December 2013 will receive a value of one.

Another dummy variable will take into account the financial crisis of 2007-2009. All months in which there was no financial crisis will receive a value of zero and the months in the period when the financial crisis happened will receive a value of one. It is hard to estimate when the financial crisis started and ended. However, I will take the 19-month period between December 2007 and June 2009 as the period for the financial crisis, as the U.S. National Bureau of Economic Research (NBER) indicates (NBER, 2015). Although NBER is related to the United States, the Great Recession was a global crisis which was felt in Europe too and I could use their data as reference points. The period between December 2007 and June 2009 will receive a value of one, while all other months that fall outside of this period will receive a value of zero.

3.3 Method of Analysis

This research uses an ordinary least squares regression model. This model is appropriate because I will test the influence of multiple independent variables on one dependent variable. I will be looking at the monthly data of one country, which means that time-series analysis would be appropriate. The regressions and tests will be run through Gretl and SPSS because both have some disadvantages, but the combination of the two will provide the best results.

3.4 Null and Alternative Hypotheses

3.4.1 Null Hypothesis

H01 There is no difference in the relationship between the macroeconomic variables (inflation, consumer confidence, change in industrial production, and GDP growth) and Bel20 volatility before the introduction of the Euro, between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002, and after the introduction of Euro bills and coins in 2002. In other words: there is no difference between the independent variables throughout the entire period.

H02: There is no difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the financial crisis and during the financial crisis.

3.4.2 Alternative Hypotheses

HA1: There is a difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the introduction of the Euro and between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002, but not after the introduction of Euro bills and coins in 2002.

HA2: There is a difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the introduction of the Euro and after the introduction

of Euro bills and coins in 2002, but not between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002.

HA3: There is a difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the introduction of the Euro, between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002, and after the introduction of Euro bills and coins in 2002.

HA4: There is a difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the financial crisis and during the financial crisis.

3.5 Models

3.5.1 Three Period Sample

The first set of models will look at three different periods. The first period is from January 1992 until December 1998, which is the period in which the Euro did not exist. The second period will be between January 1999 and December 2001, the period in which the Euro was introduced, but there were no Euro bills or coins yet. The last period will look at the period from the introduction of the Euro and the circulations of coins and bills onwards until the start of the financial crisis. This period will run from January 2002 until November 2007. All three regressions and its independent variables' coefficients will be compared. The independent variables include inflation, consumer confidence,

change in industrial production, and GDP growth. The dependent variable is Bel20 stock price volatility. No Euro dummy variables will be included and no financial crisis dummy variable will be included because the sample only runs until November 2007 and will not include the period from the start of the financial crisis onward.

The model that will be used is the same for the three different periods and is the following:

$Y = a + B1X1 + B2X2 + B3X3 + B4X4 + Ut$

With:

Y = Bel20 stock price volatility

a = y-axis intercept

X1 = inflation

X2 = consumer confidence

X3 = change in industrial production

X4= GDP growth

Ut = Error term

3.5.2 Sample until 2007 with Euro Dummies

The second sample will only include one model. The model will include data for inflation, consumer confidence, change in industrial production, GDP growth, and Euro dummies, which are the independent variables. There will be two Euro dummies included in this model, as explained in the independent variables section in chapter three. It will also include Bel20 stock price volatility as the dependent variable. This sample will

include data from January 1992 until November 2007, which marks the start of the financial crisis. This model will be used to account for the financial crisis. It will look at the relationship between the dependent variable and independent variables, without having to worry about possible effects of the Great Recession.

The model that will be used is the following:

$$Y = a + B1X1 + B2X2 + B3X3 + B4X4 + B5X5 + B6X6 + Ut$$

With:

Y = Bel20 stock price volatility

a = Y-axis intercept

X1 = Inflation

X2 = Consumer confidence

X3 = Change in industrial production

X4 = GDP growth

X5 = Dummy variable for Euro in period without coins and bills

X6 = Dummy variable for Euro in period with coins and bills

Ut = Error term

3.5.3 Sample until 2013 with Euro Dummies and Financial Crisis Dummies

This set of models will include two models. Both models will include the dependent variable Bel20 stock price volatility and the independent variables inflation, consumer confidence, change in industrial production, GDP growth, and two Euro dummies (one for the period in which the Euro was introduced, but no coins or bills were

used and one for the period in which coins and bills were used). The first model will only include the variables mentioned above, while the second model will include the dummy variable for the financial crisis, as explained in chapter 3 under independent variables. Both models will be compared to see whether the financial crisis had an impact on Bel20 stock price volatility. The first model will also be compared to the sample until 2007 with Euro dummies to determine whether the financial crisis had an impact on all macroeconomic determinants of volatility's coefficients, which are the independent variables. If there is a difference between the two models, it means that the macroeconomic determinants of volatility are individually influenced by the financial crisis, which would imply that the model which includes dummy variables for the financial crisis is not a good model to reflect stock price volatility of the Bel20.

The models that will be used are the following:

1) $Y = a + B1X1 + B2X2 + B3X3 + B4X4 + B5X5 + B6X6 + Ut$

2) $Y = a + B1X1 + B2X2 + B3X3 + B4X4 + B5X5 + B6X6 + B7X7 + Ut$

With:

Y = Bel20 stock price volatility

a = Y-axis intercept

X1 = Inflation

X2 = Consumer confidence

X3 = Change in industrial production

X4 = GDP growth

X5 = Dummy variable for Euro in period without coins and bills

X6 = Dummy variable for Euro in period with coins and bills

B7X7 = Dummy variable for the financial crisis

Ut = Error term

3.6 Important Regression Diagnostics

3.6.1 Multicollinearity

Multicollinearity means that a variable is related to another variable, which is something that should be avoided in research. To test for multicollinearity I look at the correlation coefficients between all variables using SPSS. More specifically, I look at the Pearson Correlation. After the diagnostics are run, if the Pearson Correlation between two variables has an absolute value of less than 0.5, I fail to reject the null hypothesis that there is no multicollinearity. This means that the independent variable may be included in the model. On the other hand, if the absolute value of the Pearson Correlation between two variables is greater than 0.5, we reject the null hypothesis that there is no multicollinearity and the one of the two correlated variables should be eliminated from the model.

3.6.2 Heteroskedasticity

For research it is important that there is homoskedasticity, which means that the variance of the error term is constant. If this is not the case and the error terms do not have constant variances, one can speak of heteroskedasticity. Therefore,

heteroskedasticity is tested in this study by using a White's general test. The test is performed in Gretl. Gretl will compute a chi square value of which a p-value will be derived. If the p-value is low, I reject the null hypothesis of homoscedasticity. If the p-value is high, I fail to reject the null hypothesis of homoscedasticity. If the White's test's outcomes reject the null hypothesis of homoskedasticity, the model will have to be run using robust standard errors, which eliminates heteroskedasticity. If the test fails to reject the null-hypothesis of homoskedasticity, nothing should be changed.

3.6.3 Autocorrelation

Autocorrelation means that the error terms of the variables are correlated. This is to be avoided in research. However, autocorrelation appears a lot in time-series data because the error term of one time period, might be related to the error term in a previous time period. This indicates that this study might find a presence of autocorrelation. To test for autocorrelation, I look at the value of rho for my model and at the Durbin-Watson coefficient. Both are performed in Gretl. If rho is closer than zero than to one, I reject the null hypothesis of no autocorrelation. However, if rho is closer to one than to zero, I reject the null hypothesis of no autocorrelation. If the Durbin-Watson coefficient is close to two, I reject the null hypothesis that there is no autocorrelation, while if the coefficient is not close to two, the null hypothesis of no autocorrelation is not rejected. If I reject the null hypothesis of no autocorrelation, the data should be manipulated so that the error terms are no longer correlated. To do this, the data should look at the change of the

values between month t and month t-1. If one only looks at the month-by-month change in the values of the variables, there should not be any autocorrelation.

CHAPTER FOUR

DATA COLLECTION AND PRESENTATION

In this study, the dependent variable is stock price volatility. The independent variables include inflation, consumer confidence, percentage change in industrial production, real GDP growth, and dummy variables for the Euro, Euro coins, and the financial crisis. Data for the dependent variable is specifically on the Bel20 stock index, which is derived from the stock prices of the twenty largest companies listed on the Belgian stock exchange. The other variables' data is macroeconomic data on Belgium and the dummy variables' data is based on information regarding the EMU and the EU. The data was collected from multiple publicly available databases as described in chapter 3. This research focuses on the period from January 1992 until December 2013 and looks at monthly data. The period was chosen because of the availability of data and so that the amount of data points was sufficient. Quarterly data would have resulted in an insufficient amount of data points. This chapter will discuss the screening of the data and what was done to eliminate issues that came forward during the screening. It will specifically discuss missing data, outliers, multicollinearity, heteroskedasticity, and autocorrelation. Data screening is necessary before running regressions to ensure the data is of good enough quality to produce valid results.

4.1 Missing Data

If less than 6% of the data are missing, these cases can be ignored and it is ok to proceed with the research without taking any further steps. However, if between 6% and 25% of the data are missing, analysis values will have to be assigned to the missing data according to what kind of data one is dealing with. If more than 25% of the data is missing, it should be considered to eliminate the variable from the analysis. To screen for missing data I used SPSS, which produced Table 1 below. No missing values were found, which means that no adjustments have to be made in the data.

Table 1

Univariate Statistics

	N	Mean	Std. Deviation	Missing	
				Count	Percent
Bel20vol	264	46.14166459	36.01624802	0	.0
inflation	264	2.0764	1.06381	0	.0
Consumerconfidenceindicator	264	-7.420	9.1465	0	.0
percchangeindprod	264	.233	2.4035	0	.0
realGDPgrowth	264	.4208253930	.6444648982	0	.0
Nocoinsandbills	264			0	.0
coinsandbills	264			0	.0
financialcrisis	264			0	.0

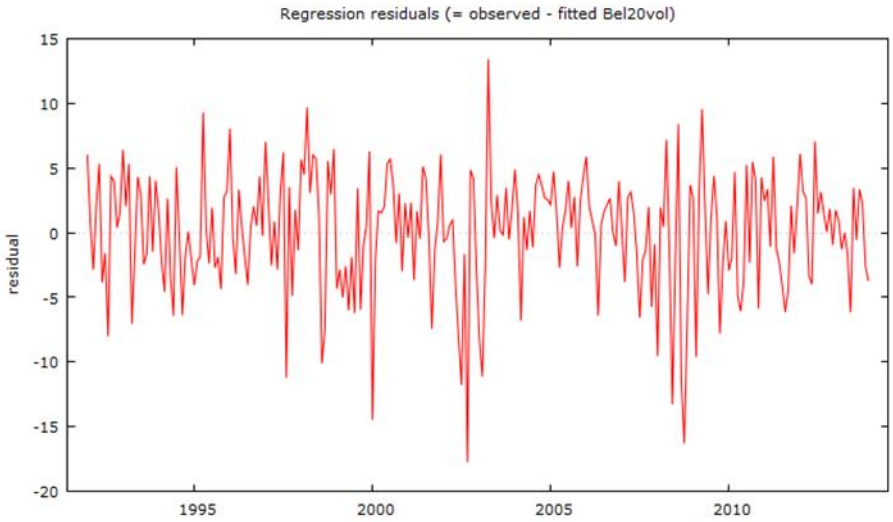
a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

4.2 Outliers

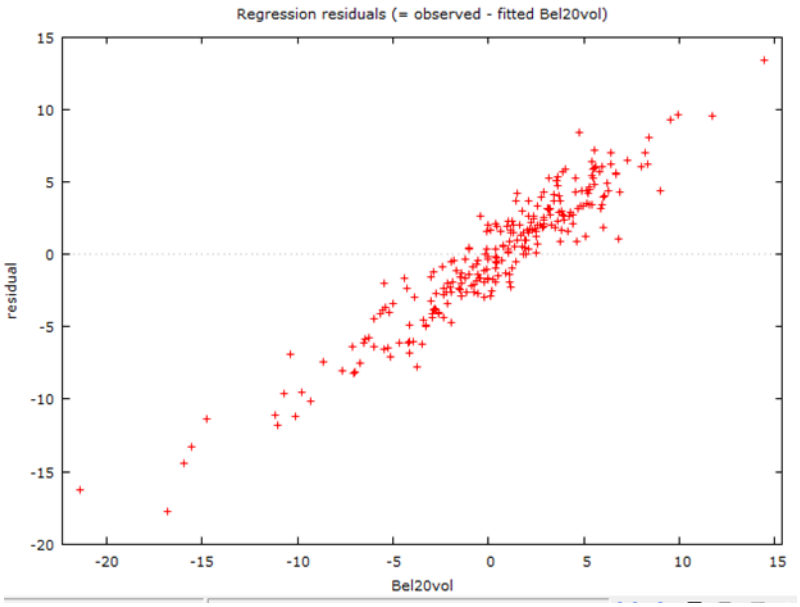
There are multiple possibilities when it comes to checking for outliers or extreme values. In this research, the use of graphs was chosen. Outliers are relative to a model. If a point falls far from the regression line or the plane defined by the other variables of the

model, it is an outlier. If outliers are found, a researcher should study if the outliers can be explained. If the outliers cannot be explained, tests to see whether or not the outliers influence the results of the study or not should be run. If they do, the outliers should be eliminated. Gretl produced graph 1 and 2 (see below). When the graphs were studied, no extreme values could be observed in either of the graphs. In Graph 1, the regression residuals were ran against time. Peaks that stand alone and differ much from the other values could not be observed. In Graph 2, the regression residuals were run against Bel20 volatility. No extreme values that lay far from the regression line could be seen. Gretl also produced Graph 3, which represents the leverage of each of residuals or how much one residual influences the model. None of the residuals showed extreme leverage, which is another indicator that there are no outliers present. In conclusion, no outliers could be observed and no adjustments had to be made to the data regarding extreme values.

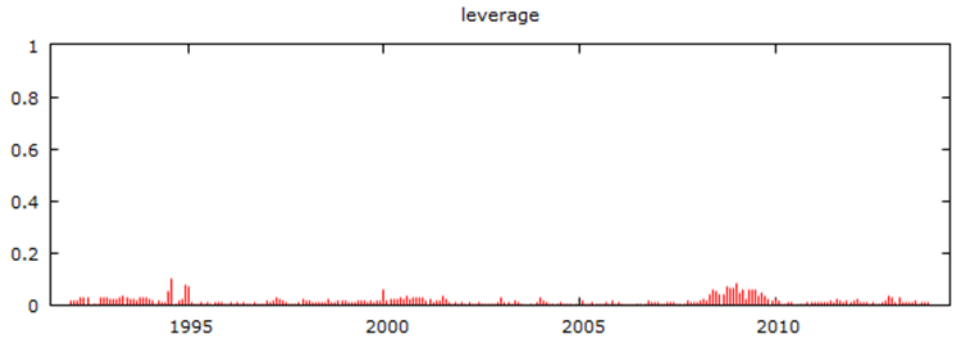
Graph 1



Graph 2



Graph 3



4.3 Multicollinearity

Multicollinearity was tested using SPSS. If the Pearson correlation coefficient of a variable is between -0.5 and 0.5, I fail to reject the null hypothesis that there is no multicollinearity. If the Pearson correlation coefficient falls outside that range, the null hypothesis of no multicollinearity is rejected. As seen in Table 2 below, only one of the

Pearson correlation coefficients has a value outside the range -0.5 to 0.5 and all other correlation coefficients fall within the range. There is a correlation of 0.543 between the dummy variable no coins and bills and the independent variable consumer confidence indicator. However, since there is only a marginal multicollinearity between these two variables and because all other variables do not show any multicollinearity, I failed to reject the null hypothesis of no multicollinearity. Resulting from this, I did not have to make any adjustments to my data and could continue with the next step regarding the regression diagnostics.

Table 2

Correlations

		Bel20vol	inflation	Consumerconfidenceindicator	percchangeindprod	realGDPgrowth	Nocoinsandbills	coinsandbills	financialcrisis
Bel20vol	Pearson Correlation	1	.037	.171**	-.079	-.124*	.103	.204**	.367**
	Sig. (2-tailed)		.552	.005	.202	.045	.095	.001	.000
	N	264	264	264	264	264	264	264	264
inflation	Pearson Correlation	.037	1	-.026	-.040	-.257**	-.012	.082	.297**
	Sig. (2-tailed)	.552		.671	.517	.000	.848	.186	.000
	N	264	264	264	264	264	264	264	264
Consumerconfidenceindicator	Pearson Correlation	.171**	-.026	1	.051	.333**	.543**	-.096	-.202**
	Sig. (2-tailed)	.005	.671		.411	.000	.000	.119	.001
	N	264	264	264	264	264	264	264	264
percchangeindprod	Pearson Correlation	-.079	-.040	.051	1	.107	-.005	.025	-.083
	Sig. (2-tailed)	.202	.517	.411		.084	.935	.685	.180
	N	264	264	264	264	264	264	264	264
realGDPgrowth	Pearson Correlation	-.124*	-.257**	.333**	.107	1	.121*	-.124*	-.390**
	Sig. (2-tailed)	.045	.000	.000	.084		.049	.044	.000
	N	264	264	264	264	264	264	264	264
Nocoinsandbills	Pearson Correlation	.103	-.012	.543**	-.005	.121*	1	-.435**	-.111
	Sig. (2-tailed)	.095	.848	.000	.935	.049		.000	.073
	N	264	264	264	264	264	264	264	264
coinsandbills	Pearson Correlation	.204**	.082	-.096	.025	-.124*	-.435**	1	.254**
	Sig. (2-tailed)	.001	.186	.119	.685	.044	.000		.000
	N	264	264	264	264	264	264	264	264
financialcrisis	Pearson Correlation	.367**	.297**	-.202**	-.083	-.390**	-.111	.254**	1
	Sig. (2-tailed)	.000	.000	.001	.180	.000	.073	.000	
	N	264	264	264	264	264	264	264	264

4.4 Heteroskedasticity

To test for heteroskedasticity Gretl was used. A White's general test was produced which gave a p-value of 0.000000 (see Table 3). As discussed in chapter 3, a low p-value indicates that the error terms do not have a constant variance. This leads to rejecting the null hypothesis of homoscedasticity. To account for this and to eliminate possible heteroskedasticity, the model will be run with robust standard errors as I will do in chapter 5.

Table 3

White's test for heteroskedasticity
OLS, using observations 1992:01-2013:12 (T = 264)
Dependent variable: uhat^2
Omitted due to exact collinearity: X7_X8

	coefficient	std. error	t-ratio	p-value	
const	1849.21	1278.98	1.446	0.1496	
inflation	-277.683	931.428	-0.2981	0.7659	
Consumer_confide~	146.133	93.5181	1.563	0.1195	
perc_change_ind_~	-161.553	268.568	-0.6015	0.5481	
real_GDP_growth	1895.22	1456.13	1.302	0.1944	
No_coins_and_bil~	-2397.15	2983.39	-0.8035	0.4225	
coins_and_bills	-546.036	1264.46	-0.4318	0.6663	
financial_crisis	12617.2	4046.30	3.118	0.0020	***
sq_inflation	-116.397	127.260	-0.9146	0.3613	
X2_X3	-50.5253	29.3772	-1.720	0.0868	*
X2_X4	71.0842	68.2870	1.041	0.2990	
X2_X5	-1439.18	399.619	-3.601	0.0004	***
X2_X6	1628.75	1300.62	1.252	0.2117	
X2_X7	755.746	601.895	1.256	0.2105	
X2_X8	-1137.83	624.444	-1.822	0.0697	*
sq_Consumer_conf~	-1.07044	2.63781	-0.4058	0.6853	
X3_X4	2.21046	12.5810	0.1757	0.8607	
X3_X5	-82.4343	54.4438	-1.514	0.1313	
X3_X6	54.4982	102.159	0.5335	0.5942	
X3_X7	19.5380	61.6365	0.3170	0.7515	
X3_X8	460.131	216.156	2.129	0.0343	**
sq_perc_change_i~	-3.92627	11.9176	-0.3295	0.7421	
X4_X5	53.7396	132.587	0.4053	0.6856	
X4_X6	-429.714	306.586	-1.402	0.1624	
X4_X7	54.1265	149.992	0.3609	0.7185	
X4_X8	376.291	258.473	1.456	0.1468	
sq_real_GDP_grow~	481.541	428.555	1.124	0.2623	
X5_X6	-617.444	1670.88	-0.3695	0.7121	
X5_X7	-1049.34	897.762	-1.169	0.2437	
X5_X8	-1668.48	1925.88	-0.8663	0.3872	

Unadjusted R-squared = 0.347618

Test statistic: TR^2 = 91.771167,
with p-value = P(Chi-square(29) > 91.771167) = 0.000000

4.5 Autocorrelation

Autocorrelation was tested to see if the error terms of the variables are correlated. I looked at both the rho value for my model and the Durbin-Watson coefficient in Gretl (see Table 4). The rho value for my model was 0.249322. According to the discussion in chapter 3, I failed to reject the null hypothesis of no autocorrelation because the value of rho was closer to 0 than to 1. The Durbin-Watson coefficient for my model was 1.499825, which confirms that I had to fail to reject the null hypothesis of no autocorrelation. This was because the value for the Durbin-Watson coefficient is close to two. Resulting from this, no further action had to be taken regarding to the data.

Table 4

Model 1: OLS, using observations 1992:01-2013:12 (T = 264)
Dependent variable: Volatility

	coefficient	std. error	t-ratio	p-value	
const	49.5784	6.85364	7.234	5.44e-012	***
inflation	-3.46592	1.97116	-1.758	0.0799	*
Consumer_confide~	0.910668	0.280128	3.251	0.0013	***
perc_change_ind_~	-0.903830	0.825872	-1.094	0.2748	
real_GDP_growth	-3.48442	3.54011	-0.9843	0.3259	
No_coins_and_bil~	10.7094	7.77401	1.378	0.1695	
coins_and_bills	12.6676	4.64578	2.727	0.0068	***
financial_crisis	53.1422	8.75873	6.067	4.65e-09	***

Mean dependent var	46.14166	S.D. dependent var	36.01625
Sum squared resid	260978.8	S.E. of regression	31.92881
R-squared	0.235016	Adjusted R-squared	0.214098
F(7, 256)	11.23533	P-value(F)	2.11e-12
Log-likelihood	-1284.904	Akaike criterion	2585.808
Schwarz criterion	2614.416	Hannan-Quinn	2597.304
rho	0.249322	Durbin-Watson	1.499825

Excluding the constant, p-value was highest for variable 6
(real_GDP_growth)

4.6 Limitations of the Model

The research uses stock price volatility data from the Bel20. This data only focuses on the stock prices of the twenty largest companies listed on the Belgian stock exchange. It might not be optimal to infer effects about the entire Belgian stock market based on information on a select amount of companies. It is possible that the stock price volatility of smaller companies was affected differently than that of the twenty largest companies.

For future research it might be interesting to include some other macroeconomic factors and other factors that influence stock price volatility. This research limited the amount of variables to five due to the availability of data. If more variables are included, the overall fit of the model may be improved.

It might also be interesting to expand the period of the study and divide that period into more different sub-periods. This could bring to light other findings than what can be discovered in my research regarding stock price volatility. Due to the availability of data, I could not expand my research period.

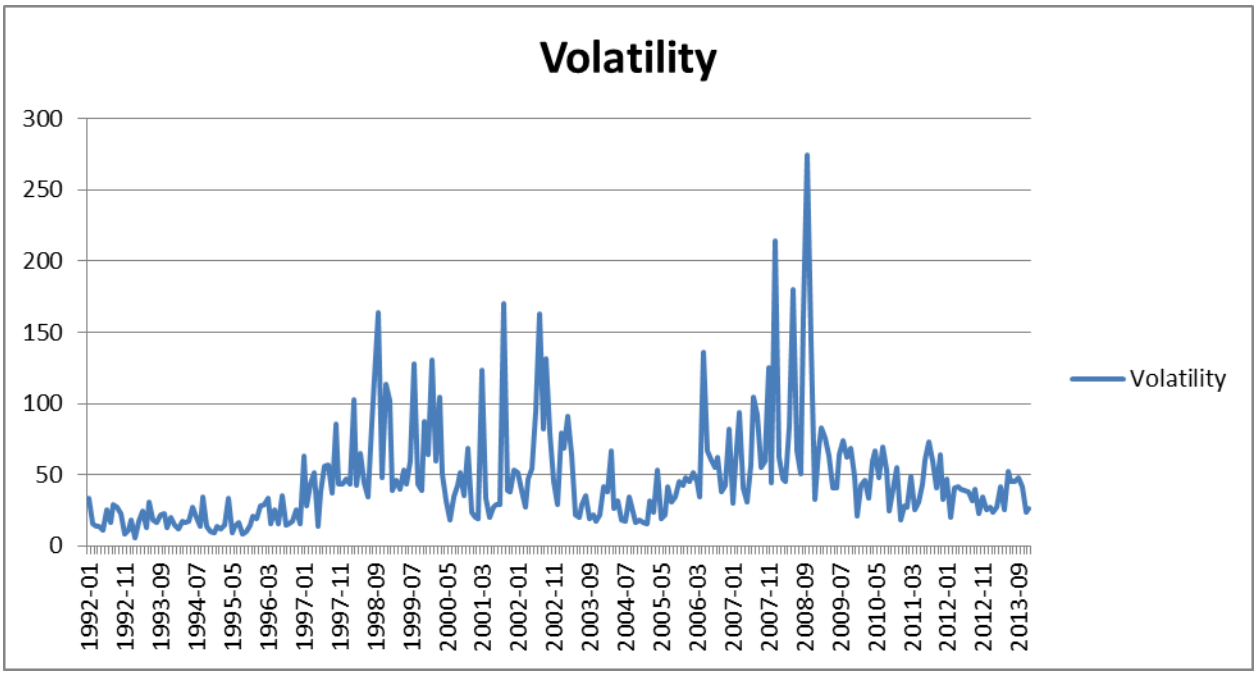
CHAPTER FIVE

DATA ANALYSIS

5.1 Linear Regression Outcomes

This chapter includes different ordinary least squares regressions with a time series structure. All regressions were run in Gretl. Regressions were run for each set of models. Heteroskedasticity was found in chapter 4 and all regressions were run with robust standard errors to account for that. To see the effect of the macroeconomic indicators on volatility it is necessary to test the statistical significance of those macroeconomic indicators. In this chapter, I tested the statistical significance of all independent variables in all sets of models to see whether the null hypothesis should be accepted or rejected. The null hypothesis 'there is no difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the introduction of the Euro, between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002, and after the introduction of Euro bills and coins in 2002' was tested. Along with this, I tested the second null hypothesis 'there is no difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the financial crisis and during the financial crisis. Graph 4 shows monthly Bel20 volatility over time from January 1992 until December 2013.

Graph 4



5.2 Three period sample

As discussed in Chapter 3, this set of models includes 3 time periods: January 1992 until December 1998, January 1999 until December 2001, and January 2002 until November 2007. Table 5 is the model for January 1992 until December 1998. It shows no statistical significance for the variables consumer confidence, percentage of industrial growth, and real GDP growth at the 95% confidence level or at the 90% confidence level. The p-values of the model are too high. It does show statistical significance for the variable inflation at the 95% and 90% confidence level because the p-value for the variable is under 0.05. If inflation increases by one percent, Bel20 volatility decreases by 18.7701.

Table 5

```
Model 1: OLS, using observations 1992:01-1998:12 (T = 84)
Dependent variable: Bel20vol
HAC standard errors, bandwidth 3 (Bartlett kernel)

                     coefficient  std. error  t-ratio  p-value
  ------------------------------------------------------------
  const                74.5719     16.6513      4.478   2.50e-05 ***
  inflation           -18.7701      7.48655    -2.507   0.0142   **
  Consumer_confide~     0.579919    0.359798    1.612   0.1110
  perc_change_ind_~    -0.571860    0.426717   -1.340   0.1840
  real_GDP_growth      -1.11178     2.67508    -0.4156  0.6788

Mean dependent var   30.68514   S.D. dependent var   27.29307
Sum squared resid    41069.93   S.E. of regression   22.80071
R-squared            0.335735   Adjusted R-squared   0.302102
F(4, 79)             4.083435   P-value(F)           0.004638
Log-likelihood      -379.2639   Akaike criterion     768.5277
Schwarz criterion    780.6818   Hannan-Quinn         773.4135
rho                  0.335819   Durbin-Watson        1.267771

Excluding the constant, p-value was highest for variable 5
(real_GDP_growth)
```

Table 6 is for the model from January 1999 until December 2001. This model shows no statistical significance for the variables inflation, consumer confidence, and real GDP growth at the 95% confidence level or at the 90% confidence level because the p-values of the model are too high. It does show statistical significance for the variable percentage change in industrial production at both confidence levels as the p-value for the variable is smaller than 0.05. If percentage change in industrial production increases by one percent, Bel20 volatility decreases by 4.68876.

Table 6

```
Model 1: OLS, using observations 1999:01-2001:12 (T = 36)
Dependent variable: Bel20vol
HAC standard errors, bandwidth 2 (Bartlett kernel)

                      coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------------
  const                94.4492      30.9077       3.056    0.0046  ***
  inflation           -17.3559      11.0405      -1.572    0.1261
  Consumer_confide~     0.466277     0.793344     0.5877   0.5610
  perc_change_ind_~    -4.68876      2.15662     -2.174    0.0375  **
  real_GDP_growth      -7.93184     16.0885      -0.4930   0.6255

Mean dependent var   55.47013   S.D. dependent var   36.63287
Sum squared resid    38866.39   S.E. of regression   35.40840
R-squared            0.172507   Adjusted R-squared   0.065734
F(4, 31)             2.766345   P-value(F)           0.044762
Log-likelihood      -176.8004   Akaike criterion     363.6008
Schwarz criterion    371.5184   Hannan-Quinn         366.3642
rho                 -0.037720   Durbin-Watson        2.048875

Excluding the constant, p-value was highest for variable 5
(real_GDP_growth)
```

Table 7 is for the time period January 2002 until November 2007. In this model, consumer confidence, percentage change of industrial growth, and real GDP growth do not show any statistical significance at the 95% and 90% confidence levels. However, inflation shows statistical significance at the 90% and 95% confidence level as the p-value is 0.0324. If inflation increases by one percent, Bel20 volatility decreases by 15.2048.

Table 7

```
Model 1: OLS, using observations 2002:01-2007:11 (T = 71)
Dependent variable: Bel20vol
HAC standard errors, bandwidth 3 (Bartlett kernel)

                    coefficient  std. error  t-ratio  p-value
  ------------------------------------------------------------
  const               87.8947     19.0820      4.606   1.93e-05 ***
  inflation          -15.2048      6.95609    -2.186   0.0324   **
  Consumer_confide~    0.655169    0.925997    0.7075  0.4817
  perc_change_ind_~   -0.340021    1.55020    -0.2193  0.8271
  real_GDP_growth     -8.67898    10.8411     -0.8006  0.4263

Mean dependent var   50.05117   S.D. dependent var   31.30699
Sum squared resid    61030.46   S.E. of regression   30.40895
R-squared            0.110459   Adjusted R-squared   0.056547
F(4, 66)             1.345465   P-value(F)           0.262502
Log-likelihood      -340.5986   Akaike criterion     691.1971
Schwarz criterion    702.5105   Hannan-Quinn         695.6961
rho                  0.308919   Durbin-Watson        1.245306

Excluding the constant, p-value was highest for variable 4
(perc_change_ind_prod)
```

The variables consumer confidence and real GDP growth are not statistically significant throughout. However, inflation is statistically significant at the 95% confidence level in two periods out of three: before the introduction of the Euro and after the introduction of Euro coins and bills. Percentage change in industrial production is also statistically significant at the 95% confidence level, but only in the period from 1999-2001, when the Euro had been introduced but there were no coins or bills in circulation. Because the statistical significance of the independent variables differs within the three periods, one can say that there is a difference between relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the introduction of the Euro, between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002, and after the introduction of Euro bills and coins in 2002. Because there is some statistical significance, the null hypothesis is rejected. However, the statistical

significance of the variable inflation is the same in the period before the introduction of the Euro, and after the introduction of Euro bills and coins. This leads us to accept the first alternative hypothesis that states that there is a difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the introduction of the Euro and between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002, but not after the introduction of Euro bills and coins in 2002.

5.3 Sample until 2007 with Euro Dummies

This model includes data for the period January 1992 until November 2007. The dependent variable is Bel20 volatility and the independent variables are inflation, consumer confidence, change in industrial production, GDP growth, and dummy variables for no Euro bills and coins but the Euro is introduced and Euro bills and coins. The data between January 1992 and December 1998 has a value of zero for all dummy variables. The data between January 1999 and December 2001 received a value of one for the first dummy variable and a value of zero for the second dummy variable. The data between January 2002 and November 2007 received a value of zero for the first dummy variable and a value of one for the second dummy variable. The results of the regression can be seen in Table 8. This model shows no statistical significance for the variable real GDP growth at the 95% confidence level or at the 90% confidence level. It does show statistical significance at the 95% confidence level for the variables inflation, and the two dummy variables. It also shows statistical significance for the consumer confidence

indicator and percentage change in industrial production at the 90% confidence level. At the 90% confidence level, investors are still able to draw conclusions and make decisions. The interpretation of the statistically significant variables is the following: if inflation increases by one percent, Bel20 volatility decreases by 17.3006. If consumer confidence increases by one, Bel20 volatility increases by 0.53448. If percentage change in industrial production increases by one percent, Bel20 volatility decreases by 1.26139. For the period when there were no coins or bills but the Euro was introduced already, volatility increases by 18.2071. For the period after coins and bills were introduced, volatility increases by 16.3570.

Table 8

Model 1: OLS, using observations 1992:01-2007:11 (T = 191)
Dependent variable: Bel20vol
HAC standard errors, bandwidth 4 (Bartlett kernel)

	coefficient	std. error	t-ratio	p-value	
const	72.4962	12.1715	5.956	1.28e-08	***
inflation	-17.3006	4.08102	-4.239	3.54e-05	***
Consumer_confide~	0.534448	0.293482	1.821	0.0702	*
perc_change_ind_~	-1.26139	0.715942	-1.762	0.0798	*
real_GDP_growth	-3.73214	3.26872	-1.142	0.2550	
No_coins_and_bil~	18.2071	8.30107	2.193	0.0295	**
coins_and_bills	16.3570	6.69617	2.443	0.0155	**

Mean dependent var	42.55554	S.D. dependent var	32.38217
Sum squared resid	144796.7	S.E. of regression	28.05243
R-squared	0.273236	Adjusted R-squared	0.249538
F(6, 184)	11.37083	P-value(F)	8.49e-11
Log-likelihood	-904.2599	Akaike criterion	1822.520
Schwarz criterion	1845.286	Hannan-Quinn	1831.741
rho	0.222948	Durbin-Watson	1.497716

Excluding the constant, p-value was highest for variable 5
(real_GDP_growth)

For this model, there is a difference between relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production,

and GDP growth and Bel20 volatility before the introduction of the Euro, between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002, and after the introduction of Euro bills and coins in 2002 that is statistically significant. The null hypothesis is rejected. The two Euro dummy variables show statistical significance and therefore, we accept the third alternative hypothesis which states that 'There is a difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the introduction of the Euro, between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002, and after the introduction of Euro bills and coins in 2002.'

5.4 Sample until 2013 with Euro Dummies and Financial Crisis Dummies

These models include data for the period January 1992 until December 2013. The independent variables are inflation, consumer confidence, change in industrial production, GDP growth, and dummy variables for no Euro bills and coins but the Euro is introduced, Euro bills and coins, and the financial crisis of December 2007 until June 2009.
The first model does not include the dummy variable for the financial crisis, while the second model will include this variable. For the first model the data between January 1992 and December 1998 has a value of zero for all both Euro dummy variables. The data between January 1999 and December 2001 received a value of one for the first Euro dummy variable and a value of zero for the second Euro dummy variable. The data between January 2002 and December 2013 received a value of zero for the first Euro

dummy variable and a value of one for the second Euro dummy variable. The results are shown in Table 9.

For the second model, the data from January 1992 until December 1998 has a value of zero for all three variables. The data between January 1999 and December 2001 received a value of one for the first dummy variable regarding the Euro and a value of zero for the second dummy variable regarding the Euro. It received a value of zero for the financial crisis dummy. The data between January 2002 and November 2007 and the data between July 2009 and December 2013 received a value of zero for the first dummy variable for no Euro bills and coins, a value of one for the second dummy variable of Euro bills and coins, and a value of zero for the financial crisis dummy variable. The data for the period between December 2007 and June 2009 has a value of zero for the dummy variable no euro bills and coins and a value of one for the other dummy variables for euro bills and coins and for the financial crisis. The results can be seen in Table 10.

For both model 1 and model 2 the consumer confidence indicator and the dummy variable for Euro coins and bills show a statistical significance at the 95% or 90% confidence level. Model 1 shows statistical significance at the 90% confidence level for the variable percentage change in industrial production. Due to the statistical significance of the dummy variable for the time period when coins and bills were in circulation in both models, we reject the null hypothesis: there is no difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the introduction of the Euro, between the introduction of the Euro in 1999 and before the introduction of Euro

bills and coins in 2002, and after the introduction of Euro bills and coins in 2002. Because the dummy variable for the period in which the Euro was introduced, but no coins or bills were in circulation does not show any statistical significance in either models, we accept the second alternative hypothesis. It states that there is a difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the introduction of the Euro and after the introduction of Euro bills and coins in 2002, but not between the introduction of the Euro in 1999 and before the introduction of Euro bills and coins in 2002.

The financial crisis dummy variable in model 2 has statistical significance at the 95% confidence level. This leads us to reject our second null hypothesis which states: 'There is no difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the financial crisis and during the financial crisis'. The alternative hypothesis is accepted: there is a difference in the relationship between the macroeconomic variables inflation, consumer confidence, change in industrial production, and GDP growth and Bel20 volatility before the financial crisis and during the financial crisis.

The interpretation of the statistically significant variables in Table 9 is the following: if consumer confidence increases by one, Bel20 volatility increases by 0.704079. If percentage change in industrial production increases by one percent, Bel20

volatility decreases by 1.15657. For the period after which Euro coins and bills were introduced, volatility increases by 19.1826.

The interpretation of the statistically significant variables in Table 10 is the following: if consumer confidence increases by one, Bel20 volatility increases by 0.910668. For the period after which Euro coins and bills were introduced, volatility increases by 12.6676. For the period of the financial crisis, volatility increases by 53.1422.

Table 9

Model 1: OLS, using observations 1992:01-2013:12 (T = 264)
Dependent variable: Volatility
HAC standard errors, bandwidth 4 (Bartlett kernel)

	coefficient	std. error	t-ratio	p-value	
const	44.7471	13.1184	3.411	0.0008	***
inflation	-0.817709	4.09780	-0.1995	0.8420	
Consumer_confide~	0.704079	0.352303	1.999	0.0467	**
perc_change_ind_~	-1.15657	0.657443	-1.759	0.0797	*
real_GDP_growth	-9.24808	6.66553	-1.387	0.1665	
No_coins_and_bil~	14.7803	10.2298	1.445	0.1497	
coins_and_bills	19.1826	6.53402	2.936	0.0036	***

Mean dependent var	46.14166	S.D. dependent var	36.01625
Sum squared resid	298507.4	S.E. of regression	34.08089
R-squared	0.125011	Adjusted R-squared	0.104584
F(6, 257)	5.370923	P-value(F)	0.000030
Log-likelihood	-1302.639	Akaike criterion	2619.278
Schwarz criterion	2644.310	Hannan-Quinn	2629.337
rho	0.375333	Durbin-Watson	1.248088

Excluding the constant, p-value was highest for variable 3 (inflation)

Table 10

```
Model 2: OLS, using observations 1992:01-2013:12 (T = 264)
Dependent variable: Volatility
HAC standard errors, bandwidth 4 (Bartlett kernel)

                     coefficient  std. error  t-ratio  p-value
  ------------------------------------------------------------
  const                49.5784     10.9962      4.509   9.94e-06 ***
  inflation            -3.46592     2.96736    -1.168   0.2439
  Consumer_confide~     0.910668    0.325316    2.799   0.0055   ***
  perc_change_ind_~    -0.903830    0.628803   -1.437   0.1518
  real_GDP_growth      -3.48442     4.32440    -0.8058  0.4211
  No_coins_and_bil~    10.7094      9.47369     1.130   0.2594
  coins_and_bills      12.6676      5.74134     2.206   0.0282   **
  financial_crisis     53.1422     14.7319      3.607   0.0004   ***

Mean dependent var   46.14166   S.D. dependent var   36.01625
Sum squared resid    260978.8   S.E. of regression   31.92881
R-squared            0.235016   Adjusted R-squared   0.214098
F(7, 256)            7.663218   P-value(F)           2.10e-08
Log-likelihood      -1284.904   Akaike criterion     2585.808
Schwarz criterion    2614.416   Hannan-Quinn         2597.304
rho                  0.249322   Durbin-Watson        1.499825

Excluding the constant, p-value was highest for variable 6
(real_GDP_growth)
```

5.5 Comparing models

The models found in Tables 5-7 are exploratory. They do tell us that that the relationship between the variables did not change over the three periods. Throughout the models, the constant is positive. The variables inflation, percentage change in industrial production, and real GDP growth have an inverse relationship with Bel20 volatility: if the variables increase, volatility decreases and vice versa. In all three models consumer confidence is positively correlated with Bel20 volatility: if consumer confidence increases, volatility increases and vice versa.

Comparing Table 8 and Table 9, it can be seen that including the data in which the financial crisis took place changes the coefficients of the variables and the variables' statistical significance significantly. This indicates that it is important to create a financial crisis dummy variable so that the effect of the financial crisis is taken out of other

variables. I chose to include the data between 2007 and 2013 to maximize the amount of observations. This indicates that the model in Table 10 is the most accurate and comprehensive model for this study.

I created a model which has a dummy variable for the entire period the Euro has been used rather than splitting the period into a two sub-periods (pre and post coins and bills). This was in order to see if splitting up periods made a difference or if the effect of the introduction of the Euro is no different between the pre and post coins and bills periods. The results can be seen in Table 11 below. Comparing table 10 and Table 11, it can be seen that splitting up the Euro period does make a difference. As seen from Table 11, the Euro dummy variable is not statistically significant and has a negative correlation with Bel20 volatility. When we split up the Euro period as seen in Table 10, the period for no coins and bills is not statistically significant and has a positive relationship with volatility. The period with coins and bills also has a positive relationship with volatility and is statistically significant at the 95% level. Due to the differences between Table 10 and Table 11, I chose the model in Table 10 as the most accurate and comprehensive one.

Table 11

Model 2: OLS, using observations 1992:01-2013:12 (T = 264)
Dependent variable: Bel20vol
HAC standard errors, bandwidth 4 (Bartlett kernel)

	coefficient	std. error	t-ratio	p-value	
const	1.84374	1.13495	1.625	0.1055	
inflation	-0.835728	0.339974	-2.458	0.0146	**
Consumer_confide~	-0.0581651	0.0352799	-1.649	0.1004	
perc_change_ind_~	0.172987	0.113732	1.521	0.1295	
real_GDP_growth	1.28785	0.587599	2.192	0.0293	**
Euro	-0.946597	0.673918	-1.405	0.1613	

Mean dependent var	0.476996	S.D. dependent var	4.853120
Sum squared resid	5538.130	S.E. of regression	4.633100
R-squared	0.105943	Adjusted R-squared	0.088616
F(5, 258)	4.108757	P-value(F)	0.001316
Log-likelihood	-776.3369	Akaike criterion	1564.674
Schwarz criterion	1586.129	Hannan-Quinn	1573.295
rho	0.116223	Durbin-Watson	1.760414

Excluding the constant, p-value was highest for variable 9 (Euro)

CHAPTER SIX

DISCUSSION, CONCLUSION, AND RECCOMENDATIONS

6.1 Discussion

As discussed in Chapter 5, the model in Table 10 is the most comprehensive one and will be used for the discussion. This model is for the period from January 1992 until December 2013 and has 264 monthly data points. It includes the dependent variable Bel20 volatility, and the independent variables inflation, consumer confidence, industrial production, GDP growth, dummies for the Euro (both with and without coins and bills, and a dummy variable for the period of the financial crisis.

The coefficient for the constant is statistically significant at the 95% confidence level and has a value of 49.5784. Although not statistically significant at the 90% confidence level, inflation has a negative relationship with volatility. Consumer confidence on the other hand is statistically significant and has a positive relationship with volatility. However, there is a minimal effect as the coefficient only has a value of 0.91. If the consumer confidence indicator increases by one, volatility is predicted to increase by 0.91, which only accounts for a 1.84% change in volatility. Percentage change in industrial production and real GDP growth are both not statistically significant at the 95% or 90% confidence level. Both independent variables also have a negative relationship with volatility. The dummy variable for no coins and bills has a positive relationship with volatility, but is not statistically significant at the 90% and 95%

confidence levels. On the other hand, the dummy variable for coins and bills is statistically significant at both confidence levels. It has a positive relationship with volatility. The coefficient for this dummy variable is 12.6676. This means that for the period after 2002, when the Euro coins and bills were in circulation, volatility increased by 12.6676 or 25.55%. The financial crisis dummy variable indicates that for the period of the financial crisis, volatility increased by 53.1422, or 107.21%. The variable is statistically significant at the 90% and 95% confidence level.

Looking at the adjusted R-squared, this study explains 21.4098% of the Bel20 stock market volatility. This means that other factors explain the other 78.5902%. In order to make a model with a better goodness of fit, I would have to add more variables. This is something that can be done in future research.

6.2 Conclusion

My findings lead me to the reject the first null hypothesis and the acceptance of alternative hypothesis 2 that states that there is a difference between volatility before the introduction of the Euro (before 1999) and after the introduction of Euro coins and bills (after 2002). This answers the research question: there is an effect of the introduction of the Euro on stock price volatility in the Bel20. I also reject the second null hypothesis and accept the fourth alternative hypothesis that states that there is a difference of Bel20 volatility before and during the financial crisis.

The implication of this research is that money managers now know that volatility increased after the introduction of Euro bills and coins. If other countries join the EMU,

this might have the same consequences for those counties as they were for Belgium: stock price volatility can increase. Money managers can use this information when investing in the equity market.

To my knowledge no research similar to mine has been performed in the past. A study by Morana and Beltratti (2002) found that there was an initial burst of stock market volatility after the introduction of the Euro. However, my study cannot support this conclusion because the model shows no statistical significance for the dummy variable of the period between 1999 and 2002. Research by Bagella, Bechetti, and Hasan (2004) indicates that the introduction of the Euro would lower exchange rate volatility, higher heterogeneous quality of institutional rules, and lessen macroeconomic policies. Although this may be true, this does not seem to reflect in lower stock price volatility according to my findings. An article written by Baele (2005) finds that shock spillover intensity has increased over the years after the introduction of the Euro. Hardouvelis, Malliaropulos, and Priestley (2006) also found evidence of increases stock market integration. Gebka and Karoglou (2013) came to the same conclusion: financial integration strengthened when awaiting the Euro and even more when the Euro was introduced. It also became larger after the financial crisis. The three studies mentioned above could explain higher stock price volatility because the Bel20 will reflect more what happens in other countries and stock markets than it did before.

6.3 Limitations of the Study and Recommendations

One of the limitations of the study is that more independent variables could have been included. However, due to the availability of data I had to limit my independent variables. Adding more variables could lead to a better fit of the model and would explain more about stock market volatility. Also, increasing the number of data points and studying a more extended period of time could add to my research. On top of that, it could be good to use a different method to get a better understanding of the results. For future research, GARCH models such as in studies by Bollerslev, Engle, and Wooldridge (1998) and Engle and Rangle (2008) and Markov switching models as used by Morana and Beltratti (2002) can be used. It is recommended to perform other research on different countries within the EMU and to compare them. It would be interesting to see whether the results are country specific or not.

6.4 Final Comments

This study finds that the introduction of the Euro had an impact on Bel20 volatility after Euro coins and bills were introduced. The purpose of the study was to introduce the subject and to gain more knowledge about the macroeconomic variables that influence stock price volatility. After the introduction of the subject through this research, much more about these implications and about the effect on other countries can be studied to gain more knowledge and to provide information to policy makers and money managers.

REFERENCES

Baele, L. (2005). Volatility Spillover Effects in European Equity Markets. *Journal of Financial and Quantitative Analysis*, 40(02), 373-401.

Baele, L., Bekaert, G., & Inghelbrecht, K. (2010). The Determinants of Stock and Bond Return Comovements. *Review of Financial Studies, Society for Financial Studies*, 23(6), 2374-2428.

Bagella, M., Bechetti, L., & Hasan, I. (2004). The Anticipated and Concurring Effects of the EMU: Exchange Rate Volatility, Institutions and Growth. *Journal of International Money and Finance*, 23(2004), 1053-1080.

Binder, J., & Merges, M. (2001). Stock Market Volatility and Economic Factors. *Review of Quantitative Finance and Accounting*, 26(5), 5-26.

Bollerslev, T., Engle, R. & Wooldridge, J. (1988). A Capital Asset Pricing Model With Time-Varying Covariances. *Journal of Political Economy*, 96(1), 116–131.

Chou, R. Y., Wu, C., & Yang, Y. (2012). The Euro's Impacts On the Smooth Transition Dynamics of Stock Market Volatilities. *Quantitative Finance, 12*(2), 169-179.

Cohen, K., Ness, W., Okuda, H., Schwartz, R., & Whitcomb, D. (1796). The Determinants of Common Returns Volatility: An International Comparison. *The Journal of Finance*, 31(2), 733-740.

Davis, N., & Kutan, A. (2003). Inflation and Output As Predictors of Stock Returns and Volatility: International Evidence. *Applied Financial Economics, 13*(9), 693-700.

Durré, A., Nardelli, S. (2007). Volatility In The Euro Area Money Market: Effects From the Monetary Policy Operational Framework. *International Journal of Finance and Economics*, 13(2008), 307-322.

EconStats. (2015). *BEL-20 (BFX) Index* [Data file]. Retrieved from http://www.econstats.com/eqty/eqem_eu_6.htm

Engle, R., Ghysels, E., & Sohn, B. (2013). Stock Market Volatility and Macroeconomic Fundamentals. *The Review of Economics and Statistics, 95(3), 776-797*.

Engle, R., & Rangel, J., (2008). The Spline-GARCH Model for Low-Frequency Volatility and Its Global Macroeconomic Causes. *Review of Financial Studies,* 21 (2008), 1187–1222.

Errunza, V., & Hogan, K. (1998). Macroeconomic Determinants of European Stock Market Volatility. *European Financial Management*, *4*(3), 361-377.

Gebka, B., & Karoglou, M. (2013). Have the GIPSI Settled Down? Breaks and Multivariate Stochastic Volatility Models For, and Not Against, the European Financial Integration. *Journal of Banking and Finance*, 37 (2013), 3639-3653.

Giovannini, M., Grasso, M., Lanza, A, & Manera, M. (2006). Conditional Correlations In the Returns On Oil Companies Stock Prices and Their Determinants. *Empirica*, 2006, 193-207.

Grossmann, A., Giudici, E., & Simpson, M. (2014). Euro Conversions and Return Dynamics of European Financial Markets: a Frequency Domain Approach. *The Journal of Economics and Finance*, 2014(38), 1-26.

Hardouvelis, G., Malliaropulos, D., & Priestley, R. (2006). EMU and European Stock Market Integration. *Journal of Business*, 79(1), 365–392.

Harvey, C. (1994). Portfolio Enhancement Using Emerging Markets and Conditioning Information. *Portfolio Investment in Developing Countries*, 1994, 1-24.

Helisek, M. (2011). Impacts of Financial Crisis on the Euro Introduction in the Czech Republic. *Acta VSFS*, 5(3), 220-240.

Kurtz, M., Jin, H., & Motolese, M. (2005). Determinants of Stock Market Volatility and Risk Premia. *Annals of Finance*, 2005 (1), 109-147

Liljeblom, E., & Stenius, M. (1997). Macroeconomic Volatility and Stock Market Volatility: Empirical Evidence on Finnish Data. *Applied Financial Economics*, 1997(7), 419-426.

Lucarelli, C., Mazolli, C., & Palomba, G. (2008). A Cross-Country Model for the Influence of the Pre-Trade Transparency on Market Liquidity and Price Volatility. *Institutional Investor*, 3(3), 60-75.

Moorhead, S., & Brooks, R. (2013). The Effect of the Introduction of the Euro on Assymetric Stock Market Returns Volatility Across the Euro-Zone. *Accounting & Management Information Systems*, *12*(2), 280-301.

Morana, C., & Beltratti, A. (2002). The Effects of the Introduction of the Euro on the Volatility of European Stock Markets. *Journal of Banking & Finance*, 2006(26), 2047-2064.

National Bureau of Economics Research. (2015). US Business Cycle Expansions and Contractions [Data file]. Retrieved from http://www.nber.org/cycles.html

NBB.Stat. (2015). Consumer Survey [Data file]. Retrieved from http://stat.nbb.be/

NBB.Stat. (2015). *Inflation and harmonised consumer price index (HICP)* [Data file]. Retrieved from http://stat.nbb.be/

OECD.Stat. (2015). Key Short-Term Economic Indicators: Industrial Production [Data file]. Retrieved from http://stats.oecd.org/

OECD.Stat. (2015). Quarterly National Accounts : Quarterly Growth Rates of real GDP, change over previous quarter [Data file]. Retrieved from http://stats.oecd.org/

Schwert, G. (1989). Why Does Stock Market Volatility Change Over Time?. *The Journal of Finance*, 44(5), 1115–1153.

Solnik, B. (1993). The Performance of International Asset Allocation Strategies Using Conditional Information. *Journal of Empirical Finance*, 1993(1), 33–55.

Tennant, F., & Tracey, M. (2014). Financial Intermediation and Stock Market Volatility in a Small Bank-Denominated Economy. *The Journal of Developing Areas*, 48(4), 73-95.