

Louvain School of Management

Did financial stability improve in the Euro area after Basel III was implemented and will it further improve under Basel IV?

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List of Abbreviations

BCBS	Basel Committee on Banking Supervision
IRB	Internal rating-based
AMA	Advanced Measurement Approaches
CRA	Community Reinvestment Act
MBS	Mortgage-backed securities
ECB	European Central Bank
OMT	Outright Monetary Transaction
FSB	Financial Stability Board
BIS	Bank for International Settlements
CET1	Common Equity Tier 1
AT1	Additional Tier 1
RWA	Risk-weighted assets
CAR	Capital Adequacy Ratio
SIFI	Systemically important financial institution
CVA	Credit valuation adjustment
VaR	Value-at-Risk
ROE	Return on equity
BBVA	Banco Bilbao Vizcaya Argentaria

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Introduction

Over the last thirty years, the topic of international banking regulation and supervision gained interest among scholars and importance in the eyes of regulators. Indeed, the number of systemic banking crises has risen and since 1970 more than 150 occurred around the globe (Laeven & Valencia, 2018). This deeply impacts the real economy and the well-being of societies as a whole. Moreover, due to the internationalisation and interconnectedness of the banking sector, cross-border spillovers often happen which makes crises even more frequent and puts all countries at risk.

Those crises highlighted the importance of financial stability and the fact that it is a public good which necessitates global efforts. As a result, the Basel Committee on Banking Supervision (BCBS) was created after a series of banking crises in 1974 with the goal of enhancing the stability of the banking sector. It issued a set of frameworks, starting back in 1988 with Basel I, to raise the resilience of banks by increasing their capital. Basel II was published a couple of years later to overcome the shortcomings of the former accord.

Nevertheless, the global financial crisis in 2008 proved that the Basel Committee's regulations were not enough to prevent such crises. Stakeholders lost faith in banks which worsened the situation.

In response, the Committee shifted to a macroprudential approach and included, among others, liquidity requirements in Basel III. The last reforms of Basel III, known as Basel IV in the banking sector, are not yet implemented but focus on restricting banks' self-assessment of risks.

This paper aims at exploring the evolution of financial stability in the Euro area after the implementation of Basel III, and the expected evolution under Basel IV. This will be assessed by looking if the banking sector in those countries is more resilient and sounder than before. From a regulatory perspective, this subject can bring insights about the effectiveness of Basel III & IV and shows the issues they bring along. Regulators can then adjust the framework and

continue their work to improve the soundness of the banking sector. This thesis will be centred around the research question “Did financial stability improve in the Euro area after Basel III was implemented and will it further improve under Basel IV?”

In order to answer this question, we will start off by reviewing the existing literature. We will begin this part by defining what the Basel Committee is and why it was created. Then, we will shortly explain the Basel I & II frameworks and examine the evolution from one to the other. We will continue with the description of the major factors which caused the global financial crisis as well as the crisis it triggered in the Euro area. This will lead us to analyse what changed in the post-crisis reforms from a broader perspective. Then, we will assess the evolution of Basel III and IV and explain the major changes of those frameworks. After that, we will discuss the impacts Basel III & IV had and will have on banks and financial stability. Finally, we will conclude this literature review with a brief summary.

In the empirical part, we will first explain the methodology used in this paper to assess the stability of banks after the introduction of Basel III. Then, we will first explain the results per bank and secondly aggregate the results of all banks in order to examine the general tendency. We will continue with a discussion of the results and state the limits to this study. Finally, we will end this paper by drawing our general conclusion.

Part I: Literature review

1. The rise of international banking prudential regulation and supervision

1.1. The creation of the Basel Committee on Banking Supervision

The Basel Committee on Banking Supervision (BCBS) was set up in 1974 by the central bank Governors of the G10¹ after several disturbances in international currencies and banking markets occurred (Basel Committee on Banking Supervision, 2018). More precisely, it is the failure of the German bank Bankhaus Herstatt which is often linked to the creation of the Committee (Bank for International Settlements, 2001). As a result, they created the BCBS to increase financial stability by establishing guidelines for banking regulation worldwide (Goodhart, 2011). The Basel Committee serves as a forum where member countries cooperate regarding international banking supervisory matters. The recommendations made by the BCBS do not have any legal force, members can choose to implement them or not. The committee is only there to promote harmonization of standards for the regulation and supervision of banks on a global level (Basel Committee on Banking Supervision, 2018).

Its first international standards on banking regulation were published in 1975 and known as the Basel Concordat. However, its most famous publications are the Basel Accords (Basel Committee on Banking Supervision, 2018) known as Basel I, Basel II, Basel III and its reform referred to as Basel IV (Basel Committee on Banking Supervision, 2018).

1.2. Basel I

The first accord of Basel was released in 1988. Its main goals were to increase stability in the international banking system as well as to remove differences in national capital requirements in order to decrease competitive inequalities. This resulted in the implementation of a capital measurement system, known as the Basel Capital Accord (Basel Committee on Banking Supervision, n.d.), where central banks of the G10 had to apply a “common minimum capital standards to their banking industries” (Basel Committee on Banking Supervision, 1988, paragraph 1). Members agreed to set a minimum ratio of capital to risk-weighted assets of

¹ According to the website of the BIS, the Group of Ten is made of Belgium, the Netherlands, France, Germany, Italy, Switzerland, Sweden, the United Kingdom, Canada, the United States, and Japan.

8%, also called the Cook Ratio (Basel Committee on Banking Supervision, n.d.). This measure helped to reduce the credit risk, which is the main risk banks face (Basel Committee on Banking Supervision, 1988). The credit risk can be defined as the possibility of loss on a receivable due to the fact that the debtor does not honour its debt when due (Kharoubi & Thomas, 2016).

One of the critics of Basel I was its lack of coverage of risk sources (Shakdwipee & Mehta, 2017). Indeed, it was only focusing on credit risk. As a result, in 1996 the “Amendment to the Capital Accord to incorporate market risk” took effect. The aim was to “incorporate within the Accord a capital requirement for the market risks arising from banks' exposures to foreign exchange, traded debt securities, equities, commodities and options.” (Basel Committee on Banking Supervision, n.d., paragraph 12) Market risk can be defined as the risk of losses due to changes in market prices (Basel Committee on Banking Supervision, 2019c).

Furthermore, one of the major aspects of the Amendment was the fact that for the first time, the Basel regulatory framework allowed banks to use an internal model to measure their market risk capital requirements (Basel Committee on Banking Supervision, n.d.).

1.3. Basel II

Basel II was released in 2004 in order to overcome the shortcomings of Basel I. The revised framework was built around 3 pillars (Basel Committee on Banking Supervision, 2003).

The first one focused on the minimum capital requirements. What did not change since Basel I was the definition of the numerator of the capital ratio as well as the fact that the ratio could not be lower than 8%. However, the definition of the denominator, the risk-weighted asset, changed to include the operational risk. Indeed, the previous Accord only covered credit and market risk. The operational risk can be defined as “the risk of losses resulting from inadequate or failed internal processes, people and systems, or external events” (Basel Committee on Banking Supervision, 2003, p.8). It is considered as a threat for banks and therefore, the latter should hold capital to protect itself from it (Basel Committee on Banking Supervision, 2003).

A major innovation of Basel II is that it was possible to measure credit and operational risk in a different manner, as a one-size-fits-all approach was not suitable nor desirable. Regarding credit risk, the first one is the standardized approach. It is quite similar to the previous Accord where credit assessments were made by external rating agencies. Then, the second one is the internal ratings-based (IRB) approaches, which contains a foundation and an advanced version (Appendix 1). They differ from the standardized approach as the capital calculation is based on banks' internal assessments of their risks. (Basel Committee on Banking Supervision, 2003)

Concerning the operational risk, two simple approaches are the basic indicator and the standardized approach. They are used for banks with less operational risk exposure. The basic indicator established the capital requirement by multiplying a bank's average gross profit by 0.15. For the standardized approach, it is quite similar than with the basic indicator, however, the calculation should be made for each business lines rather than for the whole institution directly. Finally, the Advanced Measurement Approaches (AMA), allowed banks to use their own methods to calculate their operational risk exposure under certain conditions. The Committee acknowledged that operational risk is difficult to calculate with precision and therefore aims at providing incentives for banks to improve their self-assessment techniques in order to hold enough capital buffers for this risk. (Basel Committee on Banking Supervision, 2003)

Another aspect that is treated in pillar one is securitization. Indeed, the previous Accord made capital arbitrage possible since securitization enables the transfer of ownership and risk associated with the credit to third parties. Therefore, banks were not holding enough capital compared to their own risk exposures. As a result, the new Accord created various approaches and criteria to determine the appropriate level of capital buffers banks should keep depending on their level of risk exposures. (Basel Committee on Banking Supervision, 2003)

The second pillar concentrated on supervisory review of the capital adequacy positions of institutions relative to their risks, as well as assessing their internal processes. Those measures are considered necessary to achieve effective banking supervision. Another update of the second pillar is related to stress testing. Banks using IRB approaches should execute a stress

test to determine if they have enough capital buffer in case of stress scenarios. (Basel Committee on Banking Supervision, 2003)

Finally, the third pillar is based on the effective use of disclosure to enhance market discipline and the use of proper and robust banking practices. Indeed, as banks have more and more incentives to estimate their own risk exposures with their own internal assessments, the Committee has decided to enable market participants to evaluate a bank's risk profile by making some information available. Thus, it was in the best interest of banks to use safe and reliable practices. (Basel Committee on Banking Supervision, 2003)

Although this new Accord was more developed than the previous one, the Subprime crisis showed us its limits and flaws. Indeed, Basel II was not taking into account the liquidity risk and focused on a micro-prudential perspective. Therefore, the risk of systematically important financial institutions was ignored and led to massive bankrupts during the crisis. Another critic made for Basel II was its inability to manage and control financial innovation. For example, the Committee did not see the potential danger of securitization for the economy, consequently, it did not try to prevent its risks (Rochet, 2008). Furthermore, one of the major critics of Basel II is its procyclicality. This means that when entering into a recession (expansion) the capital requirement will tend to increase (decrease), therefore banks will reduce (increase) lending, thus amplifying the recession (expansion) (Gordy & Howells, 2006).

2. The crisis leading to reforms of the Basel Accords

2.1. The subprime crisis

The subprime crisis, which erupted in 2007, was one of the worst crises since the Great Depression in the 1930s. It resulted in the sharpest and biggest drop in the global economic activity of the modern era and drove most developed economies into a deep recession (McKibbin & Stoeckel, 2010). Its causes are numerous and complex but the attribution of credit to borrowers with a high risk of default played a major role (Bianco, 2008). In this part, we will attempt to summarize and explain the major factors which caused the subprime crisis.

One cause of the subprime crisis was the low-interest rates in the US in order to stimulate the economy after the dot-com crisis in 2000 (Bianco, 2008). To recover from the latter crisis, the Federal Reserve Board decreased interest rates from 6.5% in 2000 to 1% in 2003 (Appendix 2). The federal funds' rates affect the 10-year Treasury bond yields which, most of the times, are set in relation with mortgage rates. Therefore, this decrease in funds rate led to a decrease in the 10-year Treasury bond yields (Appendix 3) and mortgage rates. This enabled many Americans to invest in the real estate, even the population with lower income who probably could not have done it with higher interest rates (Bianco, 2008).

Another cause of the subprime crisis is the fact that since the real estate collapsed in the late 1980s in the US, the goal was to increase homeownership in order to counter the crisis (Whalen, 2008). To this end, the Community Reinvestment Act (CRA), a federal law enacted in 1977, was used to meet the credit needs of low-income families. (Board of Governors of the Federal Reserve System, n.d.) Josh Rosner, a principal of Graham Fisher & Co., noted that the strategy to reach that goal was "to increase creative financing methods for mortgage origination" (Whalen, 2008, p.222). As a result, subprime mortgages were created. They allowed consumers with lower credit scores or little documentation of income to buy a property. This new type of mortgage allowed more people to have access to credit, which in turn increased demand and prices in the housing market. Although those subprime mortgages seem quite risky now, investors' appetite grew for them due to two main reasons. Firstly, they generated a high rate of return. Secondly, investors thought risks were readily transferred to others thanks to securitization. Securitization can be defined as the process of converting assets, receivables or financial instruments into a marketable security, by pooling them and then sell them as collateral for third-party investment (Bianco, 2008). In the case of the subprime crisis, it was mostly subprime mortgages that were being securitized into mortgage-backed securities (MBS). MBS are a type of tradeable assets that are backed by a mortgage or a pool of mortgages. They are then assigned an investment grade by credit rating agencies depending on their risk and sold to investors (Fabozzi, 2016).

However, and this is another factor which caused the crisis, credit rating agencies underestimated the risk of MBS for several reasons. Firstly, because MBS were composed of many different types of mortgages (subprime, adjustable-rate, Alt-A etc.) and therefore were

quite complex, which made it difficult to assess (Taylor, 2009). Then, a lack of competition and conflicts of interest prevented credit rating agencies to accurately evaluate the risk of MBS. Indeed, the agencies were paid by firms who sold MBS to investors, hence, it was for their best interest to give a good investment grade. Finally, the lack of information or incorrect information given by subprime borrowers misled agencies. As a result, investors trusted the overvalued rating of MBS given by credit rating agencies and this increased their appetite for this financial product (Bianco, 2008).

From the point of view of investors, the benefits of investing in MBS were that they had a high rate of return and generally relatively low risk thanks to the low correlation between mortgages, which increased diversification (Song & Gimple, 2019). Moreover, another factor which supposedly decreased risk was that the amount of the loan could never be higher than the price of the house itself. In that way, if borrowers could not reimburse, the bank could sell the house and get the entire amount of the loan back. Lastly, as house prices increased years after years, investors thought they had another security as even if borrowers were defaulting, the house would still be sold at a higher price than its initial price (Sanders, 2008).

Consequently, the securitized share of subprime mortgages increased significantly, from 54% in 2001 to 75% in 2006. Moreover, subprime mortgages represented \$600 billion in 2006, which was equivalent to one-fifth of the home loan market in the U.S. Due to the popularity of subprime loans with borrowers, lenders and investors, they were sometimes generated by automated underwriting. This meant that the decision to grant a mortgage was made within 30 seconds as opposed to a week for an underwriter, and therefore with minimal documentation. In 2007, 40% of subprime mortgages were made via automated underwriting, a shortcut which worsened significantly the level of risk of those types of mortgages. (Bianco, 2008)

The result of low interest rates and accessible subprime mortgages was a significant increase in homeownership, from 63% in the early 1990s to 69% in 2005. However, this also led to a housing bubble, with house prices starting to increase by 1995 (Whalen, 2008). Indeed, the increasing demand pushed house prices up, and between 1997 and 2006 home values increased by 124%. A housing bubble can be defined as “a rapid increases in the valuations of

real property until unsustainable levels are reached in relation to incomes and other indicators of affordability. Following the rapid increases are decreases in home prices and mortgage debt that is higher than the value of the property” (Bianco, 2008, p.3).

As a matter of fact, the housing bubble collapsed in 2005 with subprime mortgage borrowers defaulting and foreclosures rising drastically (Bianco, 2008). Indeed, the Federal Reserve Board raised interest rates from 1% to 5% between 2004 and 2006 (Appendix 2) as they were scared that a bubble housing was forming. However, they soon realized it was too late and stopped raising interest rates in order to limit the downturn of the housing market. In the meantime, as the supply of houses increased due to foreclosures, prices decreased, and the security put in place by banks was no longer sufficient. The value of houses had decreased below the value of the mortgage. As a result, banks, hedge funds, mortgage lenders and so forth suffered massive losses, causing stress on markets and the overall economy (Bianco, 2008).

Another important event of the subprime crisis is the Lehman Brothers bankruptcy in September 2008. This peculiar event sent a wave of fear across the global financial world. As a result, interbank borrowing contracted sharply as the risk premium rose by 5% (Appendix 4) in comparison to nearly zero in stable conditions (McKibbin & Stoeckel, 2010). Therefore, as international banks reduced their cross-border lending, they transmitted the shock across borders and the crisis became global. This illustrates the fragility of the financial market caused by its internationalization, complexity and interconnection (Haas & Horen, 2012).

The consequences of the crisis were huge and were felt all around the world. As the financial market was falling and panic increasing, businesses performance declined, unemployment increased as well as the sovereign debt of many countries. This led countries to enter into a profound recession (Basel Committee on Banking Supervision, 2019b). The crisis also had a significant social impact as millions of people fell or were at risk of falling below the poverty line (Otker-Robe & Podpiera, 2014), leading to an increase in migration flows as well (Basel Committee on Banking Supervision, 2019b).

2.2. The Euro crisis

After the subprime crisis, appeared almost seamlessly the Euro crisis (Haas & Horen, 2012). It has been the worst crisis for the monetary union since its introduction, as from early 2010 to late 2012 it was at the verge of a breakup. Eventually, the European Central Bank (ECB) managed to control it. However, a wave of Euro-scepticism has emerged (Wyplosz, 2014b). This crisis is the result of a mix of three sub crisis that we will explain and summarize hereafter (Shambaugh, 2012).

During the “Great Moderation” period which started in the mid-1980s until 2007, many advanced economies including members of the Eurozone have experienced relative macroeconomic stability (Hakkio, 2013). Indeed, inflation was low (around 2%) and there was steady growth. However, this period also marked the indebtedness of the public and the private sector (Appendix 5) (Wyplosz, 2014a). Moreover, with the creation of the Eurozone in 2000, it became easier for member states with a high deficit to borrow from other countries of the monetary union. The vulnerability of those countries was largely ignored hence divergences within the Euro area worsened (Praet, 2013).

When the economic environment started to deteriorate after the subprime crisis, all countries experienced a rise in their national debt (Wyplosz, 2014b). However, it is the countries which were the most vulnerable before the subprime crisis, with the highest public debt, that suffered the most during the sovereign debt crisis (Wyplosz, 2014a). For example, Spain, Portugal and Greece doubled their debt to GDP ratio (Appendix 6). These imbalances within the monetary union triggered contagion thus affecting the whole Euro area (Praet, 2013).

As a result of the rise in national debts, banks’ solvency was impacted partly due to the decline in value of governments’ bonds which deteriorated their capital. Additionally, as governments bonds’ value was decreasing, it caused liquidity problems since it is often used as a collateral in the interbank market. When banks faced too many problems, governments had to help and recapitalize them, thus increasing their national debt. This vicious circle led to a sovereign debt crisis, a banking crisis and a liquidity crisis (Praet, 2013). Consequently, growth slowed down and competitiveness decreased which worsened the economic situation of indebted

nations as Greece (Shambaugh, 2012). By 2012, the sovereign spread between countries of the monetary union had widened to a point that a break-up of the Euro area – the redenomination risk – was considered (Praet, 2013).

The Eurozone institutional setup was incomplete, it was missing a framework for crisis prevention as well as crisis management (Praet, 2013). As a result, the European Central Bank (ECB) took time to act, which led national debt to skyrocket in some countries (Wyplosz, 2014b). The ECB finally became active in 2012 when it introduced the Outright Monetary Transaction (OMT). It enabled the ECB, at last, to fulfil its role of a central bank by being the lender of last resort for banks and sovereigns in situations of market panic (De Grauwe, 2016).

The Eurozone crisis taught us that firstly, imbalances within the union was a risk that cannot be ignored, and that financial stability is a common good which requires all members to work for its preservation and share responsibility. Then, the crisis showed us that the union was lacking crisis prevention & management tools (Praet, 2013) and that the role of the ECB as lender of last resort is necessary. However, it also raised questions about the sustainability of the ECB in democracies, as the decision of being a lender of last resort is made upon the judgement of unelected officials of the ECB (De Grauwe, 2016). Finally, the crisis revealed the limits and flaws of the monetary union, and how financial contagion is the unintended effect of financial integration (Praet, 2013).

3. The post-crisis reforms

The 2008 crisis revealed the lack of effective prudential requirements, the limits of the tools used in order to maintain financial stability as well as the need to go beyond a micro-based approach (Galati, 2013). In addition, the global financial crisis showed the lack of effective supervision at a national level and the lack of coordination from international institutions (Moshirian, 2011). As a result, authorities around the globe reinforced their regulation and supervision and shifted to a macroprudential approach. This means that they evaluate the stability of the financial system as a whole, rather than just by looking at individual institutions (Bank for International Settlements, 2018). Macroprudential policy gained increased interest in the literature over the past decade, however, its definition and objectives are far from a consensus (Galati, 2013). The International Monetary Fund, Financial Stability Board (FSB) and

Bank for International Settlements (BIS) agreed to define macroprudential policy as “the use of primarily prudential tools to limit systemic risk” (IMF – FSB – BIS, 2016, p.4). In turn, systemic risk is defined as “a risk of disruption to financial services that is (i) caused by an impairment of all or parts of the financial system and (ii) has the potential to have serious negative consequences for the real economy”. (IMF – FSB – BIS, 2009, p.2)

Regarding the Basel Committee post-crisis actions, we can firstly cite the expansion of its membership. From the G10 at its creation, it has now expanded to 45 institutions and 28 jurisdictions (Basel Committee on Banking Supervision, 2019b). This strengthens the Committee’s ability to help implement reforms and facilitates global supervision (Basel Committee on Banking Supervision, 2009).

Secondly, the Committee published reforms named Basel III in order to overcome the shortcomings of the pre-crisis framework (Basel Committee on Banking Supervision, 2019b). We will describe and analyse the changes Basel III brought and the impact it had on financial stability hereafter.

3.1. Basel III

The financial crisis in 2008 brought to light many issues in the banking sector. Firstly, many banks had excessive on- and off-balance sheet leverage and inadequate liquidity buffers in order to face stress scenarios (Akkizidis & Kalyvas, 2018). Then, the crisis also made prudential authorities to adopt a macroprudential approach instead of a micro-prudential as in Basel I and II. Indeed, the supervision of individual institutions did not prevent systemic risk (Hennani, 2016).

As a result, Basel III was created after the G20 Leader’s Summit in Seoul in 2010 in order to improve the resilience of the banking sector (Akkizidis & Kalyvas, 2018). The goal of this new Accord is firstly to increase the banks’ ability to face financial and economic stress, and in fine prevent a spillover effect from the financial sector to the real economy. This constitutes a major innovation in the Basel Accords. Indeed, in Basel I and II measures were mostly taken under the assumption of economic stability. Stress periods were not taken into account in the

establishment of banks' reserves. The Committee also has other aims, but quite similar to the ones of Basel I and II, which are improving risk management and governance, as well as increasing banks' transparency and disclosures. Furthermore, the Committee also tries to reinforce the resolution of systematically important international banks (Basel Committee on Banking Supervision, 2011a).

This Accord stipulates many reforms on a micro-prudential and on a macroprudential level. Indeed, both are important as they are linked. Efficient risk management at the individual bank level decreases the risk of a global crisis. This Accord is based on the 3 pillars of Basel II and aims at strengthening them in order to have a more resilient regulatory capital framework (Basel Committee on Banking Supervision, 2011a). We will explain and summarize those reforms hereafter. Firstly, we will concentrate on measures related to capital, and then on aspects linked to liquidity.

The first pillar is, as in the former Basel Accords, focused on capital requirements. The Committee uses the Capital Adequacy Ratio (Cook Ratio in Basel I) in order to ensure banks have enough reserves of capital (Basel Committee on Banking Supervision, 2011a). However, what changed in Basel III is the will of the Committee to improve the quality and quantity of capital by setting a more detailed definition of its components (European Central Bank, 2010). The Capital Adequacy Ratio can be calculated as follow:

$$\text{Capital Adequacy Ratio} = (\text{Tier 1 Capital} + \text{Tier 2 Capital}) / \text{Risk Weighted Assets}$$

The numerator of this ratio is the capital, and it is composed of two different parts: Tier 1 Capital and Tier 2 Capital. Tier 1 is then subdivided into 2 parts. Firstly, the Common Equity Tier 1 (CET1) is composed of capital of the highest quality (Financial Stability Institute, n.d.) as common shares and retained earnings. The particularity of CET1 is the fact that losses are absorbed immediately when they occur. CET1 will have to represent at least 4.5% of risk-weighted assets (RWA), compared to 2% in Basel II (European Central Bank, 2010). On top of CET1, a conservation buffer of 2.5% must be established outside of stress periods. This will bring another safety margin and reinforce CET1. Then, the Additional Tier 1 (AT1) also has a capacity of absorbing losses on a going concern basis and is composed of instruments which

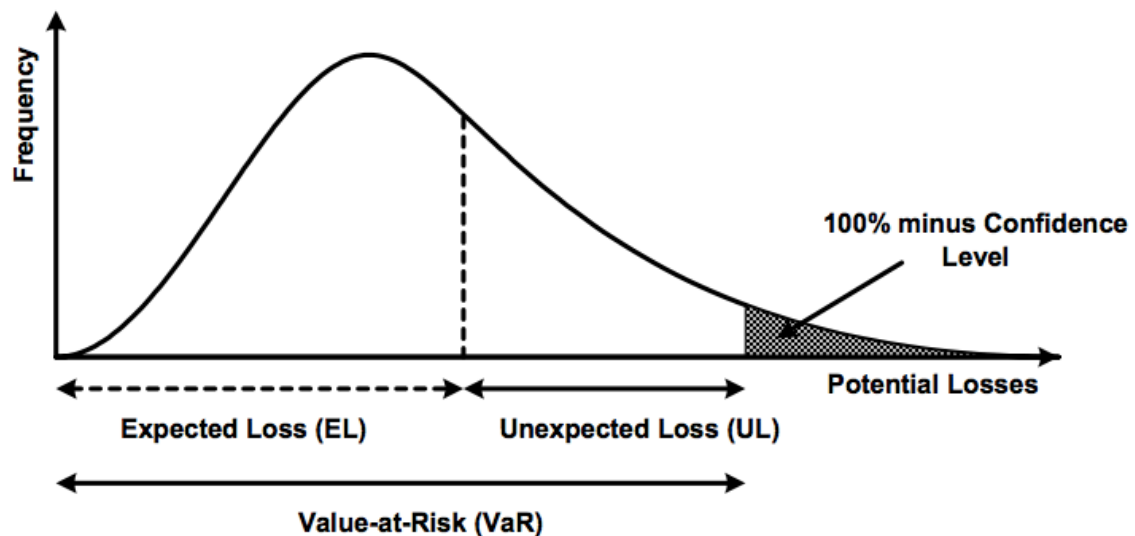
cannot be in CET1. However, certain rules apply in order to be eligible for AT1. For example, instruments need to be subordinated and cannot have a maturity date (Basel Committee on Banking Supervision, 2011a). AT1 must be at least 1.5% of RWA in Basel III, while in Basel II it was of 2% (European Central Bank, 2010). In total, we can see that Tier 1 Capital needs to represent at least 8.5% of RWA at all times in order to back banks' risk exposure with a high-quality capital base (Basel Committee on Banking Supervision, 2011a). Furthermore, Tier 2 Capital is composed of instruments that are subordinated, as well as having a maturity of at least 5 years. It must be at least 2% of RWA, compared to 4% in Basel II (Appendix 7). Finally, Tier 3 Capital has been abolished in Basel III. Throughout those reforms, we can see that the Committee wanted to make CET1 the most predominant form of capital compared to Basel II. Moreover, in Basel III the Capital Adequacy Ratio (CAR) needs to be at least 10.5% (European Central Bank, 2010).

Furthermore, the Committee has put in place a countercyclical buffer in order to reduce procyclicality, which was one of the main critics of Basel II. Indeed, in a period of excessive credit growth, an additional buffer up to 2.5% of CET1 (or other fully loss-absorbing capital) should be added. (European Central Bank, 2010)

The Committee established those new buffers in order for banks to be more resilient in stress periods. Indeed, those buffers are a safety margin and can be drawn down during periods of stress without harming the capital needed for a bank to be viable. As expressed by the Basel Committee on Banking Supervision "These measures will help ensure that the banking sector serves as a shock absorber, instead of a transmitter of risk to the financial system and broader economy" (Basel Committee on Banking Supervision, 2011a, p.5).

Particular measures have been taken regarding systemically important financial institutions (SIFIs) in order to be protected against their potential huge negative impact on the economy. Indeed, they have the capacity to transmit shocks due to their excessive interconnectedness with other systemically important banks. Therefore, the Committee decided that they should have a loss-absorbing capacity higher than for other smaller institutions (Basel Committee on Banking Supervision, 2011a).

The Committee also took measures to improve the risk-weighted capital framework after seeing the shortcomings of it during the global financial crisis (Basel Committee on Banking Supervision, 2017a). First of all, regarding securitization, the Committee took measure to reduce the reliance of banks towards credit rating agencies. Banks are required to make their own internal assessments of the risk exposure of their securitization (Basel Committee on Banking Supervision, 2011a). Secondly, in order to evaluate the risk of assets, different tools will be used depending on their type of risks. Concerning the counterparty credit risk, banks are required to establish their capital requirements using stressed inputs in order to have sufficient capital at all times, and also to avoid procyclicality. Then, in order to cover the risk of mark-to-market losses resulting from the deterioration of the creditworthiness of the counterparty, known as the credit valuation adjustment (CVA) risk, banks must have a capital charge. Indeed, while under Basel II only the counterparty default and credit migration risks were considered, the 2008 crisis taught us the importance of the CVA risk as it accounted for approximately two-thirds of losses, while only one-third were due to actual defaults (Basel Committee on Banking Supervision, 2011b). Finally, in order for banks to hold enough capital and make an accurate internal assessment of their risks, Basel III introduced a stressed value-at-risk (VaR) measurement (Basel Committee on Banking Supervision, 2011a). Value-at-risk is defined as “the potential loss in value of a static portfolio due to changes in market rates” (Dempster, 2002, p.17). In other words, thanks to the VaR calculation, it is possible to estimate the probability of losses, and therefore set enough capital. Figure 1 below shows the magnitude of potential losses and their frequency. As we can see, small losses (named Expected Loss on the graph) have a higher frequency than larger losses as in the hatched area. The capital will be set to ensure that unexpected losses are covered until the very low probability of losses at the far right. This hatched area is the confidence level. Moreover, the VaR is composed of the Expected Loss and Unexpected Loss, which means that it is the maximum losses that a bank can face with its capital (Basel Committee on Banking Supervision, 2005).



Note: This figure explains the concept of value-at-risk. The Y axis represents the frequency of losses and the X axis represents the potential losses. The hatched area is the confidence level and the VaR is the corresponding threshold.

Figure 1: An illustration of the Value-at-Risk

Source: Basel Committee on Banking Supervision, 2005

The VaR was already used in Basel II, however, what changed in Basel III is that inputs used are stressed on a continuous 12-month period (Basel Committee on Banking Supervision, 2011a). This means that banks can be better prepared for stress scenarios.

Another aspect treated in Pillar one is the leverage ratio (Basel Committee on Banking Supervision, 2011a). It is calculated by dividing the capital with the exposure measure. The capital is made of the Tier 1 capital, while the exposure measure is composed of the on-balance sheet exposures, off-balance sheet items, the exposure of derivatives and securities financing transaction. Banks must keep this ratio at 3% at all times (Basel Committee on Banking Supervision, 2020). The aim of this ratio is to limit the exposures of banks compared to their capital. Indeed, the 3% restriction was set up as a response to what happened during the global financial crisis in 2008. Banks had excessive on- and off-balance sheet leverage which led to asset prices decrease and worsened the crisis (Bertholon-Lampiris, 2015). To sum up, the leverage ratio serves as an extra layer of protection on top of the risk-based requirement. In addition, it restricts the excessive build-up of leverage to protect the financial system and the economy. All of this is achieved thanks to a simple and non-risk-based approach (Basel Committee on Banking Supervision, 2020).

The second pillar focuses on the risks that are not part of Pillar 1. For example, the risks related to a bank's strategic decision, business orientation, reputation or the level of its compliance. Banks must use an efficient framework in order to prove that they have enough capital to cover those risks (Bertholon-Lampiris, 2015). A new measure introduced with Basel III is related to corporate governance. Supervisors are now required to examine how banks' key decisions are taken and how banks are managed (Bodellini, 2019). Then, this pillar also focuses on supervision and testing the resilience of a bank's capital base thanks to stress testing. Moreover, banks are also required to perform backtesting. The latter is defined as "an ex-post comparison of the risk measures generated by the model against realized risk measures, as well as comparing hypothetical changes based on static positions with realized measures" (Basel Committee on Banking Supervision, 2011a, p.48).

Concerning Pillar 3, which focuses on promoting market discipline thanks to the use of disclosure, it also had to be reviewed in Basel III. Indeed, the crisis revealed the shortcomings of this Pillar as market participants were unable to assess properly banks' financial health. This worsened the situation and made it possible for the global financial crisis to build up. In response, the Basel Committee established basic principles in order for banks to improve the quality and transparency of their disclosures. First of all, the disclosures should be clear. This means that disclosures should be easily accessible and that complex issues are easy to spot and understand. Then, disclosures should be comprehensive and complete. All activities and significant risks must be explained with relevant data. Moreover, procedures used by banks to identify, measure and manage risks as well as the strategy used should be clearly expressed. Finally, disclosures should be consistent over time and should follow a certain format in order to allow comparison between different banks. (Basel Committee on Banking Supervision, 2014)

In addition to those three pillars, the Basel Committee introduced a global liquidity standard in Basel III. Indeed, the global financial crisis brought to light its importance. Even though some banks had enough capital during the crisis, they still experienced serious difficulties due to the fact that they were lacking liquidity. Moreover, the crisis showed us how quickly liquidity can evaporate and, at the same time, how illiquidity can last for long periods. As a result, the Basel Committee decided to establish "internationally harmonized global liquidity standards" (Basel

Committee on Banking Supervision, 2011a, p.8) in order to preserve the banking sector stability and promote an international level playing field. To this end, the Committee developed two ratios. The first one is the liquidity coverage ratio, which aims at ensuring banks have enough high-quality liquid assets to cover potential significant cash outflows during the next 30 days in case of stress scenarios. Then, the net stable funding ratio aims at promoting the resilience of banks on a longer-term. It creates incentives for banks to use more stable sources of funding for their activities over a one-year time horizon. (Basel Committee on Banking Supervision, 2011a)

Even though Basel III responded to many of the shortcomings of Basel II, some critics were made against the new accord. Firstly, implementing the new regulations could limit the availability of credit, especially for risky borrowers as small firms, and therefore reduce economic activity (Allen, Chan, Milne & Thomas, 2012). In addition, Basel III requires additional capital and liquidity in order to improve financial stability, however, this is costly and will deteriorate banks' profitability (Deloitte, 2013; King & Tarbet, 2011). Moreover, the Basel III framework has been criticised due to its complexity regarding the calculation of the capital requirements, which made banks' comparability difficult (Amorello, 2016). Finally, new regulations could affect smaller banks more than larger ones. Indeed, the latter can adapt to new regulations more easily and with fewer costs. This would reduce competition in the banking sector thus potentially increase the cost of credit, reduce economic activity and in fine reduce financial stability (Basel Committee on Banking Supervision, 2019a).

3.2. Basel IV

In December 2017 the Basel Committee published the final reforms of Basel III, better known as Basel IV in the financial industry due to the numerous changes it is going to bring (Godard & Harzi, 2018). It aims at enhancing the methodology for calculating certain risks in order to restore credibility and increase banks' comparability. Indeed, the Committee's analyses revealed a high degree of variability in the RWA leading to significant differences in the capital required for banks. As a result, this unable the level playing field, which is one of the main goals of the Basel Committee. Therefore, Basel IV is focused on enhancing the standardized approaches for the credit and operational risk, limiting the use of internal models and revising

the leverage ratio as well as the capital floor (Basel Committee on Banking Supervision, 2017a). We will present in more details the main reforms of Basel IV, however, not per pillar but per types of risks.

First of all, we will review the reforms made for the standardized and IRB approaches for credit risk. This risk constitutes a major part of banks' risk-taking activities (Basel Committee on Banking Supervision, 2017a). Thus, capital requirements should be calculated as precisely and accurately as possible.

Concerning the standardized approach, which is the most used approach worldwide, the Committee enhanced Basel IV by "improving its granularity and risk sensitivity. (...) reducing mechanistic reliance on credit ratings, (...) providing the foundation for a revised output floor to internally modelled capital requirements (...)" (Basel Committee on Banking Supervision, 2017a, p.2) Those reforms aim at restoring the level playing field by facilitating banks' comparability, reducing risks taken by banks by limiting their reliance on credit ratings (Basel Committee on Banking Supervision, 2017a) and by giving preference to the standardized approach instead of the IRB approach (Amorello, 2016).

Regarding the IRB approaches for credit risk, Basel IV aims at addressing the issue of banks under-estimating their risk weights thanks to the use of this approach in order to hold less capital (KPMG, 2018). Moreover, the new reform aims at responding to the shortcomings highlighted by the global financial crisis. These include the complexity of the IRB approaches which makes it more difficult to monitor, the lack of comparability between banks' capital requirements, and the lack of robustness in modelling various asset classes. Therefore, the new reform restricts what is accepted in this approach. For example, the use of advanced IRB approaches for certain classes of assets is forbidden. Then, the Committee also decided to set a floor for the inputs used to calculate the RWA in order to limit risk weights being driven down by banks' internal models (Basel Committee on Banking Supervision, 2017a).

The second risk framework that experienced many changes with the new reform is the one for operational risk. Indeed, the crisis showed again the limits of the previous framework as capital requirements were not enough to cover the operational risk losses for some banks.

Moreover, it highlighted the difficulty in calculating the capital requirements with internal models. Consequently, AMA has been prohibited as well as the three other standardized approaches in order to be replaced by a “single risk-sensitive standardized approach to be used by all banks” (Basel Committee on Banking Supervision, 2017a, p.8). The latter will be calculated based on a bank’s income and a bank’s historical losses. Indeed, this approach is based on two hypotheses. First, that operational risk increases with a bank’s income. Second, if a bank had historical losses related to operational risks, it is more likely that it will experience further losses linked to operational risk in the future than another bank. (Basel Committee on Banking Supervision, 2017a)

Then, the Committee decided to remove the internally modelled approach for the calculation of the credit valuation adjustment (CVA) risk due to its complexity. As a result, only two approaches, the standardized and the basic, are available. Moreover, the Committee tried to reinforce the risk sensitivity of this framework. (Basel Committee on Banking Supervision, 2017a)

Another aspect of Basel IV is the introduction of a leverage ratio buffer for global systemically important banks. It serves as an extra layer of protection to prevent from excess leverage. For those banks, the leverage ratio must equal 50% of banks’ risk-based capital buffer. Moreover, it should be composed of Tier 1 capital. In addition, the Committee decided to review the definition of the exposure measure in order to be consistent with the standardized approach of credit risk. (Basel Committee on Banking Supervision, 2017a)

Finally, the Committee enhanced the output floor of Basel II in order to make it more robust and risk-sensitive. The output floor is used to limit the benefits for banks to use internal models. In other words, the Basel Committee on Banking Supervision defines it as “a risk-based backstop that limits the extent to which banks can lower their capital requirements relative to the standardised approaches” (Basel Committee on Banking Supervision, 2017a, p.11). More precisely, when banks calculate their RWA with internal models, it cannot fall below 72.5% of the RWA calculated with the standardised approaches. This measure makes IRB approaches less attractive for banks and encourages them to use standardized approaches. In fine, the goal is to prevent banks from under-estimating their RWA in order to

hold less capital. Indeed, if banks do not hold enough capital, they could face serious issues in case of stress scenarios, which could put financial stability at stake (Basel Committee on Banking Supervision, 2017b).

In the banking industry, opinions diverge regarding Basel IV. On one hand, the simplification of the calculation of the RWA could provide some saving costs for certain banks. On the other hand, the limitation for internal models, the additional buffers and the input floor could deeply harm the viability of certain banks. Indeed, banks' profitability is already under pressure with today's regulatory environment and the high level of competition in the industry (Amorello, 2016). To conclude, even though Basel IV appears to be a threat to banks' profitability, it will make the banking system more resilient (Bodellini, 2019).

4. Impacts of Basel III & IV on European banks and financial stability

Looking back at the impact of Basel Accords on banks, we can note that since Basel III banks became significantly more resilient. Indeed, the Committee learned from the global financial crisis and implemented numerous measures in particular concerning the capital requirements and liquidity ratios (Roland Berger, 2017). As a result, banks had to reduce their balance sheets, adjust their business models, investment strategies, governance structure and increase their capital base (Amorello, 2016). In fact, the average CET1 capital ratio increased by 7% per year between 2009 and 2015 for 15 European and 8 US global systemically important banks, which equals an aggregated increase of CET1 of 80%. However, this increase in capital requirement also led to negative consequences. During the same period of time, the return on average equity decreased by 9% for the same previous European banks, while it increased by 10% for the previous American banks (Roland Berger, 2017).

This decrease in profitability for European banks is one of the main critics of Basel Accords and constitutes one of their main challenges. Indeed, with low economic growth, low-interest rates and high level of competition, banks' viability is at stake. If banks lose too much of their profitability, it could harm the economy by losing banks' capacity to finance it. According to the Committee, lending growth is already slower, while still expanding on average (Roland Berger, 2017). Moreover, a study made by Fidrmuc & Lind showed that "GDP is expected to

decrease by about -0.20% in response to 1.0 percentage point increase in the capital ratio” (Fidrmuc & Lind, 2020, p.32) Thus, the impact of financial regulation on the economy is moderate but negative. The challenge for the Basel Committee is therefore to find the right balance between stimulating economic development and improving financial stability (Roland Berger, 2017).

Those critics and fears about Basel III harming banks’ profitability further increased with the issuance of Basel IV. Indeed, its reforms concerning the RWA approach, the internal model approaches, the input floor and the buffers will contract banks’ profitability even more. As seen previously, European banks who were already facing trouble under Basel III, are likely to face significant capital shortfalls under Basel IV. It is estimated that the banking sector’s return on equity (ROE) will decrease by 0.6 percentage points. However, the consequences will vary depending on banks’ geography and business model. (Schneider, Schröck, Koch, & Schneider, 2017)

Concerning the input floor, it will represent one of the biggest constraints for banks using internal models as, on average, their RWA were 50% to 65% of what the standardised approach measured. It will, therefore, have a huge financial impact, as well as a strategic impact as banks will need to measure if internal models are still worth it, and if yes how can they optimise it in order to reach 72.5%. (Godard & Harzi, 2018)

Finally, the impact of Basel IV on European banks has been estimated and revealed that RWA are likely to increase by 13% to 22%. Therefore, the impact of the new framework on capital will be huge, but probably inferior to the impact Basel III had. However, this is not the case for the operational aspect, as banks will need to review the entire calculations. (Godard & Harzi, 2018)

To conclude, Basel Accords had mostly negative impacts for European banks as they kept decreasing their profitability over time which decreases their lending capacity. However, they also had a positive impact as they increased banks’ stability and resilience, which increases market participants’ confidence thus decreasing their cost of funding. Finally, as banks are better capitalised and have higher liquidity reserves, they are more robust vis-à-vis of shocks.

As a result, this increases financial stability and helps protect the real economy. (Fidrmuc & Lind, 2020)

5. Conclusion

The 2008 financial crisis brought to light the limits of Basel II. Regulators agreed that a substantial increase in capital and liquidity requirements was needed in order to improve the resilience of the banking sector. As a result, the BCBS published the Basel III framework in December 2010. Even if the latter is costly for European banks and can limit their lending capacity, those reforms were necessary in order to avoid or limit the intensity of systemic crises. Moreover, the reforms also had positive impacts on banks. Indeed, they increased banks' stability leading to increased markets' confidence which reduced banks' cost of funding. Other critics include the fact that tightening regulations greatly harms the economy. However, as mentioned previously a study made by Fidrmuc & Lind showed that an increase in the capital ratio only has a moderate, even if negative, effect on GDP level. In addition, not many legal tools proved to be as effective as capital in order to increase financial stability.

Basel IV was introduced in 2017 in order to increase banks' comparability and restore credibility. Indeed, the level playing field was not respected as a high degree of variability in the RWA was discovered amongst banks. As a result, this led to significant differences in the capital required for the latter. This was mostly due to the fact that certain banks were taking advantage of the use of internal models by under-estimating their risk-weights in order to hold less capital. This increased risks in the banking sector as banks were not properly capitalised compared to their risks. Regarding the critics of Basel IV, we can cite that a stronger decrease of European banks' profitability is expected. This will constitute a real challenge for banks as they are already in an environment where profit is low. Then, Basel IV is designed following a "one-size-fits-all" approach in order to prevent banks from under-estimating their risk-weights. However, as banks are different from one another this might benefit certain more than others.

To conclude, it seems that Basel III increased and Basel IV will further increase the resilience of the European banking sector, however, at a certain cost. This constitutes one of the biggest

challenges of the Basel Committee as profitability for banks is of paramount importance. Indeed, the Committee must find the right balance between economic development and financial stability.

Part II: Empirical study

Introduction

Understanding the impact Basel III & IV had and will have on financial stability is crucial in order to avoid future crisis and preserve the growth of the real economy. Therefore, this paper aims at investigating this matter by using the value-at-risk (VaR) and the violations of the latter. More precisely, we will calculate the VaR of 10 banks over a period of 5 years in order to see if the VaR increased after the introduction of Basel III. Then, we will calculate the violations of the VaR and examine if they decreased after Basel III.

We will first describe the data used in order to conduct our study and then we will explain our methodology. Furthermore, we will present our results and then discuss our findings.

6. Data and methods

6.1. Description of the data

To investigate how the financial stability in the Euro area evolved after the implementation of Basel III, we took data from daily quotations of stock from 10 of the biggest banks based in the Eurozone. Those data are retrieved from Yahoo Finance. The 10 banks chosen are: BNP Paribas SA (France), Crédit Agricole Group (France), Deutsche Bank AG (Germany), Banco Santander SA (Spain), Société Générale SA (France), ING Groep NV (The Netherlands), UniCredit SpA (Italy), Intesa Sanpaolo SpA (Italy), Banco Bilbao Vizcaya Argentaria SA (Spain) and KBC Group Bank NV (Belgium)(Business Insider, 2019). The decision to pick those banks has been made firstly because they are all based in countries that are members of the BCBS (Basel Committee on Banking Supervision, 2012), thus their commitments towards the implementation of the new reform are supposedly stronger (Kanetake & Nollkaemper, 2016). Indeed, a study made from March to August 2012 assessed the compliance of those countries towards the Basel III framework. Results indicated that for the first pillar countries were compliant or largely compliant for almost every criterion. Regarding the second and third pillars, countries were compliant. It is only the liquidity standards and the leverage ratio which

were not assessed yet (Basel Committee on Banking Supervision, 2012). Secondly, we chose banks that are in the Eurozone in order to create a more homogeneous group that is affected approximately by the same regulations, shocks and crisis. Finally, we chose 10 banks to have a database that is not too large but still significant.

The daily historical data were taken from January 2010 to December 2014. This time frame was chosen in order to observe the evolution of the value-at-risk of banks' shares after the introduction of Basel III. Indeed, 2010 was chosen to represent the year before Basel III was published. In December 2010 the first version of Basel III was released and in June 2011 the framework was reviewed. Therefore, 2011 will represent the year of the publication of Basel III and will be used to measure if the disclosure itself already had an impact. Then, the implementation of the new framework for the European Union initially followed the timeline agreed by the Basel Committee. This means that officially the application of Basel III was supposed to start as of the 1st January 2013, with full implementation on the 1st January 2019. However, the Capital Requirements Directive IV, which is a legislative package made for implementing Basel III in the European Union, was published on the 27th June 2013. Therefore, the application of Basel III started on the 1st January 2014 for countries in our database (European Commission, 2013; Bank of England, 2020). As said previously, a study showed that the countries on which we focus were already compliant with many criteria of Basel III in August 2012. As a result, we will analyse 2012, 2013 and 2014 as the years post Basel III. We suppose that the benefits of the latter, if any, should already be starting to be felt during this period of time.

6.2. Methodology

This study aims at evaluating if banks became more stable after the introduction of Basel III. In order to achieve that, we first calculate the growth rate² of our data using Excel. The latter was further used for the descriptive statistics of the growth rate.

² $Growth\ rate = \frac{P_{n+1} - P_n}{P_n}$, where P is the price of the share, and n is the day.

Then, we decided to use the value-at-risk (VaR) in order to observe the evolution of financial stability after Basel III was implemented. The VaR is defined as the maximum potential loss that could occur with a given probability. In our case, it will show us what is the maximum decrease in value of banks' shares that could happen with a confidence level of 95% and 99%. The VaR is calculated as follows:

$$Pr [r_t < VaR_{t|t-1}(\alpha)] = \alpha$$

Where r_t represents the profitability of an asset or portfolio at time t and α represents the confidence level.

The violations of the VaR can be calculated as follows:

$$I_t(\alpha) = \begin{cases} 1 & \text{if } r_t < VaR_{t|t-1}(\alpha) \\ 0 & \text{otherwise} \end{cases}$$

Where $I_t(\alpha)$ is the variable associated with the ex post observation of a violation of the VaR at α confidence level and time t (Hurlin & Tokpavi, 2007).

We decided to use the VaR as it can reflect the market risk exposure of banks. Indeed, it can indicate how much capital reserves banks need to hold in order to cover this risk. As a matter of fact, the Basel Committee uses VaR estimates to settle the amount of capital requirements banks need to have (European Central Bank, 2001). Therefore, if in our results we observe that the VaR increases in value, it will mean that banks could possibly need fewer capital reserves in order to cover market risk due to the fact that their shares' prices are less volatile.

In addition, changes in equity indices is a frequent measure used to assess financial stability (Wang & Ma, 2014). Indeed, excessive volatility in stock prices is a signal of financial market inefficiency and can create a disruption in market liquidity. This can potentially spread across the sector and harm its stability (Gadanecz & Jayaram, n.d.). The VaR will enable us to examine if there has been a decrease in volatility over the years.

Finally, the market price of shares is a valuable input in order to study financial stability. Indeed, under the efficient market hypothesis, the shares' price summarises all available information on the bank in one number. The potential risks, future benefits or losses should normally be reflected in its price. Therefore, it is supposedly a good estimate of the financial health of the entity. In addition, the price fluctuates at high frequency thus is far more precise than accounting information (European Central Bank, 2006). In our case, we took publicly available information which is the daily historical price. Even if it is less precise than high frequency data, it is still relevant information.

In order to conduct our research, we first needed to test if the distribution of our data was the standard normal (European Central Bank, 2001). We used SPSS to make the Shapiro-Wilk and Kolmogorov-Smirnov tests, as well as the QQ-plots. While most Shapiro-Wilk and Kolmogorov-Smirnov tests were demonstrating a normal distribution (Sig.>0.05) (SPSS Tutorials, n.d.), few of them were not (Appendices 8-17). However, when looking at the QQ-plots (Appendices 8-17), the distribution looks nearly normal. Hence, it is assumed that this will not pose any problem for our empirical analysis.

We effectively calculated the value-at-risk using the command in Rstudio. We calculated the VaR for each year of each bank in order to see how it evolves in time. Then, we also calculated the violations of the VaR, which can be defined as the number of times the change in the growth rate was more important than the VaR (Hurlin & Tokpavi, 2007).

7. Results

In this section, we will analyse our results by first looking at each bank separately. Then, we will observe the general tendency of the VaR of our banks as well as the violations of the VaR in order to have a broader view of what changed after the implementation of Basel III.

7.1. BNP Paribas Fortis

7.1.1. *Moments of distribution*

Table 1 : Moments of distribution for BNP Paribas

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	255	256	253	253	254
	Missing	2	1	4	4	3
Mean		-.00035656	-.00115791	.001548423	.001093509	-.00039465
Std. Deviation		.024577024	.038674695	.026684354	.017196969	.015005846
Variance		.001	.001	.001	.000	.000

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for BNP Paribas' shares growth rate.

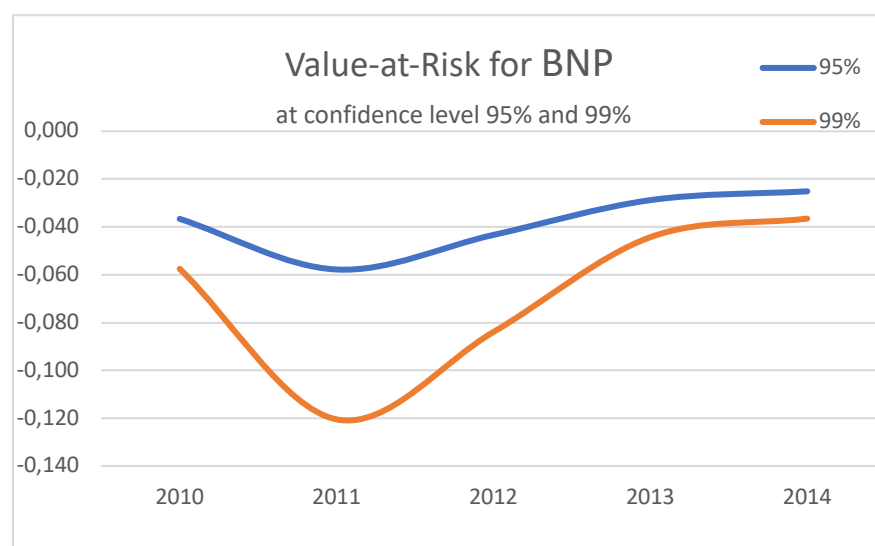
Regarding the moments of the distribution of the French bank's shares growth rate, we can observe that the standard deviation increased from 2010 to 2011, and then decreased from 0.038 in 2011 to 0.015 in 2014. The variance also decreased slightly over the years. This shows that the volatility of BNP Paribas' share prices decreased over time.

7.1.2. Value-at-risk and its violations

Table 2: Value-at-risk for BNP Paribas at confidence level 95% and 99%

BNP					
Confidence level	2010	2011	2012	2013	2014
95%	-0.037	-0.058	-0.043	-0.029	-0.025
99%	-0.058	-0.120	-0.084	-0.044	-0.037

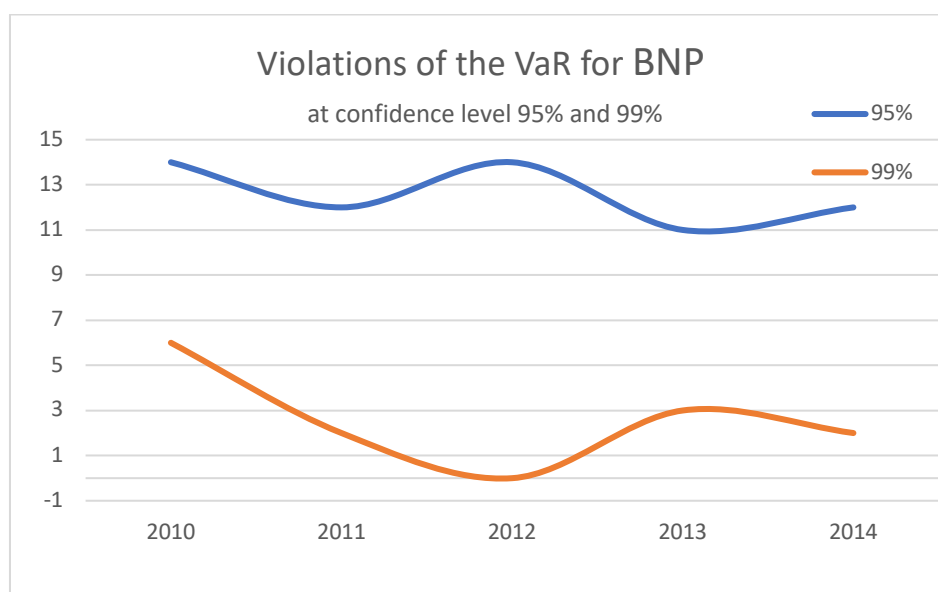
Note: This table presents the value-at-risk at the confidence level 95% and 99% for BNP Paribas' shares growth rate.



Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for BNP Paribas' shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 2: Value-at-risk for BNP Paribas at confidence level 95% and 99%

As we can see from the table and the graph above, the value-at-risk decreased from 2010 to 2011 and increased from 2011 to 2014 for both the 95% and 99% confidence level. Indeed, in 2011 BNP Paribas' profit decreased by nearly 23% compared to 2010. The bank considers that this decrease of performance is mainly due to four main factors which are the decision of the European Union to not cover the Greek sovereign debt, the overall Euro crisis, the drop in the stock market following those events and the increasing solvency requirements. This explains why the volatility of the bank's share prices increased between 2010 in 2011 for BNP Paribas (RTBF info, 2012). Looking at the results from 2010 to 2014, we can say the bank's share prices became less volatile. Thus, the market risk of BNP Paribas should have decreased too.



Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for BNP Paribas' shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 3: Violations of the VaR for BNP Paribas at confidence level 95% and 99%

Concerning the violations of the VaR, we can observe that they fluctuated but slightly decreased over the years for both confidence levels. For the 95% confidence level, 14 violations were recorded for 2010 and 12 in 2014. At the 99% confidence level, we can see 6 violations in 2010 and 2 in 2014. As the violations decreased slightly over the years on top of the VaR increasing, we can assume that the bank became more stable.

7.2. Banco Santander

7.2.1. Moments of distribution

Table 3: Moments of distribution for Banco Santander

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	251	251	248	250	250
	Missing	1	1	4	2	2
Mean		-.00128436	-.00091939	.000412917	.000501805	-.00001453
Std. Deviation		.033832480	.030371077	.025550265	.017258742	.014546963
Variance		.001	.001	.001	.000	.000

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for Banco Santander's shares growth rate.

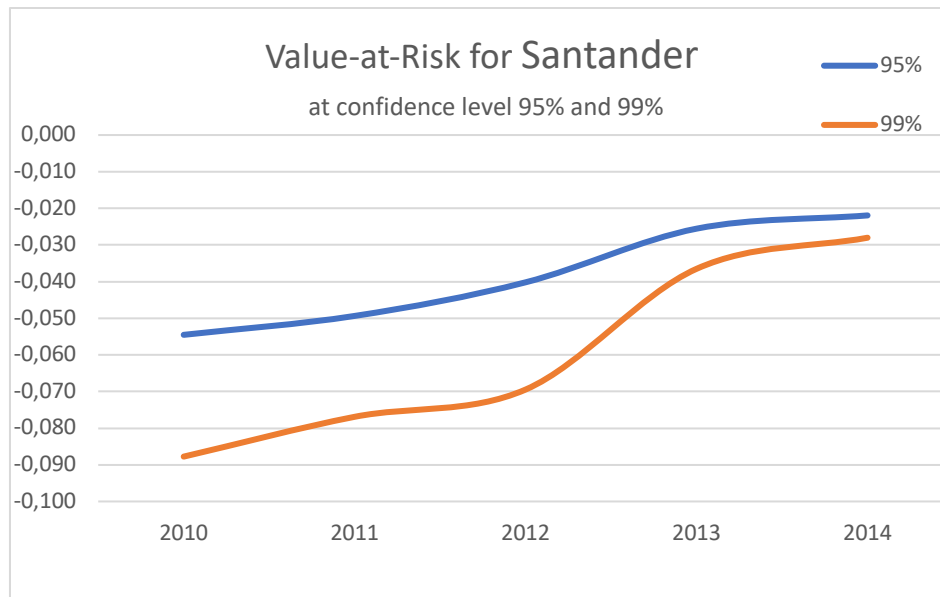
Banco Santander, one of the biggest Spanish-based banks, experienced a decrease in the standard deviation and the variance of its shares' growth rate over the years. The standard deviation was of 0.03 in 2010 and decreased to 0.01 in 2014. Again, this shows a decrease in the volatility of stock prices.

7.2.2. Value-at-risk and its violations

Table 4: Value-at-risk for Banco Santander at confidence level 95% and 99%

Santander					
Confidence level	2010	2011	2012	2013	2014
95%	-0.055	-0.049	-0.040	-0.026	-0.022
99%	-0.088	-0.077	-0.069	-0.037	-0.028

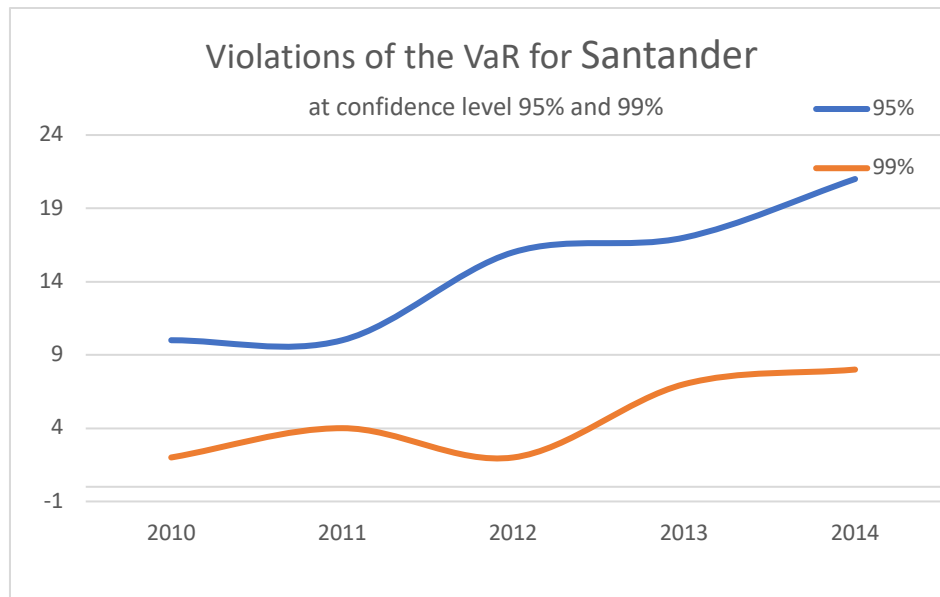
Note: This table presents the value-at-risk at the confidence level 95% and 99% for Banco Santander's shares growth rate.



Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Banco Santander's shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 4: Value-at-risk for Banco Santander at confidence level 95% and 99%

Concerning the value-at-risk, we can observe roughly the same pattern for both confidence levels. Indeed, in 2010 the VaR was of -0.055 and it increased to -0.022 in 2014 for the 95% confidence level. For the 99% confidence level, in 2010 the VaR was of -0.088 and it rose to -0.028 in 2014. The values are smaller for the 99% confidence level than for the 95% as the 99% confidence level estimates with greater probability the VaR, thus it must be less restrictive than the 95% confidence level. To conclude, the VaR of Banco Santander did not experience a major drop in 2011 as other banks. This can be partly explained due to the robustness of the bank compared to its competitors during the subprime and euro crisis. Indeed, Banco Santander was part of the world best in terms of profit and dividends during those crises (La tribune, 2010).



Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Banco Santander's shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 5: Violations of the VaR for Banco Santander at confidence level 95% and 99%

The violations of the VaR of Banco Santander increased over the years as we can see on the graph above. From 2010 to 2014 the violations doubled for the 95% confidence level and quadrupled for the 99% confidence level. The 99% confidence level values are smaller than the 95% confidence level as the VaR of the former is smaller and further to the left on the graph. This means that all violations between the 95% and 99% confidence level won't be taken into account in the 99% confidence level but will be for the 95% confidence level. We cannot conclude that Banco Santander's shares became more stable even if the variance decreased and the VaR increased as the violations increased drastically.

7.3. KBC Group

7.3.1. Moments of distribution

Table 5: Moments of distribution for KBC Group

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	256	256	253	253	253
	Missing	1	1	4	4	4
Mean		-.00044444	-.00303108	.004391596	.001903830	.000724587
Std. Deviation		.029869748	.042410318	.037168760	.020782919	.018411996
Variance		.001	.002	.001	.000	.000

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for KBC Group's shares growth rate.

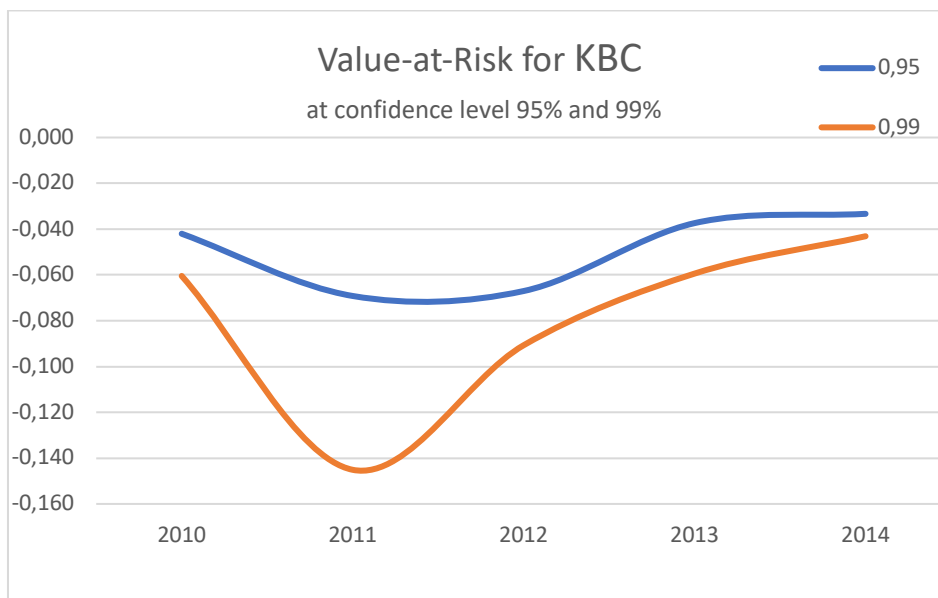
For KBC, looking at the standard deviation, we can see that it increased from 2010 to 2011 and then decreased until 2014. As a result, the volatility of the share prices seems to have decreased. The mean was negative for 2010 and 2011 and became positive from 2012 until 2014. This shows that in total the shares lost more value than they gained for the first 2 years, and that they gained more value than they lost in 2012, 2013 and 2014.

7.3.2. Value-at-risk and its violations

Table 6: Value-at-risk for KBC Group at confidence level 95% and 99%

KBC					
Confidence level	2010	2011	2012	2013	2014
95%	-0.042	-0.069	-0.067	-0.037	-0.033
99%	-0.060	-0.145	-0.091	-0.059	-0.043

Note: This table presents the value-at-risk at the confidence level 95% and 99% for KBC Group's shares growth rate.

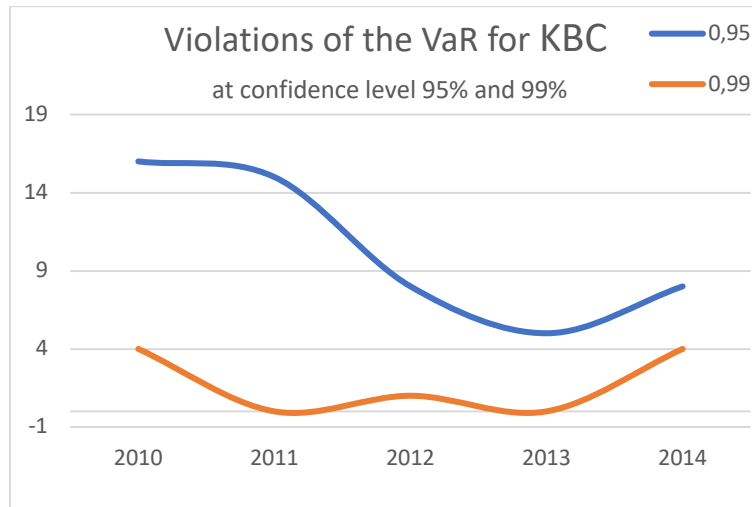


Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for KBC Group's shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 6: Value-at-risk for KBC Group at confidence level 95% and 99%

The VaR for both confidence levels decreased in 2011 and then increased until 2014 as with BNP Paribas. The same factors that impacted negatively the latter seem to have affected KBC Group in 2011 as well. Moreover, KBC Group during that period was still suffering from the subprime crisis (Zonebourse, 2012). We can argue that the Belgian-based bank became more stable since 2012 as the VaR increased from -0.07 in 2011 to -0.03 in 2014 at the 95% confidence level. The increase for the 99% confidence level is even more substantial as the VaR was of -0.15 in 2011 and rose to -0.04 in 2014. This difference between the 2 confidence

levels could be explained by a decrease of extreme values which led the 99% confidence level to rise more than the 95% confidence level.



Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for KBC Group's shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 7: Violations of the VaR for KBC Group at confidence level 95% and 99%

Regarding the violations of the VaR, we can see that they decreased for the 95% confidence level and that they stayed stable for the 99% confidence level. As a result, we can conclude that the bank seems to have gained stability over the years since the VaR increased and that violations decreased or remained stable.

7.4. Crédit Agricole

7.4.1. Moments of distribution

Table 7: Moments of distribution for Crédit Agricole

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	255	256	253	253	254
	Missing	2	1	4	4	3
Mean		-.00077746	-.00243947	.001762198	.001709804	.000760691
Std. Deviation		.026837294	.038543572	.032712705	.020459885	.018485408
Variance		.001	.001	.001	.000	.000

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for Crédit Agricole's shares growth rate.

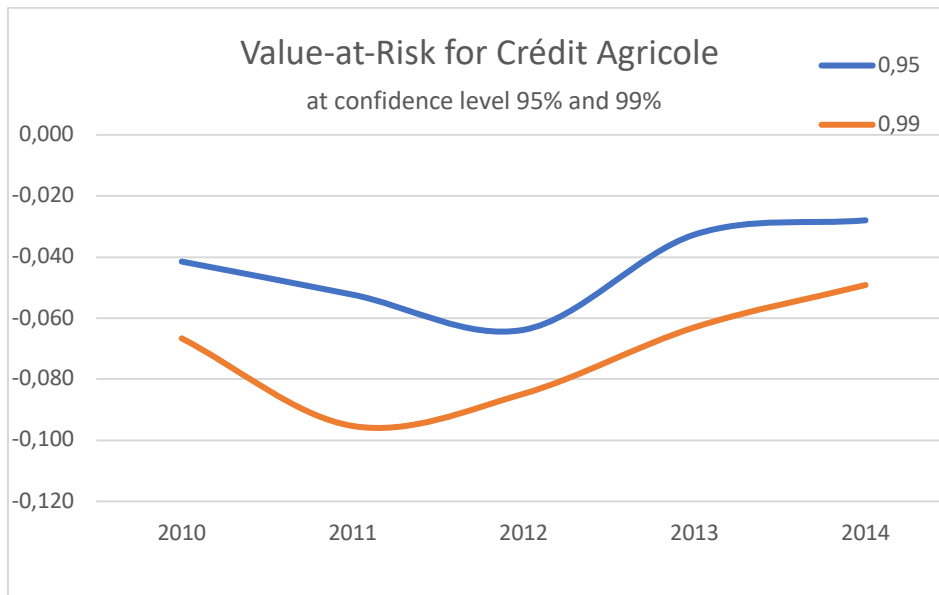
For Crédit Agricole, we can see that the standard deviation increased from 2010 to 2011 and then decreased until 2014 which means that the volatility of the share prices decreased over the years.

7.4.2. Value-at-risk and its violations

Table 8: Value-at-risk for Crédit Agricole at confidence level 95% and 99%

Crédit Agricole					
Confidence level	2010	2011	2012	2013	2014
95%	-0.041	-0.052	-0.064	-0.033	-0.028
99%	-0.067	-0.095	-0.085	-0.063	-0.049

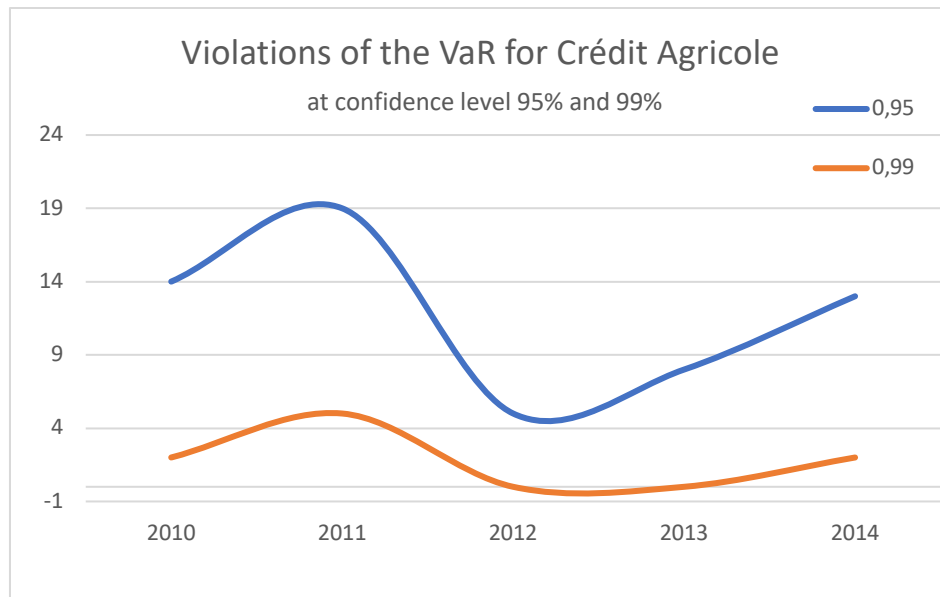
Note: This table presents the value-at-risk at the confidence level 95% and 99% for Crédit Agricole's shares growth rate.



Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Crédit Agricole's shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 8: Value-at-risk for Crédit Agricole at confidence level 95% and 99%

The VaR of the French-based bank decreased from 2010 to 2012 and then increased until 2014 for the 95% confidence level. Regarding the 99% confidence level, it decreased from 2010 to 2011 and then started to increase up until 2014. Crédit Agricole experienced massive losses in 2011 with a record of losses in 2012 due partly to the Greek sovereign debt crisis and partly to the depreciation of goodwill (Le Monde, 2013) which can explain the drop in 2011. As the VaR increased after this peculiar event, one could argue that the market risk of the bank decreased.



Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Crédit Agricole's shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 9: Violations of the VaR for Crédit Agricole at confidence level 95% and 99%

The violations of the VaR don't seem to have been impacted by Basel III as for both confidence levels they had the same number for 2010 and 2014. However, we can still see a slight decrease between those 2 years for the 99% confidence level and a sharp decrease for the 95% confidence level. As the VaR increased over time and that the violations since 2012 remained lower or at the same level than 2010 (i.e. the year before Basel III was published), one can argue that the bank's stability increased.

7.5. Société Générale

7.5.1. Moments of distribution

Table 9: Moments of distribution for Société Générale

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	255	256	253	253	254
	Missing	2	1	4	4	3
Mean		-.00040445	-.00255665	.002376404	.001594147	-.00052942
Std. Deviation		.028618122	.042779339	.033024363	.021744020	.018147397
Variance		.001	.002	.001	.000	.000

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for Société Générale's shares growth rate.

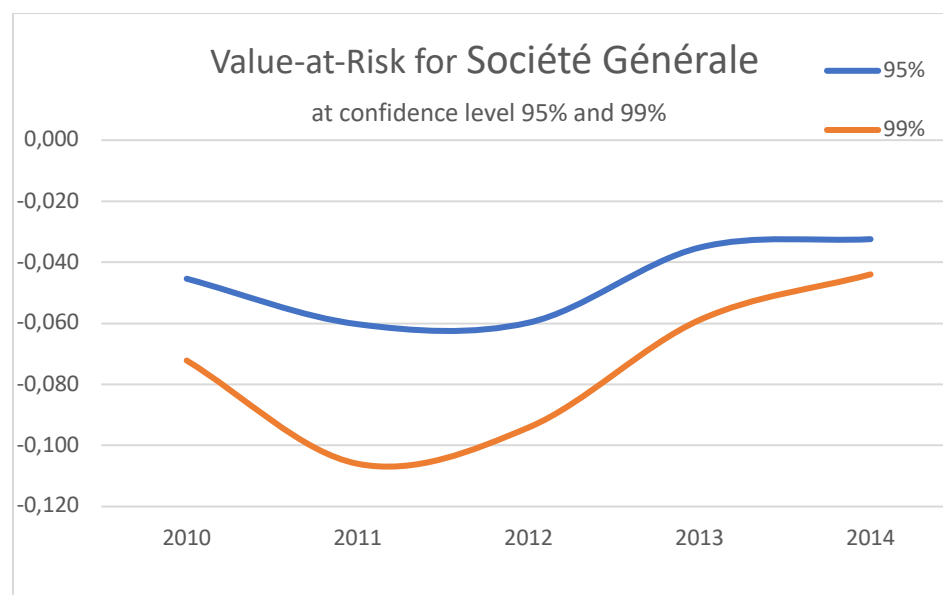
Société Générale's shares experienced an increase in the standard deviation from 2010 to 2011 and then it decreased up until 2014. As it decreased, this means that the volatility of the stock prices decreased as well. The mean fluctuated over the years but is similar for 2010 and 2014.

7.5.2. Value-at-risk and its violations

Table 10: Value-at-risk for Société Générale at confidence level 95% and 99%

Société Générale					
Confidence level	2010	2011	2012	2013	2014
95%	-0.045	-0.060	-0.060	-0.035	-0.032
99%	-0.072	-0.106	-0.094	-0.059	-0.044

Note: This table presents the value-at-risk at the confidence level 95% and 99% for Société Générale's shares growth rate.

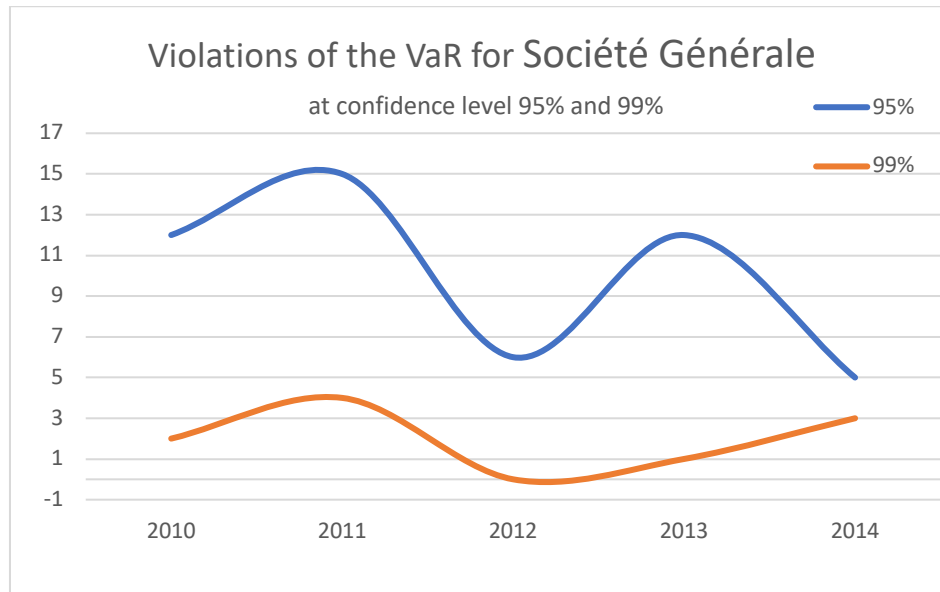


Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Société Générale's shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 10: Value-at-risk for Société Générale at confidence level 95% and 99%

The value-at-risk decreased from 2010 to 2011 for the French-based bank, stayed stable in 2012 and then increased up until 2014 for both confidence levels. Société Générale was also deeply affected by the Greek sovereign debt crisis which can explain this decrease of VaR in 2011. The bank was also subject to rumours which severely affected their stock prices in 2011 (Le Monde, 2011). As we can see from the graph, the VaR for the 99% confidence level increased more from 2012 to 2014 than the 95% confidence level. This could be explained by a decrease of extreme values which were taken into account in the 99% confidence level but

not in the 95%. One could argue that Société Générale became more stable over the years as the VaR increased.



Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Société Générale's shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 11: Violations of the VaR for Société Générale at confidence level 95% and 99%

The violations of the VaR did not follow a steady pattern for the 95% confidence level. Indeed, there were 12 violations in 2010, it increased to 15 in 2011, then decreased to 6 in 2012 but was followed by a rise in 2013 and again a drop to 5 violations in 2014. For the 99% confidence level, violations fluctuated from 0 to 4 during those 5 years. We cannot observe a steady drop in the number of violations over the years, but we can still conclude that Société Générale's stability increased as the VaR increased and that the violations did not rise significantly.

7.6. UniCredit

7.6.1. Moments of distribution

Table 11: Moments of distribution for UniCredit

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	255	255	252	251	251
	Missing	1	1	4	5	5
Mean		-.00116155	-.00274372	.000234738	.001590792	.000212461
Std. Deviation		.027292908	.039681860	.039919274	.022648071	.022391734
Variance		.001	.002	.002	.001	.001

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for UniCredit's shares growth rate.

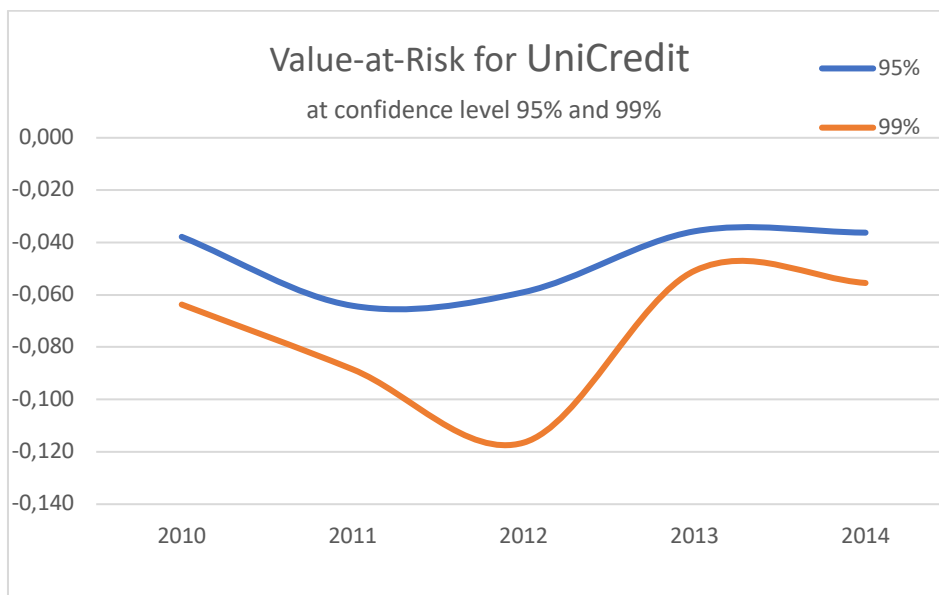
On the table above, we can see that the standard deviation increased from 2010 to 2011, remained stable in 2012, decreased in 2013 and remained constant until 2014. We can conclude that the volatility seems to have slightly decreased.

7.6.2. Value-at-risk and its violations

Table 12: Value-at-risk for UniCredit at confidence level 95% and 99%

UniCredit					
Confidence level	2010	2011	2012	2013	2014
95%	-0.038	-0.064	-0.059	-0.036	-0.036
99%	-0.064	-0.088	-0.116	-0.051	-0.055

Note: This table presents the value-at-risk at the confidence level 95% and 99% for UniCredit's shares growth rate.

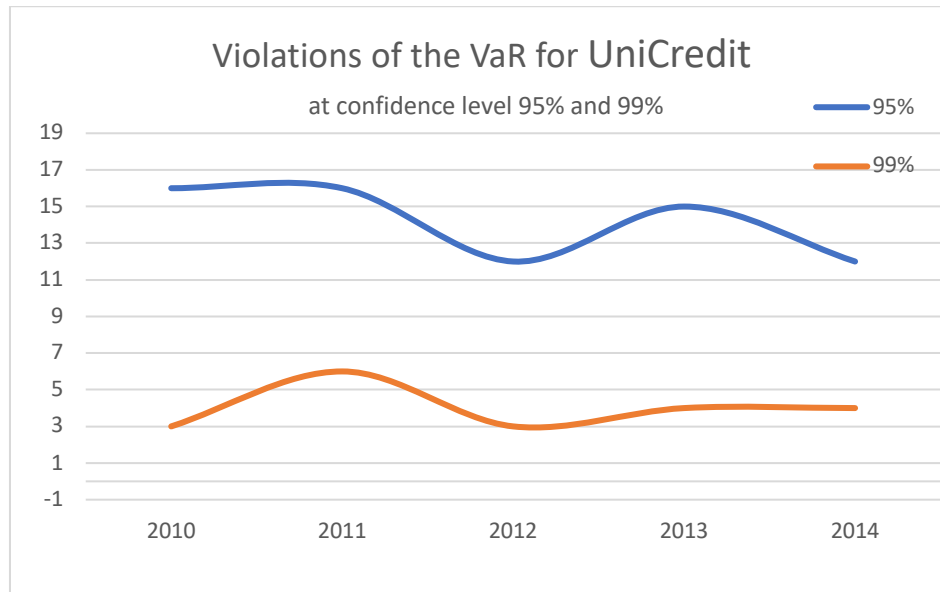


Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for UniCredit's shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 12: Value-at-risk for UniCredit at confidence level 95% and 99%

The value-at-risk for UniCredit decreased from 2010 to 2011 and then increased modestly until 2014 for the 95% confidence level. Then, for the 99% confidence level, it decreased from 2010 to 2012 and increased sharply from this date until 2014. In 2011, the biggest Italian bank experienced major issues as the impact of the Greek sovereign debt crisis, Italy's sovereign debt crisis and the country's entry into recession as well as the devaluation of 9 billion euros in goodwill (L'express, 2012). Those events had an impact on the bank's stock prices leading to a rise in volatility and a loss in the bank's stability. We cannot conclude that the bank became more stable by looking at those results as the VaR in 2010 and 2014 are close for both

confidence levels. However, looking at the VaR in 2012, after the introduction of Basel III, we can observe a rise in VaR and therefore a rise in stability.



Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for UniCredit's shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 13: Violations of the VaR for UniCredit at confidence level 95% and 99%

The number of violations of VaR seems constant over the 5 years, thus, as the VaR increased from 2012 and that violations did not increase significantly, we can conclude that the bank became more stable after the introduction of Basel III.

7.7. ING

7.7.1. Moments of distribution

Table 13: Moments of distribution for ING

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	250	251	248	250	250
	Missing	2	1	4	2	2
Mean		.000282406	-.00032872	.001217565	.001691149	-.00006194
Std. Deviation		.035075580	.043652159	.028802313	.020599908	.017272990
Variance		.001	.002	.001	.000	.000

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for ING's shares growth rate.

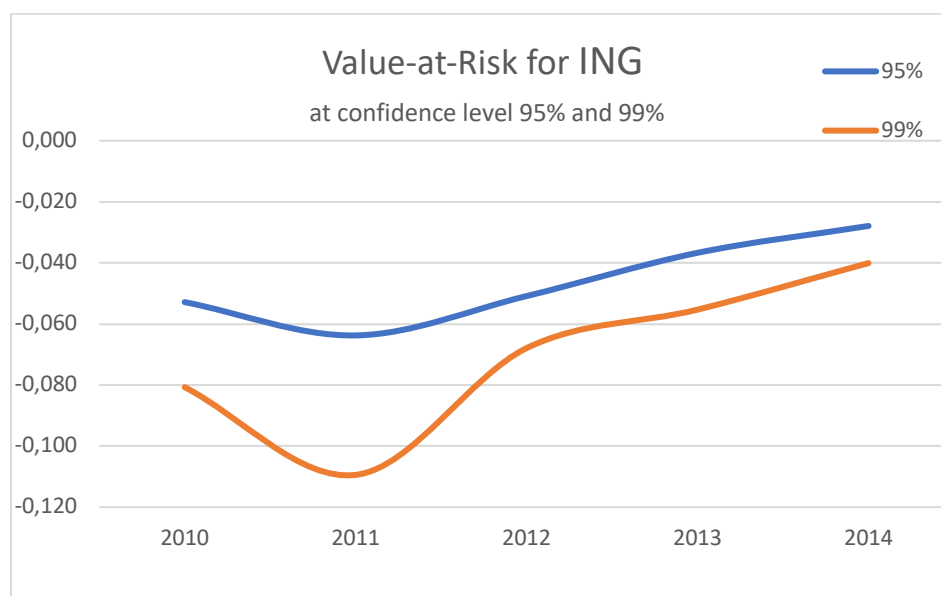
ING experienced an increase in the standard deviation from 2010 to 2011 and then a decrease until 2014. We can raise the hypothesis of a decrease in volatility during this period.

7.7.2. Value-at-risk and its violations

Table 14: Value-at-risk for ING at confidence level 95% and 99%

ING					
Confidence level	2010	2011	2012	2013	2014
95%	-0.053	-0.064	-0.051	-0.037	-0.028
99%	-0.081	-0.109	-0.068	-0.055	-0.040

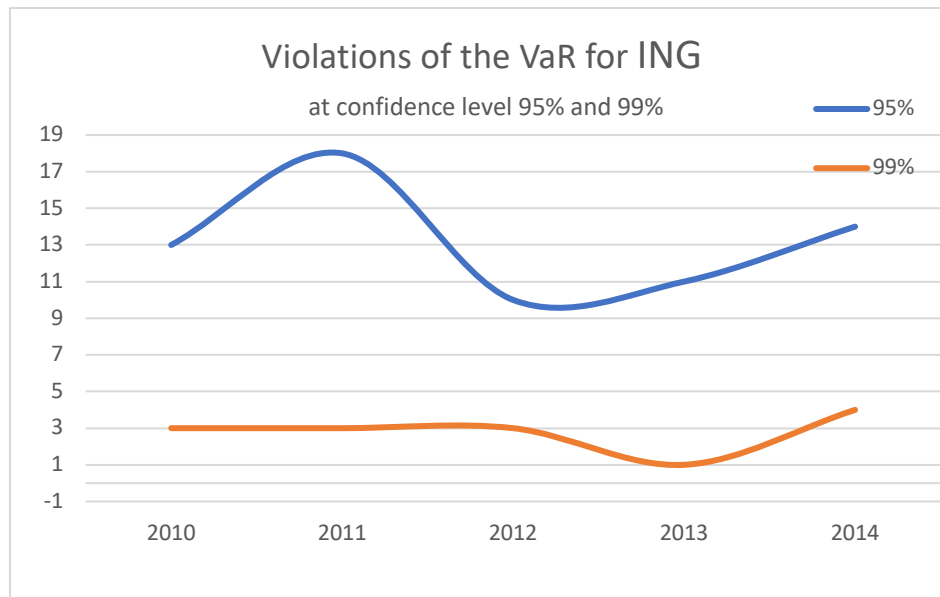
Note: This table presents the value-at-risk at the confidence level 95% and 99% for ING's shares growth rate.



Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for ING's shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 14: Value-at-risk for ING at confidence level 95% and 99%

The value-at-risk of ING also decreased from 2010 to 2011 and then increased from this point in time until 2014 for both confidence levels. As the VaR of 2010 was the double of the one in 2014, the bank should be more stable than before.



Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for ING's shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 15: Violations of the VaR for ING at confidence level 95% and 99%

When looking at 2010 and 2014, the violations did not decrease nor increase for both confidence levels. For the 95% confidence level, we can see a drop in the violations between 2011 and 2012 which is the year Basel III was introduced. However, violations increased afterwards and exceeded the 2010 level. We can still conclude that the bank became more stable after the introduction of Basel III as the VaR increased and violations did not increase significantly.

7.8. Deutsche Bank

7.8.1. Moments of distribution

Table 15: Moments of distribution for Deutsche Bank

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	255	255	252	251	251
	Missing	1	1	4	5	5
Mean		-.00045503	-.00067880	.000637140	.000199861	-.00093424
Std. Deviation		.020788783	.031165337	.025056611	.016777468	.015162592
Variance		.000	.001	.001	.000	.000

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for Deutsche Bank's shares growth rate.

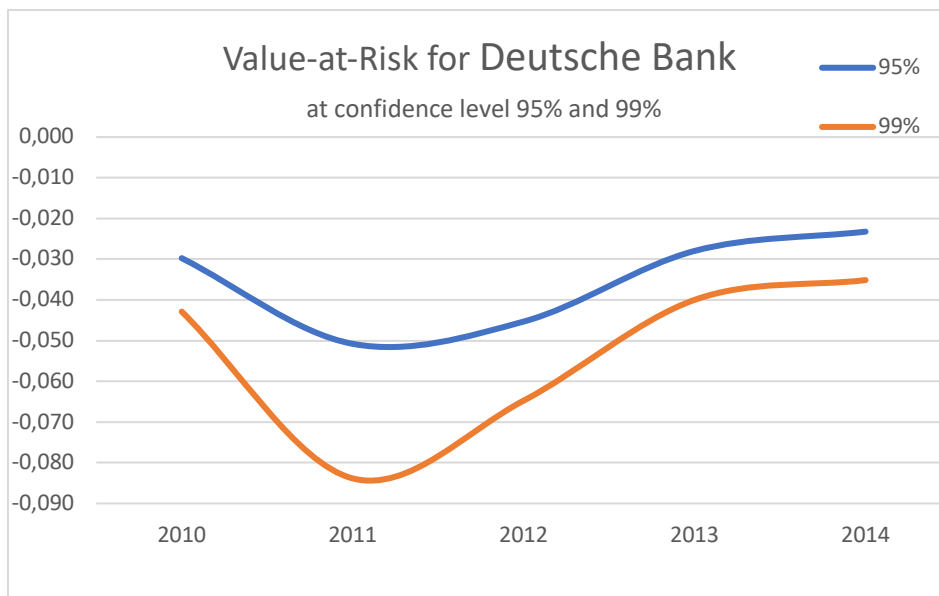
As with many banks studied previously, Deutsche Bank experienced a rise in its standard deviation between 2010 and 2011 and then a decrease until 2014. This could be explained by a decrease in the volatility of its share prices.

7.8.2. Value-at-risk and its violations

Table 16: Value-at-risk for Deutsche Bank at confidence level 95% and 99%

Deutsche Bank					
Confidence level	2010	2011	2012	2013	2014
95%	-0.030	-0.051	-0.045	-0.028	-0.023
99%	-0.043	-0.084	-0.065	-0.040	-0.035

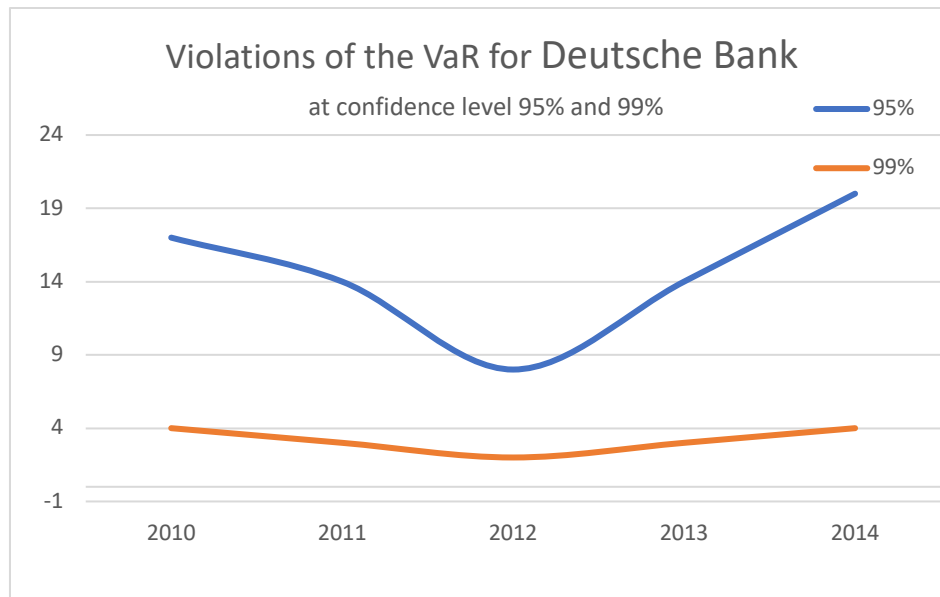
Note: This table presents the value-at-risk at the confidence level 95% and 99% for Deutsche Bank's shares growth rate.



Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Deutsche Bank's shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 16: Value-at-risk for Deutsche Bank at confidence level 95% and 99%

For both confidence level, the VaR decreased from 2010 to 2011 and then increased up until 2014, following the trends shown with the standard deviation. The German bank had 900millions of Greek debt in 2011 and had depreciated them already at 50% of its value. Thus, the Greek situation impacted negatively the bank which was reflected by a drop in the stock prices and therefore an increase in volatility. This graph shows that the VaR increased over the years after 2011 which made the bank more stable.



Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Deutsche Bank's shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 17: Violations of the VaR for Deutsche Bank at confidence level 95% and 99%

Although there has been fluctuation between 2010 and 2014, the number of violations of the first year and the last are practically similar. Therefore, no conclusion can be made regarding the decrease of violations of the VaR as an impact of Basel III. However, we can still conclude that the bank became more stable as the VaR increased and that the violations did not increase significantly over time.

7.9. Intesa Sanpaolo

7.9.1. Moments of distribution

Table 17: Moments of distribution for Intesa Sanpaolo

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	255	255	252	251	251
	Missing	1	1	4	5	5
Mean		-.00139040	-.00072583	.000403549	.001297716	.001452730
Std. Deviation		.026776815	.040373166	.031589430	.021796763	.021577626
Variance		.001	.002	.001	.000	.000

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for Intesa Sanpaolo's shares growth rate.

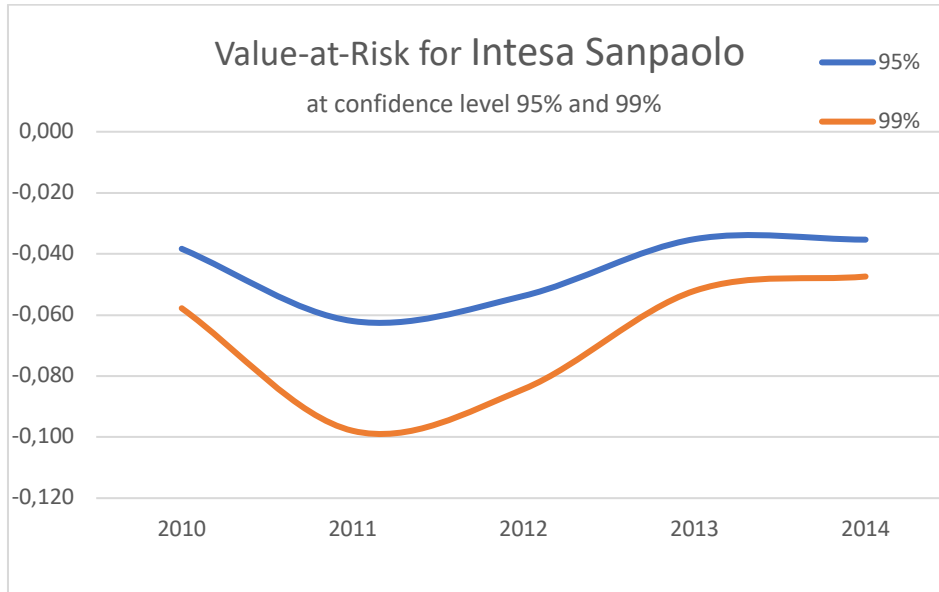
The standard deviation of the growth rate of Intesa Sanpaolo's shares followed the same pattern than the ones of most banks already studied. This means an increase in the standard deviation between 2010 and 2011 and a decrease until 2014. This raises the question of the enhanced stability of the bank over the years.

7.9.2. Value-at-risk and its violations

Table 18: Value-at-risk for Intesa Sanpaolo at confidence level 95% and 99%

Intesa Sanpaolo					
Confidence level	2010	2011	2012	2013	2014
95%	-0.038	-0.062	-0.054	-0.035	-0.035
99%	-0.058	-0.098	-0.084	-0.052	-0.047

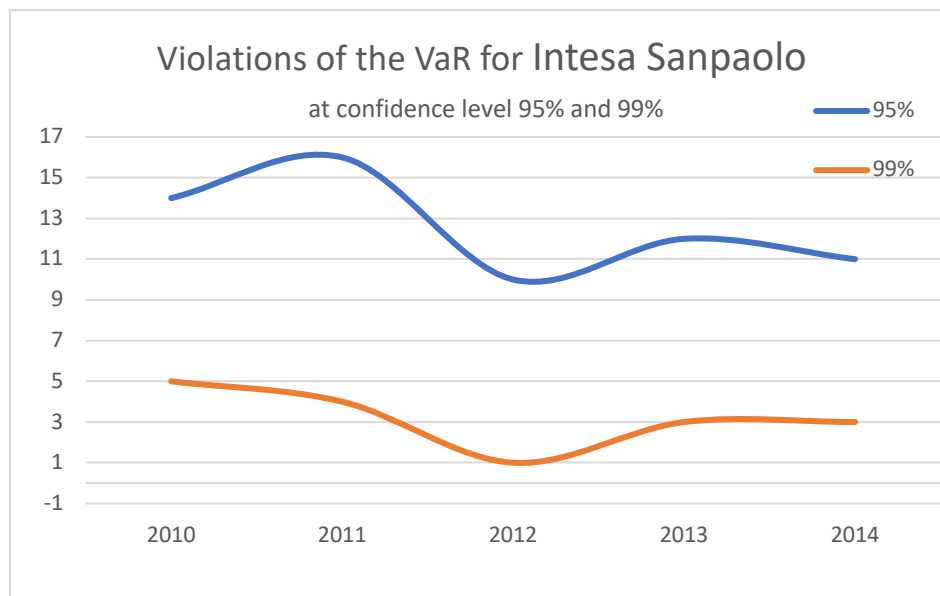
Note: This table presents the value-at-risk at the confidence level 95% and 99% for Intesa Sanpaolo's shares growth rate.



Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Intesa Sanpaolo's shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 18: Value-at-risk for Intesa Sanpaolo at confidence level 95% and 99%

The values-at-risk are in line with the results of the standard deviation. For both confidence levels, the VaR decreased from 2010 to 2011 and increased until 2014. As seen with previous banks, the second-largest Italian bank suffered greatly from the Euro crisis in 2011 which could explain those results (Les Echos, 2011). Looking at the VaR before Basel III was published (2010) and the year when its implementation was already well underway (2014), no significant increase of the VaR between those two dates can be observed for both confidence levels. Therefore, we can only conclude that the bank restored its pre-Euro crisis stability.



Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for Intesa Sanpaolo's shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 19: Violations of the VaR for Intesa Sanpaolo at confidence level 95% and 99%

The violations of the VaR increased slightly from 2010 to 2011, then it decreased to 10 in 2012, rose to 12 in 2013 and declined to 11 in 2014 for the 95% confidence level. For the 99% confidence level, the violations decreased slightly over the years as seen on the graph. We cannot conclude that a significant decrease in the violations of the VaR took place during this time frame. However, the bank is probably more stable than in 2011 as the VaR increased and violations slightly decreased or remained stable.

7.10. Banco Bilbao Vizcaya Argentaria (BBVA)

7.10.1. Moments of distribution

Table 19: Moments of distribution for Banco Bilbao Vizcaya Argentaria

		Statistics				
		2010	2011	2012	2013	2014
N	Valid	250	251	248	250	250
	Missing	2	1	4	2	2
Mean		-.00194695	-.00001285	.000535910	.001191821	-.00076248
Std. Deviation		.032889092	.034352446	.028897514	.018320324	.015949045
Variance		.001	.001	.001	.000	.000

Note: This table presents the valid and missing values, the mean, the standard deviation and the variance for BBVA's shares growth rate.

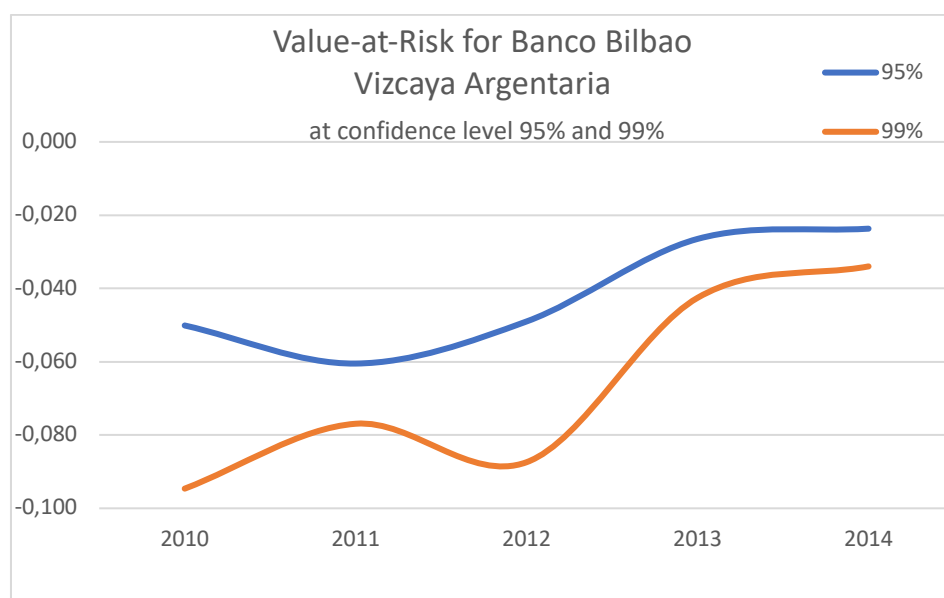
Regarding the moments of distribution of BBVA group, we can see that the standard deviation increased from 2010 to 2011 and then decreased until 2014. This decrease can demonstrate a decrease of volatility in the stock prices.

7.10.2. Value-at-risk and its violations

Table 20: Value-at-risk for Banco Bilbao Vizcaya Argentaria at confidence level 95% and 99%

Banco Bilbao Vizcaya Argentaria					
Confidence level	2010	2011	2012	2013	2014
95%	-0.050	-0.060	-0.049	-0.026	-0.024
99%	-0.095	-0.077	-0.087	-0.043	-0.034

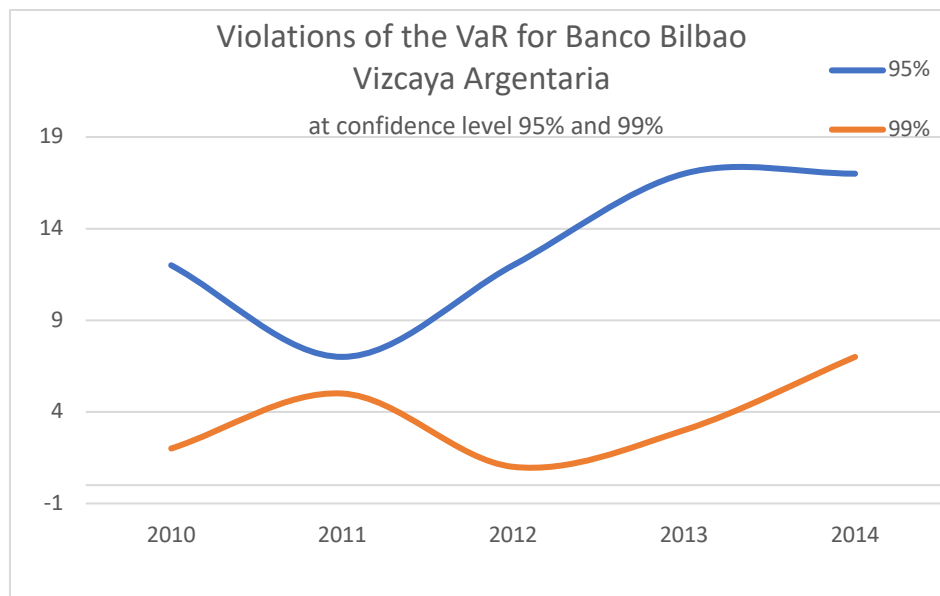
Note: This table presents the value-at-risk at the confidence level 95% and 99% for BBVA's shares growth rate.



Note: This figure presents the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for BBVA's shares growth rate. The Y axis represents the values of the VaR and the X axis represents time in years.

Figure 20: Value-at-risk for Banco Bilbao Vizcaya Argentaria at confidence level 95% and 99%

The value-at-risk decreased from 2010 to 2011 and then increased up until 2014 for the 95% confidence level. Regarding the 99% confidence level, after an increase in 2011 the VaR dropped in 2012 and increased again up until 2014. Those trends are similar to what we have seen with previous banks. This increase in the VaR over the years shows that the extreme values decreased, meaning that share prices were less volatile than before.

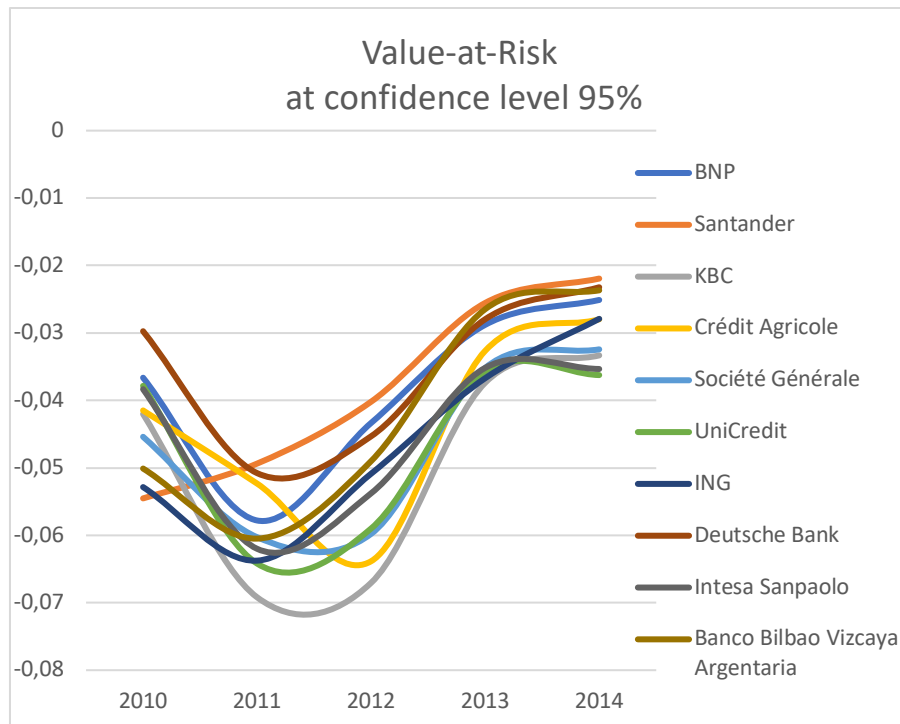


Note: This figure presents the violations of the value-at-risk at the confidence level 95% (blue line) and 99% (orange line) for BBVA's shares growth rate. The Y axis represents the number of violations of the VaR and the X axis represents time in years.
Figure 21: Violations of the VaR for Banco Bilbao Vizcaya Argentaria at confidence level 95% and 99%

The violations of the VaR increased over time for both confidence level as we can see on the graph. In 2010, 2 violations were recorded while it increased to 17 in 2014 for the 95% confidence level. For the 99% confidence level, violations increased from 2 in 2010 to 7 in 2014. As a result, no conclusions can be made on the enhanced stability of BBVA over the years. Indeed, even if the VaR increased, the positive impact may have been counterbalanced by the increase in violations.

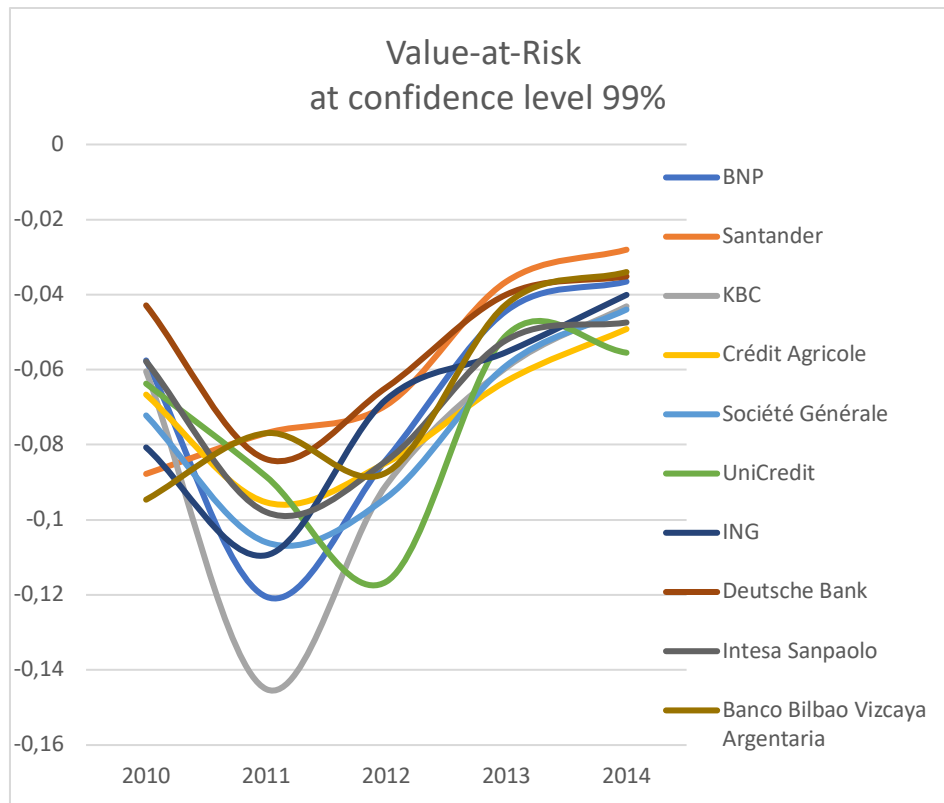
7.11. Aggregate results

After examining results by bank, we will now aggregate those data to see if there is a general trend. From what we saw, many banks seemed to have an increased volatility in the growth rate of their share prices in 2011. The latter started decreasing in 2012 or 2013 depending on banks and up until 2014.



Note: This figure presents the aggregated value-at-risk of the ten banks under study at the confidence level 95%. The Y axis represents the values of the VaR and the X axis represents time in years.

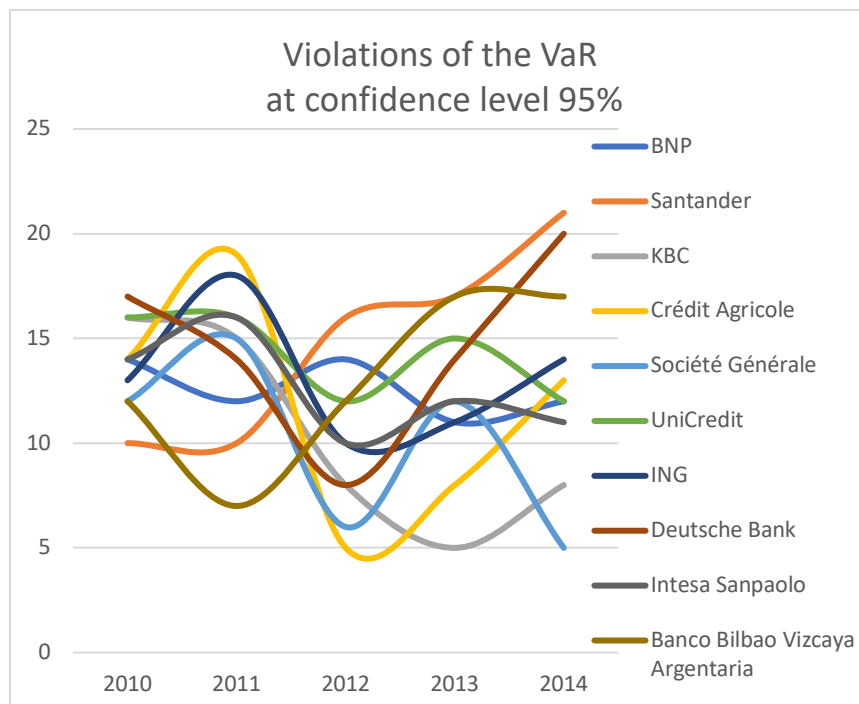
Figure 22: Aggregated values-at-risk at confidence level 95%



Note: This figure presents the aggregated value-at-risk of the ten banks under study at the confidence level 99%. The Y axis represents the values of the VaR and the X axis represents time in years.

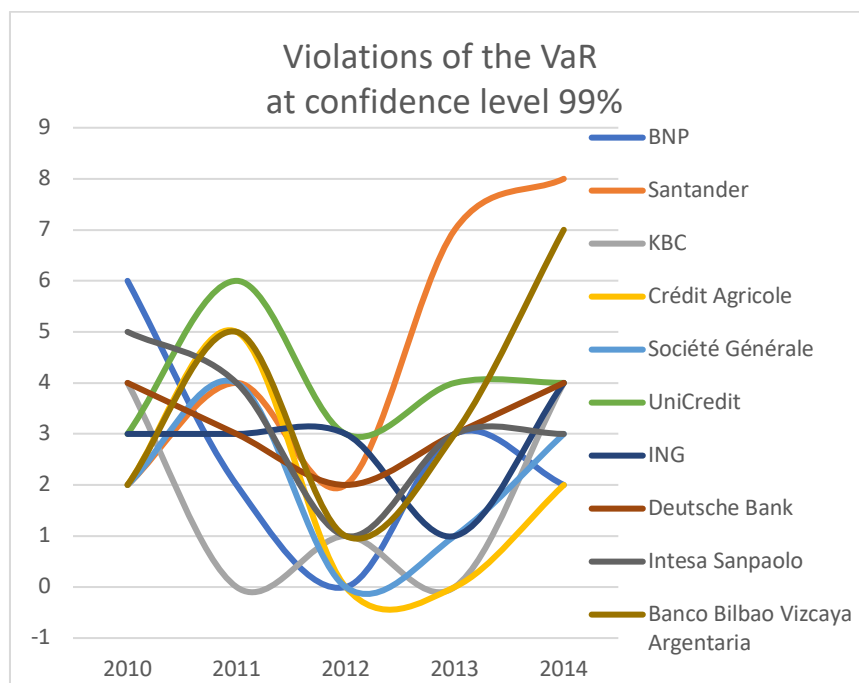
Figure 23: Aggregated values-at-risk at confidence level 99%

As we can see for both confidence levels, the VaR dropped in 2011 and/or 2012 and then rose up until 2014 except for Banco Santander. The latter wasn't affected as much as its competitors during the subprime and the Euro crisis thanks to its diversified strategy in terms of business lines and geography. Indeed, for the first crisis the bank was greatly provisioned. For the second crisis, the bank had a small exposure to Greek government securities, less than a quarter of its business in Spain and solid positions in Latin America, the UK and the US (Wachman, 2010). Therefore, Banco Santander was less impacted during the Euro crisis than its Eurozone competitors. Looking at the other banks, one could argue that as the VaR increased from 2011/2012 to 2014, banks became more stable due to the decrease of extreme values which correlates with a decrease of volatility in stock prices.



Note: This figure presents the aggregated violations of the values-at-risk of the ten banks under study at the confidence level 95%. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 24: Aggregated violations of the VaR at confidence level 95%



Note: This figure presents the aggregated violations of the values-at-risk of the ten banks under study at the confidence level 99%. The Y axis represents the number of violations of the VaR and the X axis represents time in years.

Figure 25: Aggregated violations of the VaR at confidence level 99%

As we can see on both graphs above, we cannot conclude that violations of the VaR had a tendency to decrease over the years. However, we can see that without Banco Santander and the group BBVA, most banks experienced for both confidence levels a rise of violations of the VaR in 2011 and then a drop in 2012. This coincide with the Euro crisis and the introduction of Basel III. Then, violations of VaR increased but still remained equal to or lower than the 2010 level. Knowing that Banco Santander did not suffer as much during those crises could explain the difference, however, for BBVA group no explanation was found. As a result, we can conclude that for most banks violations did not increase over time except in 2011. Yet, there is no proof that Basel III impacted positively violations of VaR as we cannot observe a significant and constant decrease.

8. Discussion

The purpose of this study was to assess the stability of banks after the introduction of Basel III. To do so, a sample of the ten biggest European banks was set up. Firstly, the analysis finds evidence that, depending on the banks, the values-at-risk decreased from 2010 to 2011 or 2012 and then increased up until 2014. However, linking those results to the introduction of Basel III is arduous. Indeed, Basel III was introduced the same year the Euro crisis hit the countries under study. Confidence on markets was at its lowest as talks about the collapse of the Eurozone became prominent. As we saw in our sample, banks were not equally affected as some had more exposure in Greece than others, thus lost investor's confidence even more (BBC News, 2011a). As the future of the Eurozone was uncertain, confidence decreased on financial markets and investors became more risk averse (Sgherri & Zoli, 2011). Therefore, stock markets fell sharply (BBC News, 2011b) increasing volatility and deteriorating VaR as seen in our study. The VaR increased after 2012 and up until 2014, however, our study does not evaluate whether it is the impact of Basel III or financial markets recovering from the Euro crisis. Indeed, the ECB took action in 2012 in order to face the Euro crisis. This could explain why the VaR increased from this date forward.

Regarding the violations of VaR, the increase in 2011 corresponds to the Euro crisis and the increased volatility resulting from it. In 2012, violations decreased significantly for most banks, but it could be due to two events. The first one being the recovery from the Euro crisis and

therefore a gain in confidence on financial markets. The second event could be that banks were already well underway for Basel III reforms and became more robust and stable. However, after 2012, violations increased for most banks, thus we cannot prove that Basel III decreased violations.

Another factor that could have altered our results is short-selling or the act of speculation itself. Indeed, it can decrease the price of shares overnight thus damaging the violations of VaR even if the bank has a good financial health.

By using the VaR and its violations, our goal was to prove that banks became more stable as they experienced less volatility after the introduction of Basel III. Volatility is a valuable measure for regulators searching for signals of future crises as it can reveal financial and economic instability (Danielsson, Valenzuela & Zer, 2016). Through our study, we have shown that VaR increased over the years therefore we made the assumption that banks became more stable. However, it is important to mention that low volatility is not always a sign of a healthy financial or banking system. Indeed, stability can be destabilising, meaning that when there is low volatility, economic agents know that risks are lower. Thus, their confidence increases and they are more inclined to take additional risks, which in turn increases the likelihood of future crises. On the other hand, high volatility can also be a sign of a pending crisis as there is higher uncertainty regarding future economic conditions. Researchers have been trying to quantify high and low volatility to better predict when a crisis is forming and mitigate its effects (Danielsson et al., 2016). In our study, we consider that as the VaR increases from 2012 which means that volatility decreased, banks became more stable as the VaR increased up until 2014. Therefore, there is no sign that economic agents took more risks after 2012 when volatility was lower.

To sum up, our results showed that banks became more stable over the years as the standard deviation of the growth rate of shares decreased, the VaR increased and the fact that violations decreased or at least remained stable. However, the limit of our study is that the correlation between those events and Basel III is not proven. As a result, further research could be made to evaluate this correlation.

Regarding Basel IV, no empirical analysis was made as the implementation date of most reforms is the 1st January 2022 (Basel Committee on Banking Supervision, 2017), therefore we cannot assess its impact yet. However, looking at the literature, we found that Basel IV is expected to be extremely costly for European banks. It is estimated that the increase of RWAs for those banks will be between 1 and 2.5 trillion euros, which will result in a need to increase capital by 13% to 22% over the years. This will decrease drastically banks' profitability but will make the banking system more resilient. (Bodellini, 2019).

Conclusion

Systemic banking crises have been affecting repeatedly our economies and societies on many levels. As recently as 2008, the global financial crisis deeply damaged banks' financial health, businesses' performance and the real estate market value. The crisis also increased unemployment and the sovereign debt of many countries and led them to enter into a profound recession. As a result, millions of people fell or were at risk of falling below the poverty line.

In response to the crises, the Basel Committee on Banking Supervision has been trying over the years to increase financial stability by making the banking system sounder and more resilient in order to resist shocks and avoid, or at least mitigate the effects of systemic banking crises.

Since the first accord introduced in 1988, a significant rise in capital requirements has taken place. Indeed, the 2008 crisis proved that the requirements put in place in Basel II were not enough and that there was a lack of effective supervision as well as a lack of coordination from international institutions.

The post-crisis reform, Basel III, aimed not only at increasing capital requirements but also at increasing its quality in order for banks to be able to withstand losses during stress periods. Moreover, liquidity requirements were introduced as the crisis highlighted their importance when panic hits markets. Then, a leverage ratio was set as many banks had excessive leverage during the crisis. Furthermore, the global standards for market risk, counterparty credit risk and securitisation were revised. Finally, regulators added a macroprudential approach to Basel III as systemic risk was not accurately represented before. This means that additional buffers were to limit procyclicality.

The last reforms published by the Committee, known as Basel IV, aims at restoring credibility and enhancing banks' comparability. In order to achieve that, Basel IV restricts the use of internal models as some banks were under-estimating their RWA in order to hold less capital.

Moreover, to encourage banks to use standardised models instead of internal models, the Committee decided to set a more robust output floor. Finally, the new reform introduced a leverage ratio buffer for systemically important banks to limit excess leverage as those banks can have a stronger negative impact on the real economy in case of failure.

The literature review illustrated that through Basel III European banks became sounder and more resilient, but lost in profitability. Basel IV is supposed to further increase the resilience of European banks but at the same time will damage their profitability to a greater extent. This constitutes one of the biggest challenges for the Basel Committee as when their profitability is decreasing their lending capacity decreases as well. Moreover, increasing the capital ratio has a negative, even if moderate, impact on GDP level. Therefore, the Committee must find the right balance between economic development and financial stability.

The purpose of the empirical analysis was to assess the stability of banks in the Euro area after the introduction of Basel III. To do so, we used the value-at-risk of ten major banks in the Eurozone for the period between the 1st January 2010 to the 31st December 2014. This period covers the year before Basel III was published up until the year where most reforms were already implemented. Results find evidence that the VaR increased after the issuance of Basel III, violations decreased or at least remained stable and that the standard deviation of the growth rate of shares decreased. This means that banks effectively became more stable. However, even if the literature review clearly suggests that the implementation of Basel III increased financial stability, the limit of this study is that no correlation is statistically proven. The increase of financial stability among the ten banks under study could also result from other factors such as the Euro crisis. To prove any correlation between the implementation of Basel III and financial stability, further quantitative analysis could be done using regressions which assess how different independent variables impact the value-at-risk or other relevant dependent variables.

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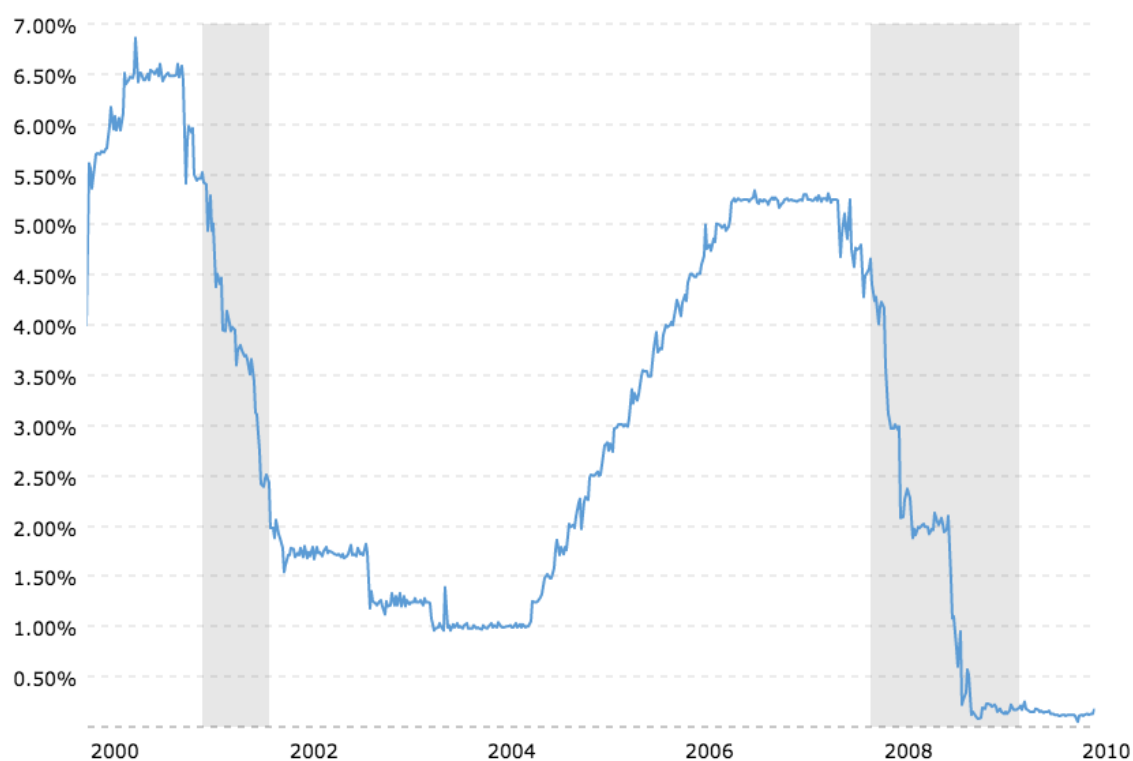
Appendices

Appendix 1: Differences between the foundation and advanced IRB approaches

Data Input	Foundation IRB	Advanced IRB
Probability of default (PD)	Provided by bank based on own estimates	Provided by bank based on own estimates
Loss given default (LGD)	Supervisory values set by the Committee	Provided by bank based on own estimates
Exposure at default (EAD)	Supervisory values set by the Committee	Provided by bank based on own estimates
Maturity (M)	Supervisory values set by the Committee or At national discretion, provided by bank based on own estimates (with an allowance to exclude certain exposures)	Provided by bank based on own estimates (with an allowance to exclude certain exposures)

Source: Basel Committee on Banking Supervision, 2003.

Appendix 2: Federal funds rate from 2000 to 2010



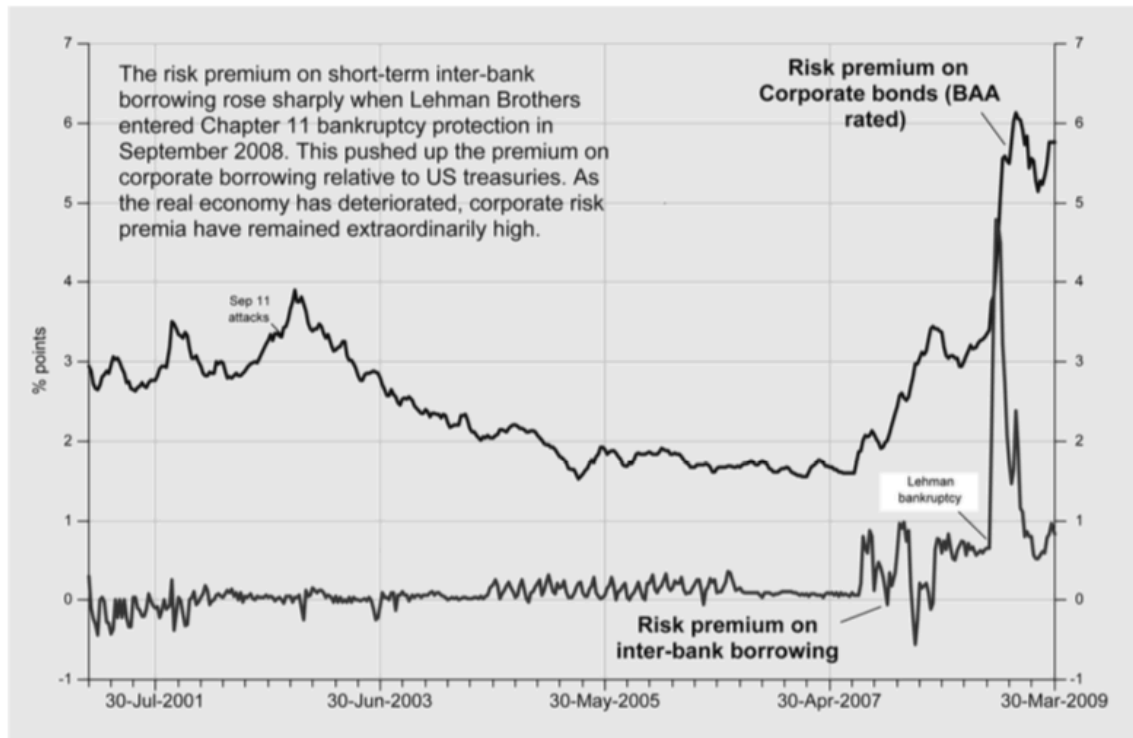
Source: Macrotrends.

Appendix 3: 10year treasury rate from 2000 to 2010



Source: Macrotrends.

Appendix 4: The rise of risk premium interbank borrowing during the 2008 crisis



Source: Federal Reserve Board (cited in McKibbin & Stoeckel, 2010).

Appendix 5: Sovereign and private debts in 1999 and 2009 for Germany, France, Italy, Greece, Ireland, Spain, Portugal and the US

	Dette publique brute		Dette privée brute	
	1999	2009	1999	2009
Allemagne	61,8	77,5	168,2	176,5
France	66,8	91,3	160,6	214,2
Italie	125,7	130,1	134,9	184,9
Grèce	101,9	138,3	61,9	133,6
Irlande	51,5	70,5	–	392,9
Espagne	69,4	62,9	159,9	281,8
Portugal	62,3	94,0	238,0	324,4
États-Unis	60,5	88,8	179,9	219,5

Source: OECD (cited in Wyplosz, 2014a).

Appendix 6: Changes in the debt to GDP ratio (%)

	1970–1990	1990–1998	1998–2007	2007–2009	2009–2014
Austria	40.0	8.2	–4.2	8.9	5.2
Belgium	78.1	–8.3	–33.2	11.7	4.8
Finland	8.7	34.3	–13.2	8.4	16.9
France	14.2	24.4	4.6	15.0	16.9
Germany	–18.3	21.0	4.7	9.3	2.7
Greece	47.0	22.9	12.8	22.4	47.3
Ireland	50.4	–39.0	–28.2	39.6	55.8
Italy	57.2	20.1	–11.1	13.1	17.3
Luxembourg	–5.2	2.4	–0.4	8.9	9.9
Netherlands	11.5	–11.1	–20.4	15.5	14.5
Portugal	19.1	–1.5	16.6	15.3	42.9
Spain	28.7	21.5	–27.9	17.7	44.9

Source: 1970-1989: Historical public debt database, IMF; 1990-2013: AMECO, European commission (cited in Wyplosz, 2014b).

Appendix 7: Main changes between Basel II and III's definition of regulatory capital

Main changes to the definition of regulatory capital					
	Basel II requirements	8%	Basel III requirements		8%
Tier 3			Abolished		
Tier 2	E.g. undisclosed reserves, subordinated debt - Deductions	4%	No substantial alterations		2%
Additional Tier 1	Some preference shares Hybrid capital - Deductions	2%	Some preference shares Portions of minority interests Hybrids with innovative features no longer accepted		1.5%
Core Tier 1	Common equity Retained earnings Minority interests Some preference shares - Deductions	2%	Common equity Retained earnings Portions of minority interests Preference shares generally excluded Silent partnerships generally excluded Portions of minority interests excluded - All existing deductions - Additional deductions (e.g. deferred tax assets)		4.5%

Source: European Central Bank, 2010.

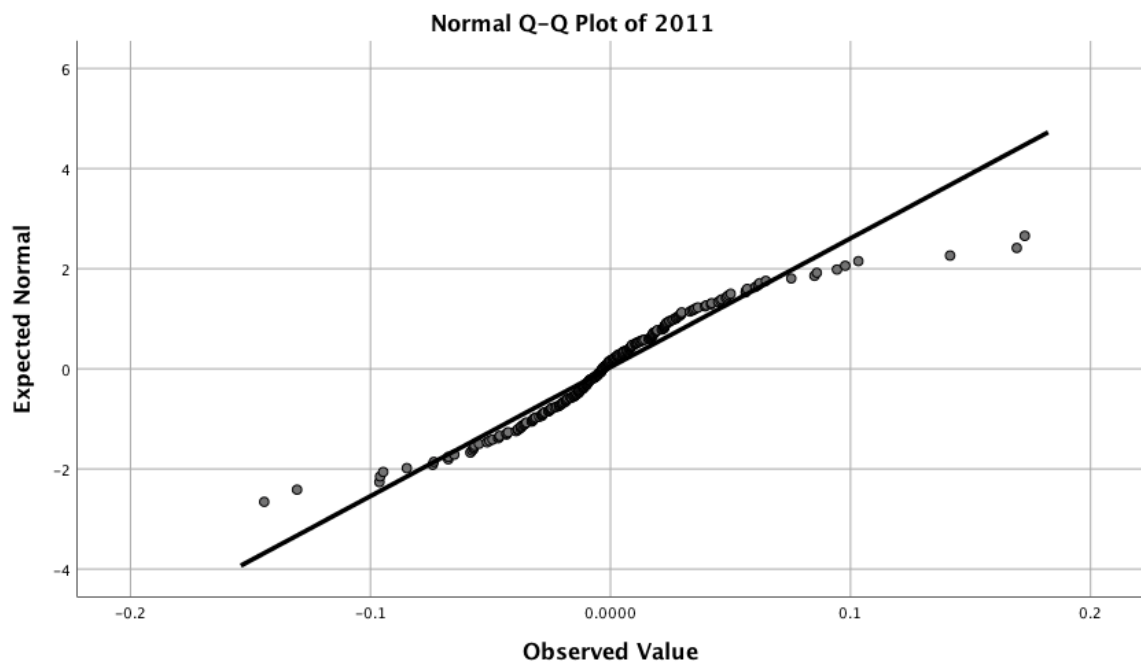
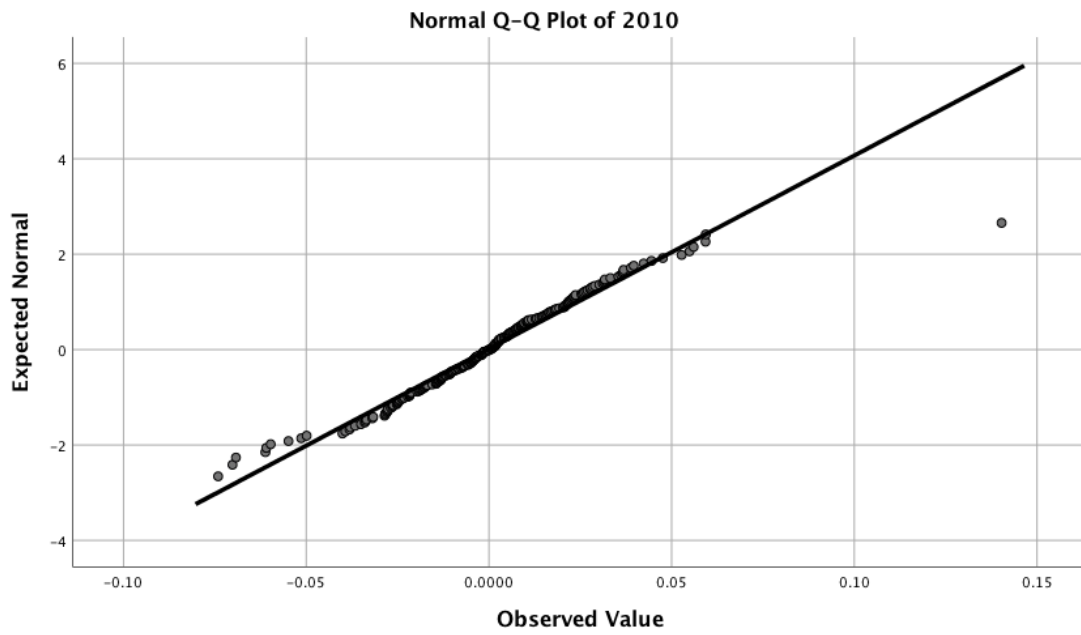
Appendix 8: Tests of Normality and Q-Q Plots from 2010 to 2014 for BNP Paribas

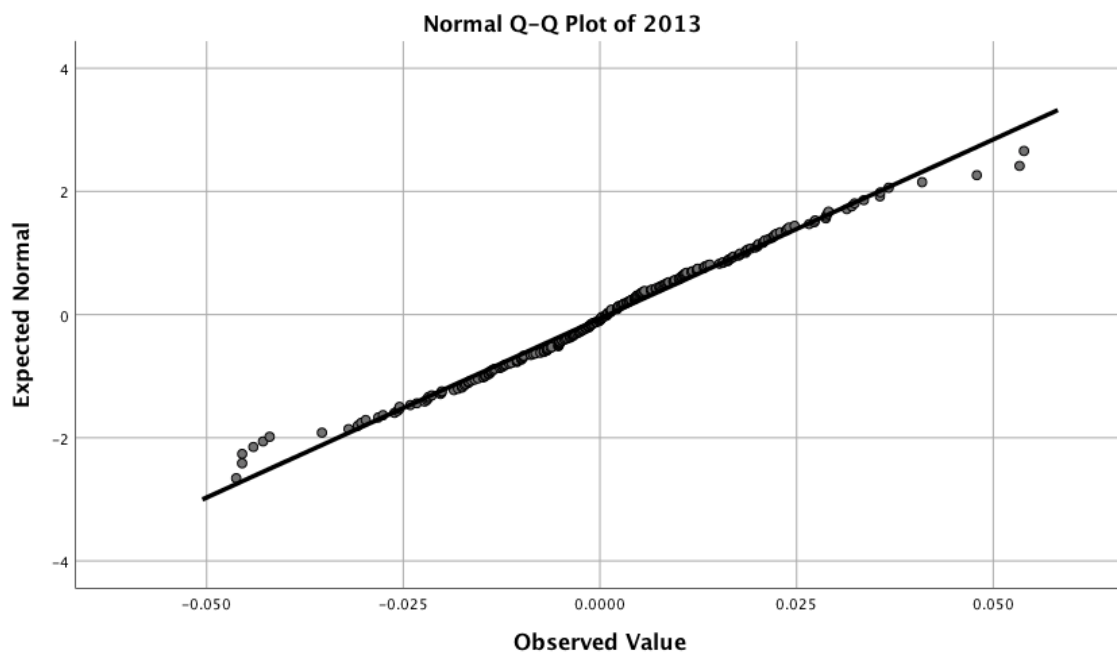
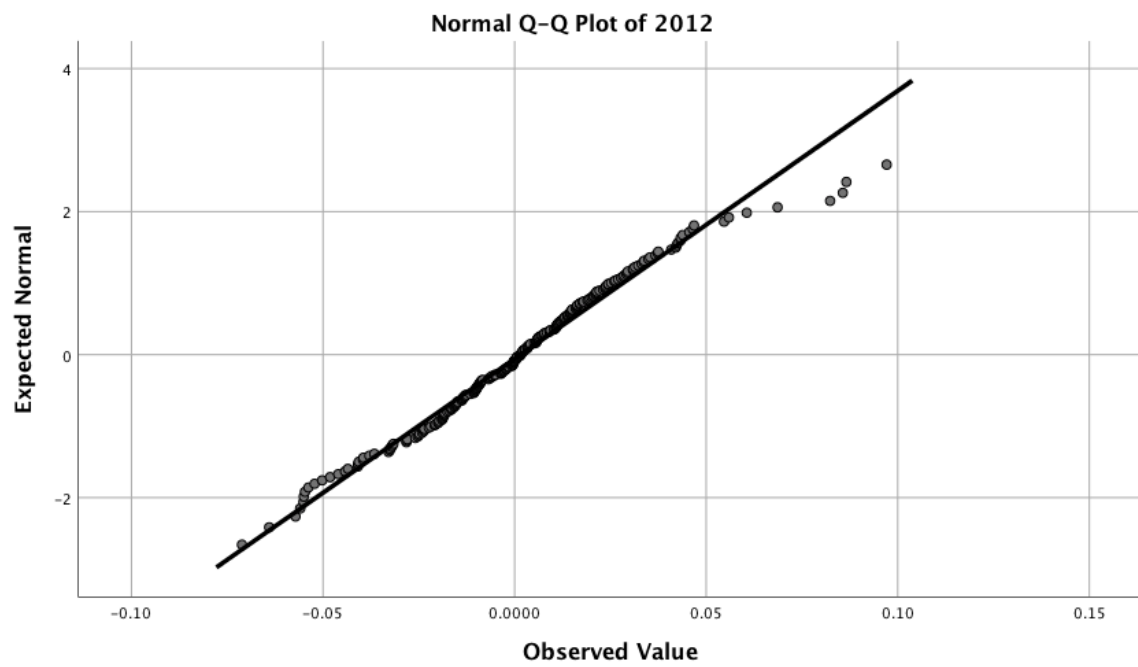
Tests of Normality

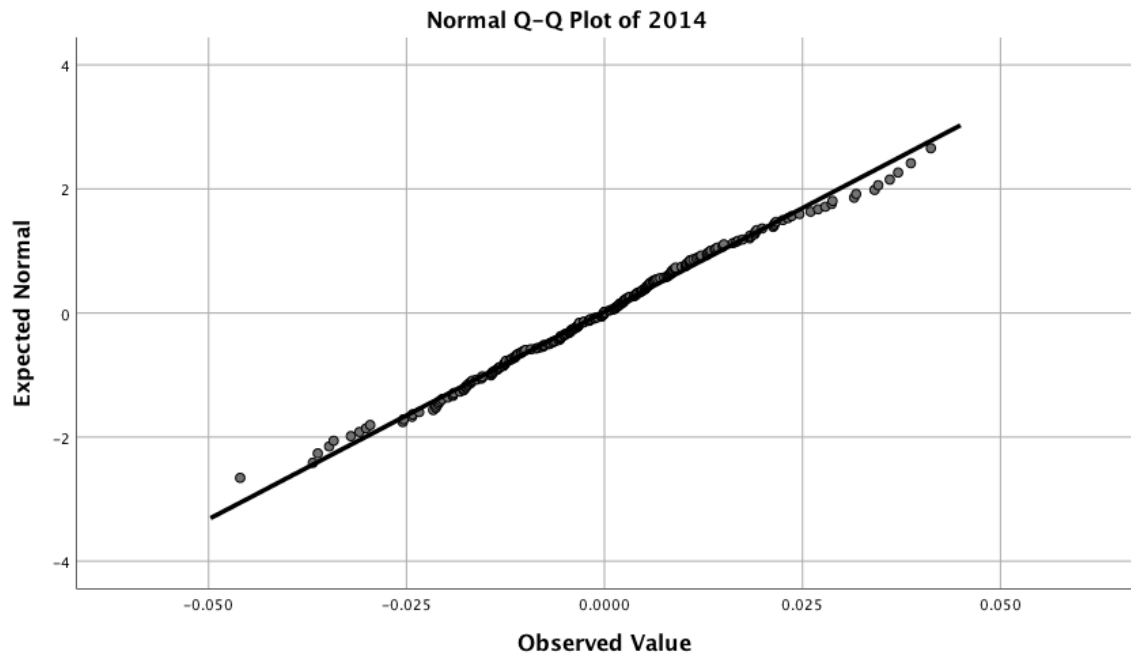
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.060	253	.028	.958	253	.000
2011	.087	253	.000	.933	253	.000
2012	.048	253	.200*	.983	253	.005
2013	.055	253	.064	.990	253	.083
2014	.039	253	.200*	.995	253	.607

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction







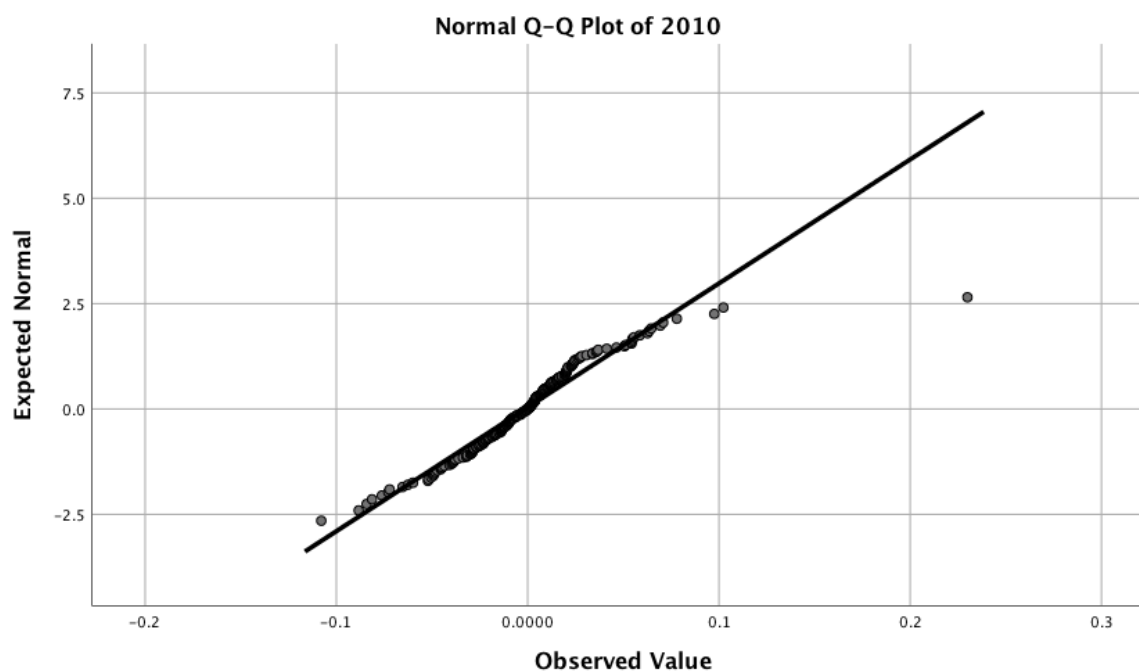
Appendix 9: Tests of Normality and Q-Q Plots from 2010 to 2014 for Banco Santander

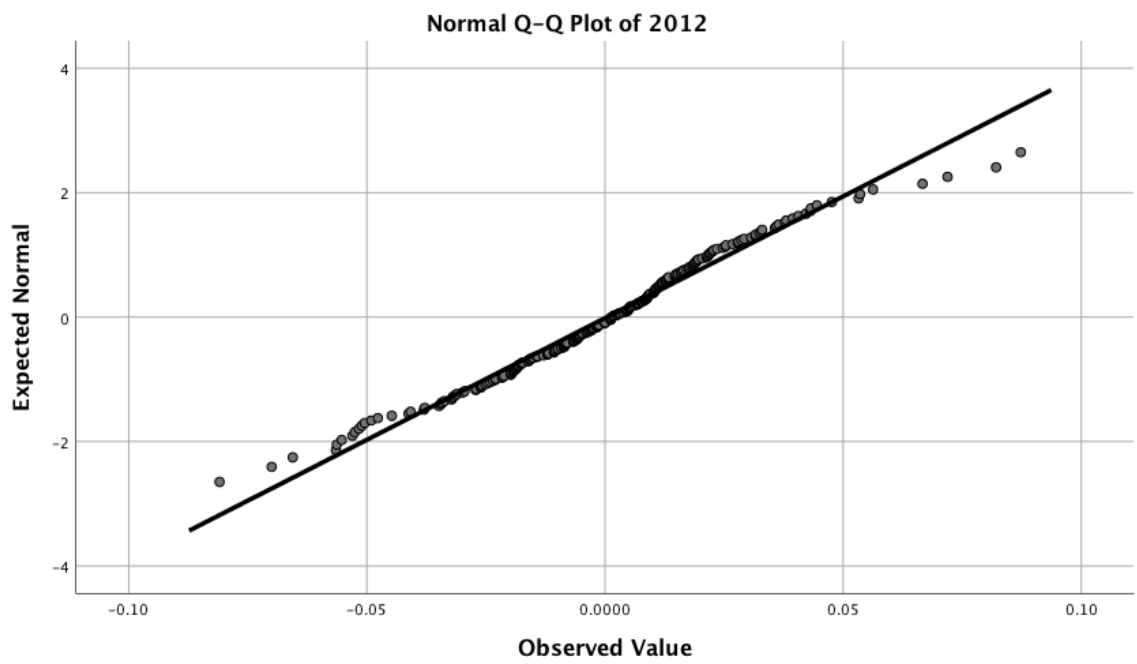
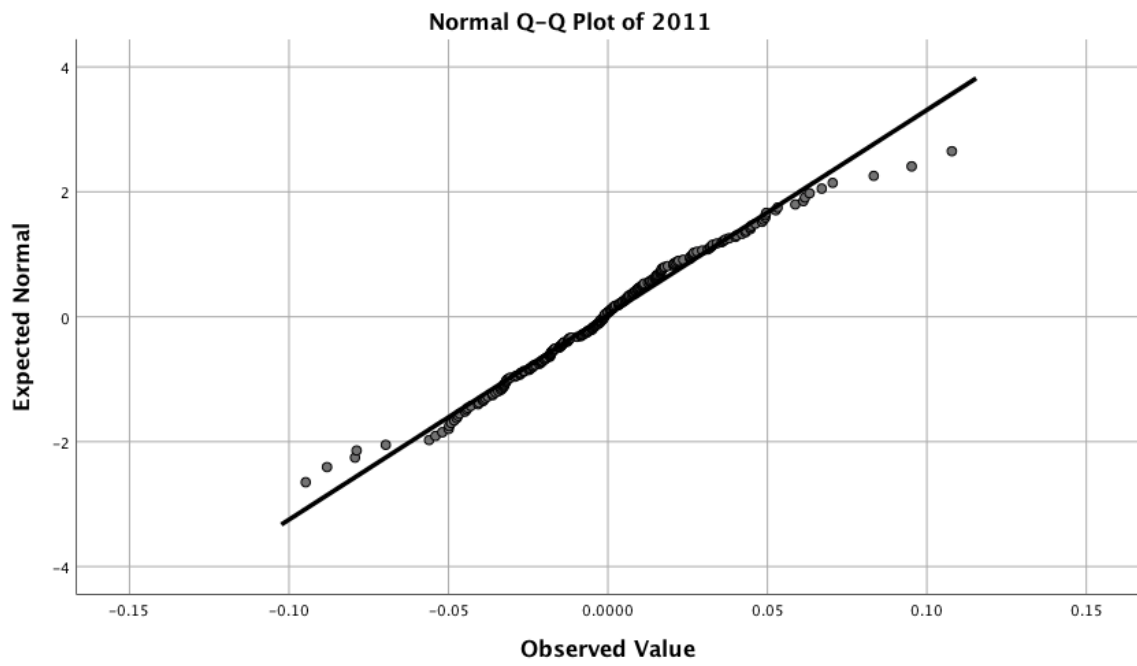
Tests of Normality

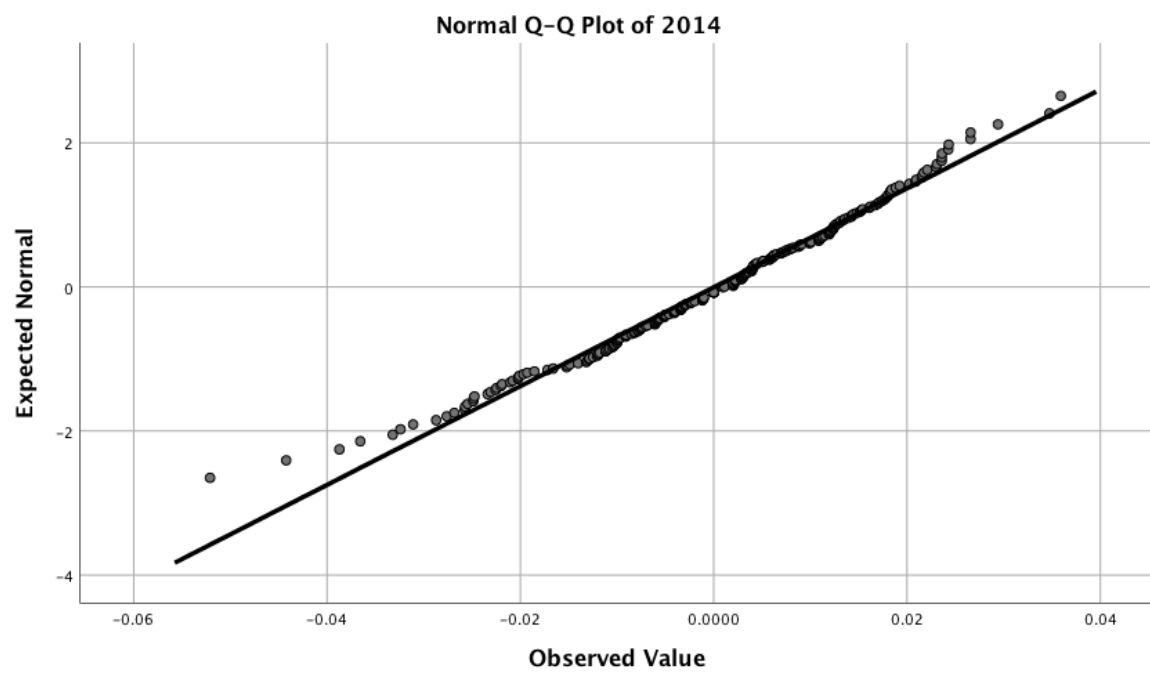
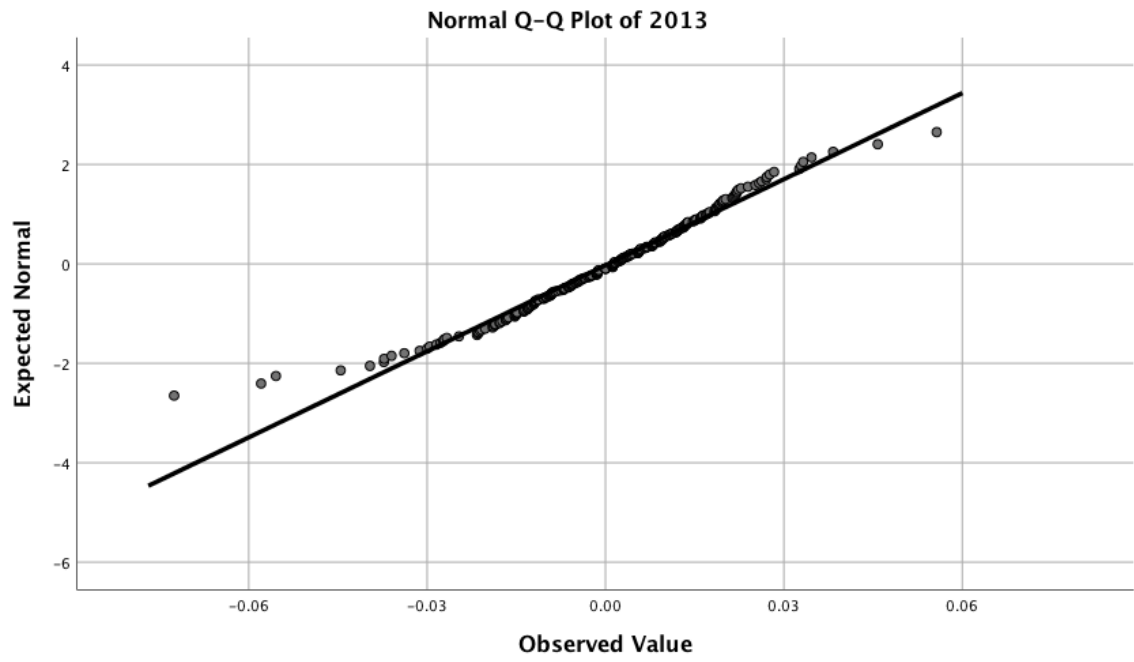
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.102	248	.000	.913	248	.000
2011	.061	248	.026	.988	248	.038
2012	.053	248	.085	.985	248	.011
2013	.045	248	.200*	.978	248	.001
2014	.055	248	.071	.987	248	.028

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction







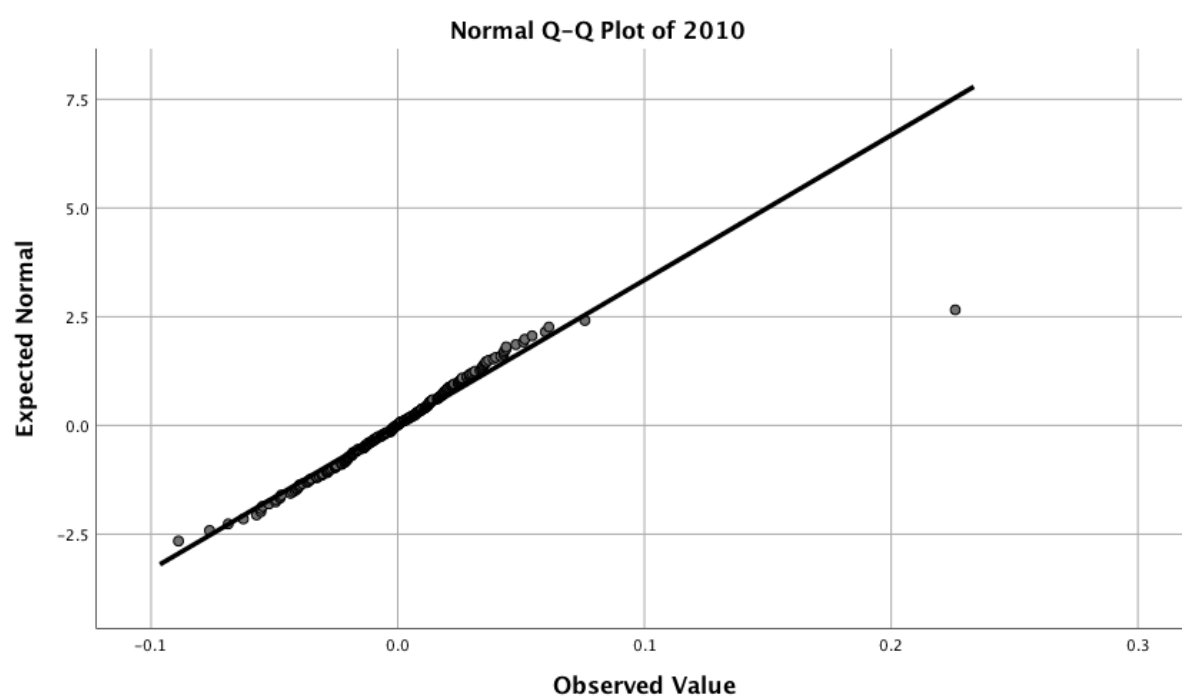
Appendix 10: Tests of Normality and Q-Q Plots from 2010 to 2014 for KBC Group

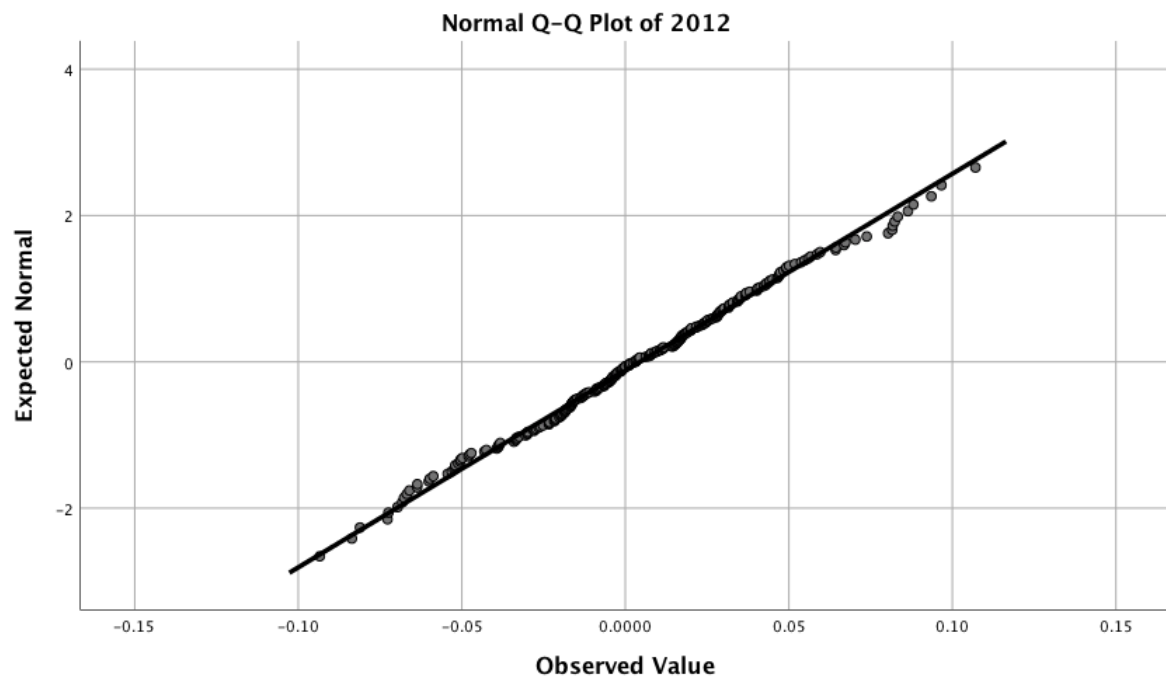
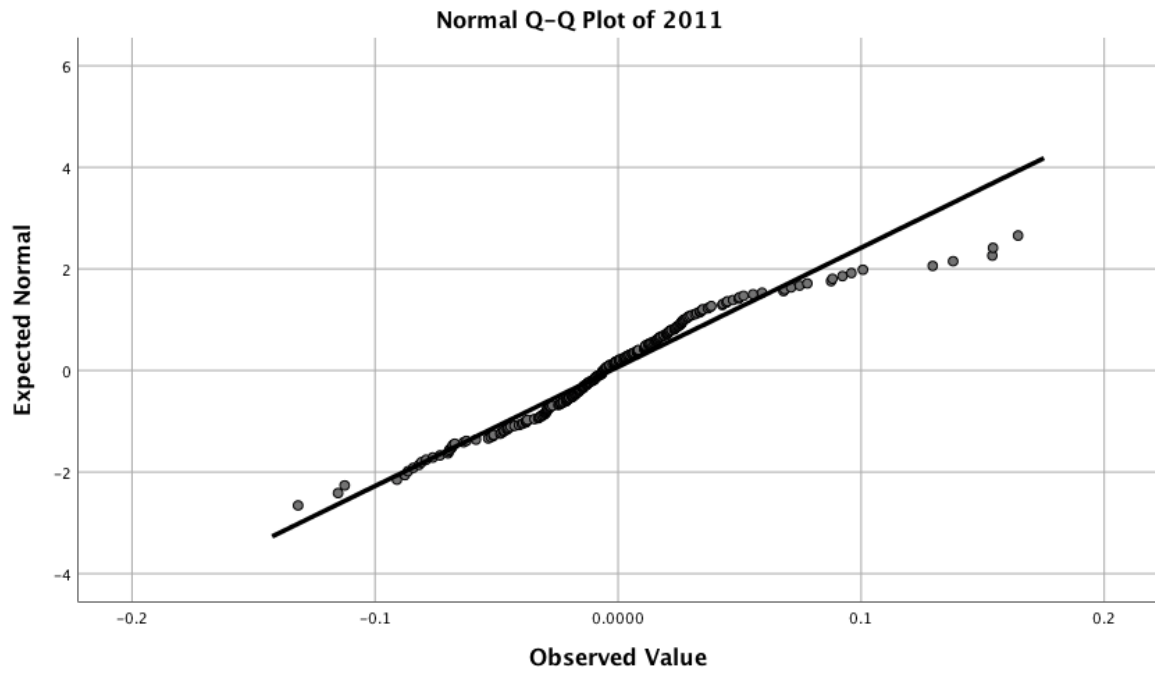
Tests of Normality

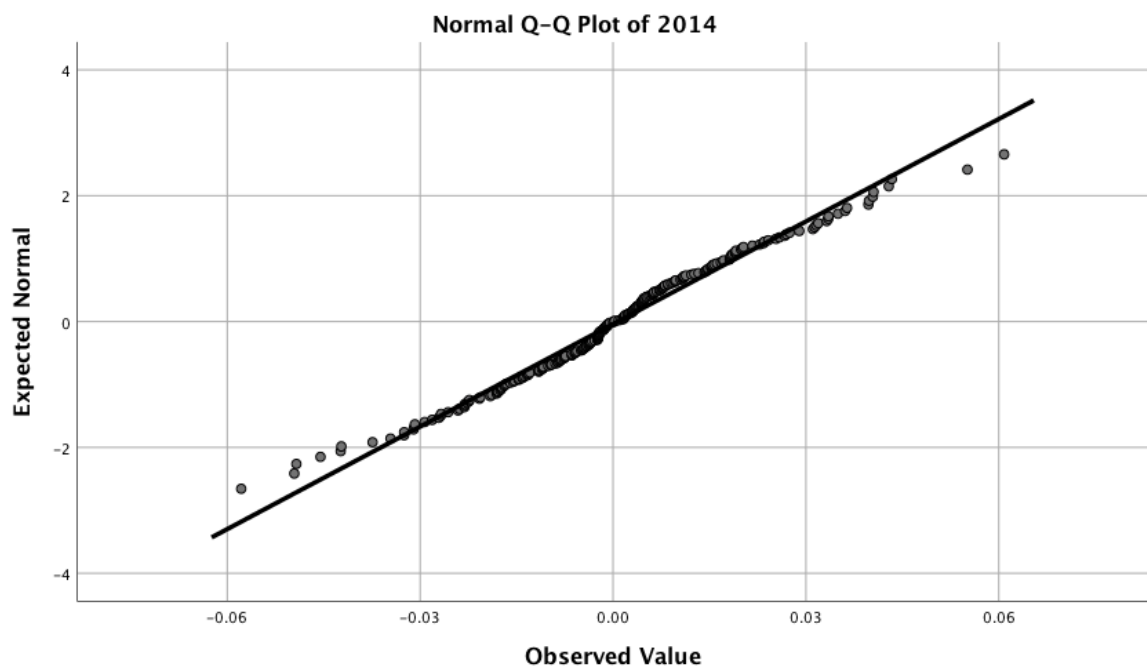
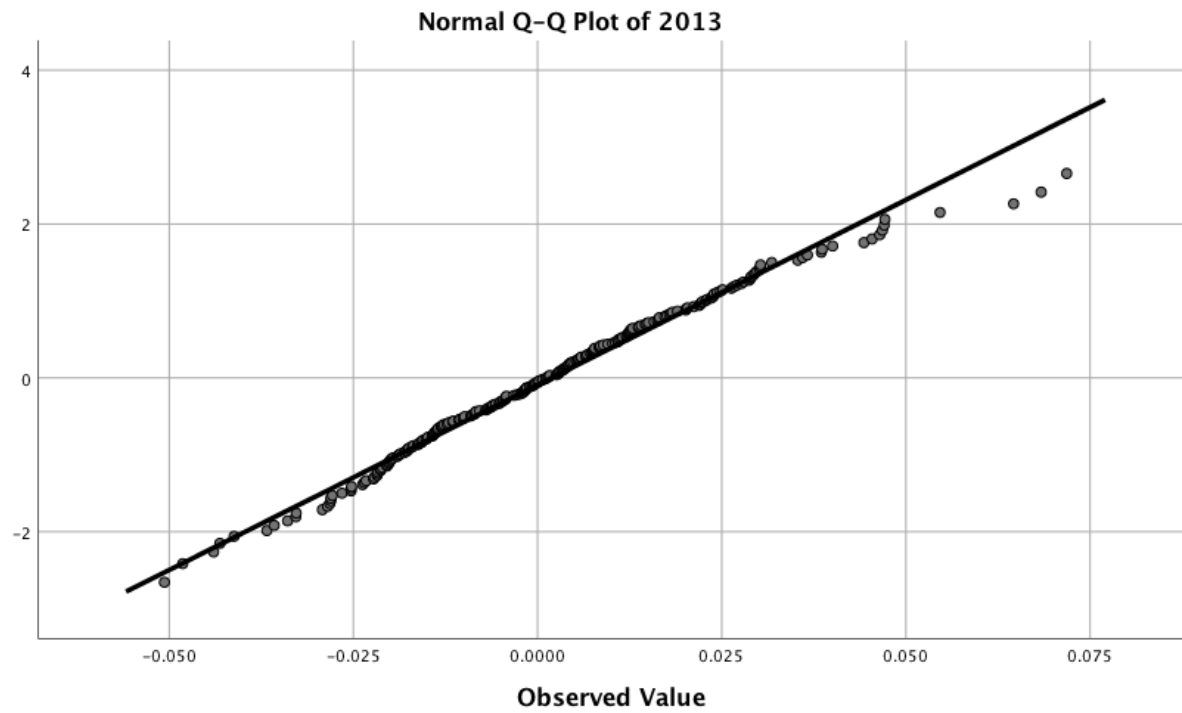
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.054	253	.069	.908	253	.000
2011	.085	253	.000	.948	253	.000
2012	.035	253	.200 [*]	.995	253	.664
2013	.041	253	.200 [*]	.988	253	.041
2014	.064	253	.014	.987	253	.022

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction







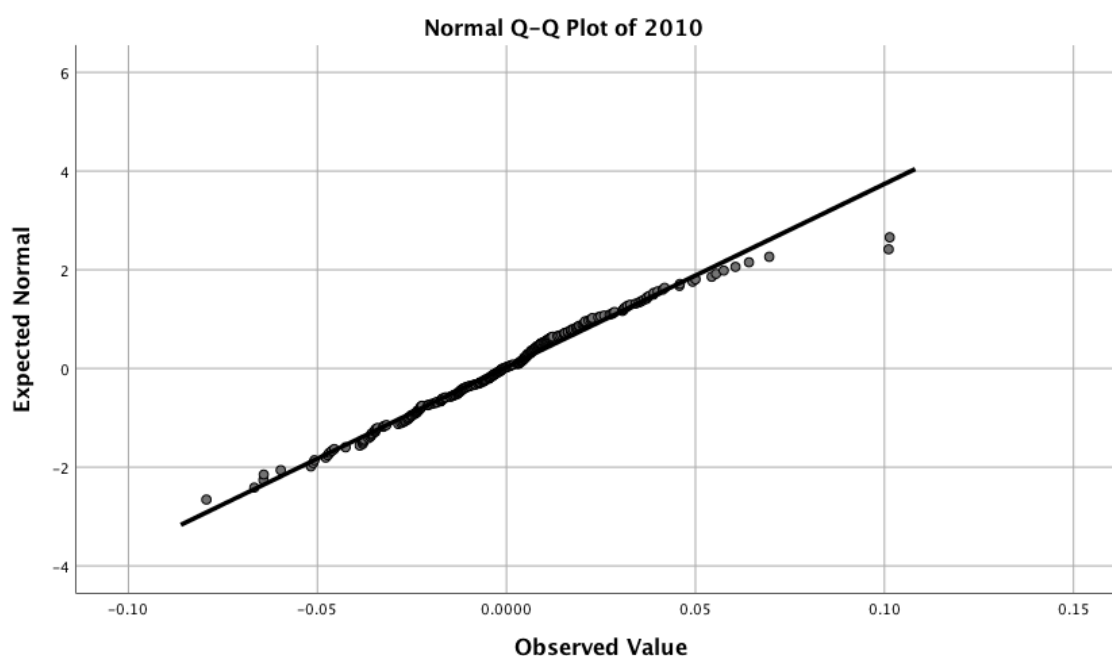
Appendix 11: Tests of Normality and Q-Q Plots from 2010 to 2014 for Crédit Agricole

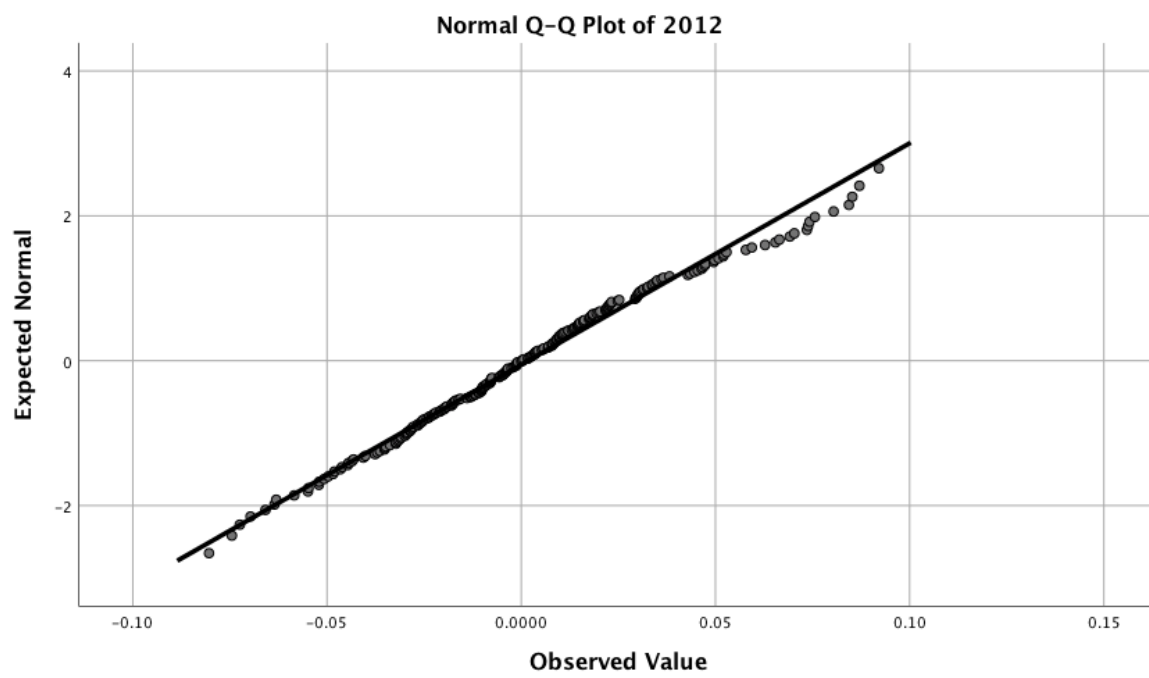
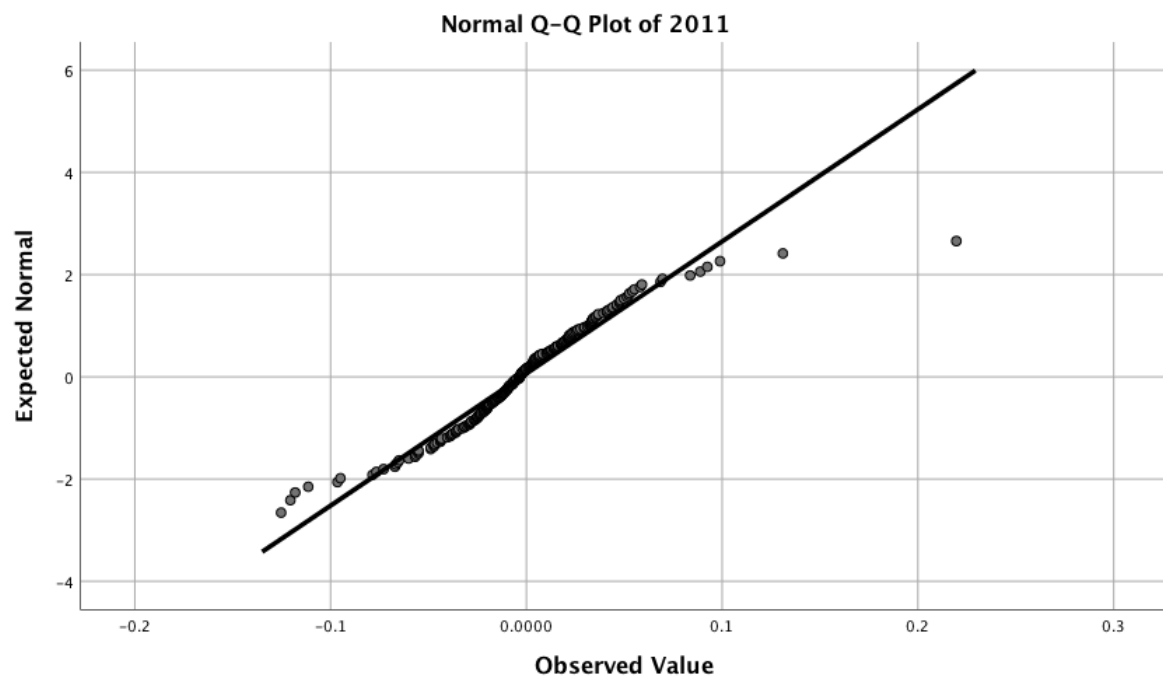
Tests of Normality

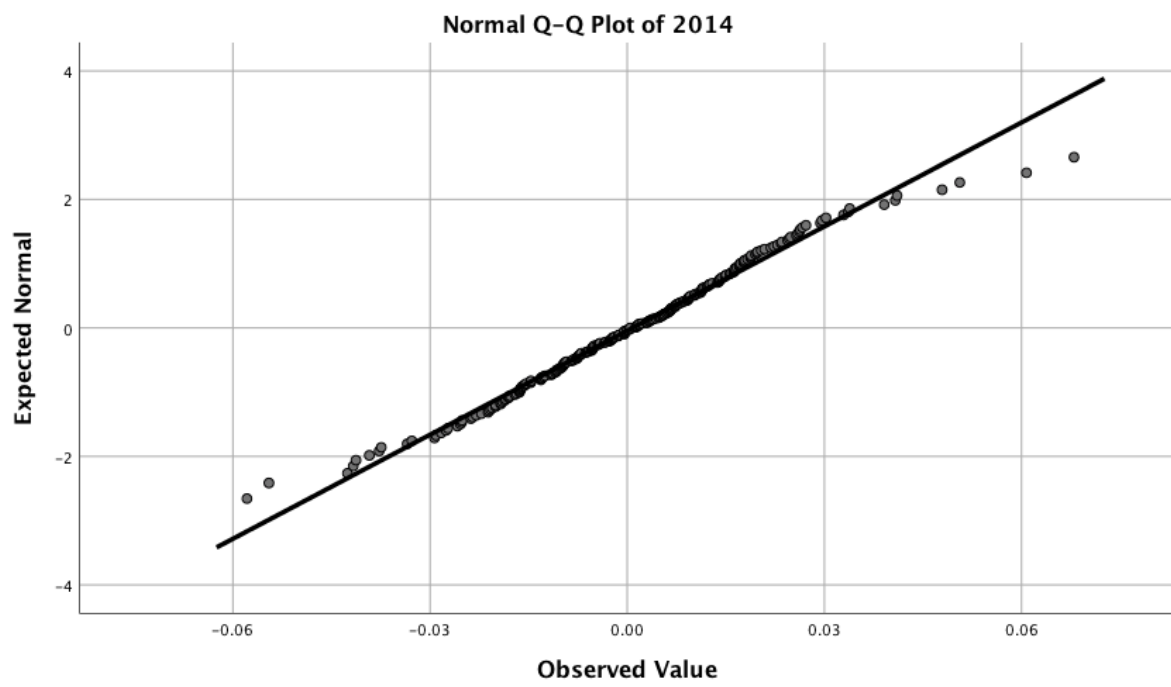
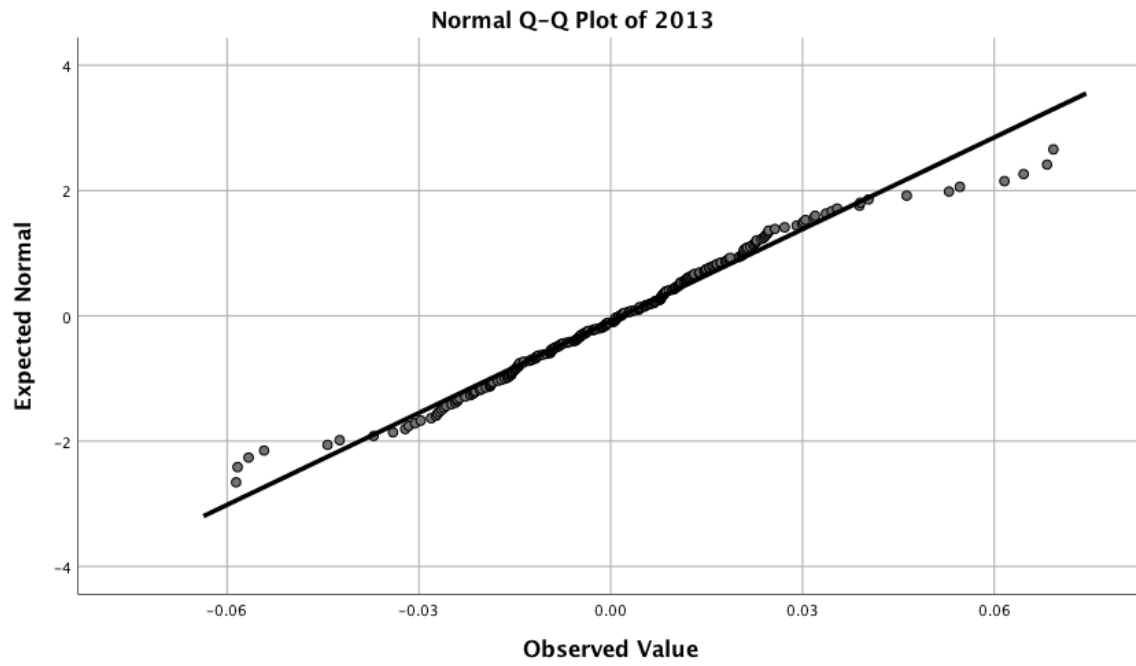
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.059	253	.035	.985	253	.009
2011	.073	253	.002	.941	253	.000
2012	.050	253	.200 [*]	.990	253	.076
2013	.048	253	.200 [*]	.981	253	.002
2014	.038	253	.200 [*]	.990	253	.082

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction







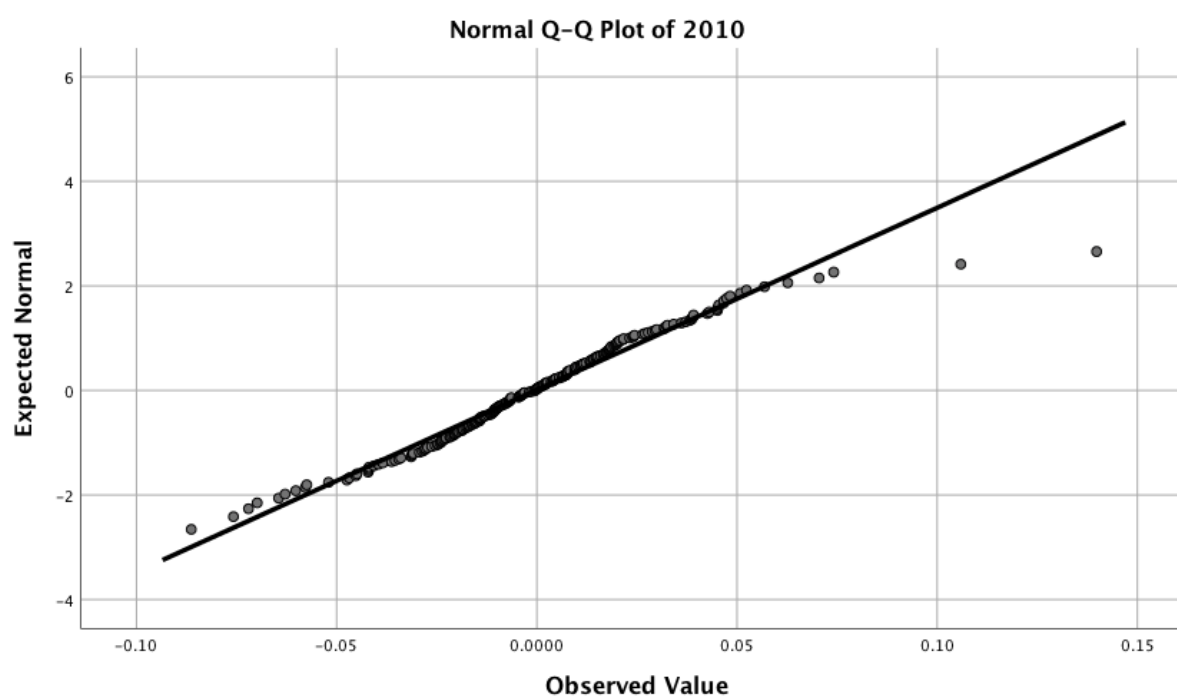
Appendix 12: Tests of Normality and Q-Q Plots from 2010 to 2014 for Société Générale

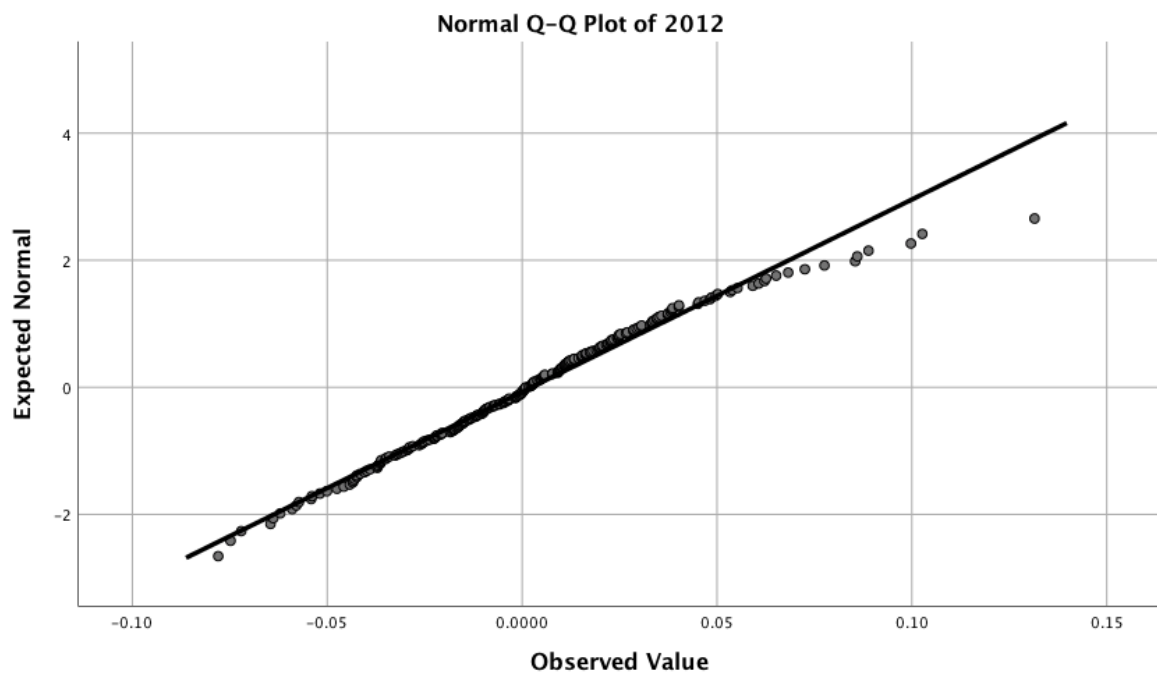
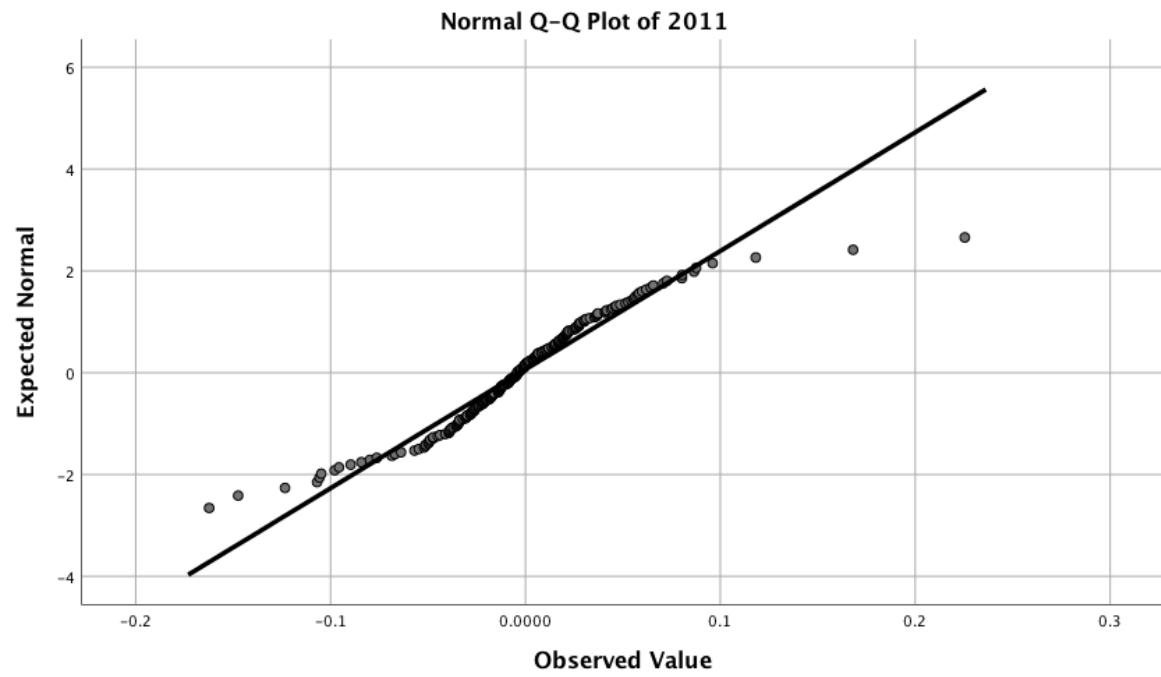
Tests of Normality

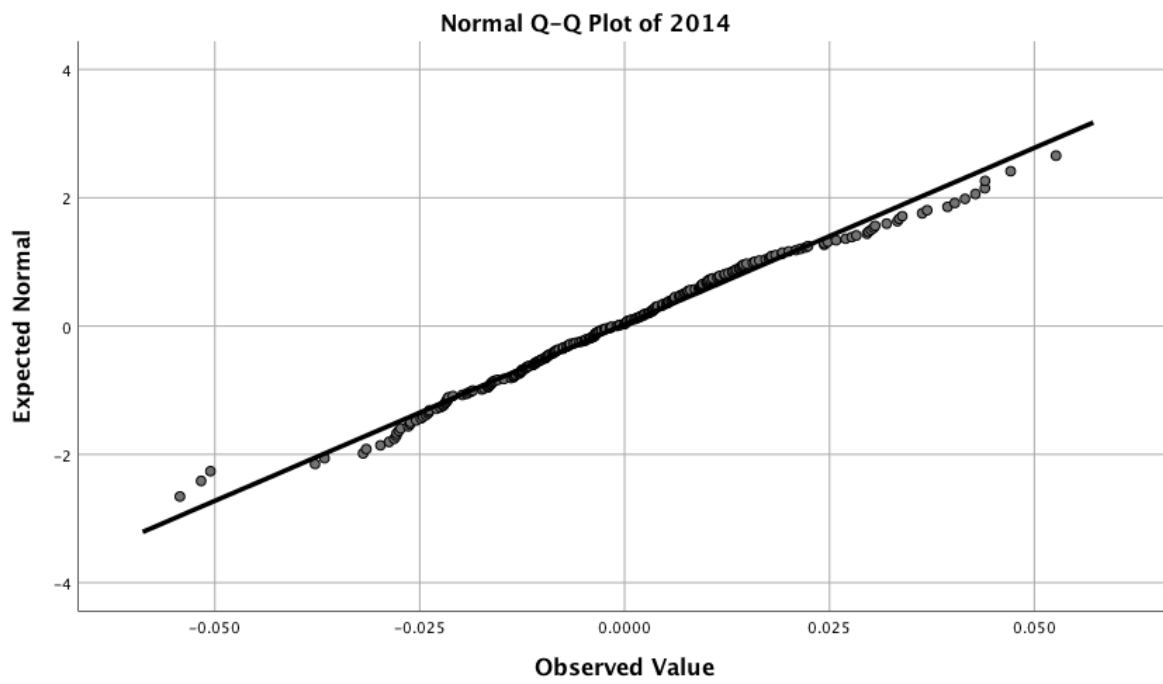
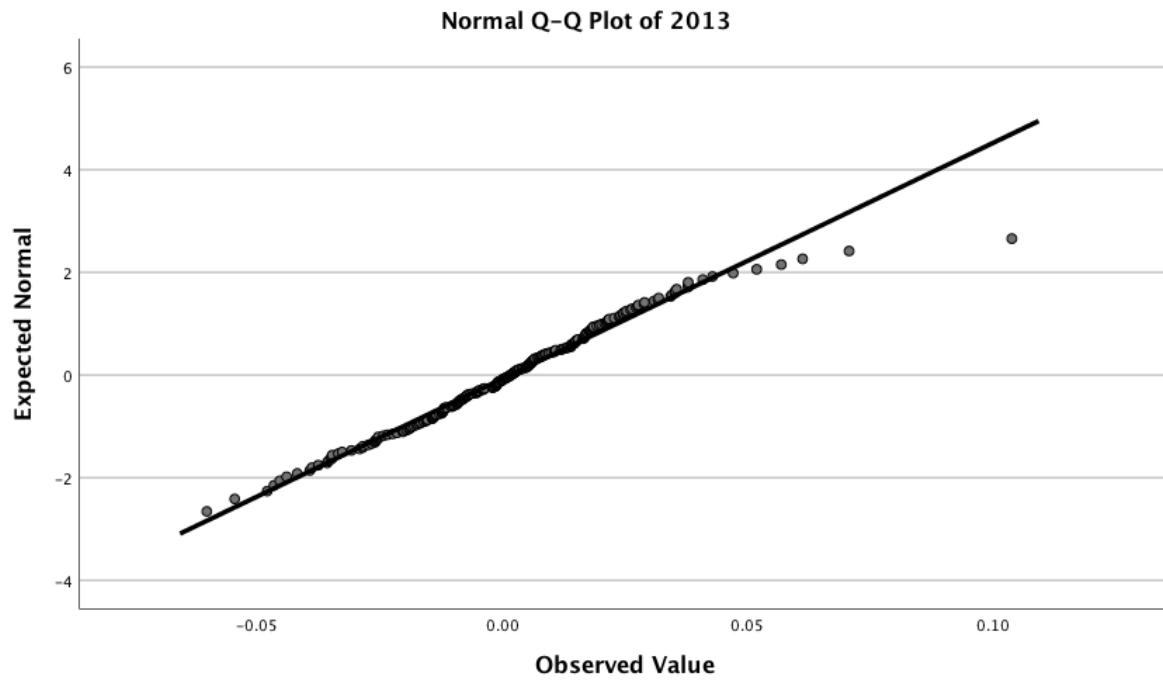
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.065	253	.011	.970	253	.000
2011	.082	253	.000	.936	253	.000
2012	.048	253	.200 [*]	.984	253	.007
2013	.047	253	.200 [*]	.980	253	.001
2014	.044	253	.200 [*]	.990	253	.072

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction







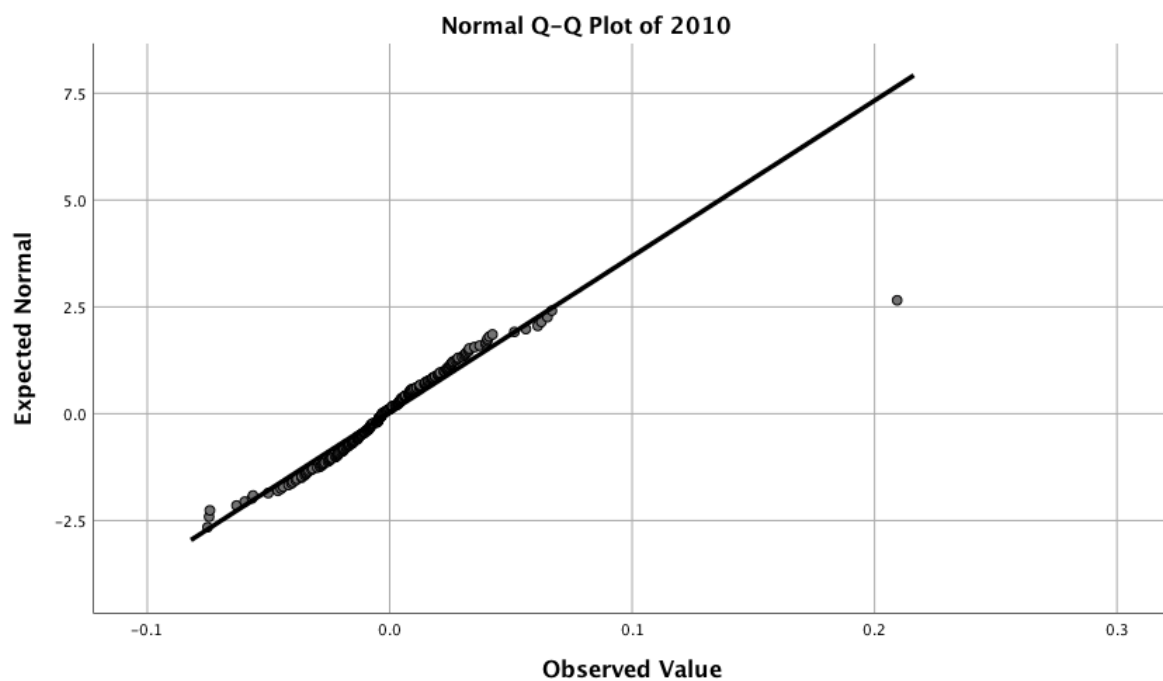
Appendix 13: Tests of Normality and Q-Q Plots from 2010 to 2014 for UniCredit

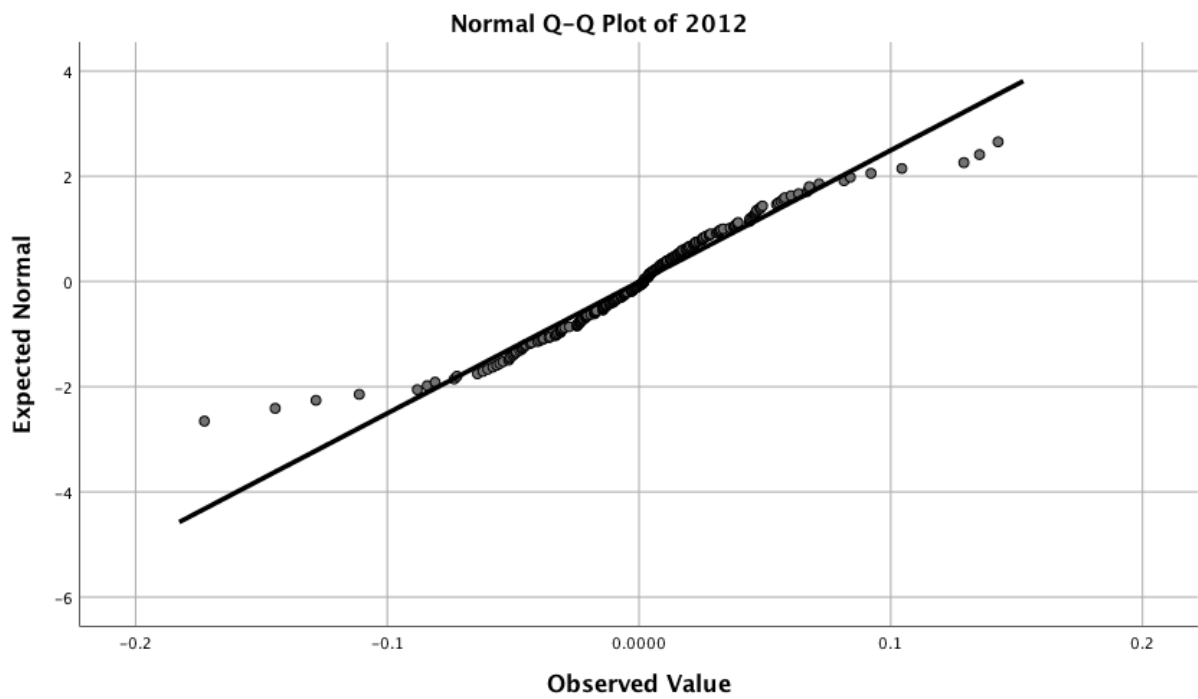
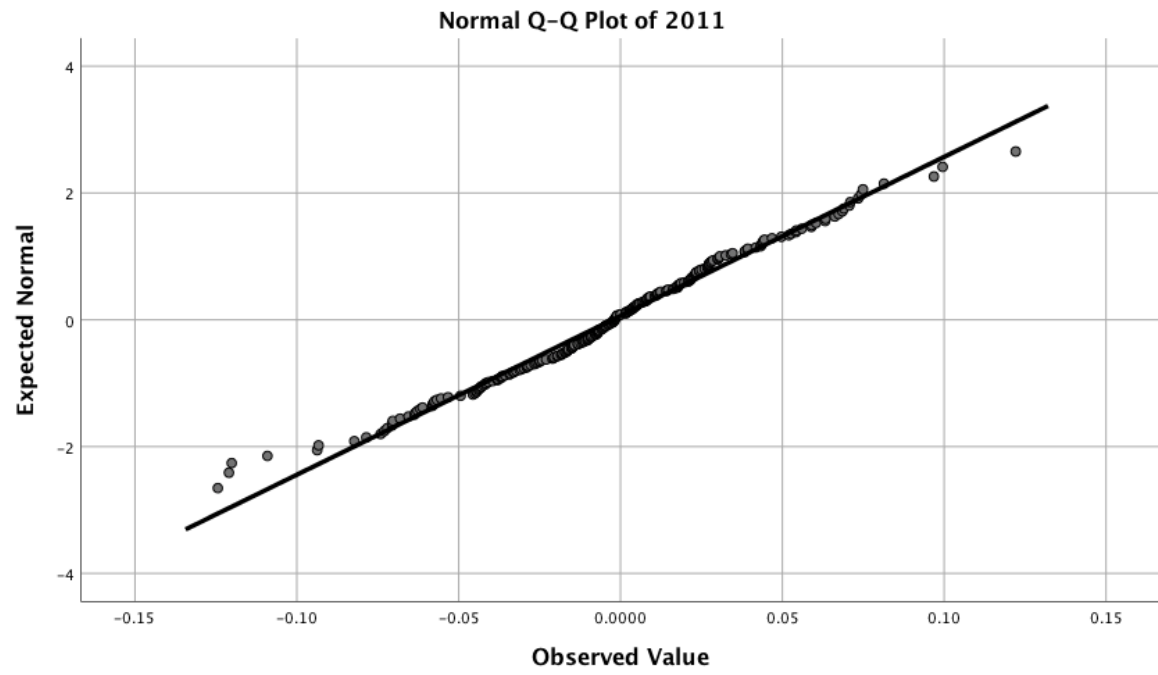
Tests of Normality

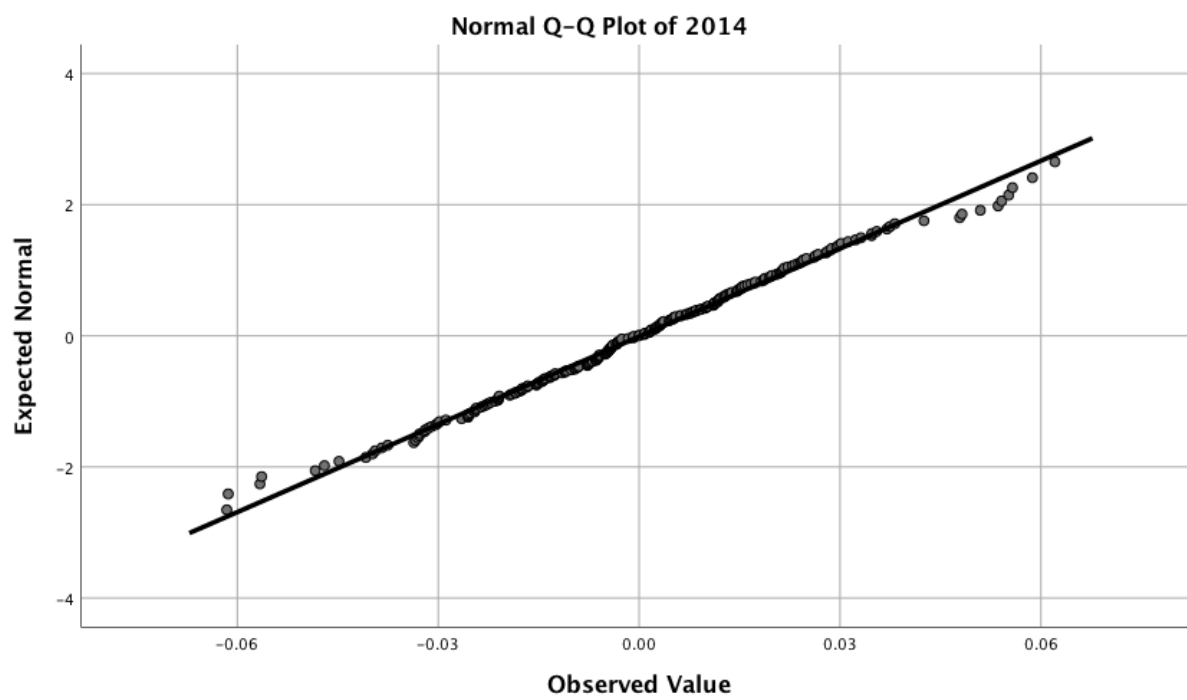
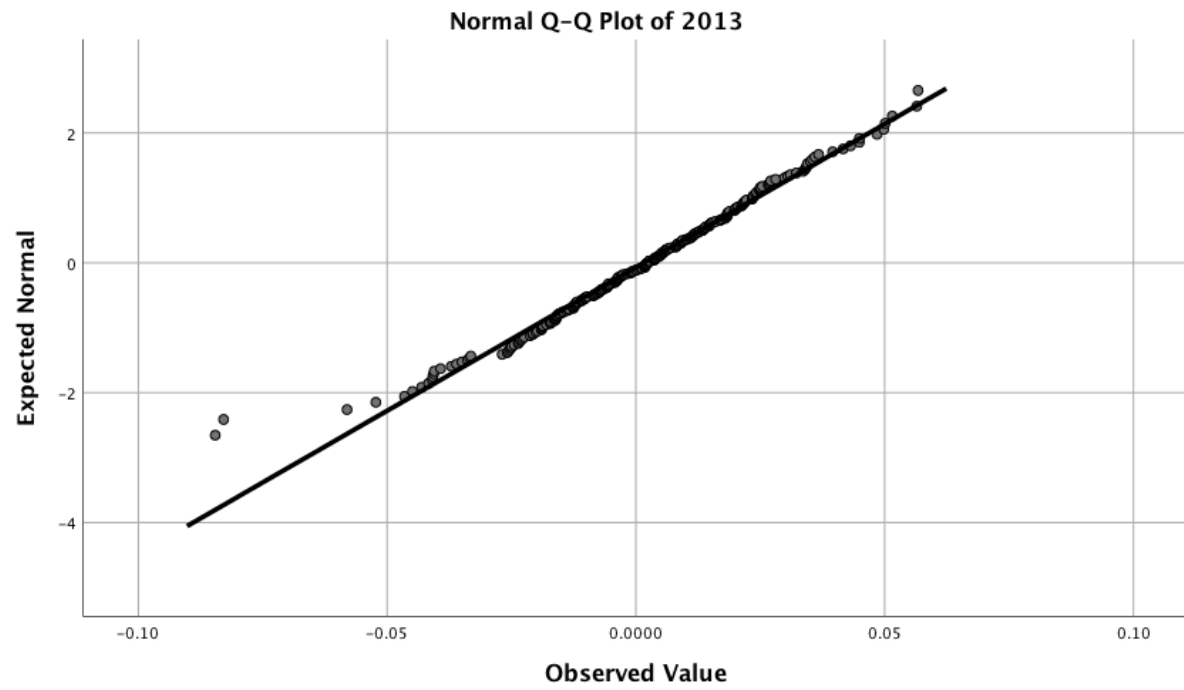
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.078	251	.001	.893	251	.000
2011	.059	251	.036	.990	251	.075
2012	.071	251	.004	.959	251	.000
2013	.034	251	.200*	.986	251	.013
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*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction







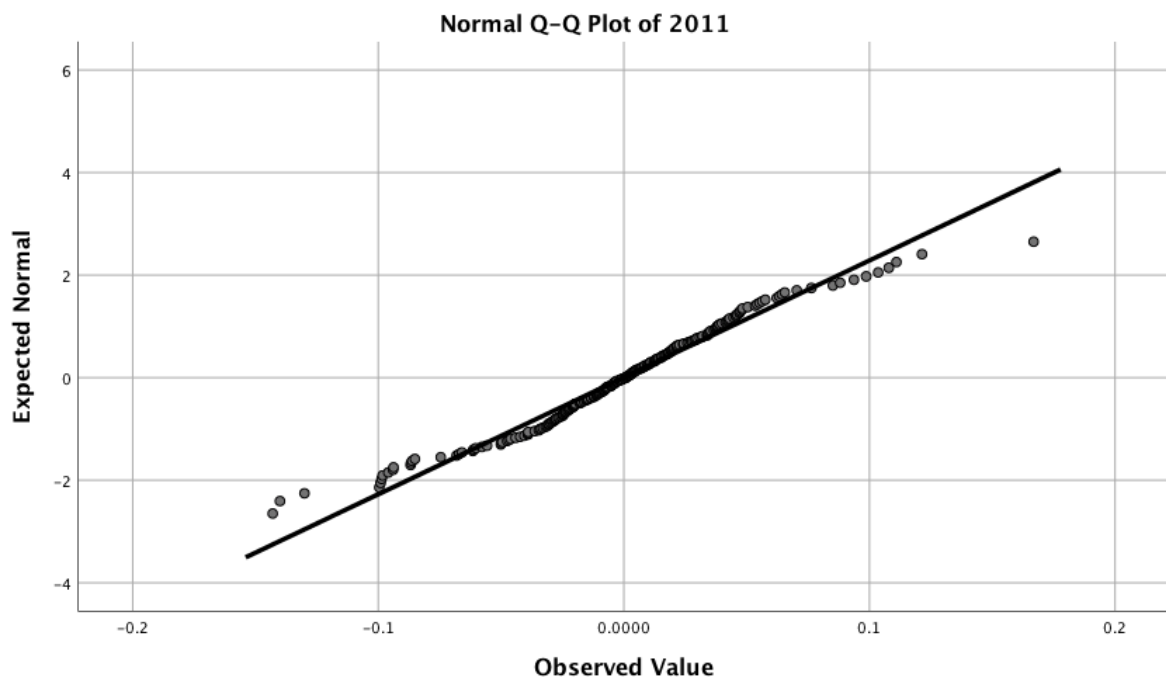
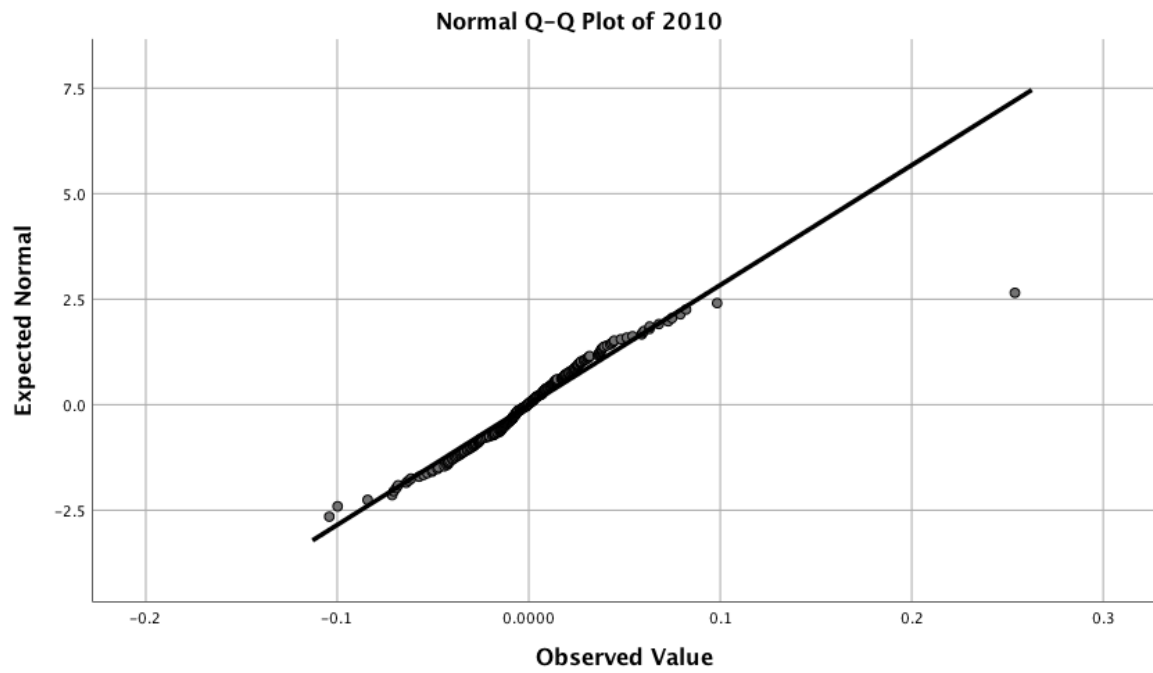
Appendix 14: Tests of Normality and Q-Q Plots from 2010 to 2014 for ING

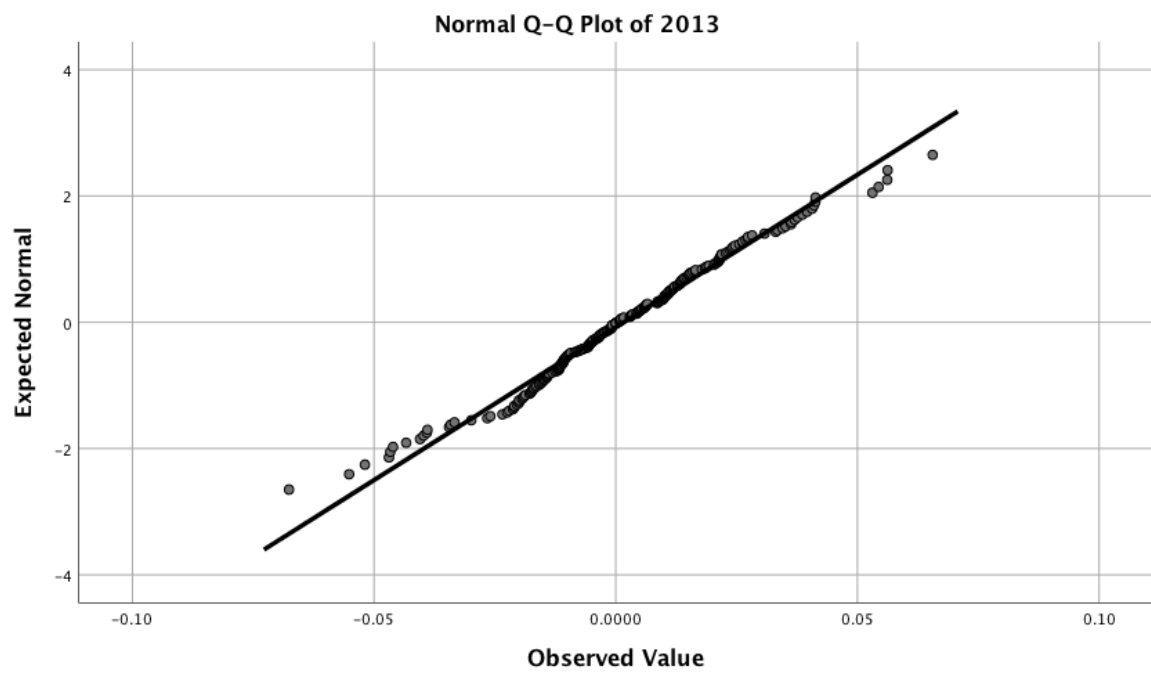
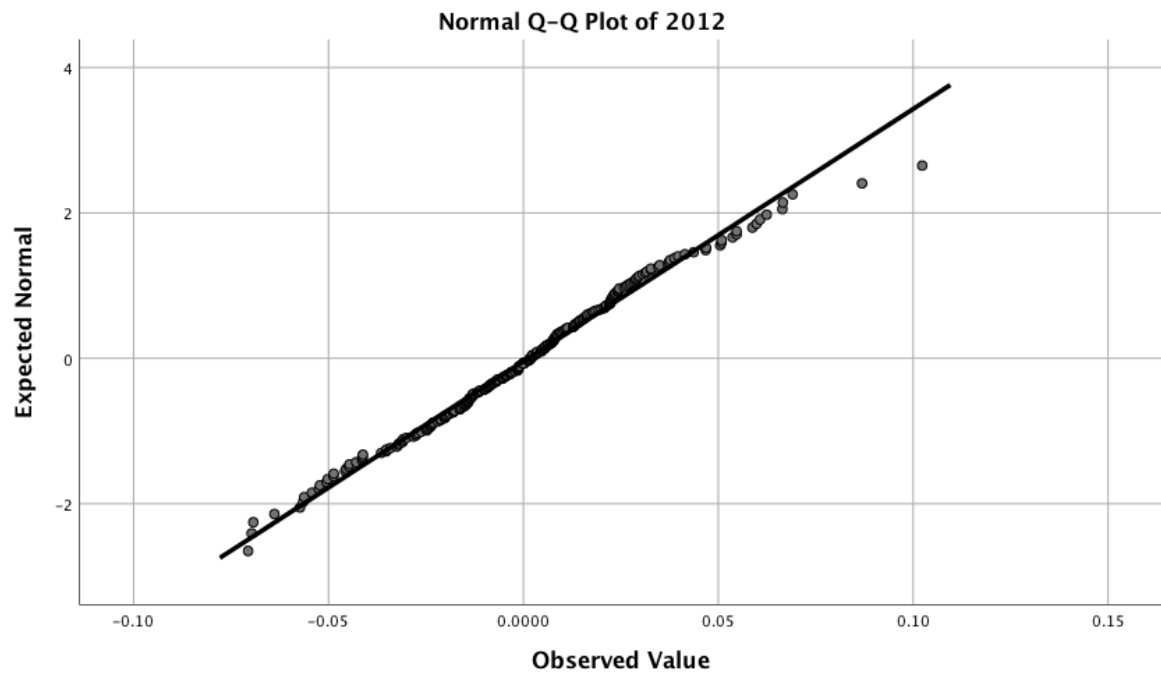
Tests of Normality

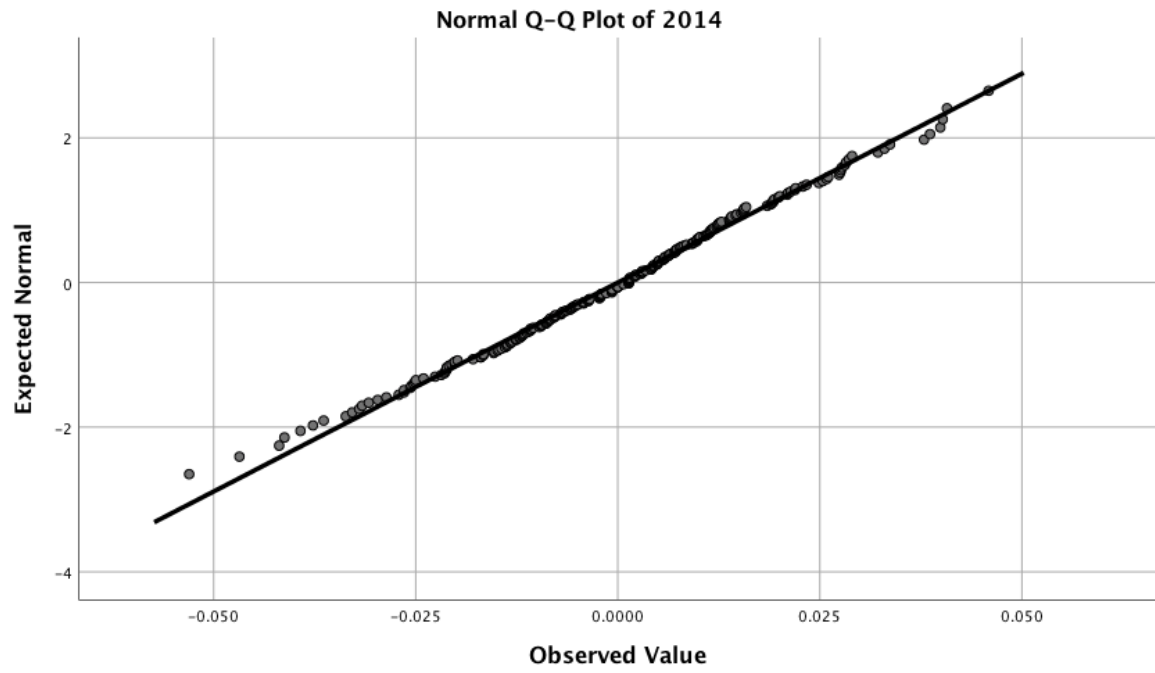
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.074	248	.002	.910	248	.000
2011	.070	248	.005	.976	248	.000
2012	.043	248	.200 [*]	.992	248	.187
2013	.053	248	.091	.988	248	.041
2014	.039	248	.200 [*]	.996	248	.707

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction







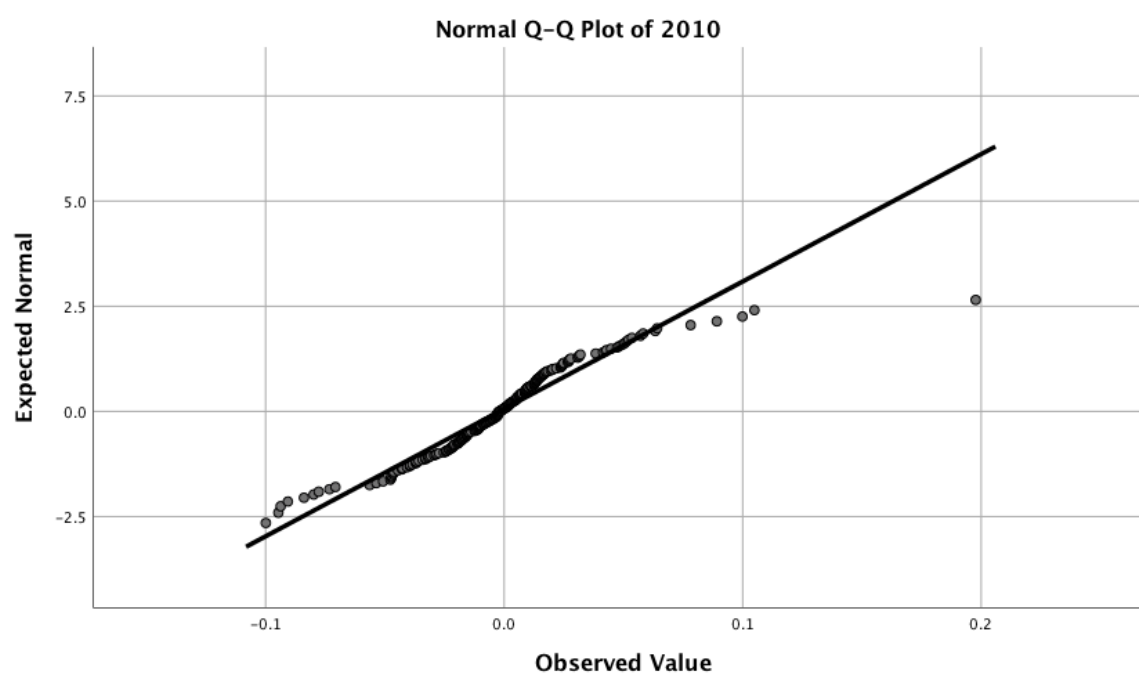
Appendix 15: Tests of Normality and Q-Q Plots from 2010 to 2014 for BBVA

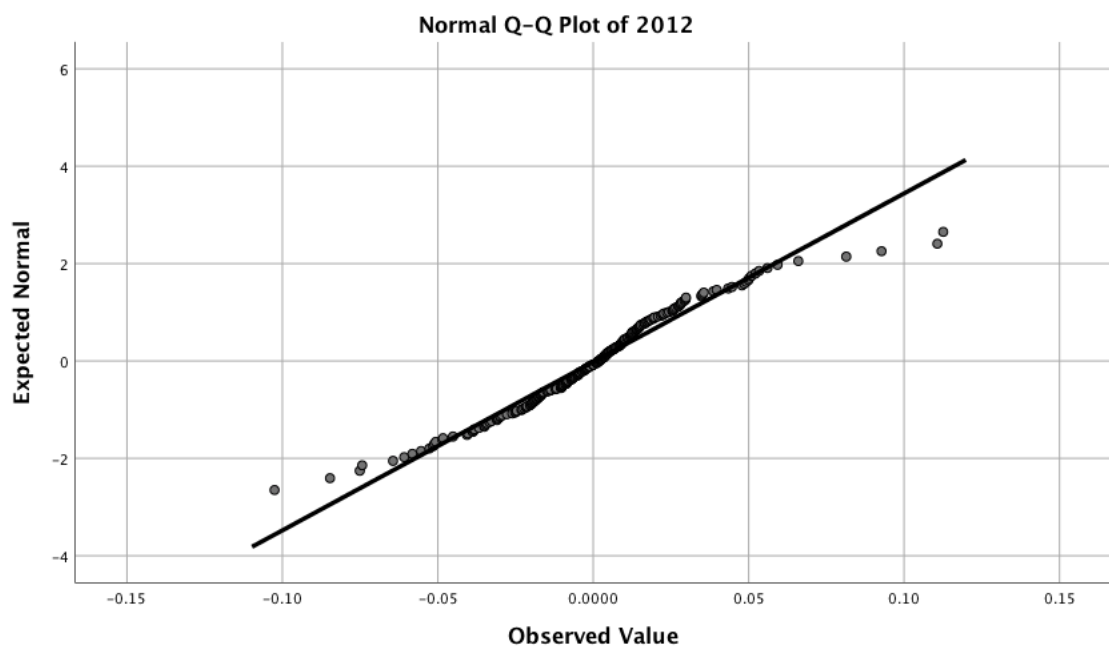
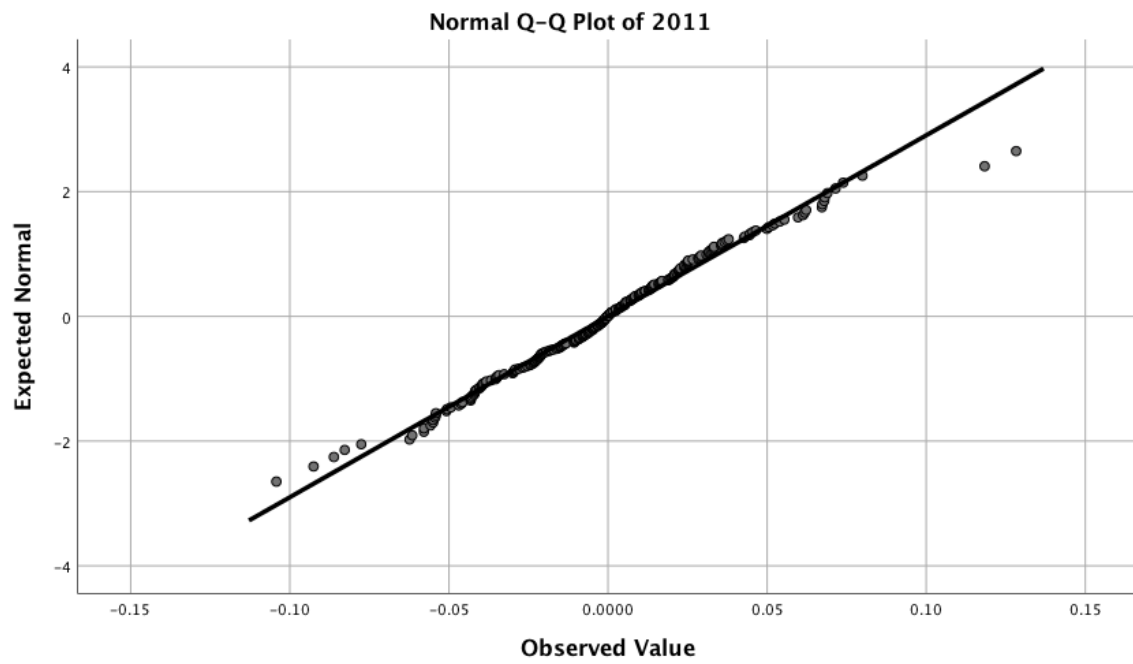
Tests of Normality

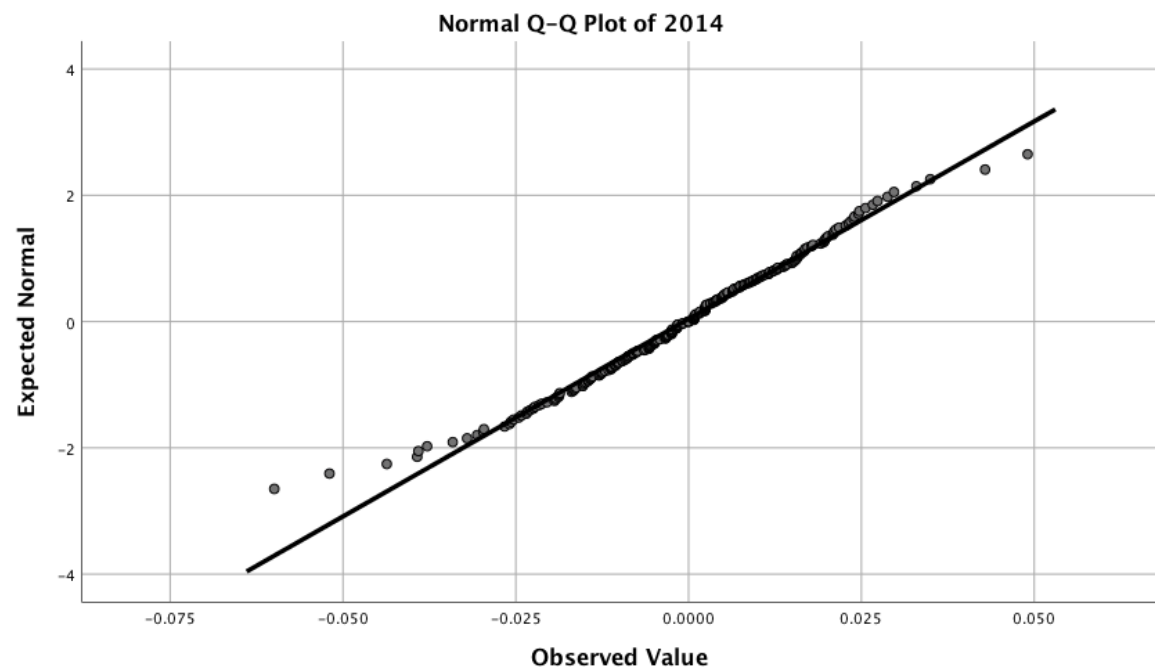
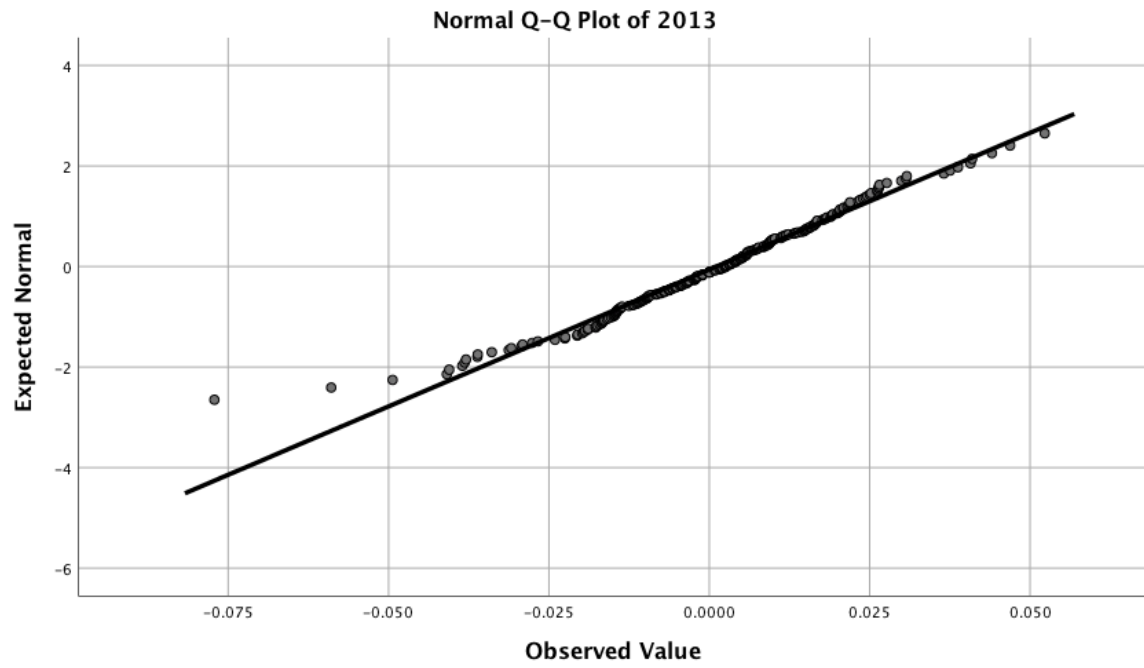
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.107	248	.000	.921	248	.000
2011	.050	248	.200 [*]	.989	248	.047
2012	.079	248	.001	.966	248	.000
2013	.043	248	.200 [*]	.983	248	.004
2014	.044	248	.200 [*]	.990	248	.103

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction







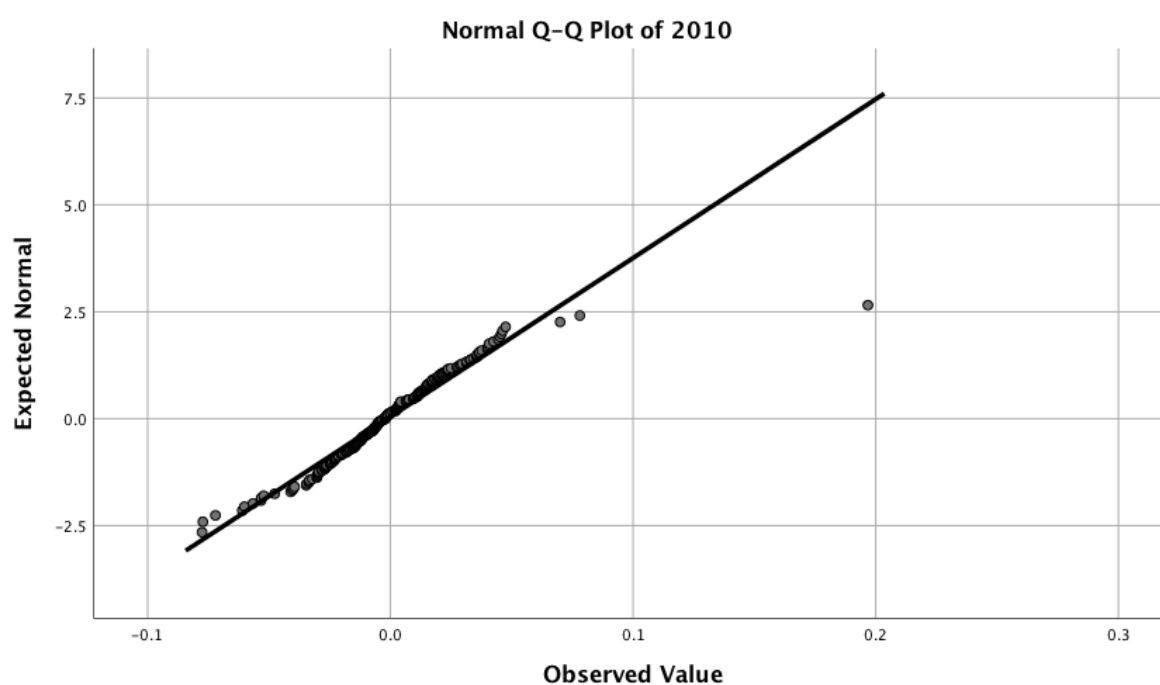
Appendix 16: Tests of Normality and Q-Q Plots from 2010 to 2014 for Intesa Sanpaolo

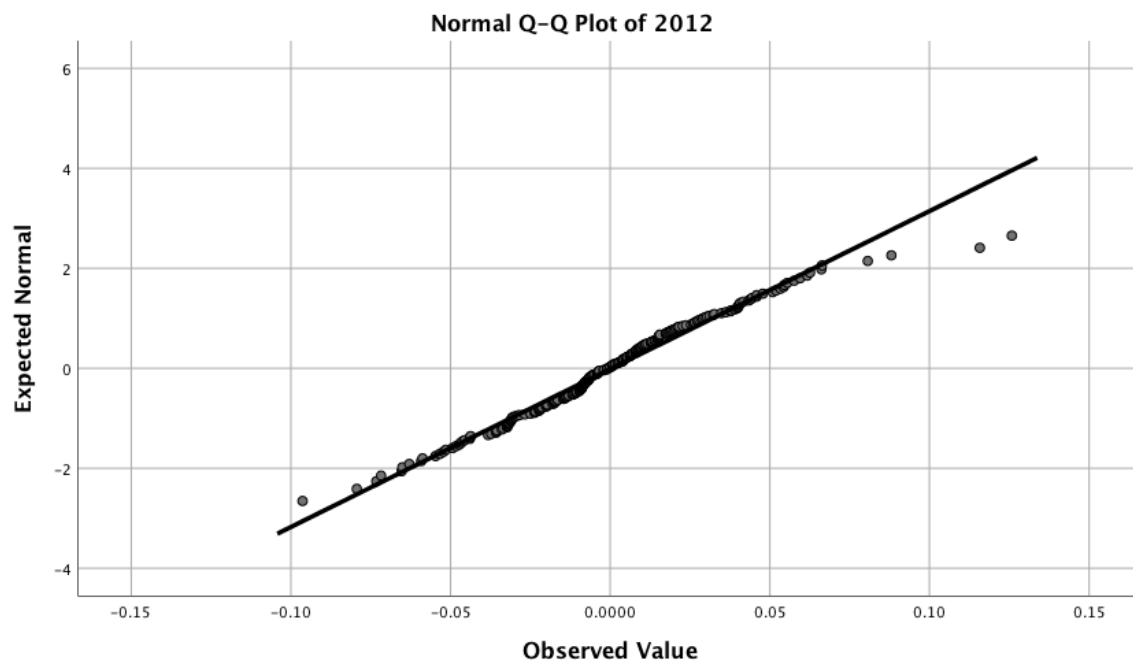
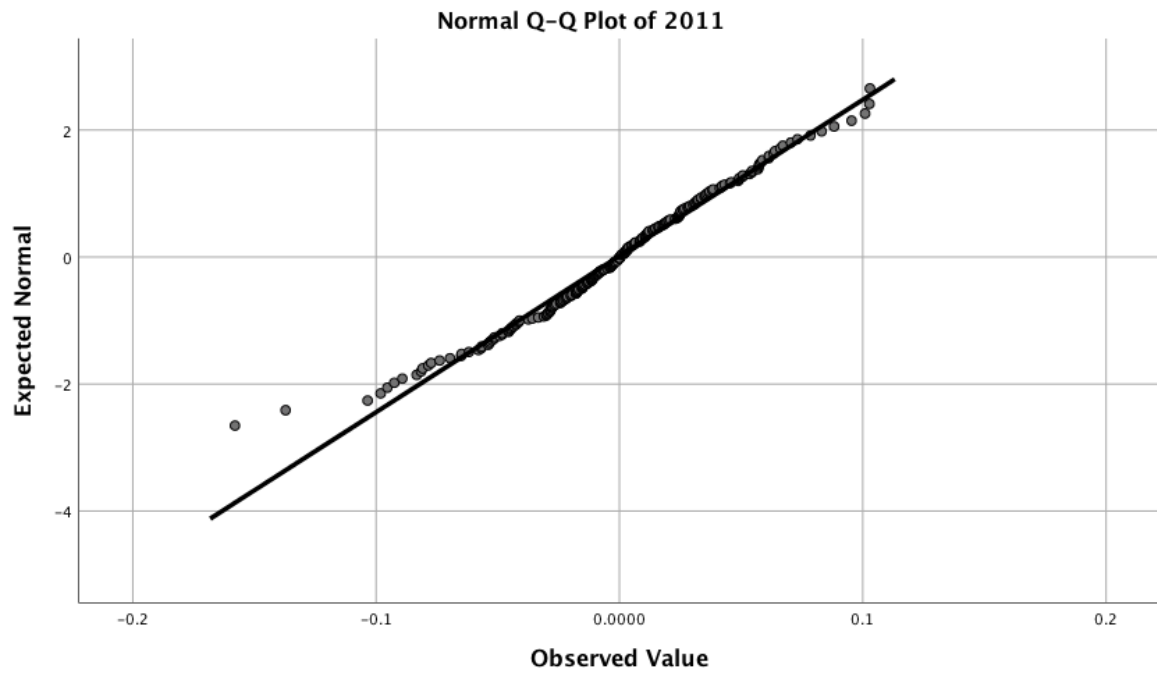
Tests of Normality

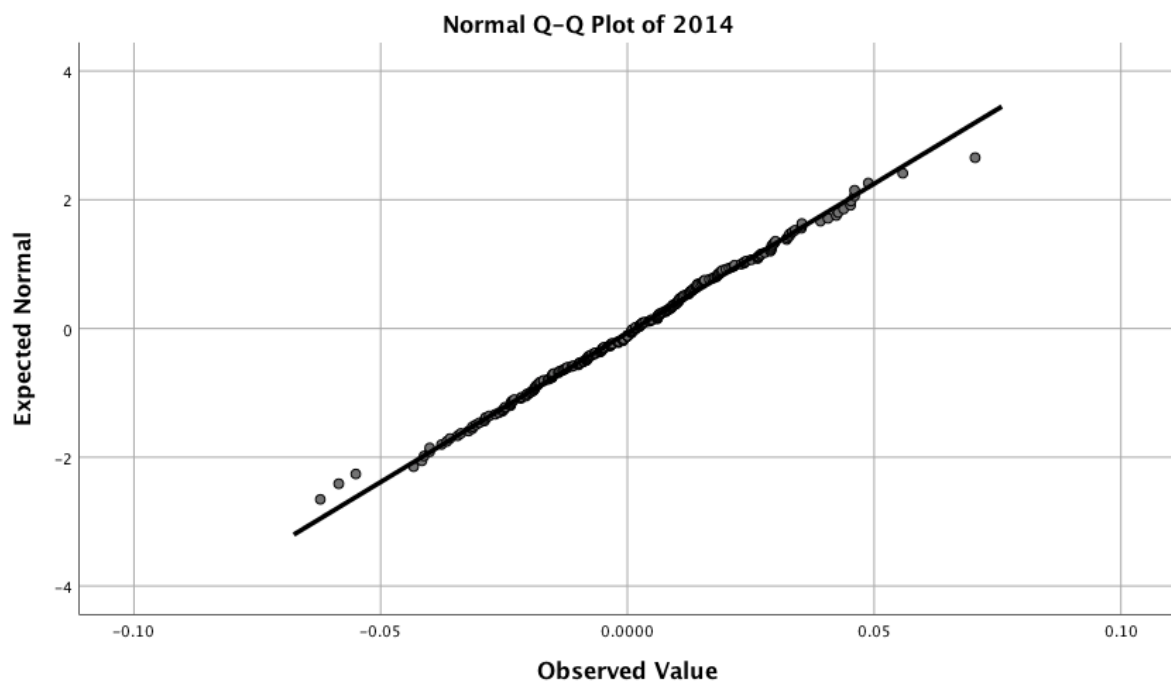
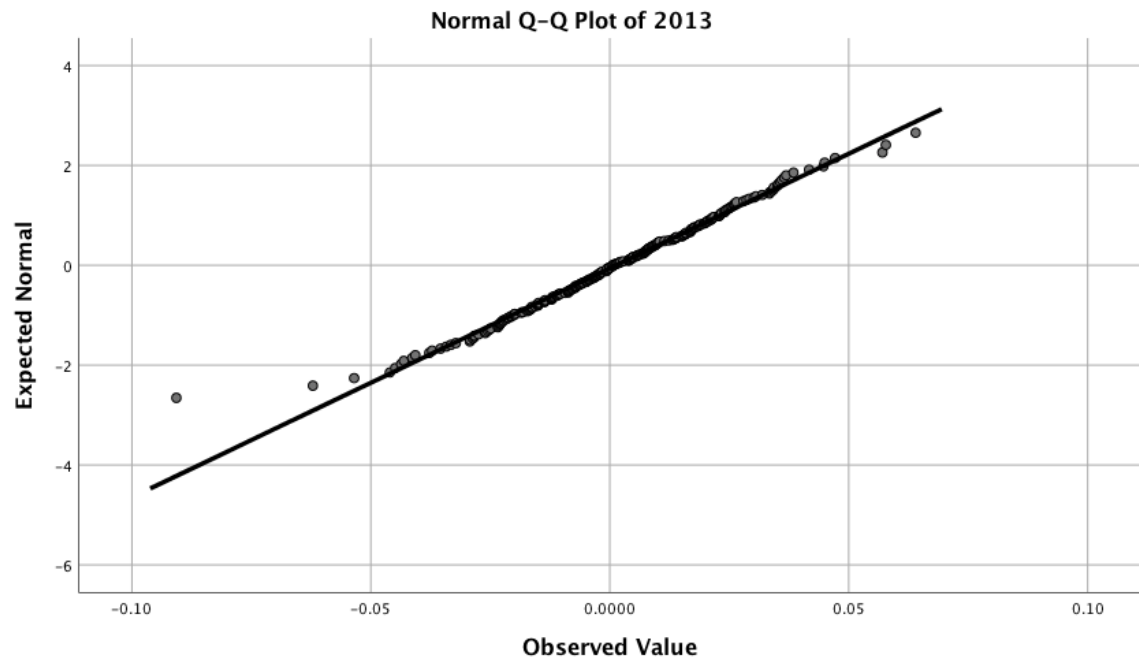
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.076	251	.001	.905	251	.000
2011	.059	251	.031	.985	251	.010
2012	.069	251	.005	.981	251	.002
2013	.033	251	.200 [*]	.991	251	.116
2014	.035	251	.200 [*]	.997	251	.959

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction







Appendix 17: Tests of Normality and Q-Q Plots from 2010 to 2014 for Deutsche Bank

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
2010	.048	251	.200 [*]	.953	251	.000
2011	.096	251	.000	.941	251	.000
2012	.046	251	.200 [*]	.989	251	.045
2013	.049	251	.200 [*]	.990	251	.084
2014	.032	251	.200 [*]	.996	251	.788

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

