Security Pricing in Reaction to Changes in Investor Attitudes, Governance and Regulation

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Abstract

The financial crisis that began in the summer of 2007 changed many aspects of the financial world. On the one hand, governing regulatory bodies around the globe introduced rules and regulations, with the goal of preventing another financial crisis of similar dimensions. On the other hand, investors changed their investment style. Structured products, viewed as one of the causes of the recent financial crisis, suffered severely. At the same time the demand for sustainable and climate related products rises massively. This thesis analyses the pricing of a variety of instruments (Bonds, Stocks, CDS, ABS and CLOs) in the aftermath of the recent financial crisis. Special attention is drawn upon the impact of changes in investor attitudes and regulatory changes on the pricing of the analyzed financial instruments.

Kurzbeschreibung

Die globale Finanzkrise, die im Sommer 2007 begann, veränderte viele Aspekte der internationalen Finanzmärkte. Einerseits wurden regulatorische Rahmenbedingungen geschafften, um zukünftige Krisen dieser Dimension zu verhindern. Anderseits veränderte sich das Investmentverhalten der Investoren. Das Volumen strukturierter Produkte, die als ein Auslöser der Krise angesehen wurden, ging massiv zurück. Gleichzeitig wächst die Nachfrage nach nachhaltigen Investments und Finanzanlagen, die Klimaschutzprojekte finanzieren. Diese Dissertation untersucht verschiedene Finanzinstrumente (Anleihen, Aktien, CDS, ABS und CLOs) seit der Finanzkrise. Dabei wird spezieller Fokus auf die Auswirkungen von regulatorischen Änderungen sowie Änderungen im Investmentverhalten der Investoren auf die Preisbildung der untersuchten Finanzinstrumente gelegt.

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List of Abbreviations

ABCP	Asset-Backed Commercial Paper
ABS	Asset-Backed Securities
ABSPP	Asset-Backed Securities Purchase Programme
AFME	Association for Financial Markets in Europe
APR	Annualized Percentage Rate
BPS	Basis Points
BVAL	Bloomberg Valuation Services
CAR	Cumulative Abnormal Returns
CDO	Collateralized Debt Obligation
CDS	Credit Default Swap
CEBS	Committee of European Banking Supervisors
CLO	Collateralized Loan Obligation
CSR	Corporate Social Responsibility
CRR	Capital Requirements Regulation
EBA	European Banking Authority
ECB	European Central Bank
EIB	European Investment Bank
ESG	Environmental, social and governance
FINRA	Financial Industry Regulatory Authority
FSB	The Financial Stability Board
G-SIBs	Global Systemically Important Banks
IOSCO	International Organization of Securities Commissions

ISIN	International Securities Identification Number
KfW	Kreditanstalt für Wiederaufbau
LCD	Leveraged Commentary and Data
LSTA	The Loan Syndications and Trading Association
MiFID	Markets in Financial Instruments Directive
MSRB	Municipal Securities Rulemaking Board
OLS Regression	Ordinary Least Squares Regression
OTC	Over-the-Counter
PCS Initiative	Prime Collateralised Securities Initiative
PIIGS	Portugal, Italy, Ireland, Greece and Spain
RMBS	Residential Mortgage Backed Securities
RV	Recreational Vehicle
SEB	Skandinaviska Enskilda Banken
SME	Small and Medium-Sized Companies
SPV	Special Purpose Vehicle
SRI	Sustainable and responsible investments
STS Securitizations	Simple, Transparent and Standardised Securitizations
SUR	Seemingly Unrelated Regressions
S&P	Standard and Poor's
TALF	Term Asset-Backed Securities Loan Facility
WAL	Weighted Average Life

1 Introduction

1.1 Motivation

The financial crisis that began in the summer of 2007 changed many aspects of the financial world. Governing regulatory bodies around the globe introduced rules and regulations, with the goal of preventing another financial crisis of similar dimensions (see e.g. Hanson et al. 2011; Acharya et al. 2011).

At the same time investors changed their investment style. Structured products, viewed as one of the causes of the recent financial crisis (see e.g. Demyanyk and van Hemert 2008; Bank for International Settlements 2008), suffered severely in the aftermath of the financial crisis. In Europe in particular, securitizations remain subdued. The European Commission, among others, made efforts to revive the securitization market (European Commission 2015), but at the same time regulations introduced since the financial crisis created burdens for investors which lead to extra costs, or lead to investors refraining from buying securitizations (Bryan and Ingram 2015; Guo and Wu 2014). Contrary to this, climate related products such as green bonds experience exponential growth. Investors actively engage in environmental, social and governance (ESG) related issues and influence corporate behavior. Financial firms with combined assets over 80 trillion U.S. dollars, including 20 out of 30 Global Systemically Important Banks (G-SIBs), eight out of ten of the largest asset managers and many leading insurance companies and pension funds, have committed to support the Task Force on Climate-related Financial Disclosure (TCFD 2017). Climate change is seen as a clear danger to financial stability (see e.g. Carney 2018).

The U.S. recently started to loosen regulations, only introduced a few years ago, again. Shortly after his election as president of the U.S., Donald Trump fulfilled his promise of a repeal of parts of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd–Frank Act 2010). The Dodd-Frank Act had been introduced in 2010. Among others, it regulates derivative products, limits the banks' proprietary trading activities and created new regulatory authorities. The U.S. risk retention rules for securitizations are also part of the Dodd-Frank Act (Section 941) and, in contrast to the European risk retention rules, are in the process of being dismantled for collateralized loan obligations (CLOs).

Within this thesis, two main questions are answered. The first question is: is security pricing in the aftermath of the global financial crisis affected by a change in investor attitudes? On the one hand, since the financial crisis a number of investors, especially in Europe, have been reluctant to invest in structured products and moved towards more “plain vanilla” products. On the other hand, ESG related products gain more and more importance for investors. So is a change in investor sentiment leading to a change in asset pricing? Are investors even willing to accept less return for ESG products, in this case green bonds, compared to conventional investments?

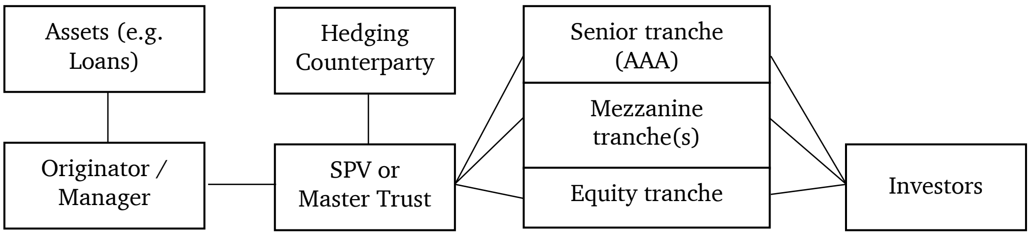
The second question is: how do (anticipated) regulatory changes affect financial markets and the pricing of financial products? Since the financial crisis, a number of regulations have been introduced worldwide. One regulation will be analyzed in detail, the risk retention rule for securitizations, introduced in Europe in 2011. Another field of study are the effects of the anticipation of changes in regulation on financial products. Implications of the anticipated repeal of regulations could be seen in the reaction of financial instruments on banks around the world.

To analyze changes in asset pricing, primary and secondary markets of the respective financial products are studied empirically. For liquid instruments like bonds, stocks and credit default swaps (CDS), secondary market prices (or spreads) are examined. For less liquid markets like asset-backed securities (ABS) and CLOs (see. e.g. Fabozzi and Vink 2012), primary market spreads are drawn upon.

1.2 Structure of a securitization and credit ratings

Financial products in form of securitizations and their changes in pricing are the focus of chapter four and five of the thesis. Therefore it is essential to understand the basic structure of a securitization. With the help of a securitization, assets are pooled, tranched and their future cash flows are sold to investors (see e.g. Fabozzi and Kothari 2008; McPherson 2000; Buchanan 2014). Different tranches with diverse credit ratings help to meet investors’ demand and risk appetite. Figure 1.1 shows the basic structure of a securitization. The underlying pooled assets, also called collateral of the transaction, are either originated (as in chapter four, auto ABS) or bought in the primary or secondary market and managed (as in chapter five, CLOs). The securitizations are issued by special purpose vehicles (SPVs) or Master Trusts and are structured in various tranches depending on their default risk. The least risky tranche is a senior tranche, followed by mezzanine and equity tranche.

Figure 1.1: Securitization structure



The various tranches issued by the SPV or Master Trust provide the investors with different risk and return profiles. The most senior tranche of a securitization is typically rated AAA, bears the lowest risk and has the lowest nominal return. The mezzanine tranches (which can be numerous) have higher risk profiles and higher coupons. The 100 largest auto ABS issued since the financial crisis (analyzed in chapter four) consist on average of 2.5 tranches in Europe and 5.2 tranches in the U.S. European CLOs issued since the financial crisis (subject of chapter five) have on average 7 tranches. The most junior tranche of a securitization, the equity tranche, bears the highest risk. As it usually does not receive a predefined coupon, is not rated and does not receive a predefined principal repayment at the end, it is similar to shares issued by corporations (see e.g. Pistre et al. 2017; Choudhry 2010). Therefore, interests of debt and equity investors in a transaction may diverge, which will be looked at closer in chapter five. A hedging counterparty may be necessary to align cash flows of the underlying assets with cash flows the investors receive (e.g. interest hedges, currency hedges etc.).

To indicate expected default risk for investors in fixed income securities, and for pricing considerations of financial instruments, credit ratings are of high importance (Bank for International Settlements 2005; Fabozzi and Vink 2012). In fact, an overreliance on credit ratings was seen as one of the causes leading to the recent financial crisis (see e.g. Bank for International Settlements 2008; He et al. 2011). Throughout the thesis, credit ratings from one or more of the three largest rating agencies Moody's, Standard and Poor's (S&P) and Fitch Ratings are used (see models chapter two, chapter four and chapter five). Table

1.1 provides an overview of the ratings provided by the three rating agencies (compare e.g. Fabozzi and Mann 2012).

Table 1.1: Credit rating classes

Moody's	S&P	Fitch	Numeric Rating	Rating description
Aaa	AAA	AAA	17	Prime
Aa1	AA+	AA+	16	
Aa2	AA	AA	15	High grade
Aa3	AA-	AA-	14	
A1	A+	A+	13	
A2	A	A	12	Upper medium grade
A3	A-	A-	11	
Baa1	BBB+	BBB+	10	
Baa2	BBB	BBB	9	Lower medium grade
Baa3	BBB-	BBB-	8	
Ba1	BB+	BB+	7	
Ba2	BB	BB	6	Non-investment grade
Ba3	BB-	BB-	5	
B1	B+	B+	4	
B2	B	B	3	Highly speculative
B3	B-	B-	2	
Caa1	CCC+	CCC+	1	Substantial risk

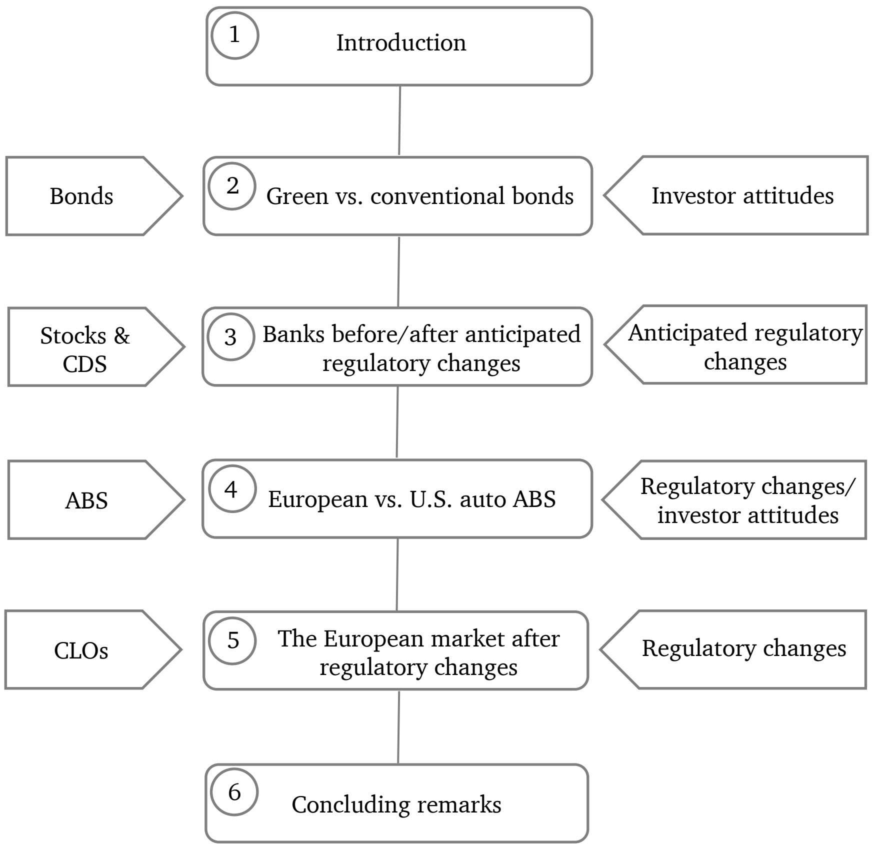
Credit ratings of the three rating agencies provided for the same security may differ, as they use slightly varying methodologies to compile their ratings. For the creation of the models of the thesis either the credit rating as a dummy variable, or the recalculated numeric rating (see Table 1.1) is applied. Recalculated numeric ratings are used in previous literature (Norden and Weber 2004; Friewald et al. 2012; Kiesel and Schiereck 2015). The highest rating available is either Aaa (Moody's) or AAA (S&P and Fitch) and corresponds to a numeric rating of 17, ratings Caa1 (Moody's), CCC+ (S&P and Fitch), or lower (not outlined in Table 1.1) correspond to a value of 1.

1.3 Thesis structure

The main body of the thesis is split into four stand-alone papers. Each paper can be read individually and consists of an introduction, a literature review, a description about data and methodologies used, a section that deals with the results of the models, and the conclusion that has been drawn for the respective research question(s). The various papers examine different financial products. Subject of the analysis are bonds (chapter two), stocks and CDS (chapter three), ABS (chapter four) and CLOs (chapter five). The combining elements for all papers are regulatory changes, which means regulatory changes that have been introduced from the governing bodies in Europe and the U.S. since the recent financial crisis, as well as changes in investor attitudes since the financial crisis. It is examined if those changes led as a consequence to changes in the underlying market of the respective products, in particular to changes in the pricing of these financial instruments.

Figure 1.2 illustrates the structure of the thesis. The left hand side of the figure shows the products analyzed per chapter. The right hand side of the figure presents the elements that may have caused a change in pricing. In the middle of the figure the six chapters are outlined.

Figure 1.2: Overview of the main structure of the thesis



Chapter two deals with green bonds, a lately developed financial product that mainly gathered importance after the recent financial crisis. The proceeds of green bonds are used to support climate related or environmental projects. Climate change is a global issue that has become more and more important for investors. Green bonds are issued worldwide and although regional differences exist, voluntary guidelines, the Green Bond Principles, connect green bonds globally. Investor demand for green bonds is high and exceeds supply by far. Issuing green bonds implies for the issuer extra costs compared to conventional bonds (e.g. a second opinion, separate accounting, reporting throughout the life of the transaction) thus the question arises if "issuing green" justifies the extra costs. Therefore, the research question, whether green bonds are priced differently from conventional bonds, is addressed. Three hypotheses are drawn. The first hypothesis is that green bonds trade tighter than non-green bonds. The second hypothesis is that pricing differences are larger for lower ratings. The third hypothesis is that pricing differences vary across industries. To find support for the hypotheses, panel regressions are utilized and secondary spreads (interpolated spreads, i.e. i-spreads above the respective benchmark of the bonds) are used. To match green and non-green bonds as closely as possible, each green bond is compared to two non-green bonds of the same issuer, with a similar maturity, the same currency, same coupon (fixed or floating) and no bond has embedded options or other structural features. The conclusion is drawn that indeed green bonds price economically marginally tighter than conventional bonds, which confirms that investors' demand for climate related, environmental products is high.

So far green bonds are not regulated differently from conventional bonds. Voluntary guidelines in the form of Green Bond Principles exist, but the issuer is not obliged to accept them if he calls his bonds "green". Many parties, especially investors, call for regulation of green products as they believe a standardization would help transparency within this new market.

Chapter three deals with anticipated market reforms triggered by a surprising market event. Donald Trump's election as president in November 2016 came as a surprise to the majority of capital market participants. The election triggered the expectation of a repeal of regulatory reforms, namely the Dodd-Frank Act. The Dodd-Frank Act had only been established a few years earlier, in the aftermath of the recent financial crisis. In chapter three, very liquid financial instruments, bank stocks and the 5 year CDS spread of banks are the chosen products to measure global reactions to a local event. The anticipated repeal or reshaping of the Dodd-Frank Act was expressed in a significant reaction of banks' stocks and CDS. The reaction of the respective secondary stock prices and CDS spreads is measured using a system of regressions with a seemingly unrelated regressions (SUR) framework (Zellner 1962).

In chapters four and five less liquid financial instruments, namely auto ABS and CLOs, are analyzed. Thus in this case no secondary prices or spreads are used to analyze changes in asset pricing, but spreads at issuance of the papers instead. In chapter four the European market is compared to the U.S. market. In chapter five just the European market, and in particular a regulation that has been introduced in the aftermath of the financial crisis, the so called risk retention rule, is analyzed. Two main questions are looked at. In chapter four the hypothesis is drawn that the auto ABS market has recovered fully since the financial crisis. Three ordinary least square regression (OLS) models are created and the U.S., as well as the European auto ABS market, is analyzed. For the U.S. market it can be concluded that the market fully recovered. For the European market though, the hypothesis cannot be confirmed but it is discovered that the market has only partially recovered. The European auto ABS market is still to a large extent dependent on support by the ECB, since numerous tranches are retained by issuers and not sold to investors. Those tranches are usually used for ECB collateral instead.

In chapter five, the question as to how the introduction of the risk retention rule (a regulation introduced in Europe in 2011) has impacted the European CLO market is answered. The focus is again the pricing of the securities, in this case CLOs, since the financial crisis. Three different areas are analyzed. The issuance volume of CLOs and the impact on CLO managers are looked at, and the question whether investors differentiate between a vertical and horizontal risk retention when investing in CLOs, is answered. The finding is that during the time of the introduction of the risk retention rule the CLO market suffered significantly.

The last chapter, chapter six, draws the final conclusion of the four papers and the thesis. Main findings are summarized and the impact of changes in regulation and investor attitudes on asset pricing is presented.

2 Are green bonds priced differently from conventional bonds?[1]

Abstract

The young growing market for green bonds offers investors the opportunity to take an explicit focus on climate protecting investment projects. However, it is an open question whether this new asset class is also offering attractive risk-return-profiles compared to conventional (non-green) bonds. To address this question, we match daily i-spreads of green labelled and similar non-green labelled bonds and look at their pricing differentials. We find that rating classes AA-BBB of green bonds as well as the full sample trade marginally tighter for the respective period compared to non-green bonds of the same issuers. Furthermore, financial and corporate green bonds trade tighter than their comparable non-green bonds, government related bonds on the other hand trade marginally wider. Issue size, maturity and currency do not have a significant influence on differences in pricing but industry and ESG rating.

2.1 Introduction

Sustainable and responsible investments (SRI) are estimated to have reached 22.89 trillion U.S. dollars globally in 2016 (Global Sustainable Investment Alliance 2017). In Canada and Europe,[2] which represent two of the three largest markets, bonds account for 64.4% of SRI. Further indicators show that this large market will grow on an accelerating pace within the next years. 409 investors representing more than 24 trillion U.S. dollars in assets signed a statement that emphasizes the need for climate resilient investments.[3] Likewise more than 1,500 investors representing around 60 trillion U.S. dollars in assets under management have signed the principles for responsible investment (Principles for Responsible Investment 2016). While the SRI market is globally expanding academic research is following. More than 2,000 studies have been published since the 1970s about

[1] This chapter is based on a working paper, Schiereck D., Hachenberg B. (2018): Are green bonds priced differently from conventional bonds?
[2] Other regions apart from Canada and Europe did not collect data on asset allocation. Canada and Europe together represent more than 57% of sustainable assets (Global Sustainable Investment Alliance 2017).
[3] http://www.iigcc.org/publications/publication/2014-global-investor-statement-on-climate-change.

environmental, social and governance (ESG) criteria (Friede et al. 2015). But contrary to the investment shares the vast majority of empirical studies has been focused on equity-linked relations, with only a small portion looking into fixed income or real estate.

In line with the overall limited research on fixed income SRI there is also hardly empirical evidence for a debt instrument that is attracting a fast growing interest of institutional asset managers while it was only recently developed: the instrument helps to invest according to the principles for responsible investment and is named green bond. The green bond market has grown significantly during the last couple of years but still represents a niche market. Future success in becoming an important contributor to financial markets and sustainable investments will, among others, depend on pricing and performance of green bonds. Pricing of green bonds vs. non-green bonds has so far been touched only in research from investment banks, advisory firms and the like. A few bonds are compared to decide if bonds trade “cheap” or “rich”. Trading strategies are outlined (Ridley et al. 2016) or indices compared (Preclaw and Bakshi 2015), but the whole population of green bonds has hardly been analyzed so far and existing studies vary in design and results (Bloomberg 2017; Karpf and Mandel 2017; Zerbib 2017). Within this study we compare green labelled and non-green labelled[4] bonds of the same issuers and thereby add to the literature that examines pricing of ESG instruments compared to conventional assets.

The majority of ESG studies report positive influence of ESG criteria on corporate financial performance. Friede et al. (2015) provide evidence that positive findings in bond studies are even higher than in equity studies (63.9% compared to 52.2%). Similar results are explored in loan studies (Goss and Roberts 2011). Positive findings can be defined in multiple ways. Firms facing stronger external monitoring through effective government mechanism are rewarded with lower yields and superior bond ratings (Bhojraj and Sengupta 2003). Firms with superior corporate social responsibility (CSR) scores obtain cheaper equity financing as in El Ghoul et al. (2011). Recent studies about the corporate bond market confirm that bonds with high composite ESG ratings have tighter spreads and tend to outperform their peers with lower ESG ratings (see e.g. Polbennikov et al.

[4] Bloomberg tags bonds with a green bond label when the use of proceeds is dedicated to mitigating climate change and advancing environmental sustainability solutions. Within this study, the term green bonds always refers to green labelled bonds as defined by Bloomberg, the term non-green bonds to non-green labelled bonds.

2016). Likewise investors demand significantly higher stock returns and lenders demand significantly higher interest rates for loans of companies with environmental concerns (Chava 2014). But research also shows that findings are not always positive. There is evidence as well that socially responsible firms do not have lower cost of public debt (Menz 2010). Renneboog et al. (2008) conclude that the question whether CSR is priced by capital markets is still open. To contribute to this discussion, we analyze the pricing of green bonds in comparison to conventional bonds. Our results indicate that green bonds are priced slightly different from conventional bonds.

The rest of the paper is structured as follows. The next section provides a literature review and develops the testable hypotheses. Section 3 presents the data and methodology as well as the descriptive statistics. Section 4 documents the empirical results and Section 5 concludes the paper and outlines possible areas of future research.

2.2 Sample literature review and hypotheses development

A green bond is a debt security, whose proceeds are used to support climate-related or environmental projects. The ESG approach usually focuses on analyzing the issuer. But the same issuing institution (being it agencies, financials, corporates, municipals, sovereigns or SPVs) can issue green and/or non-green bonds. For the decision if a bond is considered "green" the use of proceeds for specific projects is crucial.

The green bond market is relatively young, the first green bond was issued in 2007 as a climate awareness bond from the European Investment Bank (EIB)[5]. At the same time, a group of Swedish investors, pension funds and investors focused on SRI, developed together with Skandinaviska Enskilda Banken (SEB) and the World Bank the concept of green bonds. Their first bond was brought to market to a wider range of investors in 2008.[6] During the next couple of years a number of multilateral development banks and other financial institutions issued green bonds, with the first green bonds brought to market by corporate institutions in 2013. In 2016, 81 billion U.S. dollars of green bonds were issued (Climate Bonds Initiative 2017) with the total volume of outstanding green bonds amounting to 166 billion U.S. dollars (Ridley and Edwards 2017).

[5] http://www.eib.org/investor_relations/press/2007/2007-042-epos-ii-obligation-sensible-au-climat-la-bei-oeuvre-a-la-protection-du-climat-par-le-biais-de-son-emission-a-l-echelle-de-l-ue.htm?lang=en.
[6] http://treasury.worldbank.org/cmd/htm/GreenBond.html.

To avoid information asymmetry between issuers and investors, green bond issues are not only accompanied by regular reporting about use of proceeds. Around 60% are also certified through an external party in the form of a second party opinion (Boulle et al. 2016), which could be issued by a profit or non-profit organization. For all market participants, issuers, investors as well as the involved consortium, rating agencies and certifying institutions, it is necessary to define the “green label”. Efforts have been made through the “Green Bond Principles” (ICMA International Capital Markets Association 2016), first developed by 13 financial institutions in 2014 and updated yearly thereafter. The Green Bond Principles are voluntary guidelines, thus market participants also call for binding standards which would help develop the market even further (Krimphoff 2016). A second party opinion, regular reporting, possibly a sustainability consultant or certification and holding proceeds in separate accounts makes the issuance of green bonds more expensive than issuing conventional, non-green bonds. External costs for the issuer, such as a second party opinion, are estimated to be between 0.3 and 0.6 basis points (bps) for a 500 million U.S. dollars issue, depending on the level of work (Ceci 2016). Certification of the issue, e.g. through the non-profit organization Climate Bonds Initiative, costs 0.1 bps.[7] Internal costs for the issuer, like establishing the required internal processes for selecting projects and assets, management of proceeds and regular reporting, are very much dependent on the issuer and frequency of issuing green bonds.

The question arises if green bonds and conventional bonds price equally and the issuer has to bear additional costs for issuing green. Research has been conducted to analyze if increased fixed costs for CSR (called “overinvestment” by Goss and Roberts 2011) harm corporate financial performance and thus increase bond holders default risk. Frooman et al. (2008) investigate bonds and stocks and come to the conclusion that positive corporate social performance reduces risk for long term bondholders without harming stockholders through the addition of fixed costs. Stellner et al. (2015) measure credit ratings and zero-volatility-spreads of corporate bonds and find only weak statistical support that positive corporate social performance results in reduced credit risk. On the other hand though, they show that superior corporate social performance is rewarded in countries with above average ESG performance. Menz (2010) reveals that the risk premium for bonds of socially responsible firms does not significantly differ from that of less responsible

[7] See https://www.climatebonds.net/standards/certification/get-certified.

corporations. Derwall and Koedijk (2009) measure the performance of socially responsible bond and balanced funds and their matched conventional fund counterparts. Their results indicate that the average SRI fund performed similar to conventional funds, while SRI balanced funds modestly outperform the respective conventional ones by 1.3%. Oikonomou et al. (2011) investigate the impact of corporate social performance on corporate bond spreads and ratings. In general, they show that good corporate social performance is rewarded with lower spreads and higher ratings. Arguments for or against a positive link between corporate social performance and asset performance usually arise from an issuer level. Goss and Roberts (2011) e.g. state that companies with superior corporate social performance have a more favorable risk profile. Chava (2014) shows that lenders price environmental concerns about issuers such as hazardous waste, toxic emissions and climate change concerns. Oikonomou et al. (2011) not only argue from an issuer level, but also state that research has shown that not all components of a bond spread can be explained, thus corporate social performance could be one of the missing pieces to the empirical asset pricing puzzle. We hypothesize that the green component of the bond is an additional feature for the investor, which leads to higher demand and thus justifies tighter pricing of a green bond.

Hypothesis 1. *Green bonds trade tighter than non-green bonds.*

The investor benefits from investing in green bonds in various ways. In contrast to conventional (non-project) bonds he is able to follow the exact use of his proceeds, choose projects which fulfill his requirements and has a complementary source of analysis in addition to his usual credit analysis. He also benefits from the full faith and credit of the issuer, as in case of default he is in line with other creditors of the same ranking. For sustainable investors the product range is limited. With green bonds they receive an additional product to invest into. Thus it appears reasonable to assume that investors would be willing to accept a tighter spread for green bonds than for conventional, non-green bonds. On the other hand the investor is exposed to risk of “green-washing”, i.e. incorrectly labelled green bonds. Since the issuer still has the power to choose if his bond is labelled green and no sanctions are put in place if this labelling is incorrect, the investor could, in the worst case, be made liable for investing in a non-green product from his investor base. Green bonds are issued from the full range of fixed income issuers across various currencies, rating classes, maturities and issue sizes. A high percentage of green bonds is issued from government related institutions which on average trade tighter than lower rated issuers. This leads to the following hypotheses

Hypothesis 2. *Differences in pricing between green and non-green bonds are larger for lower rated bonds.*

Hypothesis 3. *Differences in pricing between green and non-green bonds vary across industries.*

2.3 Data and methodology

To analyze if green bonds trade tighter than non-green bonds we use data from Bloomberg. We look at the whole population of in August 2016 outstanding, labelled green bonds. We exclude 76 municipal bonds and 39 ABS as these are unique in nature, issued in various tranches and rarely perfectly comparable to other issues. This leaves us with 617 bonds. Since liquidity of the bonds is critical for bond pricing (Driessen 2003; Amato and Remolona 2003; Bao et al. 2011; Zerbib 2017) we only include bonds with a new issue volume of at least 150 million U.S. dollars equivalent. The price of smaller issues might be distorted by a liquidity premium the market charges. We recalculate 23 local currencies with their exchange rate at the respective date of new issue into U.S. dollars. Using 150 million U.S. dollars as a threshold we obtain 199 bonds to proceed our analysis with.

As a next step we include "plain vanilla bonds" only, i.e. we drop 36 structured bonds (bonds with call options, caps, floors, multi-coupons, linked to an index, etc.) from our sample. We do not drop bonds with make whole calls and calls at par three months before maturity of the bond, which have become very common, especially for corporate issuers.[8] We adjust for 13 bonds which are set up twice, as RegS and 144A tranches and include one tranche only, the RegS tranche for European issuers and 144A tranche for U.S. as well as Asian and Australian issuers.

[8] There is evidence that make whole calls may influence pricing of bonds (Mann and Powers 2003; Nayar and Stock 2008). Analyzed are groups of bonds only though, a "perfect match" of bonds of the same issuers with identical features has not been conducted yet.

Bonds are mostly traded over-the-counter (OTC) and reliable pricing data is not as easily available as for equities (Duffee 1998; Warga 1991). Since the evolution of TRACE[9] a number of bond studies use TRACE data (Bessembinder et al. 2006; Edwards et al. 2007; Bao et al. 2011) to analyze fixed-income securities. TRACE requires broker-dealers who are member firms of the Financial Industry Regulatory Authority (FINRA) to report trades in eligible securities. Eligible securities as defined by FINRA have to be, among others, denominated in U.S. dollars, and not all bond types are eligible yet. Our green labelled bonds are a global portfolio of all different types of issuers, supranational organizations, development banks, financials, corporates and real estate companies, issued in various currencies. Therefore, TRACE has pricing data available for only 21% of our green bonds. Thus we use Bloomberg data in this study, as Bloomberg prices all apart from one security in question. Bloomberg has various proprietary pricing sources, we consider Bloomberg Valuation Services[10] (BVAL) as the most suitable source to use. BVAL combines data from various pricing sources, TRACE, Municipal Securities Rulemaking Board (MSRB), exchanges and broker quotes.

To decide if a green bond is trading cheap or rich compared to a similar bond (similar in terms of issuer, ranking, currency, maturity and coupon, i.e. fixed or floating) we use Bloomberg's i-spreads[11] for the fixed rate bonds. I-spreads are noted in bps above a risk free benchmark, usually the swap rate. In contrast to yields they have the advantage to separate interest and credit part of the yield. To decide if a similar non-green bond trades significantly different from a green bond we just look at the credit part of the yield.

The i-spreads we use consist of the difference between the yield in question and the interpolated swap rate at the same maturity. We consider swap rates as the better proxy for the risk-free benchmark in contrast to government securities, in line with previous studies (see e.g. Zhu 2006; Hull et al. 2004). The use of swap spreads as a benchmark

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9 TRACE is FINRA's Corporate and Agency Bond Price Dissemination Service that reports OTC secondary market transactions in eligible fixed income securities.

10 See e.g. https://www.bloomberg.com/enterprise/content-data/pricing-data/ for further explanation. According to Bloomberg BVAL provides transparent and highly defensible prices of fixed income securities across the liquidity spectrum. The methodology combines direct market observations from contributed sources with quantitative pricing models to generate BVAL evaluated prices.

11 Bloomberg's definition of i-spread: "I-Spread is the interpolated bond spread to a benchmark curve. The I-Spread is calculated by taking the interpolated, maturity matched yield on a benchmark curve, and subtracting that value from the selected bond's yield to worst. This differs from a standard benchmark spread, where the selected bond's yield is compared to the nearest already existing point on a curve, rather than an interpolated point."

compared to government securities has a number of advantages. Cross-country comparisons are more meaningful, “noise” regarding benchmark government securities is excluded and the curve is fully available with no need for stripping (Mann and Fabozzi 2013). In a number of countries the swap market is also more liquid than the government bonds market. Bloomberg lists more than 220 swap curves, depending on currency, tenor etc. Our bonds are issued in 23 different currencies and for our data we look at the i-spread above 25 different swap curves. For the floating rate notes, we use the discount margin (i.e. spread above their respective benchmark, Euribor, Libor etc.). We download daily historic spreads since issuance of the green bonds up to October 2016. For all spreads we use the bid side of the market, transaction costs are not examined. We also do not separate the new issue premium of bonds, which may “cheapen” bonds by a few bps compared to already outstanding bonds of the same issuers in the first couple of trading days.

To avoid the problem of heterogeneity among bonds (see e.g. Roberts and Viscione 1984) we decide not to use rating classes or indices to compare our sample but to use matched pairs instead. Matched pairs have been used in previous bond studies. Maul and Schiereck (2017) e.g. provide a comprehensive overview of matched pairs used in bond event studies. We match each green bond with two comparable non-green bonds, one with a shorter maturity, the other one with a longer maturity. In order to be considered comparable bonds, the non-green bonds have to fulfill the following criteria: (i) bonds must be from the same issuer as the green bond; (ii) bonds must have the same ranking as the green bond; (iii) bonds must be denominated in the same currency as the green bond; (iv) bonds must not be structured (callable, puttable, convertible, dual currency, dual coupon, step up/down coupon, index linked); (v) bonds must be either fixed or floating, depending on the green bonds; (vi) issue size must be at least 150 million U.S. dollars equivalent; (vii) bonds must be secured/unsecured, depending on the green bonds. For every green bond we take the two comparable non-green bonds with the closest maturity to their green counterpart. 17 bonds do not have two comparable non-green bonds, so this leaves us with a subsample of 132 green bonds to analyze, issued by 73 different counterparts.

As a next step we define a historic time frame for our analysis. To avoid including bonds that only have a very short remaining maturity and thus no representative trading, we decide not to use historic prices up to date, but a past period instead. We take the 1st of October 2015 to 31st of March 2016 and download daily i-spreads[12] for the comparable bonds. If the non-green bonds are issued after the green bond or matured before our cut-off date for historic prices, 31st of March 2016, we take the next closest bonds for which the full data set is available. If no full data set is available, we take the closest bond to the green bond. 30 of our green bonds were issued after March 31st 2016 and for 37 green bonds not both comparable non-green bonds are available (18 green bonds do not have a shorter comparable bond, 14 green bonds do not have a longer comparable bond, for 2 green bonds their comparable bonds were only issued after our sample period, for 3 green bonds their comparable non-green bonds had issue amounts < 150mm USD equivalent). We also exclude 1 bond which is not rated and 1 bond which was only outstanding a few days during our sample period, so this leaves us with 63 green bonds and 126 non-green bonds to analyze. Table 2.1 provides an overview of the sample selection procedure.

Table 2.1: Sample selection procedure

This table shows the sample selection procedure to compare green labelled and non-green labelled bonds during the investigation period from October 1st 2015 to March 31st 2016. The final sample is used for the empirical analysis throughout the paper.

	Securities
Initial sample	732
Less municipal bonds	-76
Less asset backed securities	-39
Less volume < 150 million U.S. dollars equivalent	-418
Less structured bonds	-36
Less bonds set up twice, RegS as well as 144A	-13
Less bond not priced by Bloomberg	-1
Less no comparable bonds available	-17
Less bonds issued after sample period	-30
Less not both comparable bonds available for sample period	-37
Less "other"	-2
Final sample	63

The final sample includes 39 issues from government related institutions (such as development banks, supranational organizations, cities etc.), 12 issues from financial firms, 8 from corporate issuers and 4 from real estate companies (see Appendix A.1). The

[12] For simplicity we use the expression i-spread in this study for both, the i-spread above the swap rate for the bonds with the fixed coupon as well as the discount margin above the reference rate for the floating rate securities.

high number of supranational organizations and other government related institutions is also reflected in the high average rating. According to previous literature (e.g. Norden and Weber 2004; Friewald et al. 2012; Kiesel and Schiereck 2015) we recalculate the ratings of our sample by using a numerical 17 grade scale (AAA/ Aaa=1, AA+/Aa1=2,.., CCC/Caa1 and below =17). The mean rating of green and non-green bonds is 3.05 (Aa2/AA). The average remaining maturity of the sample at the end of our sample period is 5 years. We look at 7,032 daily observations of green bonds. Table 2.2 provides descriptive statistics of the i-spreads of our sample.

Table 2.2: Descriptive statistics for daily i-spreads of green bonds

This table shows descriptive statistics of daily i-spreads of our sample of green bonds for the investigation period October 1st 2015 to March 31st 2016. Mean, standard deviation, minimum and maximum i-spreads are shown in bps. I-spread is the interpolated spread above the bond's respective swap benchmark for fixed rate bonds and discount margin for floating rate bonds.

	Mean	Standard Deviation	Min	Max	N
AAA	12.913	25.000	-25.734	68.458	3241
AA	40.833	38.148	-14.813	144.792	1445
A	79.618	37.905	19.018	205.967	1691
BBB	150.842	62.586	41.048	260.323	655
Total	47.539	55.679	-25.734	260.323	7,032

As a next step we use linear interpolation to align the i-spreads of the two comparable non-green bonds with the respective green bond. For the linear interpolation we use Isaac Newton's formula

$$i_M = i_s + \frac{i_l - i_s}{t_l - t_s}\,(t_g - t_s) \tag{2.1}$$

where i_M is the model i-spread of the non-green bonds, i_s the empirical i-spread of the shorter non-green bond, i_l the empirical i-spread of the longer non-green bond, t_l the time to maturity in months of the non-green longer bond, t_s the time to maturity in months of the shorter non-green bond and t_g the time to maturity in months of the green bond. Thereafter, we compare the daily difference between the empirical i-spread i_g and the theoretical i-spread i_M.

$$i_{d,t} = i_{g,t} - i_{M,t} \tag{2.2}$$

For our sample period we obtain 7,032 daily observations for green bonds and 14,064 daily observations for non-green bonds. We also check for ESG issuer ratings. We take data from Bloomberg and look at ratings from the providers Sustainalytics and RobeccoSAM. 11 of the issuers and 12 of the issues of our sample hold a rating from at least one of the two firms. Table 2.3 shows descriptive statistics of green and non-green bonds.

Table 2.3: Descriptive statistics of green and non-green bonds

This table shows descriptive statistics of our sample of green and non-green bonds for the investigation period October 1st 2015 to March 31st 2016. ESG rating is on issuer level, counted are issuers that have a rating by one of the firms RobeccoSAM or Sustainalytics as shown on Bloomberg. The mean remaining maturity is calculated from the last day of the investigation period. Amount issued is shown in U.S. dollars equivalent, recalculated using the exchange rate at the issue date of the respective bond.

	Green	non-green
Issuer	39	39
Government related issues	39	78
Financials	12	24
Corporates	8	16
Real Estate	4	8
median rating	3.05 (AA)	3.05 (AA)
ESG rating (issuer)	11	11
Amount issued (mean)	810 million	1.7 billion
Amount issued (mean) AAA	959 million	2.1 billion
Amount issued (mean) AA	689 million	1.8 billion
Amount issued (mean) A	708 million	1.2 billion
Amount issued (mean) BBB	593 million	535 million
Remaining maturity	5 years	5 years
Countries	15	15
Currencies	8	8
Total (issues)	63	126
Total (observations)	7,032	14,064

2.4 Empirical results

To obtain a better overview we group the bonds into rating categories from AAA to BBB. Our group of bonds does not include any non-investment grade bonds. For every split rated bond we use the highest rating category. The results of our analysis are presented in Table 2.4. The daily delta between green and non-green bonds $i_{d,t}$ is across all rating classes more negative than positive. AA, A and BBB rated green bonds trade more days and also on average tighter than their comparable non-green bonds. On the contrary AAA rated green bonds trade more days wider than their comparable non-green bonds and their average spread is wider than the average spread of the comparable non-green bonds.

Table 2.4: I-spreads of green bonds vs. non-green bonds

This table shows the daily (t) (October 1st 2015-March 31st 2016) delta between green and non-green (interpolated) bonds, i_d . The sample is sorted by rating classes, spreads green i_g and non-green i_M are shown in interpolated spread terms (bps) above the bond's respective swap benchmark for fixed rate bonds and discount margin for floating rate bonds. Daily i_d (tightest and widest), mean and median are also shown in bps.

Rating	n bonds	Tightest daily i_d	Widest daily i_d	Mean i_d	Median i_d	t tighter	t wider	Mean i_g	Mean i_M
AAA	29	-14.51	8.60	0.45	0.64	1,300	1,941	12.91	12.47
AA	14	-15.90	10.12	-0.99	-0.64	934	511	40.83	41.82
A	15	-48.70	43.60	-3.88	-0.83	883	808	79.62	83.50
BBB	5	-32.15	24.57	-2.69	-1.00	367	288	150.84	153.54
Total	63	-48.70	43.60	-1.18	0.04	3,484	3,548	47.54	48.72

The arithmetic mean of the daily delta between green and non-green comparable bonds shows single A rated green bonds being the richest compared to their non-green counterparts. The delta is relatively small though, green single A bonds trade on average 3.88 bps (4.87%) tighter, AA rated bonds 0.99 bps (2.42%) tighter and BBB rated green bonds 2.69 bps (1.78%) tighter than their comparable non-green bonds. Overall, green bonds trade 1.18 bps (2.48%) tighter than their comparable non-green counterparts during our sample period. AAA rated green bonds on the other hand trade 0.45 bps (3.49%) wider.

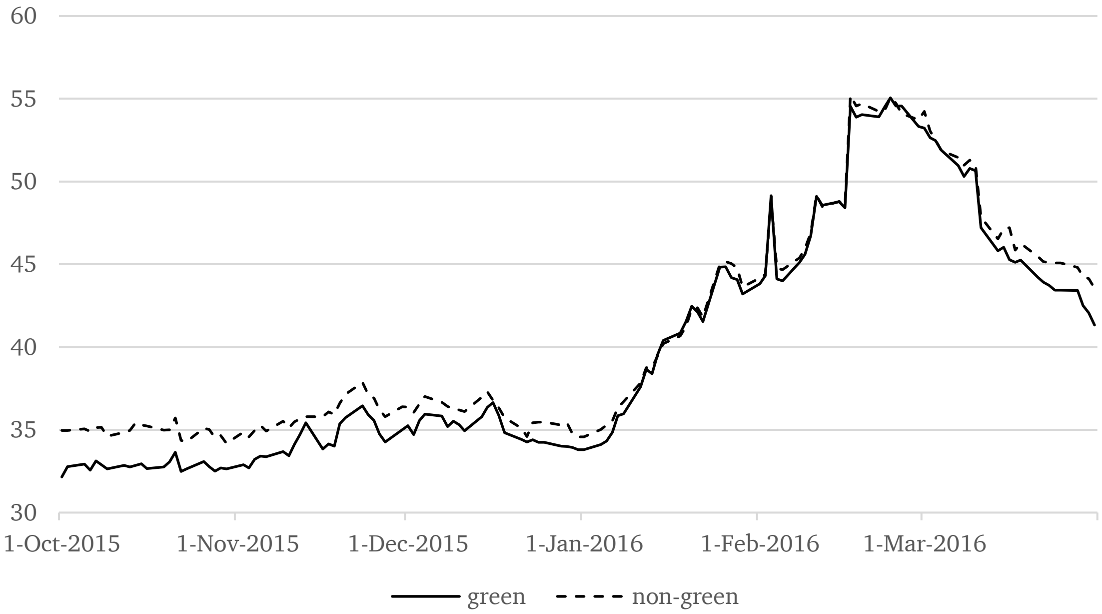
The correlation between green and non-green i-spreads is high, for most rating classes 0.99, for single A rated bonds 0.94. Figure 2.1 graphically displays average spreads of green bonds and their comparable non-green bonds from October 1st 2015 to March 31st 2016 on a daily basis, grouped by rating classes. Single A rated green and non-green bonds clearly show the largest pricing differential among ratings examined.

Figure 2.1: Green bonds vs. non-green bonds

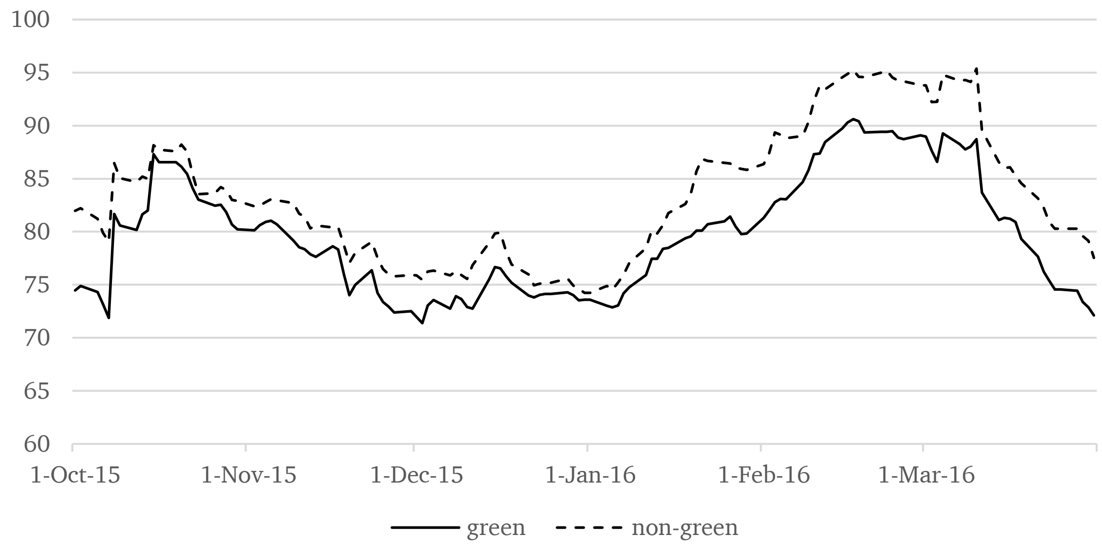
This figure shows the development of green and non-green daily i-spreads between October 1st 2015 and March 31st 2016, in bps. Spreads are calculated in daily means of the sample, non-green bond spreads are interpolated spreads of comparable bonds.

Panel A: AAA rated green bonds vs. AAA rated non-green bonds

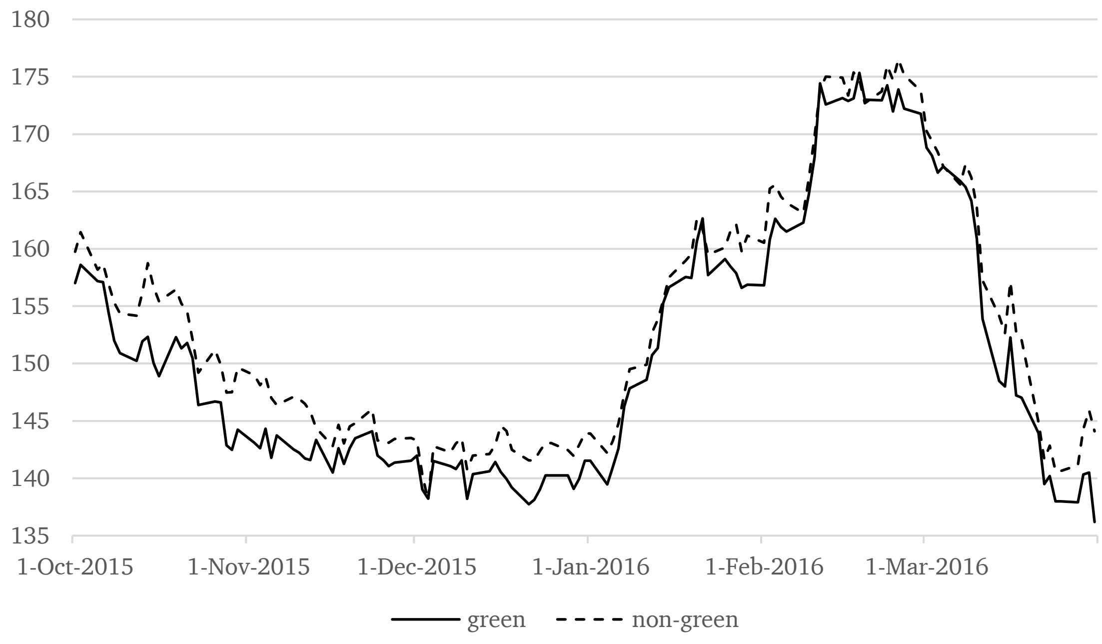
Panel B: AA rated green bonds vs. AA rated non-green bonds



Panel C: A rated green bonds vs. A rated non-green bonds



Panel D: BBB rated green bonds vs. BBB rated non-green bonds



To further investigate if green bonds are priced significantly different from their non-green comparable bonds we use the non-parametric Wilcoxon rank sum as well as the parametric two sample t-test. We use the same classification as before, i.e. group our sample by rating classes. We also retain for the green bonds the market observed spread, for their non-green comparable bonds the interpolated spread of the two bonds surrounding the green bond in question. Results of the analysis are presented in Table 2.5.

Table 2.5: Results Wilcoxon rank sum and t-test for ratings and industries

This table shows the p-value results of the Wilcoxon rank sum and t-test, grouped by ratings and industries. I-spreads between green and non-green bonds are analyzed for investigation period October 1st 2015-March 31st 2016. It also shows the correlation r between i-spreads of green and non-green bonds, grouped by ratings and industries for the same sample period.

	Total sample	AAA	AA	A	BBB
N	14,064	6,482	2,890	3,382	1,310
p value Wilcoxon rank-sum	0.107	0.312	0.387	0.000	0.316
p value t-test	0.209	0.474	0.489	0.002	0.419
r green, non-green	0.989	0.993	0.994	0.936	0.986
	Total sample	Government related	Financials	Corporates	Real Estate
N	14,064	9,222	1,906	1,888	1,048
p value Wilcoxon rank-sum	0.107	0.753	0.000	0.000	0.126
p value t-test	0.209	0.732	0.000	0.071	0.566
r green, non-green	0.989	0.995	0.947	0.957	0.995

For the full sample the statistic results show that green and non-green bonds are not priced significantly different. Thus despite an economically observed tighter pricing of green bonds we cannot find statistical significance and need to reject the hypothesis, that overall green bonds trade tighter than non-green bonds. The same results are captured for rating classes AAA, AA and BBB. For single A rated securities, on the other hand, the Wilcoxon rank sum as well as the t-test indicate significance, which shows that i-spreads of the two samples green and non-green bonds are different. The results provide support to our second hypothesis, that differences in pricing are larger for lower rated bonds. With the exception of rating class BBB (the smallest of our sample) the delta between i-spreads of green and non-green bonds becomes larger for lower rated rating classes on an absolute level. Looking at a relative level this cannot be confirmed though. Thus we partially accept our second hypothesis.

To test the results further we separate our sample of bonds by type of industry. We use the group “government related”, which includes all supranational organizations, development banks, cities and other government related issuers. We additionally use the groups “financials”, “corporates” and “real estate”. This time Wilcoxon rank sum and t-test show significance for groups financials (both tests) and corporates (Wilcoxon rank sum test). Group financials includes ratings AAA, AA and A, group corporates includes ratings AA, A and BBB. The results of the tests indicate already, that we may be able to support our third hypothesis that differences in pricing between green and non-green bonds vary across industries.

Since the issue size of financials and corporates compared to our government related bonds tends to be smaller and also the issue size of our non-green bonds tends to be larger in most cases than the issue size of the green bonds, we also test the influence of issue size to our sample of bonds. In addition, we want to test for variables which show significance in the Wilcoxon rank sum test, namely industries government related and financials. We also want to investigate features like maturity and currency of the issues. We use a panel regression with the daily delta between green and non-green i-spreads as the dependent variable and the International Securities Identification Number (ISIN) of the bonds as the cluster variable. Our first Model, 1.1, is a random-effects model with the general term

$$\begin{aligned} Y_{i,t} = {} & \beta_1 Size\ green_{it} + \beta_2 Size\ nongreen_{it} + \beta_3 Financials_{it} + \beta_4 Government \\ & + \beta_5 Currency_{it} + \beta_5 Maturity_{it} + \alpha + u_{it} + \varepsilon_{it} \end{aligned} \tag{2.3}$$

where $Y_{i,t}$ is the delta of the daily i-spread i_g of the green bonds and the respective model spread of the interpolated non-green bonds i_M at date *t, Size green* is the logarithmized issue size of the green bonds recalculated at date of issuance into U.S. dollars, *Size non-green* is the logarithmized issue size of the non-green bonds recalculated at date of issuance into U.S. dollars, *Financials* is a dummy variable, which takes value one if the issuer is a financial company and zero otherwise, *Government* is a dummy variable, which takes value one if the issuer is a government related firm and zero otherwise, *Currency* is a dummy variable, which takes value one if the issue is denominated in Euro or U.S. dollars and zero otherwise, *Maturity* is the remaining maturity of the issue, β is the coefficient for the independent variables, α is the intercept, u_{it} is the between-entity error and ε_{it} the within-entity error. We do not account for other firm specific variables, such as leverage, market capitalization, interest rate coverage ratio etc., as conducted in previous literature (Collin-Dufresne et al. 2001; Bhojraj and Sengupta 2003) as the bonds we compare are issued by the same companies. An overview of the dependent and independent variables used throughout this paper is shown in Table 2.6.

Table 2.6: Overview of variables

Variable	Description
$i_{d,t}$	Delta of daily i-spread between green and interpolated non-green bonds
Size Green	Logarithmized issue amount of green bonds in U.S. dollars
Size non-Green	Logarithmized issue amount of non-green bonds in U.S. dollars
Financials	Dummy variable that takes value 1 if the issuer of the bond is a financial firm, 0 otherwise
Government	Dummy variable that takes value 1 if the issuer is government related, 0 otherwise
Maturity	Maturity of the green bond
Currency	Dummy variable that takes value 1 if currency is Euro or U.S. dollars, 0 otherwise
ESG	Dummy variable that takes value 1 if the issuer is rated by RobeccoSAM or Sustainalystics, 0 otherwise
Rating	Highest rating of S&P, Moody's and Fitch, ratings have been coded from 1 (AAA) to 4 (BBB)
AAA	Dummy variable that takes value 1 if the rating is AAA, 0 otherwise
AA	Dummy variable that takes value 1 if the rating is AA, 0 otherwise
A	Dummy variable that takes value 1 if the rating is A, 0 otherwise
BBB	Dummy variable that takes value 1 if the rating is BBB, 0 otherwise

We also use a population-averaged model, Model 1.2, which is defined as

$$Y_{i,t} = \beta_1 Size\ green_{it} + \beta_2 Size\ nongreen_{it} + \beta_3 Financials_{it} + \beta_4 Government + \beta_5 Currency_{it} + \beta_5 Maturity_{it} + \alpha + r_{it} \tag{2.4}$$

with the same dependent and independent variables, clustered by ISIN, α as the intercept and r_{it} the error term. Model results are presented in Table 2.7.

Table 2.7: Random-effects and population-averaged panel regression (clustered by ISIN)

This table shows coefficients of model results for a random effects (Model 1.1, 2.1, 3.1, 4.1) and a population-averaged panel regression (Model 1.2, 2.2, 3.2, 4.2) testing significance of various independent variables to dependent variable $i_{d,}$ which is the delta between empirical observed i-spreads of green bonds and interpolated i-spreads of non-green bonds. For a detailed description of panel variables please see Table 2.6.

*shows significance p<0.05, **shows significance p<0.01, ***shows significance p<0.001

	Model 1.1	Model 1.2	Model 2.1	Model 2.2	Model 3.1	Model 3.2	Model 4.1	Model 4.2
Size green	0.295	0.295	0.060	0.061	0.016	0.017	-0.287	-0.288
Size non-green	-0.542	-0.542	-0.571	-0.573	-0.874	-0.876	-0.745	-0.745
Financials	-6.003	-6.003*	-3.713	-3.712				
Government	1.859	1.859	6.646	6.647*	7.930*	7.931*		
Currency	1.063	1.063	1.548	1.549	2.260	2.261	2.029	2.029
Maturity	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001
ESG			6.034	6.033*	7.896*	7.895**	4.277	4.278
AAA					4.021	4.021	7.715	7.715
AA					1.661	1.661	4.743	4.743
A					1.505	1.506	-0.138	-0.139
N	7032	7032	7032	7032	7032	7032	7032	7032
rho	0.740		0.730		0.731		0.746	

Results of the population-averaged Model 1.2 show that contrary to expectations, neither volume nor currency are significant variables, but the coefficient for the dummy variable financials is significant and negative.

In addition, we test if the existence of an ESG rating has an influence on the delta of our spreads. For the ESG rating we also create a dummy variable, which takes value one if the issuer has at least one ESG rating from Sustainalytics or RobecoSAM and zero otherwise. We use the same panel regression models as before and create our third Model 2.1 for the random-effects panel regression, Model 2.2 for the population-averaged regression, both including the *ESG* dummy variable. This time the population-averaged Model 2.2 indicates that the *ESG* as well as the *Government* dummy variables are significant with a positive coefficient. In a further step we include dummy variables for each rating class apart from BBB, which take value one if the rating is AAA, AA or A and zero otherwise, and leave out the dummy variable *Financials*. We test the same models as before, Model 3.1 with a random-effects panel regression and Model 3.2 with a population-averaged panel regression. This time both models, Model 3.1 as well as Model 3.2 show significance for *ESG* as well as the *Government* dummy. In a last step we leave out the dummy variable *Government* and conduct the same analysis using Model 4.1 for the random-effects regression and Model 4.2 for the population-averaged regression. This time no variables are significant. We use the same regressions with the cluster variable issuer to test our models. Nearly all variables show high levels of significance. Results are presented in Table 2.8.

Table 2.8: Random-effects and population-averaged panel regression (clustered by issuer)

This table shows coefficients of model results for a random effects (Model 1.1, 2.1, 3.1, 4.1) and a population-averaged panel regression (Model 1.2, 2.2, 3.2, 4.2) testing significance of various independent variables to dependent variable $i_{d,}$ which is the delta between empirical observed i-spreads of green bonds and interpolated i-spreads of non-green bonds. For a detailed description of panel variables please see Table 2.6.

*shows significance p<0.05, **shows significance p<0.01, ***shows significance p<0.001

	Model 1.1	Model 1.2	Model 2.1	Model 2.2	Model 3.1	Model 3.2	Model 4.1	Model 4.2
Size green	0.276	0.285	0.274	0.268	.690***	.723**	.687***	.709*
Size non-green	-1.352***	-1.310***	-1.354***	-1.319***	-.630***	-.682**	-.636***	-.706**
Financials	-5.297	-5.209**	-3.395	-3.356				
Government	3.549	3.561*	8.007*	7.991***	23.315***	22.109***		
Currency	2.718***	2.614***	2.726***	2.652***	1.580***	1.495**	1.565***	1.435*
Maturity	-0.000	-0.000	-0.000	-0.000	-.0007***	-.001***	-.001***	-.000**
ESG			5.732	5.697**	10.731**	10.347***	-3.546	-2.941
AAA					-6.098	-5.396	2.062	2.552
AA					-14.530***	-13.291***	-12.824***	-10.940**
A					8.047*	7.352**	9.386*	8.152*
N	7032	7032	7032	7032	7032	7032	7032	7032
rho	0.740		0.730		0.722		0.734	

The results of our models show that we are able to accept our third hypothesis that differences in pricing between green and non-green bonds vary across industries. Neither issue size of the bond nor maturity or currency have significant impact on the pricing differentials, but rather the industry (notably government related and financials), as well as the existence of an ESG rating have a significant influence. During our sample period, government related green bonds tend to trade marginally wider than non-green bonds, with a positive coefficient of the dummy variable *Government*. Financial green bonds tend to trade tighter than their comparable non-green counterparts, with a negative coefficient of the dummy variable *Financials*. One possible explanation for this difference in pricing can be seen from an issuer perspective. Government related issuers are actively promoting growth of the green bond market and may fear that tight pricing of green bonds compared to non-green bonds might hurt market growth. The EIB e.g. states on their climate awareness bonds factsheet[13] that "… EIB is committed to provide leadership in climate finance". The same factsheet points out that no premium is charged for their climate awareness bonds, climate awareness bonds are priced like other EIB bonds of comparable size and maturity. Similar statements are made by Kreditanstalt für Wiederaufbau (KfW) in their brochure about green bonds (KfW 2016).

Financial issuers on the other hand might be more pricing sensitive. A different explanation could result from an investor perspective. Dedicated sustainability, green bond and ESG funds are naturally looking for the highest return for their investor base and their demand for single A rated securities might be larger than for AAA and AA rated securities. On the other hand BBB securities might be too close to non-investment grade and investors might fear downgrade rating migration. We have to bear in mind though that our group of BBBs was small, for larger groups results may be different. Looking at our results investors might come to the conclusion that AAA and government related green bonds offer good value compared to non-green bonds. However, single A rated and financial non-green bonds might offer better value compared to green bonds if the investor does not need to buy "green". Our dummy variable ESG is significant and, surprisingly, positive. This could mean that if an issuer has an ESG rating, dedicated ESG investors might not be "forced" to buy a (often smaller) green bond issue but can instead

[13] http://www.eib.org/investor_relations/documents/eib-cab-factsheet.htm

also buy the comparable non-green bonds, since the issuer and thus all issues may be considered ESG conform.

2.5 Conclusion

The majority of empirical research on ESG so far documents that financial instruments of companies that follow the ESG approach perform better than financial instruments of companies who do not follow this approach. We look at green and comparable, non-green bonds over a sample period from 1st of October 2015 to 31st of March 2016. Comparing daily i-spreads of 7,032 green bonds and 14,064 non-green bonds, we first provide evidence that green bonds on average do not trade significantly tighter than their counterparts. However, pricing differentials are economically most obvious and show statistical significance for single A rated bonds, with green bonds trading 3.88 bps (4.87%) tighter than comparable non-green bonds. Green bonds with rating classes AA and BBB trade economically tighter than their non-green comparable bonds, but we could not find any statistical significance. Although issuing green bonds is more expensive than issuing non-green bonds, the difference in pricing between green and non-green bonds for rating classes AA, A and BBB could potentially make up for external costs the issuer has to bear, like a second party opinion and a possible certification of the transaction.

Analyzing the pricing differentials further, our results indicate that significant are neither maturity, nor volume or currency, but rather industries, namely government related and financial issuers, as well as the existence of an ESG issuer rating. Government related green bonds trade marginally wider than comparable non-green bonds, on the contrary financial green bonds trade tighter than non-green bonds.

3 The impact of expected regulatory changes: The case of banks following the 2016 U.S. election[14]

Abstract

We analyze bank stocks and CDS spreads around the U.S. presidential election on November 8, 2016. We find a strong rally in bank stocks combined with an overall widening in bank CDS spreads during the days after the announcement of the election result. Following Donald Trump's victory, market participants appear to anticipate a lowering of financial sector regulation, particularly with respect to the Dodd-Frank Act. In addition, we find that G-SIBs reacted more positive than non-G-SIBs, with stocks having larger gains and CDS remaining relatively stable. Non-G-SIB stocks, on the other hand, gained less and their CDS widened, indicating less favorable changes from deregulation than for G-SIBs.

3.1 Introduction

In the night from November 8 to November 9, 2016, it was officially announced that the Republican Donald Trump won the U.S. presidential election and will become the 45th president of the United States. Trump's victory came as a surprise to the vast majority of capital market participants. Following Trump's inauguration, market participants expect a repeal or significant reshaping of the Dodd-Frank Wall Street reform and consumer protection act (Dodd–Frank Act 2010). Two days after his election, Donald Trump already published on his webpage that the Financial Services Implementation Team will be working on dismantling the Dodd-Frank Act,[15] a promise, he had given initially in an interview to Reuters on May 17, 2016, during his election campaign.[16] The Dodd-Frank Act was adopted by the Democrats in 2010 in the wake of the financial crisis in order to preserve financial stability and avert another crisis. It created new regulatory authorities and control mechanisms, limits the banks' proprietary trading activities and banks'

[14] This chapter is based on an article published in Finance Research Letters, Volume 22, 2017, Hachenberg B., Kiesel F., Kolaric S., Schiereck D.: The impact of expected regulatory changes: The case of banks following the 2016 U.S. election, Pages 268-273, ISSN 1544-6123, http://dx.doi.org/10.1016/j.frl.2016.12.021.

[15] https://web.archive.org/web/20161111062731/https:/www.greatagain.gov/policy/financial-services.html.

[16] http://www.reuters.com/article/us-usa-election-trump-banks-idUSKCN0Y900J.

investments in hedge funds and private equity funds (Volcker Rule). At the same time, the Dodd-Frank Act regulates derivative products, which were partially responsible for the subprime mortgage crisis.

Changes in regulation result in a change in security prices and have been analyzed through event studies beginning in the 1980s (Schwert 1981) and numerously thereafter (e.g. Eyssell and Arshadi 1990; Veronesi and Zingales 2010). Schäfer et al. (2016) come to the conclusion that recent regulatory changes, notably the Dodd-Frank Act and Volcker rule, succeeded in reducing bail-out expectations for banks relative to the post-bail-out level and were linked to a decline in bank stock prices and a widening in bank CDS spreads. Regulatory changes, being the implementation of new regulatory rules or deregulation, are discussed by various different parties, not only politicians, but also experts and lobbying groups, and naturally take a long time to be finalized. Any leakage of new information, anticipation of changes or even rumours are likely to effect security prices. Therefore, defining the right point in time of an event is key for the use of event studies. Hence, using event studies for regulatory changes is particularly challenging (Lamdin 2001). The unexpected victory of Donald Trump offers an ideal setting to test the true impact of anticipated changes to regulation on capital markets. His earlier comments about deregulation and dismantling the Dodd-Frank Act (e.g. to the news agency Reuters, May 17, 2016 and the New York Economic Club September 15, 2016)[17] have only gained significance with his election victory. The event of having both a Republican president and a Republican-controlled senate and the resulting policy changes that may now take place gain special attention (Roberts 1990) and pave the way for a regulatory reform. With two vacant Fed governor seats to fill, as well as a nomination for the powerful post of vice chair of supervision, Trump is expected to change the central bank setting and with it monetary and regulatory oversight very quickly.

The aim of this study is to empirically analyze the reaction of bank stocks to the outcome of the U.S. presidential election in 2016 and the expected deregulation that is to follow. Policy changes are associated with increased volatilities and the announcement of a change in government frequently leads to a drop in share prices (Pástor and Veronesi 2012). However, in this case, after Asian markets fell sharply the day following the election, and European markets opened initially weaker, the Dow Jones Industrial

[17] http://time.com/4495507/donald-trump-economy-speech-transcript/.

Average closed gaining 1.4% and the FTSE 100 ended the day increasing by 1%. Stock prices of American banks climbed during the days following the election in a manner not seen since before the financial crisis in expectations of a significant Wall Street reform. Since the expected reforms would not only influence American banks, we anticipate a spillover to banks worldwide and therefore analyze banks globally. As a stronger effect can be assumed for closely regulated institutions, we divide global banks into two subgroups, G-SIBs[18] and non-G-SIBs.

We additionally look beyond bank stocks reaction to Trump's victory and also investigate the reaction of banks' CDS spreads. Banks have to make important economic choices based on the expected future economic policy choices of governments and constraints from regulation (Brogaard and Detzel 2015). In this context, the outcome of the U.S. elections can be seen as a drastic change in government policy. We use CDS spreads and stock returns to estimate the impact of the result of the U.S. election on global banks. CDS are a marked-based measure of firm risk and changes in CDS spreads directly relate to changes in firms' risk (Jorion and Zhang 2007). Dismantling the Dodd-Frank Act would enable banks to shift into riskier business, like proprietary trading and engagements in private equity funds, again.

3.2 Sample construction and methodology

The goal of the present study is to analyze stock and CDS market reaction following the announcement of Donald Trump's victory of the 2016 U.S. presidential election. The result of the election was disclosed during the night from November 8 to November 9, 2016, allowing capital markets to respond to the election result on Wednesday, November 9, 2016, which we treat as the official announcement day.

For our sample construction, we first collect all financial institutions with CDS and stock data available through Datastream. We thereby exclude all insurance and real estate firms, non-bank holding companies, and other miscellaneous investment firms. We additionally dropped firms with functions related to depository banking and credit card companies (e.g. Western Union, American Express). Following the majority of prior

[18] As defined by The Financial Stability Board (FSB) in consultation with Basel Committee on Banking Supervision and national authorities, http://www.fsb.org/wp-content/uploads/2015-update-of-list-of-global-systemically-important-banks-G-SIBs.pdf.

research on CDS (e.g. Jorion and Zhang 2007; Kiesel et al. 2016; Schiereck et al. 2016) we use the five year senior CDS mid spread in U.S. dollars. We therefore also dropped all observations with either insufficient CDS spread or stock price data during the 120 days estimation period, ending 6 days prior to the event day. This sample selection process left us with a total of 71 financial institutions from 25 countries. We further divide our sample into G-SIBs and non-G-SIBs, as particularly G-SIBs may benefit from regulatory changes, as they currently face the strongest regulatory requirements of all financial institutions (for a full list of our sample banks see Appendix A.2).

To properly capture the short-term impact of the expected deregulation on banks' stock prices and CDS spreads, we estimate a system of regressions using a SUR framework (Zellner 1962). This approach is better suited than the traditional two stage market model event study for regulatory or similar events, because all firms are affected at the same time and in the SUR framework the regressions are estimated simultaneously, thereby accounting for potential cross-correlations (Binder 1985). This approach has been frequently used in prior reseach (e.g. Doidge and Dyck 2015; Schäfer et al. 2016; Schiereck et al. 2016) and for stock returns the SUR model takes the following form:

$$\begin{aligned} R_{1t} &= \alpha_1 + \beta_1 R_{Mt} + \tau_1 Event + \varepsilon_{1t} \\ &\dots \\ R_{it} &= \alpha_i + \beta_i R_{Mt} + \tau_i Event + \varepsilon_{it} \\ &\dots \\ R_{Nt} &= \alpha_I + \beta_N R_{Mt} + \tau_N Event + \varepsilon_{Nt} \end{aligned} \tag{3.1}$$

where R_{it} are the daily stock returns for firm i with with $i = 1,\dots,N$, R_{mt} are the benchmark returns of the local value-weighted Datastream market index of the country of origin of the respective firm, while α_i and β_i are the firm specific regression coefficients, representing the intercept and sensitivity of firm i to the local benchmark index, and ε_{it} is the error term. *Event* is a vector of dummy variables for our event, which is equal to 1 on the event day, the $[0;0]$ event window, during 5 days surrounding the event, the $[-2;+2]$ event window, and the 11 days surrounding the event, the $[-5;+5]$ event window. The cumulative abnormal returns for each firm (CAR_i) is calculated by multiplying each τ_i by the number of days in the event window (Doidge and Dyck 2015). We estimate the regression using 120 trading days, ending 6 days prior to the event day.

Abnormal CDS spread changes are estimated on basis of a constant return model, following the approach of Schäfer et al. (2016) and Schiereck et al. (2016). The difference to the market model described in Equation (1) is the absence of a market return. We therefore estimate:

$$\begin{aligned}
&\Delta \mathrm{CDS}_{1t} = \mu_1 + \tau_1 Event + \varepsilon_{1t} \\
&\dots \\
&\Delta \mathrm{CDS}_{it} = \mu_i + \tau_i Event + \varepsilon_{it} \\
&\dots \\
&\Delta \mathrm{CDS}_{Nt} = \mu_N + \tau_N Event + \varepsilon_{Nt}
\end{aligned} \tag{3.2}$$

The left-hand side of the equation, ΔCDS_{it}, is the difference in the CDS spread of firm i from t-1 to t. On the right-hand side of the equation, μ_i denotes the mean of first differences of the CDS spread changes of firm i during the estimation window. In all other aspects the procedure follows those of the stock returns.

3.3 Results

The results of the stock event study are presented in Table 3.1. We find an overall positive reaction for our entire sample of banks. Especially during the longer event windows, highly significant and positive average abnormal returns of up to 4.43% during the [−5;+5] day event window can be observed. Splitting the sample into G-SIBs and non-G-SIBs provides further insights into the differential effect the election results had on these financial institutions. G-SIBs, on average, experienced highly significant positive returns, which are particularly pronounced during the [−2;+2] and [−5;+5] day event windows with 6.32% and 7.71%, respectively. For non-G-SIBs, on the other hand, the returns are much lower. For these institutions, the average abnormal return is insignificant on the announcement day [0;0] and amount to only 2.88% during the [−5;+5] day event window. The average abnormal returns for non-G-SIBs are significantly lower than for G-SIBs for all event windows.

Table 3.1: Stock event study results

	n	Event day [0; 0]		Event window [−2; +2]		Event window [−5; +5]	
		Average return (%)	Average abnormal return (%)	Average return (%)	Average abnormal return (%)	Average return (%)	Average abnormal return (%)
All banks	71	0.383	0.603***	6.335	4.224***	3.839	4.427***
[*t*-value]			[2.237]		[6.354]		[4.658]
G-SIBs	23	2.103	1.355***	9.647	6.319***	8.982	7.714***
[*t*-value]			[3.570]		[6.017]		[5.287]
Non-G-SIBs	48	-0.441	0.232	4.748	3.250***	1.374	2.875**
[*t*-value]			[0.672]		[3.989]		[2.442]
G-SIBs versus non-G-SIBs			1.123		3.069		4.839
[*t*-value]			[1.991]*		[2.217]**		[2.444]**
[Z-score]			[1.775]*		[2.328]**		[2.402]**

This table shows the stock event study results from the SUR analyses using a 120 day estimation period for the 71 sample banks. The sample banks are further divided into G-SIBs and non-G-SIBs. The average return refers to the unadjusted return, while the average abnormal return refers to the abnormal returns estimated using the SUR analyses. The returns are given in percentage points and the values for the event day [0; 0] and the [−2; +2] and [−5; +5] event window are shown. Average abnormal returns are tested for equality to zero and the associated *t*-values are given in brackets. The equality of means and medians between the two samples are tested for statistical significance using the two sample *t*-test and the Wilcoxon rank-sum test. The associated *t*-values and Z-scores are given in brackets. ***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table 3.2 shows the results for the CDS spread changes. Overall, a significant widening in CDS spread levels can be observed. However, when the sample is split into G-SIBs and non-G-SIBs, it can be seen that this increase is driven entirely by non-G-SIBs. Non-G-SIBs experience a highly significant widening of their CDS spreads of up to 6.73 bps during the [−5;+5] day event window. For G-SIBs, on the other hand, CDS spreads barely change and their spread changes are significantly lower than for non-G-SIBs. This result, in combination with the stock results, provides evidence that larger, more closely regulated institutions stand to benefit from changes in regulation, as stockholders gained significant positive returns, while there appear to be no negative consequences in credit markets for these institutions. In contrast, even though stockholders of non-G-SIBs benefited to a certain extent as well, their debtholders did not. This may indicate that these banks may shift into more risky business activities as a result of lower anticipated regulatory levels, which will be more beneficial to their stockholders than their debtholders.

Table 3.2: CDS event study results

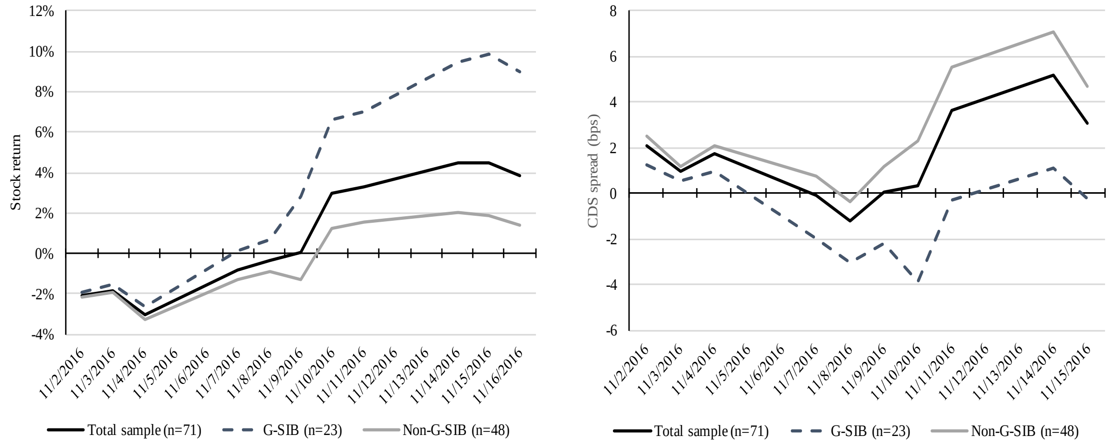
		Event day [0; 0]		Event window [−2; +2]		Event window [−5; +5]	
	n	Average spread change (bps)	Average abnormal spread change (bps)	Average spread change (bps)	Average abnormal spread change (bps)	Average spread change (bps)	Average abnormal spread change (bps)
All banks	71	1.282	1.418***	1.923	2.508***	3.610	4.897***
[*t*-value]			[5.091]		[2.825]		[4.688]
G-SIBs	23	0.841	0.922*	−1.209	−0.804	0.179	1.069
[*t*-value]			[1.979]		[−0.556]		[0.527]
Non-G-SIBs	48	1.493	1.656***	3.423	4.094***	5.254	6.732***
[*t*-value]			[4.811]		[3.902]		[5.996]
G-SIBs versus non-G-SIBs			−0.734		−4.898		−5.662
[*t*-value]			[−1.238]		[−2.696]***		[−2.643]**
[Z-score]			[−0.805]		[−2.697]***		[−2.660]***

This table shows the CDS event study results from the SUR analyses using a 120 day estimation period for the 71 sample banks. The sample banks are further divided into G-SIBs and non-G-SIBs. The average spread change refers to the unadjusted spread change, while the average abnormal spread change refers to the abnormal spread changes estimated using the SUR analyses. The spread changes are given in bps and the values for the event day [0; 0] and the [−2; +2] and [−5; +5] event window are shown. Average abnormal spread changes are tested for equality to zero and the associated *t*-values are given in brackets. The equality of means and medians between the two samples are tested for statistical significance using the two sample *t*-test and the Wilcoxon rank-sum test. The associated *t*-values and Z-scores are given in brackets. ***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Figure 3.1 graphically illustrates the stock as well as CDS market reaction surrounding the results of the 2016 U.S. presidential election using unadjusted stock returns (Figure 3.1 Panel A) and CDS spread changes (Figure 3.1 Panel B). The stock market reaction of the banks is initially very positive, particularly for the sample of G-SIBs. Non-G-SIBs, on the other hand, show a more subdued equity market reaction, which quickly stabilizes following the announcement of the election results. The banks' CDS spreads, in contrast, remained comparatively stable prior to the announcement of the election result. Following the announcement, however, CDS spreads widened. This widening is particularly pronounced for non-G-SIBs, while the CDS spreads of G-SIBs remained comparatively resistant. Overall, this indicates that market participants appear to believe that particularly G-SIBs stand to gain from changes in the regulation of financial institutions, while smaller institutions may be less affected overall.

Figure 3.1: Stock and CDS market reaction to the 2016 U.S. presidential election result

Panel A: Stock market reaction to the 2016 U.S. presidential election results *Panel B: CDS market reaction to the 2016 U.S. presidential election results*



This figure shows the sample banks' stock and CDS market reaction to the announcement of Donald Trump winning the 2016 U.S. presidential election in the night from November 8 to November 9, 2016. The graphs show the cumulative average unadjusted stock price reaction (Panel A) and the cumulative average unadjusted CDS spread reaction (Panel B), starting 5 trading days prior to and ending 5 trading days following the announcements of the results of the 2016 U.S. presidential election.

To further investigate the drivers of the observed abnormal stock returns and abnormal CDS spread changes, we conduct several OLS regressions. The regression for the average abnormal stock returns takes the following form:

$$CAR_i = G\text{-}SIB_i + IB_i + VOLA_i + LEVERAGE_i + \varepsilon_i \tag{3.3}$$

And for the average abnormal spread changes the following form:

$$CASC_i = G\text{-}SIB_i + IB_i + VOLA_i + LEVERAGE_i + LIQUIDITY_i + \varepsilon_i \tag{3.4}$$

The dependent variable CAR_i and $CASC_i$ are the average abnormal stock returns and average abnormal spread changes for firm i on the event day [0;0] and during the [−2;+2] and [−5;+5] day event windows, respectively. The independent variables are *G-SIB*, a dummy variable that takes the value of 1 if the bank is a G-SIB according to the Financial Stability Board (FSB) and the Basel Committee on Banking Supervision 2015 list,[19] *IB* is a dummy variable which is defined as 1 if the bank is identified as an investment bank (SIC code 6211) and 0 otherwise, *VOLA* is the stock return volatility during the [−126;−6] estimation window, *LEVERAGE* is the total debt to total assets ratio

[19] See http://www.fsb.org/wp-content/uploads/2015-update-of-list-of-global-systemically-important-banks-G-SIBs.pdf for the full list of G-SIBs.

of the bank at the end of 2015, and *LIQUIDITY* is the ratio of non-zero daily CDS spread changes to the total number of trading days during the 120-day estimation period.

Table 3.3 presents the results of the regression analyses. For stocks, the coefficient for the variable *G-SIB* is significant and positive, particularly when using the CAR for of the [−5;+5] day event window as the dependent variable. Moreover, stockholders of investment banks appear to gain more, as the significant and positive coefficient of *IB* suggests. Lower levels of regulation appear to be perceived as particularly beneficial for these institutions. In addition, the stockholders of more highly leveraged banks also appear to gain, as the significant coefficient for *LEVERAGE* documents, while the stock volatility does not have an influence. For CDS spreads, the coefficient for *G-SIB* is likewise significant when using the [−2;+2] and [−5;+5] event window spread changes as the dependent variables. The negative sign suggests that not only stockholders of the closely regulated G-SIBs appear to gain from anticipated lower levels of regulation, but also debtholders. The coefficient for the variable *LIQUIDITY* is highly significant and negative, indicating that higher levels of liquidity are associated with lower spread changes. The remaining variables have no significant influence on the observed spread changes.

Table 3.3: Regression results

	Stocks			CDS		
Event window	[0; 0]	[−2; +2]	[−5; +5]	[0; 0]	[−2; +2]	[−5; +5]
G-SIB	0.007	0.005*	0.003**	−0.658	−4.870***	−5.227**
	(0.005)	(0.003)	(0.002)	(0.551)	(1.838)	(2.112)
IB	0.019	0.009***	0.004**	−0.600	−2.709	−2.310
	(0.013)	(0.003)	(0.002)	(1.502)	(2.383)	(2.069)
VOLA	0.022	0.261	0.032	5.495	74.937	124.477
	(0.227)	(0.162)	(0.108)	(30.364)	(104.073)	(110.316)
LEVERAGE	0.003***	0.001**	0.001**	−0.114	−0.054	−0.520
	(0.001)	(0.001)	(0.000)	(0.085)	(0.444)	(0.366)
LIQUIDITY				−5.241***	−15.597***	−23.880***
				(1.985)	(5.776)	(6.412)
CONSTANT	−0.012*	−0.006	−0.002	2.881***	5.275	10.100***
	(0.006)	(0.004)	(0.002)	(1.092)	(3.951)	(3.597)
Adj. R^2	0.114	0.156	0.101	0.068	0.161	0.267
F-value	4.13***	6.41***	4.40***	1.93	4.26***	8.44***
N	71	71	71	71	71	71

This table shows the results of the OLS regressions, using firm *i*'s cumulative abnormal stock return and abnormal CDS spread change of the event day [0;0] and the [−2; +2] and [−5; +5] event windows as the dependent variable. *G-SIB* is a dummy variable that takes the value of 1 if the bank is a G-SIB according to the Financial Stability Board (FSB) and the Basel Committee on Banking Supervision 2015 list, *IB* is a dummy variable, which is defined as 1 if the bank is identified as an investment bank (SIC code 6211) and 0 otherwise, *VOLA* is the stock return volatility during the [−126;−6] estimation window, *LEVERAGE* is the total debt to total assets of the bank at the end of the year 2015, and *LIQUIDITY* is the ratio of non-zero daily CDS spread changes to the total number of trading days in the 120 day estimation period. The standard errors are corrected for heteroskedasticity and given in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

3.4 Conclusion

Our empirical analyses show that the announcement of Donald Trump's victory in the 2016 U.S. presidential election in the night from November 8 to November 9, 2016, led to significant movements in banks' stock prices and CDS spreads. Overall, stock prices increased in the wake of the election announcement, while CDS spreads widened. This is potentially due to an anticipated deregulation of financial institutions during the Trump presidency, which may allow banks to again increase their exposure to more risky business activities, such as proprietary trading. Moreover, our results show that the stockholders of G-SIBs gained more than stockholders of non-G-SIBs, while CDS spreads only widened for non-G-SIBs. For the closely regulated G-SIBs, the possibility of lower levels of regulation in the future is seen as beneficial to equity and credit market participants alike. For non-G-SIBs, on the other hand, concerns that these banks may shift into riskier businesses, which potentially benefits stockholders more than debtholders, appear to be more prevalent.

4 Auto ABS since the financial crisis: A comparison between the European and U.S. market[20]

Abstract

We empirically analyze auto ABS in Europe and the U.S. since the financial crisis. We find that both markets have recovered, but the number of retained tranches in Europe is high and especially the European market is still relatively intransparent. By analyzing primary market spreads, we further investigate which credit and liquidity factors investors take into account when making investment decisions. We conclude that for the European as well as U.S. market type of originator, nature of collateral, weighted average life of the securitization and issuance amount are important variables for investors. Credit ratings only play a major role for the U.S. market, but for the European market the picture is not as clear – especially the subordinated, often retained tranches do not necessarily show a higher spread. This suggests that the European market depends not only on investors, but to a large extent ECB funding, as well, and has not shown the recovery the U.S. market experienced.

4.1 Introduction

Securitizations and their influence on capital market disruptions have been widely discussed since the recent financial crisis. Especially the growth of mortgage-backed securities together with the boom of the housing market were the focus of criticism. With "originate-to-distribute[21]" products capital markets had decoupled from the real economy. In the wake of the financial crisis many investors, especially in Europe, withdrew from investing in securitizations across asset classes. This is particularly surprising as default rates of mortgage backed securities were very low in Europe compared to the U.S. In Europe, default rates of residential mortgage backed securities (RMBS) e.g. never rose above 0.1%, whereas in the U.S. AAA-rated RMBS backed by prime mortgages reached a

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[20] This chapter is based on a working paper, Hachenberg B., Kiesel F., Schiereck D. (2018): Auto ABS since the financial crisis: A comparison between the European and U.S. market.

[21] Products were created just to be sold to investors and the due diligence of loans was not as intense, as it would have been if kept on balance sheet by the originator.

default rate of 3% and defaults of AAA-rated RMBS backed by subprime mortgages even peaked at 16% (European Commission 2015).

In this article, we analyze the European and U.S. auto ABS market following the financial crisis, from 2010 to the 1st half of 2017. Auto loan and lease ABS were never seen as the cause of the crisis, but suffered from the bad image, that came along with securitizations in general. Tighter market regulation has also made it more difficult for various institutional investors to buy ABS, as well as issuers to securitize their collateral. Auto financing is seen as the key to auto sales though and securitization of automobile loans and leases was traditionally the key to its refinancing (Fabozzi and Kothari 2008), thus a very close connection between capital markets and the real economy and an effective risk transfer.

We investigate if auto ABS, one of the oldest classes of ABS, are still an important instrument to provide funding for issuers and a reliable investment for investors, or if the market has not recovered meaningfully since its contraction during the financial crisis. We also empirically study the credit factors investors take into account when investing in auto ABS.

In the wake of the crisis various parties call for more transparency on structured products. The European Commission e.g. proposed a regulation on simple, transparent and standardised (STS) securitizations (European Commission 2015). Organizations like the Prime Collateralised Securities (PCS) initiative, set up in 2012, have been established, that promote, among others, standards of transparency and simplicity. A further objective is to look at the transparency of auto ABS. We compare European and U.S. transactions to work out the differences and investigate if the markets are in different cycles. This study contributes to the existing literature about structured products and sheds light on current auto ABS in Europe and the United States.

The remainder of the paper is structured as follows. Section 2 provides an overview of the recent literature about securitizations and in particular auto ABS. Section 3 describes the data and methodologies we use. Section 4 then outlines descriptive statistics and empirical results, and the last section ends the paper with the conclusion.

4.2 Literature review and status quo on auto ABS

4.2.1 Literature review

Literature about securitizations is manifold. The role of credit rating agencies and credit ratings of securitizations, especially during the financial crisis and the boom years leading to the crisis, have been intensively discussed. Criticized have been a number of factors, leading from the fee model rating agencies followed over the overreliance rating agencies enjoyed to the models they used. He et al. (2012) reveal that investors price the risk that larger issuers of mortgage-backed securities receive more inflated ratings than smaller issuers, particularly during boom periods. The Bank for International Settlements (2008) discovers, among others, an overdependence on ratings as well as other weaknesses in investors' risk management. By analyzing collateralized debt obligations (CDOs) Griffin and Tang (2012) come to the conclusion that one of the top three rating agencies frequently made positive adjustments to their credit rating model that resulted in much larger AAA-rated tranches.

Fabozzi and Vink (2012) look at the variables investors rely upon other than credit ratings when investing in ABS and find significance in internal and external credit enhancement, commercial ABS and size of tranche. Acharya et al. (2013) analyze asset-backed commercial paper (ABCP) conduits as a mean to use securitization without risk transfer but regulatory arbitrage instead. Various new regulations have been established after the crisis from both, the financial regulatory authorities in the U.S. and European Union. Guo and Wu (2014) e.g. study the risk retention regulation on ABS, disclosure on securitized assets and informational asymmetries between issuers and investors. Albertazzi et al. (2015) analyze whether banks use asymmetric information for their advantage when issuing securitizations. They conclude that for their dataset of a million mortgages the default probability of securitized mortgages is, for given observable characteristics, lower than for the non-securitized mortgages. Looking at securitized loans only, their findings are different though. They show that banks maintain a higher share of risk in deals with better-quality-loans. A point of discussion are also the pros and cons of a true-sale securitization vs. keeping assets on balance sheet (see e.g. Higgins and Mason 2004).

Auto ABS are typically true-sale securitizations (i.e. a legal separation of originator and issuer of the security, the later a SPV) in both regions, the U.S. as well as in Europe. Comparing structured finance markets in the U.S. and Europe (see Table 4.1), we notice that the pure volume of the U.S. market is still a multiple of the European market, with the difference even increasing since the crisis (AFME 2017).

Table 4.1: Structured finance issuance in Europe at the U.S.

This table shows structured finance issuance in Europe and the U.S. in billion Euro from 2010 up to the 1st quarter of 2017 (AFME 2017).

	European Historical Issuance	U.S. Historical Issuance
2010	378.0	1225.7
2011	376.8	1052.8
2012	257.8	1568.5
2013	180.8	1517.4
2014	217.0	1443.3
2015	216.6	1635.4
2016	238.6	1796.7
2017	36.7	410.6

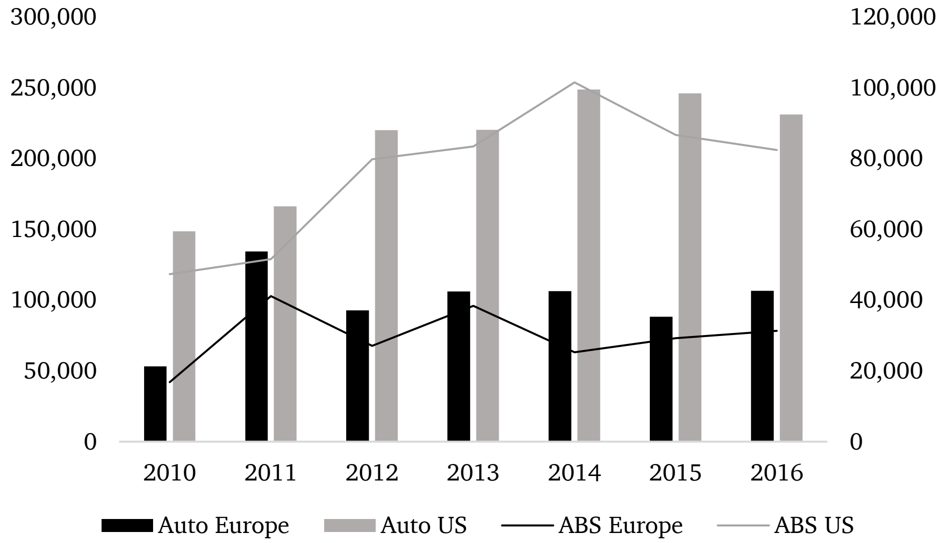
According to the Association for Financial Markets in Europe (AFME), the volume of outstanding securitizations at the beginning of 2017 was 1,244 billion Euro in Europe and 8,681 billion Euro in the U.S. However, an "outstanding" securitization does not necessarily mean it is placed with investors. A recent development in Europe, since 2008, is that the issuer retains tranches, or even the full securitization. In many cases the European Central Bank (ECB) provides liquidity for banks against those retained tranches. The amount of placed vs. retained structures varies for the years and asset classes in question and fluctuates roughly in between 30% and 70% for European structures. In the U.S. the issuer rarely retains any paper above the 5% risk retention rule, which we will discuss in the next chapter.

The percentage of ABS[22] of outstanding securitizations is very similar, around 6% in Europa and 7% in the U.S. ABS backed by auto loans and leases belong to consumer ABS[23]. The percentage of auto ABS of total securitizations has grown since the crisis in both markets, and their relative importance has risen (see e.g. DZ Bank AG 2017; Mohr 2015). Figure 4.1 shows the total auto ABS and ABS issuance in Europe and the U.S. since 2010.

[22] European ABS issuance includes auto, credit card, leases, loans, receivables and other; U.S. ABS issuance includes auto, credit card, home equity, student loan, equipment leases, manufactured housing and other.
[23] For a more detailed description of consumer ABS see e.g. Fabozzi and Kothari (2008).

Figure 4.1: Auto and total ABS issuance in Europe and the U.S.

This figure shows yearly auto ABS issuance in Europe and the U.S. from 2010 to 2016 (right hand scale) as well as total ABS issuance in Europe and the U.S. (left hand scale), all in million U.S. dollars. European figures include auto leases, U.S. figures include all types of auto ABS. Source: https://www.sifma.org/resources/research/europe-structured-finance-issuance-and-outstanding/ and https://www.sifma.org/resources/research/us-abs-issuance-and-outstanding/.



Looking at auto transactions in Europe and the U.S., the first obvious distinction is that in Europe usually the collateral of auto ABS is considered prime collateral. In the U.S. on the contrary apart from prime loan collateral also subprime or near-prime collateral is securitized. The concept of the FICO[24] score, which does not exist in its form in Europe, helps to distinguish the collateral in the U.S. into three classes. The weighted average FICO score of the underlying loans of prime securitizations is more than 680, near-prime transactions have a FICO score between 620 and 680, and subprime transactions below 620 (see e.g. Lancaster et al. 2008). Looking at the age of the vehicle, prime auto ABS securitize loans of new vehicles, whereas subprime transactions can consist of used cars, as well (see e.g. Fabozzi and Kothari 2008).

Subprime auto loans have recently been the focus of criticism, warning about relaxing underwriting standards and rising loss severities (Office of the Comptroller of the Currency 2016; Curry 2015). But also prime U.S. auto securitizations are experiencing

[24] FICO is a credit score developed by the company FICO, whose original name was Fair Isaac Corporation.

weaker underwriting trends (longer original loan terms as well as slightly lower FICO scores) and thus an increase in cumulative loss rates (Moody's Investor Service 2017).

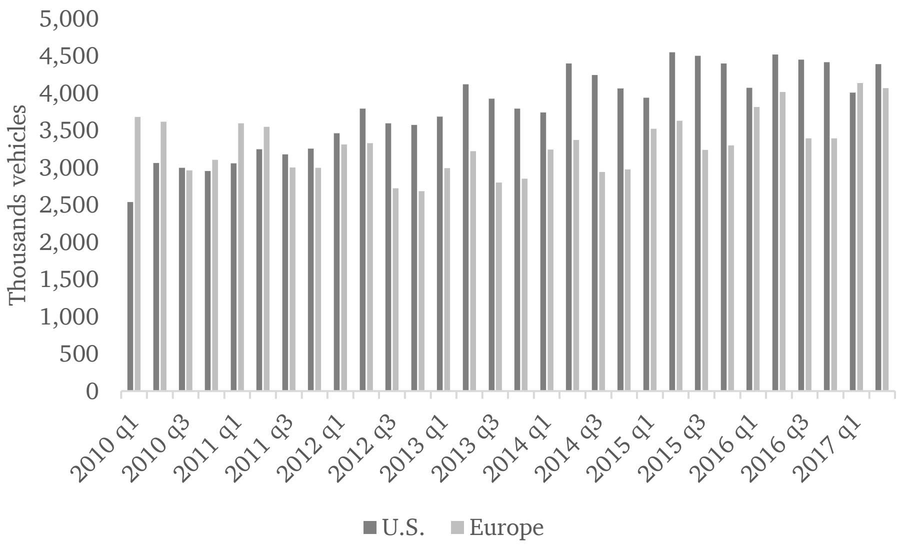
U.S. auto ABS are not only classified by collateral quality, but the collateral is also further categorized into fleet, floorplan, motorcycle, rental and recreational vehicle (RV) transactions (see e.g. Fabozzi 2000). The securitization of auto lease cash flows exists in both jurisdictions, the U.S. as well as Europe, as a separate asset class. In Europe, loan and lease originators are typically banks or captives (auto manufacturer finance subsidiaries), in the U.S., on the other hand, there are also a number of Specialty Finance Companies which originate auto loans (Sze and Shah 2017).

4.2.2 Status quo

Both, issuers as well as investors, benefit from securitization. Securitization offers issuers an additional funding source. The issuance of auto ABS is, among others, dependent on the general macro-financial framework, private consumer spending and, more importantly, automobile sales. U.S. and European automobile sales are at or near their recent highs (see Figure 4.2).

Figure 4.2: Vehicle sales in Europe and the U.S.

This figure shows monthly vehicle sales (new vehicle registrations in Europe; sales of autos and light trucks, not seasonally adjusted, in the U.S.) from 2010 to June 2017, sales are in thousands. Source: European Automobile Manufacturers Association; Bureau of Economic Analysis.



The investor benefits from an investment that can be tailor-made to his risk appetite and investment horizon. For investors the credit rating of their investment and the credit rating migration throughout the life of the transaction are very important. Analyzing rating migration for auto securitizations, it becomes obvious, that auto ABS receive more upgrades than downgrades. This is the case for the following reasons: Over the relatively short life of the auto transactions, their credit enhancement increases. Credit enhancement increases as a consequence of non-declining reserve accounts, the availability of excess spread to turbo notes and trapping excess spread within the ABS transaction (Sze and Shah 2017). The ratio of upgrades vs. downgrades is even better for auto transactions compared to other structured finance instruments. Looking at the combined ratio of upgrades vs. downgrades of auto ABS securitizations for credit rating agencies DBRS, Fitch Ratings, Moody's Investor Services and S&P in Europe (Table 4.2), it is 79/0 for 2016 and 23/0 for the 1st quarter of 2017 (AFME 2017). On the contrary, AFME reports for securitizations overall a ratio of upgrades vs. downgrades of 2,094/424 for 2016 and 471/182 for the 1st quarter of 2017. In the U.S. the picture is similar. The ratio of upgrades vs. downgrades for auto securitizations is 697/0 for DBRS, Fitch Ratings, Moody's Investor Services and S&P for 2016 and 136/0 for the same rating agencies for the 1st quarter of 2017. Again securitizations overall have a significantly worse ratio of 13,784/5,632 for 2016 and 2,367/1,117 for the 1st quarter of 2017.

Table 4.2: Credit rating migration in Europe and the U.S.

This table shows the ratio of upgrades/downgrades of the four credit rating agencies DBRS, Fitch Ratings, Moody's Investor Services and S&P. Data for 2016 is the full year, for 2017 1st quarter (AFME 2017).

		Europe	U.S.
2016	Auto securitizations	79/0	697/0
	All securitizations	2,094/424	13,784/5,632
2017	Auto securitizations	23/0	136/0
	All securitizations	471/182	2,367/1,117

Looking at the pricing of primary securitizations and secondary levels, a dependence in both markets, the European as well as the U.S. market, has been achieved through the support of the ECB and Federal Reserve Bank. The ECB started buying, among others, auto ABS through its Asset-Backed Securities Purchase Programme (ABSPP) in November 2014. Up to the end of June 2017 the ECB bought ABS in the amount of around 24.1 billion Euro[25]. Eligible are the most senior tranches of ABS or guaranteed mezzanine

[25] The history of cumulative purchase breakdowns of the asset purchase programme is published at https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html.

tranches (European Central Bank 2014). As auto ABS are typically not guaranteed, the ECB buys their senior tranches only. The Federal Reserve Bank allows through its program Term Asset-Backed Securities Loan Facility (TALF) since November 2008 the refinancing of, among others, ABS backed by auto loans. Thus borrowers receive lower margins than otherwise achievable (see e.g. Gârleanu and Pedersen 2011).

4.3 Sample construction and methodology

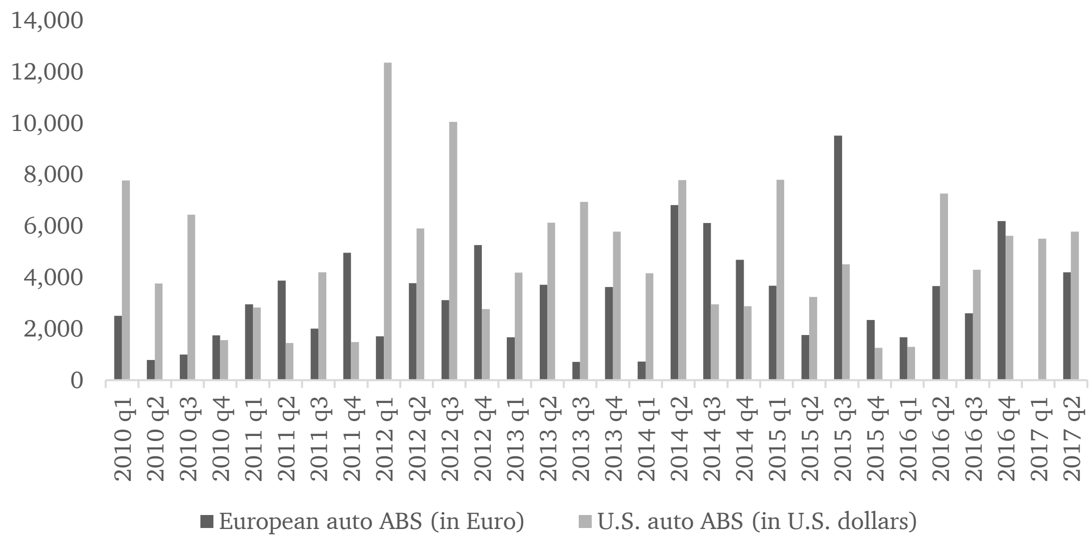
As subprime and near-prime auto transactions only exist as a classification in the U.S. and not throughout Europe, we concentrate on prime and lease transactions only.

For the European transactions, we use data from the internal data base of a large European bank and supplement missing components through Thomson Reuters, Global Capital and the weekly publication "Global ABS/CDO Weekly Market Snapshot" published by J.P. Morgan. Our goal is to look at the development of auto ABS after the financial crisis, thus we filter for auto ABS transactions from the beginning of January 2010 to the end of June 2017. The database includes 324 transactions with a total of 703 tranches for the time span. We take a closer look at the largest 100 transactions (loans and leases). We define largest transactions by looking at the original notional across tranches. Non-Euro currencies, like the pound sterling, Norwegian krone, U.S. dollar, Polish zloty, Australian dollar and Swedish krona we recalculate into Euro at their respective exchange rate at date of issuance of the auto ABS. Two of the largest 100 transactions are private placements without any further details like yield, credit rating etc., thus we exclude them and include the next two largest transactions. The remaining sample of 100 European auto transactions consists of 247 tranches. The total volume of the 100 largest transactions is 973.51 billion Euro original amount at issuance, thus on average less than one billion Euro per transaction. Taking into account the head institutions only, the transactions are originated by 12 different companies.

For the U.S. data we use the weekly publication "Global ABS/CDO Weekly Market Snapshot" published by J.P. Morgan and supplement missing data again, were applicable, through Thomson Reuters and Global Capital. As a first step, we collect all prime auto loan and lease transactions from January 2010 to the end of June 2017. To obtain a good comparison of similar transactions in Europe and the U.S., we analyze securitizations collateralized by prime auto loans and leases only and leave out U.S. subprime, fleet, floorplan and motorcycle/truck securitizations. Looking at the 100 largest transactions, the cut off is 1.250 billion U.S. dollars original amount at issuance. All U.S. transactions are issued in U.S. dollars. Since 19 transactions have the same issue amount, we include the transactions issued first until our sample includes 100 deals. Figure 4.3 shows the timeline of issuance of our 100 largest European and U.S. auto ABS securitizations.

Figure 4.3: Auto ABS in Europe and the U.S. between 2010 and the 1st half of 2017

This figure shows quarterly issuance (in millions) of the 100 largest European and U.S. auto ABS from 2010 to the 1st half of 2017. For European transactions, issuance amount is the original notional across tranches for each transaction, recalculated at date of issuance into Euro for non-Euro currencies. U.S. auto ABS are shown in U.S. dollars.

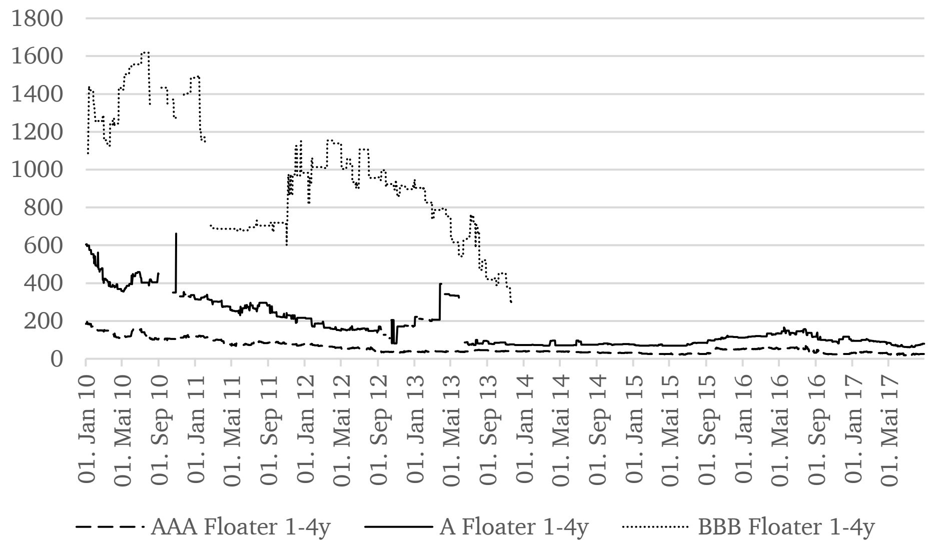


The 100 largest auto ABS transactions in the U.S. consist of 534 different tranches, thus structurally it is already obvious that compared to Europe, with a mean of less than 2.5 tranches per transaction, U.S. deals are more complex. With a variety of different tranches they are more tailor-made to the specific needs of the investors. In terms of number of issuers, our U.S. sample is also more heterogeneous, since the 100 transactions are originated by 15 different institutions.

As a next step, we look at issuance spreads of European and U.S. auto transaction, to extract variables investors consider when buying a transaction. Secondary market spreads in ABS are still existent, but as the secondary market in ABS is not very liquid, prices may not be sufficiently reliable as a basis for analysis (Fabozzi and Vink 2012). Markit e.g. is one of the largest providers of secondary quotes of auto ABS transactions in Europe. Quotes are obtained from up to 16 dealers, but even AAA-rated auto loan ABS are not quoted every day. Single A-rated auto loan ABS are missing a large number of quotes and for lower rated tranches it is even more difficult to receive daily prices. Figure 4.1 shows secondary prices for European auto ABS from 2010 to 2016.

Figure 4.4: Secondary auto ABS spreads in Europe

This figure shows secondary spreads of floating rate auto loan ABS in Europe, in bps above the respective benchmark from January 2010 to the 1st half of 2017. Source: Markit.



In the U.S. ABS secondary prices are available on TRACE[26] now, so going forward it will be easier to analyze U.S. secondary markets.

Since our ABS portfolios consist of floating and fixed rate ABS tranches issued in various currencies, spreads are noted above different benchmarks, mid swaps, Euribor, Libor, etc. To obtain a meaningful comparison, we use the spread in bps above the respective benchmark only and not the overall yield of the transaction.

Important factors to consider for investors when looking at an investment and justifying if the spread they receive is fair, are: (1) credit risk, (2) liquidity risk and (3) optionality risk (Fabozzi and Mann 2010). Since prepayments[27] are remarkably stable and independent from the level of interest rates for auto loans, we can neglect the optionality risk and will concentrate on (1) credit risk and (2) liquidity risk in this analysis.

We analyze securitizations with prime auto loans and leases as collateral, thus the underlying credit risk is relatively homogenous. All transactions are issued by SPVs. The

[26] TRACE is FINRA's Corporate and Agency Bond Price Dissemination Service that reports OTC secondary market transactions in eligible fixed income securities.
[27] For a more detailed discussion on prepayments for auto loans and leases see e.g. McPherson (2000).

originator of the collateral can be a captive (i.e. a finance subsidiary of an auto manufacturer), a bank or a specialty finance company.

Structurally, securitizations from captives may differ from securitizations issued by banks. Captives may promote vehicle sales by offering a low or even zero percent annualized percentage rate (APR) to borrowers. To avoid negative excess spread in the transaction, a yield supplement in the pool may need to be created, e.g. by holding a cash reserve or overcollateralization of the pool (Fabozzi and Kothari 2008). To analyze whether transactions whose underlying collateral is originated by captives, price differently than transactions from banks or specialty finance companies, we use the dummy variable *captives*. For an overview of the variables we use throughout this paper see Table 4.3.

Table 4.3: Overview of variables

Variable	Description
Auto ABS Spread	Spread at date of issuance of the respective auto ABS paper, noted in bps above its benchmark.
Captive	Dummy variable, which takes value 1 if the originator of the loans/leases is a captive, 0 otherwise.
Loan	Dummy variable, which takes value 1 if the underlying is an auto loan (prime in the U.S., all auto loans in Europe), 0 otherwise.
WAL	Original weighted average life of the transaction in years at issuance.
logAmount	Logarithmized original amount at issuance, in U.S. dollars for U.S. transaction; in Euro for European transactions, local currencies recalculated using the exchange rate at date of issuance.
Controls	Dummy variables for each quarter, from quarter 1 to 30; each of these equals one if the securitization was completed during the corresponding quarter, 0 otherwise.
Credit Rating	Dummy variable for each rating class from AAA to CC, which takes value 1 if the credit rating has the respective rating class, 0 otherwise.
Rating Numeric	Recalculated credit rating using a numerical 17 grade scale.
ECB	Dummy variable that takes value 0 if date of issuance was on or before 31st of October 2014, 1 if date of issuance was thereafter.

We also want to investigate whether it is important for investors when looking at the credit risk of a transaction to consider the type of the underlying collateral. Our European and U.S. portfolios include securitizations with auto loans as well as auto leases as collateral. Auto leases differ from auto loans in many ways. One important factor to consider is residual risk[28], i.e. the risk of the residual value of the car at the end of the lease term, a risk often borne within the structure of the securitization. We would expect investors to demand higher spreads for ABS with auto leases as underlying compared to

[28] For a comprehensive description of handling residual value risk in auto securitizations see e.g. McPherson (2000).

auto loans. To account for auto loans and leases, we introduce the dummy variable *prime loans*.

Looking at our second spread component, (2) liquidity risk, we use a variable for the weighted average life (WAL) of the transaction, *WAL*. We also create a variable *amount*. *Amount* is the logarithmized original notional of a tranche at issuance. Provided a tranche from the European portfolio is not issued in Euro, we recalculate the original notional at issuance into Euro using the exchange rate at date of issuance. Since a longer WAL binds investors' capital for a longer term, we expect spreads to be wider for tranches with longer maturities. Larger amounts at issuance should lead to better liquidity in the secondary market thus we expect tighter spreads for tranches with larger original issue amounts, all else being equal.

We analyze the impact of our variables on spread at issuance using OLS regressions, corrected for heteroscedasticity (White 1980).

Our first model (4.1) is defined as

$$Auto\ ABS\ Spread_{i,t} = \beta_0 + \beta_1 Captive_{it} + \beta_2 Loan_{it} + \beta_3 WAL_{it} + \beta_4 logAmount_{it} + \varepsilon_{it}$$

where ε_{it} is the idiosyncratic error term. For a more detailed description of the regression variables we use see Table 4.3.

In our second model we want to control for macroeconomic conditions at time of issuance of the securitizations. Thus we follow (Fabozzi and Vink 2012) and use time control variables for each quarter.

Our second model (4.2) is defined as

$$\begin{aligned} Auto\ ABS\ Spread_{i,t} & \\ &= \beta_0 + \beta_1 Captive_{it} + \beta_2 Loan_{it} + \beta_3 WAL_{it} + \beta_4 logAmount_{it} \\ &+ Controls_{it} + \varepsilon_{it} \end{aligned}$$

One of the characteristics of an ABS is tranching the underlying pool, to receive securities for various risk appetites[29]. The credit rating of a tranche reflects the credit risk of that tranche. In our third regression model we account for credit ratings and create dummies for all rating categories. According to previous literature (Norden and Weber 2004;

[29] For a more detailed explanation on tranching securities see e.g. Fabozzi and Mann (2012).

Friewald et al. 2012; Kiesel and Schiereck 2015) we recalculate the original ratings at new issuance of our two portfolios using a numerical 17 grade scale (Aaa/AAA=1, Aa1/AA+=2,.., Caa1/CCC and below =17). The securitizations are rated by Moody's Investor Services, S&P and Fitch Ratings. A number of tranches are rated by two or even all three credit rating agencies. For our calculations we use the lowest of the ratings available. We have to bear in mind though, that the difference between credit ratings from various rating agencies can be large, in some cases in our portfolios it is three notches, which may hinder the accuracy of the results. The mean rating of our European portfolio is 3.3711. Descriptive statistics of the portfolio can be found in Table 4.4.

A large number of the European tranches, 115 out of 247, were retained by the issuing institutions and not marketed externally. Out of these retained tranches 51 tranches do not have a credit rating. The European Commission proposed two legislative measures, a regulation on securitization that includes, among others, risk retention rules, but also a set of criteria to identify STS securitizations and amendments to the capital treatment of securitizations. The risk retention rules (Article 405 of the Capital Requirements Regulation, Article 51 of the Alternative Investment Fund Managers Regulation and Article 254 of the Solvency II Delegated Act) require institutions bound by those provisions to only invest in securitizations if, among others, the originator, sponsor or original lender has explicitly disclosed, that he is retaining a material net economic interest of at least 5% of the securitization. For auto ABS these are usually the subordinated tranches. In total, there are 53 tranches without a credit rating, 51 retained, 2 publicly marketed. All tranches without a rating are subordinated tranches. Looking at the total volume of retained tranches, which is 280.42 billion Euro original amount at issuance, we see that this is nearly 29% of our total portfolio thus significantly higher than the 5% risk retention rule that is required. In many cases banks use retained tranches for ECB collateral against which the ECB provides funding to them. In addition to the retained tranches, a volume of 158.74 billion Euro, thus more than 16%, was privately placed, leaving us with only around 55% publicly marketed.

In the U.S. similar provisions to the risk retention rules that were described earlier exist under Section 941 of the Dodd-Frank Act that came into effect in 2010. Under certain conditions securitizations of qualifying U.S. auto loans (not leases) can be exempt from these rules though. Contrary to Europe, the percentage of retained paper in the United

States is hardly ever higher than 5%. Furthermore, amongst the 522 U.S. tranches are only two tranches without a credit rating.

Our third and final model (4.3), including credit ratings, is defined as follows:

$$\begin{aligned} Auto\ ABS\ Spread_{i,t} \\ &= \beta_0 + \beta_1 Captive_{it} + \beta_2 Loan_{it} + \beta_3 WAL_{it} + \beta_4 logAmount_{it} \\ &+ \beta_{5-23} Credit\ Rating_{it} + Controls_{it} + \varepsilon_{it} \end{aligned}$$

4.4 Empirical results

4.4.1 Descriptive results

Table 4.4 shows descriptive statistics of the 100 largest European and U.S. prime auto loan and lease securitizations issued between 2010 and the 1st half of 2017.

Table 4.4: Descriptive statistics

This table shows descriptive statistics of the 100 largest auto ABS transactions in Europe and the U.S. issued between 2010 and the 1st half of 2017. Transaction mean amount is shown in Euro for European transactions (non-Euro currencies are recalculated into Euro with their respective exchange rate at date of issuance), in U.S. dollars for U.S. transactions. WAL is shown in years, mean rating is calculated using a numerical 17 grade scale (Aaa/AAA=1, Aa1/AA+=2,.., Caa1/CCC and below =17).

	Europe	U.S.
Tranches	247	522
Transaction mean amount	973.51	1479.59
Issuer	12	15
WAL	3.01	2.11
mean credit rating	3.37	1.92
highest credit rating	Aaa/AAA	Aaa/AAA
lowest credit rating	CC	Baa3/BBB
yield at issuance	1.75	1.17
spread	77.88	39.75
Fixed rate tranches	90	413
Floating rate tranches	137	66
Loans (% of tranches)	83	81
Captives (% of tranches)	67	89

The lowest credit rating of our European portfolio is 17 which corresponds to CC. The lowest rating of our U.S. portfolio on the other hand is 10, which corresponds in this case to Baa3/BBB, thus still investment grade. The weighted average credit ratings of our portfolios are showing the same picture. The European sample with a weighted average rating of 3.37, corresponding to approximately Aa2/AA, is lower than the weighted average rating of our U.S. sample with 1.92, which is slightly better than a rating of Aa1/AA+. As in Europe no distinction between prime, near-prime and subprime collateral exists, but all auto ABS transactions are considered prime, it is not surprising that a portfolio with the highest auto ABS class in the U.S. has a slightly higher mean rating than a European portfolio. The difference between both portfolios (about one notch) is relatively small though and both mean ratings are on the high end compared to other asset classes.

The WAL of the European transactions is longer and the average notional at issuance is smaller than their U.S. peers'. All else being equal, investors face higher risk through the longer maturity as well as lower liquidity of the European portfolio (see e.g. Fabozzi and Mann 2010). Thus as expected the average yield at issuance as well as spread (in bps above the respective benchmark) is higher for the European portfolio.

The number of different issuers is larger in the U.S. than in Europe. U.S. auto ABS did face criticism recently, that many specialty finance companies with lower underwriting criteria would enter the market (Börsen-Zeitung 2017). At least for our sample of the largest 100 prime loan and lease transactions we cannot find evidence for this. Our sample includes just two specialty finance companies which are both in the market for decades already.

The underlying loans and leases usually have a fixed interest rate. Traditionally in Europe securitizations are swapped and tranches are issued for investors in floating rate format, since the buyer base, especially banks, has a preference for floating rate issues. Looking at the 90 fixed rate tranches in Europe it becomes obvious that none of the 90 tranches was publicly marketed and most were retained by the issuer. An explanation might be that for the retained tranches the issuers avoid the costs of swapping the deal (S&P Global Ratings 2017). The U.S. market on the other hand is dominated by fixed rate tranches, since the demand of the buyer base (pension funds', insurance companies' et al.) is mainly for fixed rate tranches.

4.4.2 Regression results

The results of our regression models are shown in Table 4.5[30]. Our dependent variable *Auto ABS Spread* is affected by all independent variables in the U.S. portfolio, most of

[30] All models are controlled for heteroscedasticity and multicollinearity.

them are highly significant. The European data shows significance for all variables apart from prime loans.

Table 4.5: Regression results

This table shows regression results of our first, second and third model. A detailed description of the variables used is available in Table 4.3. The tables show the coefficients and *t*-statistics, corrected for heteroscedasticity, in parentheses. The "-" sign denotes not included, the basis category are AAA tranches and European tranches rated below BBB-/Baa3 are omitted. * p<0.05; ** p<0.01; *** p<0.001

	Model (1)		Model (2)		Model (3)	
	Europe	U.S.	Europe	U.S.	Europe	U.S.
Captive	-30.6376***	-11.32681*	-28.02115**	-9.74374*	-33.9825***	-8.222976*
	(-3.70)	(-2.44)	(-3.52)	(-1.72)	(-3.64)	(-2.80)
Prime loan	-12.65661	-21.40109***	-9.293106	-25.00043***	-19.02218*	-25.8049***
	(-1.46)	(-3.83)	(-1.13)	(-3.96)	(-2.10)	(-4.98)
WAL	15.06753**	8.369741***	11.6452**	10.46295***	16.79162**	9.997957***
	(3.54)	(3.82)	(2.93)	(5.72)	(3.76)	(8.73)
Size of tranche	-13.23686***	-20.45539***	-14.09801***	-20.493138***	-00.51282	7.55402**
	(-4.78)	(-7.11)	(-5.99)	(-7.37)	(-2.81)	(-3.22)
Quarter dummies	no	no	yes	yes	yes	yes
AA+/Aa1	-	-	-	-	9.623537	44.10019***
					(0.45)	(4.32)
AA/Aa2	-	-	-	-	35.60921*	52.22448***
					(2.24)	(4.68)
AA-/Aa3	-	-	-	-	21.26183	49.34165***
					(0.90)	(5.45)
A+/A1	-	-	-	-	34.43796**	87.97634***
					(3.03)	(5.67)
A/A2	-	-	-	-	-7.803067	86.19147***
					(-0.45)	(5.69)
A-/A3	-	-	-	-	omitted	78.76629***
						(8.21)
BBB+/Baa1	-	-	-	-	omitted	174.9913***
						(18.04)
BBB/Baa2	-	-	-	-	69.34259	144.3161***
					(1.76)	(9.94)
BBB-/Baa3	-	-	-	-	omitted	154.3505***
						-9.52
adjusted R^2	0.3569	0.4286	0.5936	0.4766	0.4730	0.7504
F-test	18.76	96.04	7.23	24.31	4.48	75.55
Number of observations	129	449	129	449	129	449

The sign of the coefficient is for all variables in Europe and the U.S. the same and as expected. For an investor it is an important credit factor to know, if auto loans and leases are originated by captives or banks/specialty finance companies. The coefficient for captives is higher and more significant in Europe than in the U.S. An explanation may be, that a large number of the tranches of our European portfolio are originated by banks from the so called “PIIGS” countries (Portugal, Italy, Ireland, Greece and Spain) which suffered from wider spreads in the wake of the financial crisis. None of the European captives on the other hand has their origin in the PIIGS countries. The same explanation may hold true for the variable prime loans in our European portfolio which is, in contrast to the U.S. portfolio, not significant. Looking at the auto leases which are included, we notify that none of the originators is headquartered in a PIIGS country, in contrary to the originators of our prime auto loans.

In our second model, we use exactly the same variables as in the first model, but control for macroeconomic conditions through time variables. We use quarter dummies for both portfolios[31] (not shown in the results table). Our U.S. as well as European portfolio show the same results. Almost all variables are highly significant, the coefficients are showing the same expected signs and the explanatory power of the model is significantly higher. This underlines our previous results and reveals that all variables matter for investors.

In our third model we use the same variables as before but also include credit rating dummies, for the European portfolio from Aaa/AAA to CC, for the U.S. portfolio from Aaa/AAA to Baa3/BBB. Looking at the U.S. portfolio, all variables apart from *amount*, which is less significant in model 3[32], have the same level of significance. All included credit rating dummies are highly significant and the explanatory power of the model is much higher.

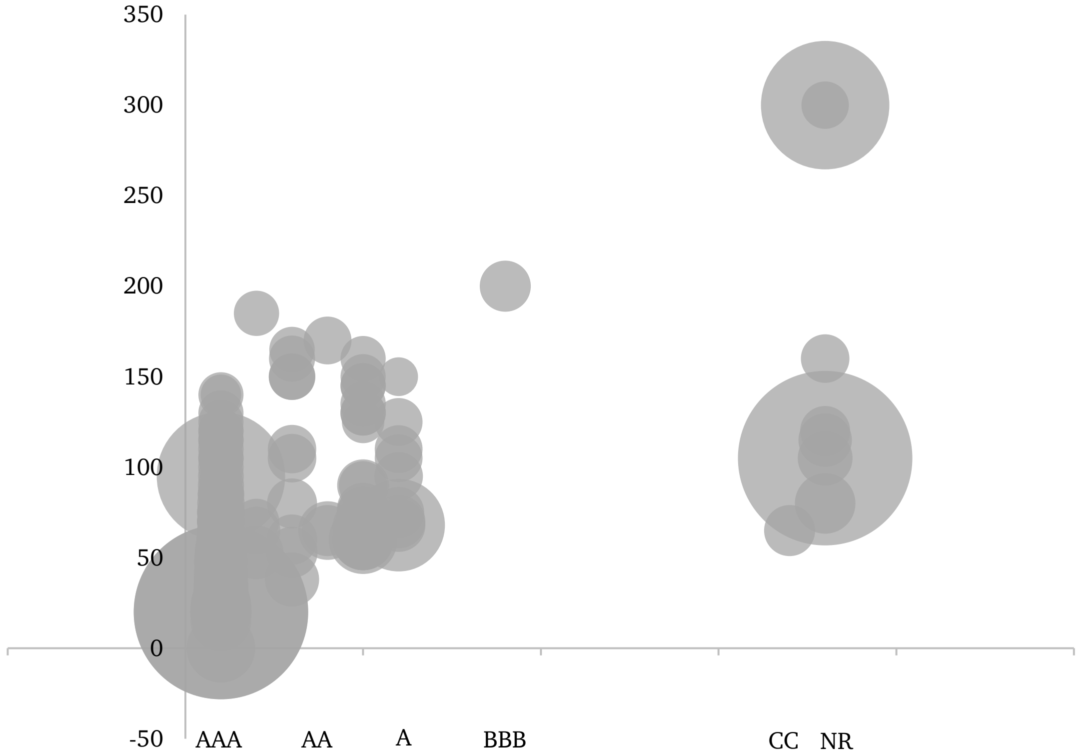
The picture of the European portfolio is different though. Most credit rating dummies for lower ratings are omitted and hardly any variable is significant, no variable is highly significant. The coefficients seem to be in “disorder” as well, i.e. not a clear sign that investors are compensated for a lower credit rating through a higher spread. Figure 4.5 shows a plot of our rating and spread results.

[31] Quarter 29 is not existent for the European portfolio as no transactions were issued during that time frame, quarter 8 and 23 are omitted; for the U.S. portfolio quarter 9 is omitted.

[32] Variable *amount* shows the same behavior as experienced by Fabozzi and Vink (2012), which can be explained by the high correlation between credit rating and amount (the higher the rating the larger the tranche size typically for ABS).

Figure 4.5: Spreads and ratings distribution of European auto ABS

This figure shows spreads and ratings of our European auto ABS portfolio. Spreads are shown in bps above the respective benchmark at date of issuance of the transaction.



Tranches without public spread at new issuance (109 tranches) are not shown in Figure 4.5 and not rated tranches (53 tranches) are only shown when a spread at new issuance is available. Although our figure can demonstrate only limited information, it already becomes obvious that a higher credit spread compensating for a lower credit rating is not necessarily visible.

An explanation might be the high number of retained tranches in Europe, especially subordinated, i.e. lower rated (or not rated) tranches. As those tranches are not marketed publicly in many cases no spread at new issuance of the transaction is available, or even if it is available it may not be a spread a rational investor would be willing to buy the tranche at. Thus we conclude that for the European auto ABS market it is much more difficult to obtain a transparent picture and the market does not seem to have fully recovered since the crisis.

4.4.3. Robustness of the results and further analyses

We test our results using the third model, but substitute the various credit rating dummies through one single variable called *rating numeric*. This variable is calculated using the numerical 17 grade scale described earlier. Our results are the same as before. For our U.S. portfolio the same variables are significant, including our new variable *rating numeric*. On the contrary the European portfolio does not show significance for the new variable *rating numeric*.

As a next step we want to test a possible influence of ABSPP to our dependent variable *Auto ABS Spread* for the European portfolio. As the ECB starting buying auto ABS in November 2014, we use a dummy variable that takes the value of 1 if the issuance of the auto ABS was on or after November 1st 2014, value 0 if the issuance did take place before that date. The results show significance for variable *ECB* in the first model, all other variables do not change. If we include our control variables (the second model), *ECB* does not show any significance any more, which leads to the impression that significance of the variable *ECB* was not necessarily due to the ECB buying ABS, but rather general macroeconomic conditions.

4.5 Conclusion

We examine the European and U.S. auto ABS market following the financial crisis, from 2010 to the 1st half of 2017. We look at prime auto loans and leases in both markets. Our findings suggest that the auto ABS market still plays an important role in the capital markets and particularly to finance the real economy. High asset quality and an ease in liquidation of delinquent receivables makes this asset class very appealing. The percentage of auto ABS of total ABS has increased since the crisis, even more importantly for placed ABS compared to retained tranches. Investors benefit from high ratings and hardly any downward rating migration. The market is, despite a push from regulators and others, still relatively intransparent. The number of private placements and retained transactions and tranches, in excess of the risk retention rule, is high in Europe (45% for our portfolio). Thus it is challenging to retain all details necessary to value securitizations. This is especially true for subordinated tranches of European auto ABS. In addition no binding system like TRACE exists in Europe for ABS which would require market participants to publish secondary levels. The U.S. market on the other hand is still more mature than the European market. Volumes of the overall market and the average notional of transactions are larger. Structural features take care of specific investor needs, with a large number of tranches per transaction designed to account for investor demand. The percentage of retained tranches above the 5% risk retention rule is low and markets overall are more transparent.

We further look at auto ABS spreads at issuance of the securitizations, to analyze which credit risk and liquidity factors investors consider when investing in auto ABS. We find that the following factors are important in our models: The nature of the collateral (auto loan or auto lease), the issuer (captive or other), the average life of the transaction as well as the original amount at issuance are fundamental factors investors consider for European as well as U.S. transactions. Not surprisingly, the credit rating is significant for all rating classes, as well. However, the impact of the credit rating only holds for the U.S. portfolio, since a large number of the subordinated tranches in Europe is without rating and/or retained by the issuer of the transaction.

We conclude that the U.S. auto ABS market seems to have fully recovered since the financial crisis. The European market is important for issuers as well as for investors, but to a large extent dependent on funding from the ECB instead of investor demand and thus has not recovered fully since the financial crisis.

5 The CLO market in Europe: Impact of the risk retention rule[33]

Abstract

We empirically analyze CLOs in Europe since the financial crisis. In 2011 the so-called “risk retention rule” came into force, originally designed to align interests between issuers and investors. We study the implications and effects the risk retention rule had on managed cash CLOs (arbitrage deals). We conclude that the market suffered severely during the time the rule was introduced, but an alignment of interests does not necessarily seem to have been attained. Furthermore, we analyze the implications the form of risk retention (vertical or horizontal) has on asset pricing. We find that CLO manager experience, credit rating and issuance amount are important factors which influence pricing expectations of CLO investors, but the form in which the CLO manager retains the risk does not seem to play a role.

5.1 Introduction

With issuances of 214 billion Euro in 2017 vs. 203 billion Euro in 2007, leveraged loans and high yield bonds hit a record high in Europe in 2017, even breaking through the heights seen shortly before the financial crisis in 2007 (compare Wade and Millar 2018). Likewise 2017 has been a record year for European CLOs with 51 deals coming to the market, a total of 20.9 billion Euro (Wade and Millar 2018). This accounts for the strongest year for European CLO issuance to date since the financial crisis.

However, post-crisis CLO volumes are far from the levels seen before the financial crisis. According to Choudry “by the end of 2007, the growth in volumes of CLO issuance had become so significant that CLO vehicles were the largest non-bank lenders or purchasers of leveraged loans in the primary market. These leveraged loans were used in leveraged buyouts (LBOs), and formed an important source of financing to the private equity sector” (Choudhry 2010).

[33] This chapter is based on a working paper, Hachenberg B. (2018): European CLOs: Impact of the risk retention rule.

CLOs, as most securitizations, had been hit severely by the recent financial crisis. Valuations and ratings of loans underlying the securitizations dropped massively and thus CLOs suffered and became difficult to manage. Default levels were low though, S&P for example reports defaults of less than 0.4% out of just under 10,000 U.S. CLOs rated between 1994 and 2017 (S&P Global Market Intelligence 2018).

One of the many regulations introduced after the financial crisis is the so-called “risk retention rule”. Sponsors or originators of securitizations are required to retain at least 5% of the securitization throughout the life of the transaction. Goal of the regulation is the alignment of interests between sponsor/originator and investor.

Within this study, we analyze the implications the introduction of the risk retention rule had on securitizations, especially on managed CLOs. We construct a unique comprehensive dataset consisting of European cash CLOs and investigate if the regulation reached its goal. To this aim, we look at three fields. Firstly, we look at new issuances of CLOs since introduction of the risk retention rule. An alignment of interests could be followed by increased investor demand and thus increased issuance. Secondly, we analyze implications of the rule on CLO managers. Thirdly, we study the form in which the risk retention is retained and analyze if the form of risk retention influences issuance spreads.

This study contributes to the existing literature about CDOs and the regulations introduced since the financial crisis. The remainder of the paper is structured as follows. Section 2 provides an overview of the recent CLO literature and the risk retention rule. Section 3 describes the data and the applied methodologies. Section 4 then outlines descriptive statistics and our empirical results, and the last section concludes the paper.

5.2 Function of a CLO, history of the risk retention rule and current state of literature

5.2.1 Function of a CLO

CLOs are securitizations backed by a pool of debt, usually loans to corporates. These loans are generally senior secured and leveraged (i.e. the borrower has a significant level of debt, e.g. through a leveraged buyout operation).

CLOs can be balance sheet[34] or arbitrage deals (also called market value or open value transactions), the latter being much more common nowadays. If the CLO underwriter originated the loans and held them on his balance sheet, the CLO is mainly issued for regulatory or funding purposes. On the contrary, arbitrage deals, the focus of our study, have a CLO manager who typically acquires loans in the primary or secondary market and benefit from the spread between assets and liabilities of the transaction. Furthermore, a reinvestment period gives the CLO manager the flexibility to purchase loans to offset prepayments for a certain period throughout the life of the transaction and manage the portfolio according to guidelines defined at origination of the CLO. The asset manager is compensated through a fee (senior management fee) and often in addition a performance fee (subordinated management fee)[35]. Fitch Ratings lists in their CLO Asset Manager Handbook 74 global CLO managers, who are either subsidiaries of insurance companies, banks, private equity firms or asset managers (Fitch Ratings 2017) and specialized in the management of leveraged loans.

A CLO is tranched, typically consisting of a few rated debt tranches and an unrated equity tranche. The equity tranche, also called first-loss-tranche, junior tranche or preferred shares, bears the highest risk of the transaction, but receives the excess return and has specific rights, e.g. the right to call the CLO (see e.g. Fabozzi and Mann 2012). In most cases the performance of a CLO is judged by the performance of the equity tranche, and the CLO manager often receives a performance fee linked to the excess cash flow the equity holders receive. Additional approaches to judge the performance of CLOs also exist, Moody’s for example makes an effort to “balance the interests of the equity with that of the debt investors” and publishes a report that includes a variety of performance factors and CLO manager rankings (Moody's 2009; Sallerson and Haicheng 2017; Sallerson 2016).

CLO structures have changed slightly since the financial crisis. Post-crisis CLOs, called CLOs 2.0 (compared to CLOs 1.0 before the crisis), have amongst others smaller AAA-tranches, no structured finance bucket (i.e. are not allowed to buy other CLOs or other structured finance paper), have more allowances for discount purchases, and looser restricted trading conditions (see e.g. Preston et al. 2017; Deloitte 2017). During a credit

[34] For further details on balance sheet and arbitrage CLOs see e.g. Choudhry (2010) and Lucas et al. (2007).
[35] Management fees and the “waterfall” of a CLO are explained in detail e.g. in Lucas et al. (2007).

downturn CLOs 2.0 should be more stable than CLOs 1.0 (see e.g. Pistre et al. 2017; Preston et al. 2017).

Potential information asymmetries between investors and issuers of securitizations and the possibility of adverse selection of the collateral pool are commonly analyzed. Albertazzi et al. (2015) study whether banks use asymmetric information for their advantage when issuing mortgage securitizations. For their set of data they see a lower default probability for securitized mortgages than for non-securitized mortgages. The findings are consistent with an earlier study from Ambrose et al. (2005). Contrary to this, Berndt and Gupta (2009) reveal that borrowers whose bank loans are sold perform worse than their peers and they suggest, amongst others, that banks should retain parts of the loans.

Guo and Wu (2014) study the risk retention regulation on ABS, disclosure on securitized assets and informational asymmetries between issuers and investors. They find that for a risk-averse bank and a risk-averse investor within a dynamic model of asymmetric information, a flat-rate risk retention requirement cannot be optimal for all asset classes. Sufi (2007) analyzes information asymmetries within syndicates of corporate loans and reveals that the lead bank retains a larger share in the loan when the borrower needs more intense monitoring.

The main difference between the mentioned studies and our paper is that loans underlying the CLOs we analyze are only in rare cases securitized by the banks which originated the loans. Usually the loans are acquired by a CLO manager in the primary or secondary market. Thus we have no evidence for asymmetric information and adverse selection but instead need to assume that the CLO manager acts in the best interest of the investor when choosing the loans, as he is compensated through, amongst others, performance fees (also called subordinated fees). Other reasons for a CLO manager to act in the best interest of the investor would be his reputation, a potential to only increase his assets under management (and thus, again, additional fees independent from performance, called senior management fee) when his CLOs perform well, as well as the risk that the CLO structure may break CLO specific tests, which could lead as a worst consequence to a termination of the transaction or replacement of the CLO manager.

Benmelech et al. (2012) analyze the performance of, amongst others, arbitrage CLOs and come to the conclusion that the securitization of syndicated loans is fundamentally different from that of other asset classes. They argue that interests aligned through the lending syndicate of corporate loans help to avoid adverse selection in the collateral pool. They found evidence for this even for loans originated by the bank acting at the same time as the CLO underwriter.

Liebscher and Mählmann (2017) study market inefficiencies of the syndicated loan market by analyzing the performance of CLOs. Their findings are that heterogeneity in manager performance is consistent, but top managers do not seem to raise their fees when receiving additional assets under management.

Bozanic et al. (2018) provide evidence through using methods of computational linguistics that loans securitized in CLOs have more standardized financial covenants than loans which are not securitized. Their findings are even stronger for larger shares of CLO investors per loan and when CLO investors buy loans in the primary market.

5.2.2 History of the risk retention rule and current state of literature

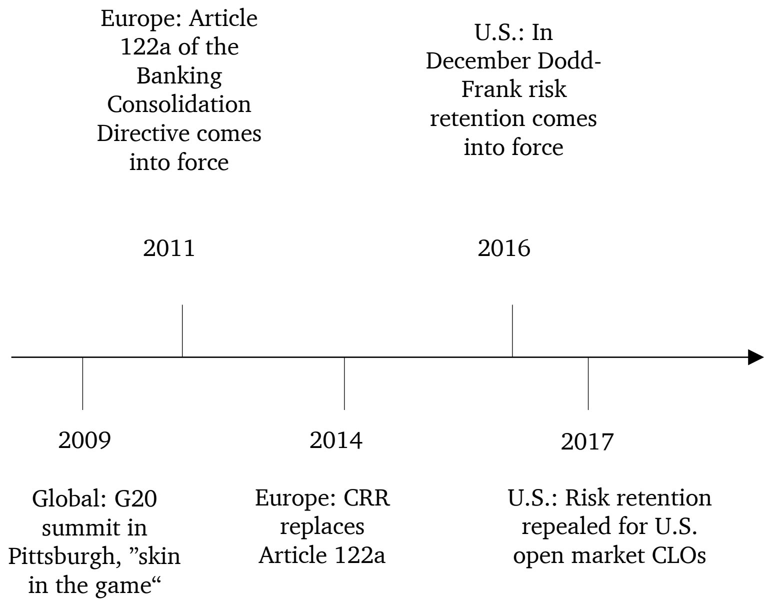
Leaders of the G20 summit in Pittsburgh decided in September 2009 that "securitization sponsors or originators should retain a part of the risk of the underlying assets, thus encouraging them to act prudently" (Leaders' Statement: The Pittsburgh Summit 2009). So called "originate-to-distribute" products had been the focus of criticism and seen as a contributor to the recent financial crisis. By asking sponsors or originators to retain some "skin in the game" leaders of the G20 wanted to align incentives of investors and sponsors/originators and avoid conflicts of interest. At the same time the International Organization of Securities Commissions (IOSCO) stressed not only the need for an efficient and smoothly functioning securitization market to support economic growth, but also recommended "the retention by originators and/or sponsors of a long-term economic exposure to the securitisations" (Technical Committee of the International Organization of Securities Commissions 2009).

In Europe leaders acted through amendments of the Banking Consolidation Directive by Directive 2009/111/EC (Official Journal of the European Union 2009). Article 122a was added which requires that "A credit institution, other than when acting as an originator, a sponsor or original lender, shall be exposed to the credit risk of a securitisation position in its trading book or non-trading book only if the originator, sponsor or original lender has explicitly disclosed to the credit institution that it will retain, on an ongoing basis, a material net economic interest which, in any event, shall not be less than 5 %" (Official Journal of the European Union 2009).

In summer 2010 the Committee of European Banking Supervisors (CEBS) elaborated guidelines for the convergence of supervisory practices with regards to Article 122a. They conducted a public hearing and gave the industry three months to respond to their proposals (CEBS 2010a). Although European guidelines were the subject of discussion, CEBS received global comments from banks, providers of financial services, legal firms and associations. A number of them stressed, amongst others, that the proposed risk retention rule would materially impact managed CLOs and thus the syndicated loan market, as CLO managers are generally thinly capitalized asset managers (see e.g. LSTA The Loan Syndications and Trading Association 2010; AFME BBA ISDA 2010; Loan Market Association 2010). Their fear was that loan liquidity would be severely affected and as a consequence the availability of growth capital to companies reduced. Furthermore, they outlined that the proposed risk retention rule was not aligned with the risk retention provisions of the Dodd-Frank Act.

In their response at the end of 2010, CEBS agreed that for managed CLOs "there may be no entity that can adequately and efficiently fulfill the role of originator, sponsor or original lender". Instead of grandfathering managed CLOs from the risk retention rule though, they discussed that under certain conditions the creation of an "originator special purpose vehicle" fulfilling the requirements may be allowed (CEBS 2010b). There was still a lot of uncertainty about the risk retention rule, especially for CLOs, but Article 122a of the Banking Consolidation Directive together with the related CEBS (now the European Banking Authority) guidelines and the Questions & Answers published by the European Banking Authority came into force at the beginning of 2011 for new securitizations. The rules were replaced with the Capital Requirements Regulation (CRR) at the beginning of 2014. Figure 5.1 shows the main steps in the enforcement of the risk retention rules in Europe and the U.S.

Figure 5.1: Roadmap of the risk retention rule



It took until 2013 for arbitrage CLO managers to find (if at all) a way to fulfill the risk retention rule and find (or borrow) the capital to retain risk (see e.g. Börsen-Zeitung 2013). They either go the "originator route" (the entity that originally holds and then sells assets to the CLO issuer is allowed to retain the risk), or the "sponsor route" (a credit institution or investment firm that manages the CLO retains the risk).

As CLO managers based in the United Kingdom may lose their status as investment firms licensed under the Markets in Financial Instruments Directive (MiFID) due to Brexit (see e.g. Clifford Chance 2016), more CLOs in 2017 have been issued going the "originator SPV" route than before Brexit was decided (McGarry et al. 2017).

Present risk retention rules are Article 405ff. of the Capital Requirements Regulation, Article 51 of the Alternative Investment Fund Managers Regulation and Article 254 of the Solvency II Delegated Act. Institutions bound by those provisions can only invest in securitizations under the condition that the originator, sponsor or original lender has explicitly disclosed that he is retaining a material net economic interest of at least 5% of the securitization. Thus the current rules are investor based, i.e. the investor has to make sure that the securitization he buys follows the risk retention rules. The offering circular of a CLO provides details regarding the risk retention rules, but this can be up to a few pages, outlining that the investor should contact his own legal, accounting, regulatory and other advisors to determine whether the information provided is sufficient to fulfill the risk retention rules. The current, fragmented and "investor based approach" of the European rules is on the edge of being changed again and largely replaced with combined securitization regulation provisions (Official Journal of the European Union 2017b, 2017a).

In Europe, the CLO manager has various options to retain the risk. He can take a so-called "horizontal retention", i.e. retain 5% in one tranche, the equity tranche. He can also retain a "vertical" slice in the securitization, which would be 5% of each tranche (see e.g. Geithner 2011). Due to the nature of the CLO, the interests of the equity tranche holder (who receives excess return and has the possibility to call the deal) and those of the debt tranche holder may diverge. Thus by having "skin in the game" in the form of an equity tranche, the CLO manager bears (part of) the risk of the first-loss-tranche, but at the same time increases his goals, i.e. in addition to a subordinated performance fee, he also benefits from excess cash flow of the transaction and might be tempted to buy riskier collateral than otherwise if not invested.

Tavakoli (2008) names this problem very explicitly. She sees a clear conflict of interest between manager and debt investor, once the manager has a claim on the equity cash flows. She explains that there is a risk of moral hazard, as by the time losses are larger than the initial equity investment of the manager, the manager benefits if the spread income of the portfolio is as high as possible. Any further losses above the equity will be borne by the debtholders. Since further losses reduce the principal amount of the next most senior tranche, the coupon payment is then calculated off of a lower principal amount. This leads to the consequence that the deal liabilities are decreasing and the CLO manager earns more excess spread. This behavior could be limited by implementing trading restrictions and cash flow triggers in the structure of the transaction, but the risk retention rule does not mention any of this. On the contrary, today's CLOs 2.0 even have looser restricted trading conditions than former CLOs 1.0 (see e.g. Preston et al. 2017; Deloitte 2017).

Furthermore, the equity owner has the right to call the transaction and opportunity to refinance the deal in a tighter spread environment, something which has recently become very common. Liebscher and Mählmann (2017) find that superior equity tranche performance does not come at a cost for debt note holders. Their dataset however only takes into account CLOs issued up to 2012. On the contrary, Morgan Stanley (2017) reports that recently structural leverage ratios of European CLOs increased significantly (e.g. by creating single-B tranches), which is positive for equity investors but not for debt investors, as they bear the tail risk of the transaction.

Overall, we summarize that by retaining solely parts of the equity tranche, interests of the debt and the equity investor and as such interests of the sponsor/originator and the investor are not necessarily aligned. The situation can be different when the CLO manager retains a vertical slice, here we would not rule out that interests of the sponsor/originator and investors are aligned.

In the U.S., the risk retention rules came into force in December 2016, but are currently in the process of being changed again. The U.S. Treasury recommends a "broad qualified exemption for CLO risk retention" (U.S. Department of the Treasury 2017). Arguments for an exemption are that CLO managers would act more like asset managers, as they buy loans in the open market instead of originating them and receive compensation through a performance fee. In addition CLO managers would have limited access to capital and the additional burden, especially for smaller managers, may create an unhealthy consolidation in an important sector of corporate borrowing.

5.3 Sample construction and methodology

As a base for our analysis we use data from the internal database of a large European bank. We analyze European CLOs since the financial crisis, thus we use securitizations from 2010 to 2017. In order to receive a homogenous sample, we exclude CLOs whose collateral are loans to small and medium-sized companies (SME CLOs) and synthetic CLOs[36]. We also exclude CLOs that are not rated by at least one of the rating agencies Moody's, S&P and Fitch Ratings.

CLO tranches that are issued in non-Euro currencies (pound sterling, U.S. dollar) we recalculate into Euro, using the exchange rate at date of issuance of the respective tranche. As date of issuance we use the pricing date of the CLO[37]. Descriptive statistics of the CLO sample are shown in Table 5.1. The sample includes 253 CLOs and the average

[36] For a detailed description on synthetic CDOs see e.g. Choudhry (2010).
[37] Only in rare cases where no pricing date is available we use the settlement date as date of issuance.

number of tranches is relatively high at slightly more than 7 per CLO. Asset managers includes any firm that is not a bank, which can be an alternative asset manager, private equity firm, CLO manager etc.

Table 5.1: European CLOs 2010-2017

This table shows descriptive statistics of European CLOs (excluding SME and synthetic transactions) issued between 2010 and 2017.

Descriptive statistics	
CLOs	253
Tranches	1,898
Mean # tranches	7.51
Total Amount (Euro)	131,505,158,089
Mean Amount CLO (Euro)	519,783,234
CLO Managers	48
Banks	7
Asset Managers	41

We manually complement missing data with the use of the weekly publication “Global ABS/CDO Weekly Market Snapshot” published by J.P. Morgan, the CLO Asset Manager Handbook published by Fitch Ratings, Creditflux and Leveraged Commentary and Data (LCD) published by S&P.

Thereafter we split our sample of CLOs into balance sheet and arbitrage deals. The high average issuance amount per CLO (see Table 5.1) is driven by balance sheet transactions, arbitrage transactions are smaller on average. We take a specific look at the CLO managers of arbitrage deals. CLO managers that consolidated between 2010 and 2017 we report by their current firm (as of March 2018).

We analyze the structural leverage of the arbitrage CLO sample by calculating the relative size of the equity (first loss) tranches of the corresponding CLOs to find out if recent structures are more equity friendly than they used to be. As we believe an alignment of interests between debt investors and CLO manager cannot be guaranteed if the CLO manager holds the equity part of the transaction (horizontal retention), we want to find out if a vertical retention (which may align interests) has any significance for the investors, which may lead to increased investor demand and thus a reduction in yield. Therefore we analyze issuance spreads of our CLO sample. We refrain from using trading prices, as CLOs rarely trade and prices differ widely.

The debt tranches of our sample CLOs are floating rate notes which typically price above Euribor. The equity notes usually do not have set coupons as they receive the excess cash flow. For our analysis, we include all rated debt tranches with spreads available at primary issuance. This reduces our sample of 1,898 tranches (see Table 5.1) to 1,438 tranches. The sample is further reduced by 153 tranches for which no retention form is published, neither by Fitch nor LCD. We use OLS regressions, corrected for heteroscedasticity and the issuance spread (in bps above the benchmark) as the dependent variable. As independent variables we take a number of control variables. We first recalculate the original ratings at issuance of our CLO debt tranches using a numerical 17 grade scale (Aaa/AAA=1, Aa1/AA+=2,.., Caa1/CCC and below =17). The CLOs are rated by Moody's, S&P and Fitch Ratings, most tranches are rated by two credit rating agencies. For our calculations, we use the lowest of the ratings available. Our first independent variable is the *numeric rating* of a tranche. As the next variable, we take the logarithmized amount of the original notional at issuance of the tranche, *log amount*. Since a number of ways exist to account for performance of CLO managers, we decide to use the experience of the manager.[38] Therefore, we rank the CLO managers by issuance volume for the time span in question into four groups and create the variable *manager ranking*. To control for macroeconomic conditions during our time span we group the CLOs by date of issuance and create quarter dummies for each quarter as in previous literature (see e.g. Fabozzi and Vink 2012). As a last, most important step, we look at the form of risk retention (vertical/horizontal) and create a dummy for *vertical*. We want to test vertical risk retention vs. horizontal risk retention, since we believe the vertical form of risk retention is the more favorable for a debt investor, as interests appear to be more aligned that way.

Our model is defined as (5.1)

$$CLO\ Spread_{i,t} = \beta_0 + \beta_1 Rating_{it} + \beta_2 Manager_{it} + \beta_3 logAmount_{it} + \beta_4 Vertical_{it} + Controls_{it} + \varepsilon_{it}$$

where ε_{it} is the idiosyncratic error term. An overview of our variables is provided in Table 5.2.

[38] Commonly, a CLO manager's performance is judged by performance of the equity piece, since the debt tranches receive a predefined coupon. The performance of the equity piece can only be looked at during the life of the transaction, respectively after all tranches are fully paid.

Table 5.2: Overview and definition of variables

Variable	Description
CLO Spread	Spread at date of issuance of the respective CLO tranche, noted in bps above its benchmark.
Numeric rating	Recalculated lowest credit rating using a numerical 17 grade scale (AAA/Aaa = 1, AA+/Aa1 = 2, … , CCC/Caa1 and below = 17).
Manager ranking	CLO managers are grouped by experience (issuance volume) into four groups. The first group is defined as issuance volume > 3 bn Euro, the second is defined as issuance volume ≤3 bn Euro and > 1.4 bn Euro, the third is defined as issuance volume ≤ 1.4bn Euro > 850 m Euro, the fourth group is defined as issuance volume ≤850 m Euro.
logAmount	Logarithmized original amount at issuance in Euro, local currencies are recalculated using the exchange rate at date of issuance.
Controls	Dummy variables for each quarter, from quarter 1 to 28; each of these equals one if the securitization was completed during the corresponding quarter, 0 otherwise.
Vertical	Dummy variable, which takes value 1 if the form of risk retention is vertical, 0 otherwise.

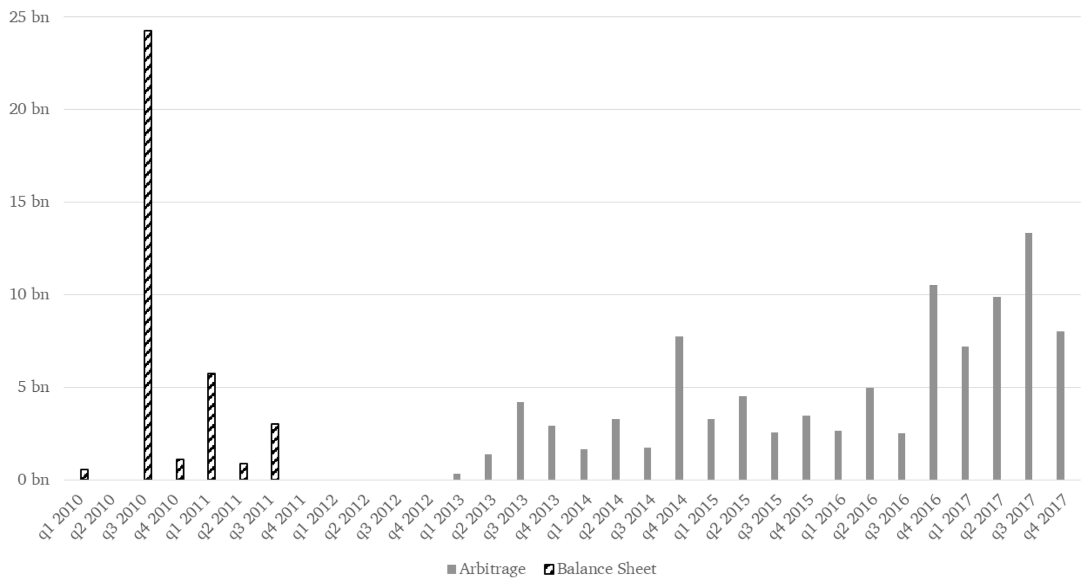
5.4 Empirical results

5.4.1 Descriptive results

Figure 5.2 shows issuances of European CLOs from 2010 to 2017[39]. It becomes evident that while there were ongoing discussions about details of the risk retention rule, in 2010, no arbitrage CLOs were issued at all.

Figure 5.2: European CLO issuances 2010-2017

This figure shows quarterly issuances of European CLOs from 2010 to 2017 (excluding synthetic and SME CLOs), in billion Euro. Non-Euro tranches are recalculated into Euro with their respective exchange rate at date of issuance of the CLO.



[39] Refinancings and resets are included in our sample.

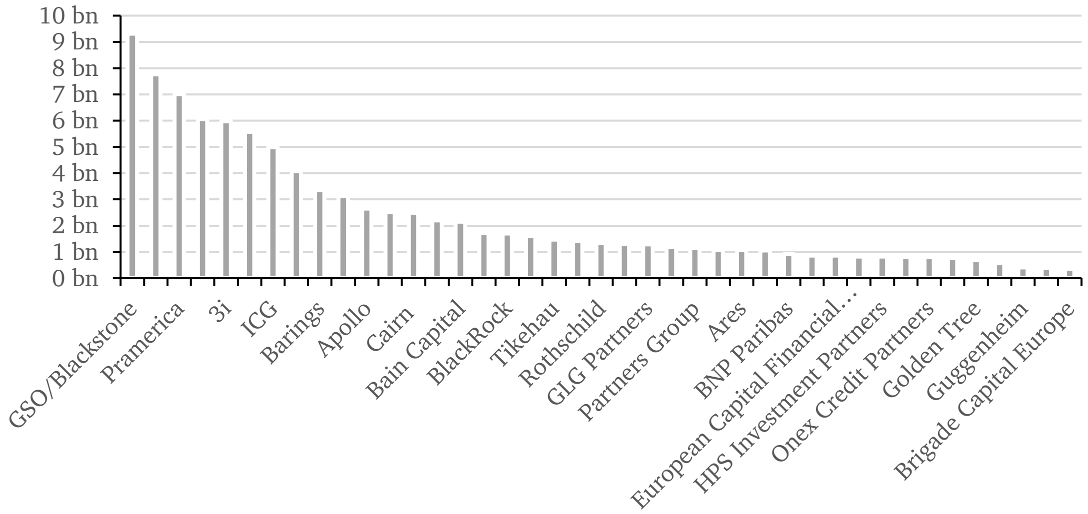
During the years 2010-2012 only a few CLOs were issued, hardly any public deals and the thin CLO market was dominated by balance sheet transactions. Private equity firms had difficulties acquiring financing for their European transactions, in contrast to the U.S., which was mainly seen as a consequence of a lack of CLO demand (see e.g. Börsen-Zeitung 2011). At the same time the CLO market was driven by a consolidation wave of CLO managers. Fitch estimated in 2008 already that around 20% of the 62 European CLO managers would need to leave the business, as they need around 2-3 outstanding deals to cover their costs (Baird 2008).

It took until 2013 before the European market reopened for arbitrage CLOs. Market participants becoming comfortable with the new regulation landscape was seen as a reason for the increased level of CLO issuance (see e.g. McLoughlin et al. 2015). Since then the market recovered with a record issuance in 2017.

Figure 5.3 shows that 41 CLO managers issued arbitrage CLOs between 2010 and 2017. Thus the number of CLO managers decreased even further than predicted by Fitch, down more than 30% from the 62 CLO managers in the market in 2008. This can again be seen as a consequence of the risk retention rule, as smaller managers struggle to find a solution to retain parts of their securitization. Discussions about the risk retention rule were going on since 2009 and the rule came into force in 2011.

Figure 5.3: European CLOs by manager, 2010-2017

This figure shows issuances of European arbitrage CLOs sorted by manager between 2010 and 2017, in Euro. Non-Euro currencies are recalculated with their respective exchange rate at date of issuance of the CLO into Euro.



Despite the increased level in issuances over the last couple of years, the CLO market saw a sharp spread tightening, especially since the market reopened for arbitrage CLOs again. Figure 5.4 shows that throughout our sample period spreads of AAA-rated CLO tranches continuously tightened. Due to the tighter spread environment, refinancings of existing tranches and/or resets of transactions, initiated by the equity investor, became very common.

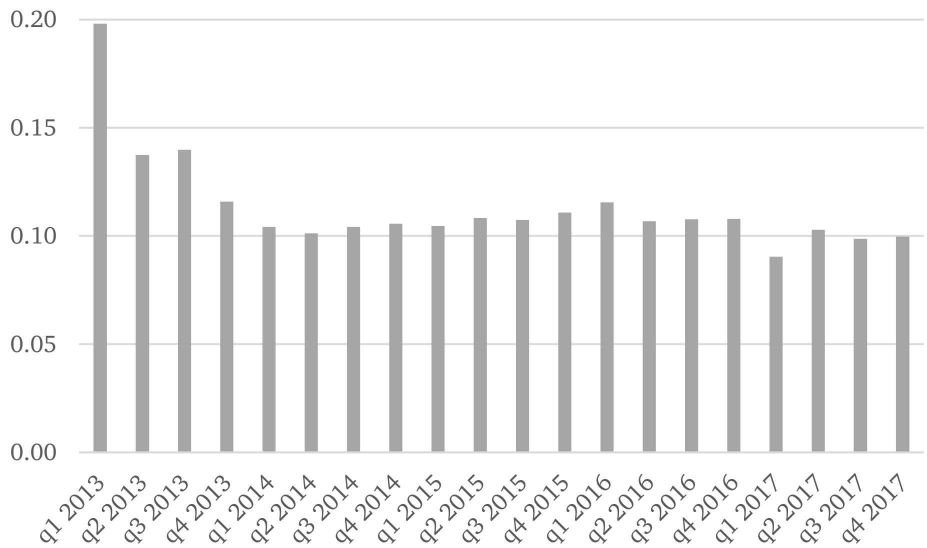
Figure 5.4: European CLO spreads 2010-2017

This figure shows spreads at new issuance of AAA-rated tranches of European CLOs (excluding SME and synthetic CLOs) from 2010 to 2017. Spreads are shown in bps above the respective benchmark of the CLO at date of issuance.

Morgan Stanley (2017) states that "… the structural leverage ratios are increasing significantly, a positive for equity tranche investors." We analyze our CLO data, to find out if Morgan Stanley's stated increase can also be confirmed for our timeframe and data. Hence we look at the relative size of the equity tranche of each CLO in comparison to the total original issuance amount of the corresponding CLO. We come to the conclusion that indeed average structural leverage increased since 2010. Thus if the CLO manager retains the risk in form of an equity tranche (horizontal retention) he benefits from a more equity friendly structure. Recently the relative size of the equity tranche is comparatively stable at around 10%. Figure 5.5 shows the average size of the equity tranche of our sample portfolio, with quarterly vintages of CLOs sorted by date of issuance.

Figure 5.5: Equity tranches of European CLOs 2010-2017

This figure shows the relative size of equity tranches of European arbitrage CLOs issued between 2010 and 2017, per quarter. Tranches issued in non-Euro currencies are recalculated into Euro with the respective exchange rate at date of issuance of the CLO.



Tavakoli (2008) reports for cash arbitrage CDOs a typical equity tranche of 8% to 20% of the transaction. Therefore, the current leverage ratio of European CLOs is on the high end and thus equity-friendly, but still within the boundaries.

The goal of the risk retention rule is to align interests of originators/issuers and investors. To judge if this goal was reached in the case of arbitrage CLOs, we study where in the capital structure the CLO manager retains risk.

Fitch Ratings shows for various CLOs the risk retention investment form and structure type (Fitch Ratings 2017). For our sample of 1,898 European CLO tranches, 340 tranches are from CLOs which follow the „horizontal retention structure“, 452 tranches are from CLOs which follow the “vertical retention structure” and for 1,106 tranches the form of risk retention is not reported by Fitch. Additional data we complete through LCD, which leaves us with a total of 956 tranches (50%) following the “vertical retention structure”, 731 tranches (39%) the “horizontal retention structure” and for 211 tranches the form of risk retention is not reported. Only 14 of those 211 tranches were issued in 2010, thus before the risk retention rule came into force. Table 5.3 shows the split of tranches following the horizontal or vertical retention.

Table 5.3: Horizontal and vertical retention

	full sample	debt tranches with spread
total	1898	1438
horizontal risk retention	731	565
vertical risk retention	956	720
form of risk retention n.a.	211	153

Typically the prospectus of the CLO contains a paragraph which outlines that at least 5% of the securitization is retained throughout the life of the transaction, but not in which form. This leads to the consequence that the investor does not necessarily know if his and the interests of the sponsor/originator are aligned. The risk retention rule does not require the CLO manager to publish the form of risk retention. The investor might not know if the CLO manager retains the same tranche the CLO investor aims to buy, unless the CLO manager e.g. explicitly states this during the roadshow or in the marketing material of the deal. The investor report might contain this information (double checking a sample of our CLOs we found some investor reports containing the form of risk retention, others did not publish the data) but the first investor report is only published after a (primary) purchase of the investor.

In the U.S., the risk retention rule was only implemented in 2016 thus less data is available. But the percentage of CLO managers retaining the equity piece is even higher than in Europe. Deutsche Bank reports that close to 60% of CLOs issued in 2017 follow the horizontal retention structure (Deutsche Bank 2017) and the CLO manager retains parts of the equity tranche, a path which some CLO managers followed even before the financial crisis and the introduction of the risk retention rule (see e.g. Benmelech et al. 2012).

Furthermore, we study who has “skin in the game”, i.e. who provides capital to retain parts of the securitization. Again, the CLO manager has several alternatives. He has the possibility to obtain bank financing (mainly available for top tier managers), he can secure third party equity investment or he can provide the capital through a majority-owned affiliate (see e.g. Labbé 2017; Coffey 2015). Only the last option qualifies for us as having “skin in the game”. As CLO managers usually do not report which route they take to finance the retained part, it is hard for us to draw a final conclusion, but it seems likely that external financing is a valid option.

5.4.2 Regression results

The results of our regression model are shown in Table 5.4. Since we only look at tranches which have a spread available at issuance of the CLO, the debt tranches, our sample consists of 1,285 observations. Our control variables *numeric rating* of a tranche, *log amount* and *manager ranking* are, as expected, highly significant. This means that for a CLO investor the credit rating of a CLO tranche is of very high importance and thus reflected in the spread at issuance of the tranche. The higher the numeric credit rating, the more spread he expects. The same is true for the original issuance amount of the CLO tranche. The original issuance amount is of high importance for the investor and reflected in the spread at issuance of the CLO. The investor expects for larger issuance amounts a more liquid secondary market in the transaction. This corresponds to previous findings in literature, which outline the importance of credit ratings and liquidity in fixed income instruments (see e.g. Fabozzi and Mann 2010; Amato and Remolona 2003). Likewise the manager ranking, which in this case is the experience of the individual CLO manager, is of high importance for the CLO investor. The investor distinguishes between managers with more and managers with less experience in managing CLOs and this is reflected in the spread at issuance of the CLO, as well.

Table 5.4: Regression results

This table shows regression results of our model. A detailed description of the variables used is available in Table 5.2. This table shows the coefficients and *t*-statistics, corrected for heteroscedasticity, in parentheses. * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Numeric Rating	39.36***
	(101.69)
Manager Ranking	5.78***
	(3.56)
Size of tranche (log amount)	11.79***
	(8.57)
Form of Risk Retention (vertical)	0.92
	(2.94)
adjusted R^2	0.94
F-test	742
Number of observations	1,285

The form of risk retention *vertical* (vertical or horizontal) however does not show any signs of significance. Thus it appears that for the investor the form of risk retention is of rather minor importance and not reflected in the spread at issuance of the CLO.

5.4.3 Robustness of the results

As a next step we want to test the robustness of our model. We use our previous model and cluster the population of tranches by individual CLOs. Our new results are very similar to the previous numbers. The control variable *numeric rating* of a tranche, the control variable *log amount* as well as *manager ranking* are highly significant again. This means that for the investor the credit rating of a CLO tranche, the original amount at issuance of the CLO tranche and thus the liquidity as well as the experience of the CLO manager are key indicators when investing in a CLO and therefore reflected in the primary spread. The form of risk retention *vertical* does again not show any significance. This leads to the conclusion that the form in which the sponsor/originator retains the risk in the CLO, vertical retention or horizontal retention, is of minor importance for the investor. The results of the regression model are shown in Table 5.5.

Table 5.5: Clustered regression results

This table shows regression results of our model clustered by CLO respectively quarter of issuance. A detailed description of the variables used is available in Table 5.2. The table shows the coefficients and *t*-statistics, corrected for heteroscedasticity, in parentheses. * p<0.05; ** p<0.01; *** p<0.001

	Clustered by CLO:	Clustered by Quarter:
Numeric Rating	39.36***	39.36***
	(80.01)	(30.05)
Manager Ranking	5.78**	5.78**
	(3.10)	(3.06)
Size of tranche (log amount)	11.79***	11.79***
	(10.29)	(7.36)
Form of Risk Retention (vertical)	0.92	0.92
	(0.38)	(0.28)
adjusted R^2	0.94	0.94
F-test	-	-
Number of observations	1,285	1,285

As a last step we use our previous model and cluster the population of CLO tranches by time of issuance. Therefore, we create calendar quarters of issuance and cluster CLOs issued in the same quarter. Our results, presented in Table 5.5, look very similar again.

The control variables n*umeric rating* of a tranche*, log amount* as well as *manager ranking* are highly significant. At the same time, the form of risk retention, *vertical*, does not show any significance.

5.5 Conclusion

In this paper, we investigate European CLOs since the financial crisis. Specifically, we analyze the effects of the risk retention rule, which came into force in 2011, on managed cash CLOs (arbitrage deals). With the introduction of the risk retention rule the regulator aims to align interests between sponsor/originator and investor of a securitization.

We find that during the time of the introduction of the European risk retention rule the European CLO market suffered severely. Contrary to the U.S., for about three years no arbitrage deals were issued. European CLO managers consolidated and the number of CLO managers in the market decreased from 62 in 2008 to 41 at the end of 2017.

The European risk retention rule is “investor based”, i.e. the investor bears the risk that the CLO manager does not fulfill the requirements. Thus it creates an additional burden on the investor and does not necessarily support the revival of a healthy securitization market.

We also analyze the form in which the originator/sponsor retains the risk. By retaining a horizontal part of the CLO transaction, we cannot fully confirm an alignment of interests between (debt) investor and CLO manager. We come to the conclusion that the risk retention rule did not reach its goal, as an alignment of interests between sponsor/originator and investor cannot be guaranteed. A path that may be considered, is to follow the U.S. and repeal the risk retention rule for European arbitrage CLOs, as well.

Furthermore, by looking at the variables that influence the spread at issuance of a CLO we find high significance for the CLO manager experience, rating of a tranche and the original amount at issuance. The form of risk retention (vertical or horizontal) does not seem to play a role and thus it seems to be of minor importance for the investor.

As an area for further research it would be interesting to find out if the leveraged loan market was hurt by a lack of European CLO demand, or if other, less stable investors, as e.g. hedge funds, did take their place instead.

6 Concluding remarks

In this thesis the reaction of securities, most notably the pricing of securities, is analyzed. Two questions are of particular importance. Firstly, the pricing of securities in reaction to changes in investor attitudes. Secondly, the pricing of securities in response to actual and anticipated changes in regulation. Object of investigation are bonds, stocks and CDS, auto ABS and CLOs. All financial instruments are analyzed in the aftermath of the recent financial crisis.

The findings are twofold. Investor attitudes have an (economically) positive effect on green bonds (analyzed in chapter two), as ESG criteria gain importance among investors and drive pricing tighter. On the other hand, investors are still relatively reluctant to invest in securitizations in Europe, which becomes obvious comparing the European and the U.S. auto ABS market.

The examined changes in regulation have imminent effects on the pricing of the analyzed financial instruments. The anticipated dismantling of the Dodd-Frank Act, which market participants expected after Donald Trump's election as president of the U.S., led to a significant reaction of bank stocks and CDS, in particular G-SIBs' stocks and CDS. Stocks gained and CDS spreads tightened, thus resulting in a positive reaction for investors in G-SIBs. On the other hand, during the time a regulation was introduced in Europe, the risk retention rule for securitizations, European CLOs suffered severely. The market came to a hold for arbitrage CLOs and it took market participants, CLO managers as well as investors, years to adopt to the regulatory changes. Looking at the results of the thesis in detail, the following can be concluded.

In chapter two the pricing of green and conventional bonds is compared. A panel regression is used to look at secondary i-spreads of green bonds and interpolated, matching pairs of non-green bonds. 7,032 daily i-spreads of green bonds and 14,064 i-spreads of non-green bonds are examined over a timeframe of 1st of October 2015 to 31st of March 2016. The results show that green bonds price economically tighter than non-green bonds, but with no statistical significance. Only for rating classes single A statistical significance is evident. Examining maturity, currency and issuing volume further, no statistical significance is found. But industries, in this case government related issuers as well as financials, and the existence of an ESG rating, are significant variables which influence pricing. Although issuing green bonds is more expensive than issuing conventional bonds, at least the external extra costs should be covered by the overall marginally tighter pricing of green bonds. So in this case investor attitudes (increased focus on ESG products) led to a change in the pricing of the securities.

In chapter three the effects of Donald Trump's election as president of the U.S. on stocks and CDS, and with it an anticipated dismantling of the Dodd-Frank Act, is analyzed. The event study of the analyzed 71 financial institutions across 25 countries shows that the reaction of G-SIBs vs. non-G-SIBs is different. G-SIBs' stock prices rise and their CDS spreads tighten, thus a looser regulation is seen as positive for these banks. On the other hand stocks of non-G-SIBs', which are less regulated, rise, but not as strongly as G-SIBs' stocks. The CDS spreads of non-G-SIBs widens. Thus in contrast to G-SIBs, for non-G-SIBs the fear might be that riskier business activities might only be positive for equity holders, but not necessarily for debt holders.

Chapter four compares European and U.S. auto ABS. The largest 100 European and U.S. auto ABS are looked at in the aftermath of the recent financial crisis, from 2010 to the 1st half of 2017. The study shows that the auto ABS market still plays an important role in financing the real economy. The share of auto ABS of total ABS even increased compared to the time before the financial crisis. The results of the models suggest that the U.S. auto ABS market has stabilized since the financial crisis, on the other hand European auto ABS still seem to be to a large extent dependent on ECB funding. Thus attitudes of the European investors changed since the crisis, as the market is still not back in equilibrium.

Chapter five's starting point is similar. The focus is again on securitizations issued since the financial crisis, in this case European CLOs issued from 2010 to 2017. Contrary to European auto ABS though, no European arbitrage CLOs were issued for a number of years. As this happened during the same time as the introduction of the risk retention rule for securitizations, regulation may have played an important role. Thus in this case stricter regulation, among others, may have led to a market hold, as well as to consolidation of CLO managers. Looking at the results of the deployed models, for the investor the form of risk retention, vertical or horizontal, surprisingly does not seem to be of importance. An issuer/originator who keeps a horizontal risk retention may not have the same objectives as a debt investor. The question arises whether the regulation reached its goal, as an alignment of interests between debt investor and originator/issuer cannot be guaranteed.

Overall, it can be concluded that both, changes in investor attitudes, as well as changes in regulation, impact the pricing of financial products to a certain extent. Evidence is provided for a variety of financial instruments (bonds, stocks, CDS, ABS and CLOs).

It will be interesting to see how further changes in regulation and investor attitudes affect pricings. The European Commission is e.g. working on a common language for sustainable finance and a label for green financial products.

Appendix

Table A.1: Sample of green labelled bonds

This table shows the sample of green labelled bonds. The issuer name, coupon, maturity and currency of the issues are given. Rating is always the highest rating available from one of the three rating agencies Moody's, Standard and Poor's and Fitch Ratings.

#	Issuer Name	Coupon	Maturity	Currency	Rating
1	ABN AMRO Bank NV	0.75	09.06.2020	EUR	A
2	African Development Bank	1.375	17.12.2018	USD	AAA
3	Agence Française de Développement	1.375	17.09.2024	EUR	AA
4	Agricultural Bank of China Ltd	2.125	20.10.2018	USD	A
5	Apple Inc.	2.85	23.02.2023	USD	AA
6	Australia & New Zealand Banking Group Ltd	3.25	03.06.2020	AUD	AA
7	Bank of America Corp	1.95	12.05.2018	USD	A
8	Berlin Hyp AG	0.125	05.05.2022	EUR	AAA
9	BPCE SA	1.125	14.12.2022	EUR	A
10	City of Gothenburg Sweden	Floating	03.06.2020	SEK	AAA
11	City of Oslo Norway	2.35	04.09.2024	NOK	AAA
12	City of Paris France	1.75	25.05.2031	EUR	AA
13	Digital Realty Trust LP	3.95	01.07.2022	USD	BBB
14	Electricité de France SA	2.25	27.04.2021	EUR	AA
15	Electricité de France SA	3.625	13.10.2025	USD	A
16	Engie SA	1.375	19.05.2020	EUR	A
17	European Investment Bank	3	23.04.2019	SEK	AAA
18	European Investment Bank	1.375	15.11.2019	EUR	AAA
19	European Investment Bank	Floating	24.07.2020	SEK	AAA
20	European Investment Bank	1.625	04.02.2025	CHF	AAA
21	European Investment Bank	2.25	07.03.2020	GBP	AAA
22	European Investment Bank	1.25	13.11.2026	EUR	AAA
23	European Investment Bank	2.5	15.10.2024	USD	AAA
24	European Investment Bank	0.5	15.11.2023	EUR	AAA
25	Export Development Canada	0.875	30.01.2017	USD	AAA
26	Export Development Canada	1.25	10.12.2018	USD	AAA
27	Export-Import Bank of India	2.75	01.04.2020	USD	BBB
28	Export-Import Bank of Korea	2.125	11.02.2021	USD	AA
29	Hera SpA	2.375	04.07.2024	EUR	BBB
30	Iberdrola International BV	2.5	24.10.2022	EUR	BBB
31	ING Bank NV	2	26.11.2018	USD	A
32	ING Bank NV	0.75	24.11.2020	EUR	A
33	IBRD	0.25	20.03.2017	EUR	AAA
34	IBRD	3.5	29.04.2019	AUD	AAA
35	IBRD	1.375	23.06.2019	SEK	AAA
36	IBRD	2.125	03.03.2025	USD	AAA
37	IBRD	1.25	27.11.2018	USD	AAA
38	KfW	0.375	22.07.2019	EUR	AAA
39	KfW	1.75	15.10.2019	USD	AAA
40	KfW	2.4	02.07.2020	AUD	AAA
41	KfW	1.625	05.06.2020	GBP	AAA
42	KfW	0.125	27.10.2020	EUR	AAA
43	KfW	1.875	30.11.2020	USD	AAA

#	Issuer Name	Coupon	Maturity	Currency	Rating
44	Kommunalbanken AS	2.125	11.02.2025	USD	AAA
45	Kommuninvest I Sverige AB	1.5	23.04.2019	USD	AAA
46	Morgan Stanley	2.2	07.12.2018	USD	A
47	Nederlandse Waterschapsbank NV	0.625	03.07.2019	EUR	AAA
48	Nederlandse Waterschapsbank NV	1	03.09.2025	EUR	AAA
49	NRW Bank	0.75	28.11.2017	EUR	AA
50	NRW Bank	0.25	05.11.2018	EUR	AA
51	NRW Bank	0.875	10.11.2025	EUR	AA
52	Province of Ontario Canada	1.75	09.10.2018	CAD	AA
53	Province of Ontario Canada	1.95	27.01.2023	CAD	AA
54	Regency Centers LP	3.75	15.06.2024	USD	BBB
55	Societe Generale SA	0.75	25.11.2020	EUR	A
56	Stockholms Lans Landsting	1	28.05.2021	SEK	AA
57	Sumitomo Mitsui Banking Corp	2.45	20.10.2020	USD	A
58	Svensk Exportkredit AB	1.875	23.06.2020	USD	AA
59	TenneT Holding BV	0.875	04.06.2021	EUR	A
60	TenneT Holding BV	1.75	04.06.2027	EUR	A
61	Transport for London	2.125	24.04.2025	GBP	AA
62	Unibail-Rodamco SE	2.5	26.02.2024	EUR	A
63	Unibail-Rodamco SE	1	14.03.2025	EUR	A

Table A.2: Sample banks, G-SIBs and non-G-SIBs

This table shows the sample banks, divided into G-SIBs (Panel A) and non-G-SIBs (Panel B). The bank name, country of origin, and standard industry classification (SIC) code are given. The list of G-SIBs is taken from http://www.fsb.org/wp-content/uploads/2015-update-of-list-of-global-systemically-important-banks-G-SIBs.pdf.

#	Name	Country	SIC code
Panel A: G-SIBs			
1	Banco Santander	Spain	6029
2	Bank of America	United States	6029
3	Barclays	United Kingdom	6029
4	BNP Paribas	France	6029
5	Citigroup	United States	6029
6	Credit Agricole	France	6029
7	Credit Suisse Group	Switzerland	6029
8	Deutsche Bank	Germany	6029
9	HSBC Holdings	United Kingdom	6029
10	Industrial and Commercial Bank of China	China	6029
11	JPMorgan Chase & Co	United States	6211
12	Morgan Stanley	United States	6211
13	Nordea Bank	Sweden	6029
14	Societe Generale	France	6029
15	Standard Chartered	United Kingdom	6029
16	Goldman Sachs Group	United States	6211
17	UBS Group	Switzerland	6282
18	Unicredit	Italy	6029
19	Wells Fargo & Co	United States	6029
20	Bank of China	China	6029
21	Royal Bank of Scotland Group	United Kingdom	6029
22	Mizuho Financial Group	Japan	6029
23	Mitsubishi UFJ Financial Group	Japan	6029
Panel B: Non-G-SIBs			
24	Acom	Japan	6141
25	Allied Irish Banks	Ireland	6029
26	Australia and New Zealand Banking Group	Australia	6029
27	Banca Monte dei Paschi di Siena	Italy	6029
28	Banco de Sabadell	Spain	6029
29	Banco Popular Espanol	Spain	6029
30	Bank of India	India	6029
31	Banco Bilbao Vizcaya Argentaria	Spain	6029
32	Banca Popolare di Milano	Italy	6029
33	Commonwealth Bank of Australia	Australia	6029
34	Commerzbank	Germany	6029
35	Danske Bank	Denmark	6029
36	Erste Group Bank	Austria	6029
37	Industrial Bank of Korea	South Korea	6029
38	Intesa Sanpaolo	Italy	6029
39	Bank VTB	Russian Federation	6029
40	KBC Groep	Belgium	6035
41	Lloyds Banking Group	United Kingdom	6029
42	Mediobanca Banca di Credito Finanziario	Italy	6029
43	National Australia Bank	Australia	6029
44	Natixis	France	6029
45	Oversea-Chinese Banking Corporation	Singapore	6029
46	PHH	United States	6162
47	Sberbank Rossii	Russian Federation	6029
48	Skandinaviska Enskilda Banken	Sweden	6029
49	Svenska Handelsbanken	Sweden	6029
50	Bank of Ireland	Ireland	6029

#	Name	Country	SIC code
51	Westpac Banking Corp	Australia	6029
52	Woori Bank	South Korea	6029
53	State Bank of India	India	6029
54	Abu Dhabi Commercial Bank PJSC	United Arab Emirates	6029
55	Akbank	Turkey	6029
56	Banco de Chile	Chile	6029
57	Banco do Brasil	Brazil	6029
58	Banco Popolare	Italy	6029
59	Credit Saison	Japan	6153
60	DBS Group Holdings	Singapore	6029
61	First Gulf Bank	United Arab Emirates	6029
62	HDFC	India	6162
63	ICICI Bank	India	6029
64	ING Groep	Netherlands	6029
65	KB Financial Group	South Korea	6029
66	Nomura Holdings	Japan	6211
67	Shinhan Financial Group	South Korea	6029
68	Bank of East Asia	Hong Kong	6029
69	Swedbank	Sweden	6029
70	Keycorp	United States	6029
71	Macquarie Group	Australia	6211

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