

The financial crisis as game changer

Evidence from primary market RMBS spreads in the UK and the Netherlands

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Summary

Securitisation is the process of converting existing assets or future cash flows into marketable securities. Through this process illiquid debt contracts, such as residential mortgages in the case of RMBS, can be pooled and sold as bonds to investors. The securitisation markets forms an essential element of the global financial system and the global financial crisis. However, most research in this field has focused on the US market or uses pre-crisis data. This thesis focuses on Dutch and UK residential mortgage-backed securities (RMBS) issued in the post-crisis period (September 2009 until July 2014). The goal of the research is to answer our main research problem: “Which factors influence the launch spreads for RMBS in the UK and the Netherlands?”

To answer this research question we will focus on testing variables from six areas: the credit rating, the market conditions, structure and collateral pool features, currency features, macro-economic variables and regulatory changes.

Our data sample consists of all publicly issued, floating rate, Dutch and UK tranches, including buy-to-let transactions, totalling 176 observations. We have regressed the variables in a single-variable regression, a multivariate regression analysis and we have built a reduced form model. The reduced form model takes the form of:

$$\begin{aligned} \text{Primary spread} = & -29.92 + 63.02 * \text{AA rated dummy} + 146.33 * \text{A rated dummy} + 1.52 * \\ & \text{Difference CB/RMBS (in basis points)} + 0.20 * \text{Secondary market index (in basis points)} + \\ & 2.55 * \text{Credit enhancement (\%)} + 10.20 * \text{Weighted lifetime (in years)} + 1.25 * \text{CDS} \\ & \text{volatility (index)} + 31.63 * \text{Buy-to-let dummy} + 2.33 * \text{GDP growth (\%)} - 0.46 * \text{Economic} \\ & \text{sentiment (index)} - 9.69 * \text{Master trust dummy}. \end{aligned}$$

Notes: Omitted category is the triple A rating dummy. All variables are significance at a p-value of 1%, except for the economic sentiment variable which is significant at a p-value of 10%. Appendix B shows the full Eviews output for our regression models.

The reduced form model has an R^2 0.821 (adjusted R^2 of 0.809) which is very close to the results from the multivariate regression analysis, which includes all the variables tested (R^2 of 0.836 and an adjusted R^2 of 0.814).

From our analysis we conclude that:

- The influence of credit ratings on RMBS spreads is still present in the post-crisis sample but to a much lesser extent than in the pre-crisis sample.
- Market conditions, such as the CDS volatility and the secondary market index influence the post-crisis Dutch and UK RMBS spreads.

Structure and collateral pool variables are also important:

- Credit enhancement has a surprising positive effect on spreads in our analysis.
- Master trust issues trade at a risk discount compared to stand-alone issues
- Transactions covered by Buy-to-Let mortgages need an additional risk premium.
- The weighted average lifetime of a note has a positive effect on the spread. Notes with a longer expected lifetime require a higher risk premium.
- The macro-economic factors, economic sentiment and GDP growth, have a significant but minimal influence toward the RMBS spreads.
- We believe that post-crisis regulatory changes have a large impact on RMBS spreads. Even though the precise effect of regulatory changes is hard to capture, we believe that we have managed to do so.

Preface

If you are reading this thesis it means that I have successfully finished my Master's degree in Financial engineering and management. I would really like to thank my parents for their never-ending support. I would also like to thank all my family and friends who have supported me in any way over the past seven years. Furthermore, I would like to especially thank my supervisor at the Rabobank, Ruben van Leeuwen, for the all the advice and support you have given me over the last eight months. I want to thank Dr. Berend Roorda and Dr. Reinoud Joosten for their support and supervision. Finally, thank you Manon for being by my side.

Sander ten Have

Utrecht, October 29, 2014

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1 Introduction

In this first chapter we will give a short introduction to Residential Mortgage-backed Securities (RMBS). After this we will define the scope of this research and motivate the reason of performing this research. Further, we will describe the research questions which will be answered in this thesis. This chapter concludes with an overview of the structure for the rest of this thesis.

1.1 Residential mortgage-backed securities

Securitisation is the process of converting existing assets or future cash flows into marketable securities. Through this process illiquid debt contracts, such as residential mortgages in the case of RMBS, can be pooled and sold as bonds to investors. Securitisation forms an essential element of the global financial system and the global financial crisis. Over the last decades securitisation has developed into a complex financial instrument. Some have described securitisation as financial alchemy (Schwarcz, 1994) or have even compared it to Frankenstein's doomed masterpiece (Gelpern & Levitin, 2008). However, the demand for these investment products seemed to be infinite prior to the financial crisis. In 2007, about €2,750 billion worth of new deals were placed in the European and the US securitisation markets combined (also known as asset-backed securities markets or simply ABS markets) (AFME, 2014). Figure 1 displays the new issuance of European and US asset-backed securities over time. It can be noticed that the US market is already making a recovery from the post-crisis lows, while new European issuance is still lagging.

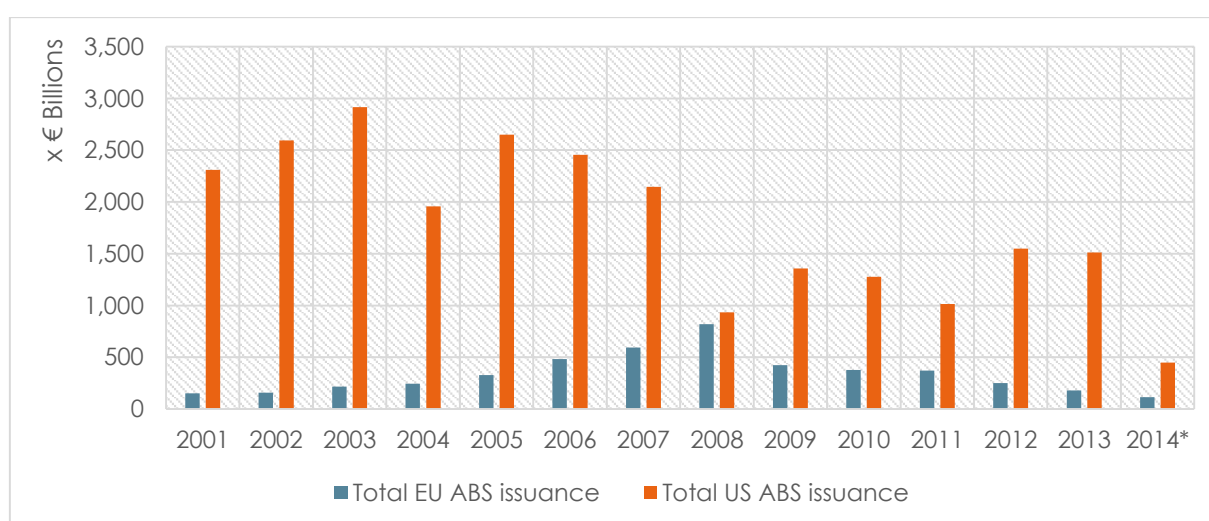


FIGURE 1: TOTAL ISSUANCE (PER YEAR) OF ASSET-BACKED SECURITIES IN THE US AND EU. * THIS DATA ONLY INCLUDE TRANSACTIONS ISSUED IN THE FIRST HALF OF 2014. SOURCES: AFME (2014).

Let us focus on the European ABS market. Figure 2 gives an overview of the total size of public issued European ABS transactions over the last years (including the credit crisis). It can be concluded that RMBS has the largest share in the European ABS market in almost every year. The impact of the credit crisis of 2008 can also be identified in Figure 2. European ABS issuance levels dropped from over €300 billion in 2007 to €50 billion in 2008 and as low as around €20 billion in 2009.

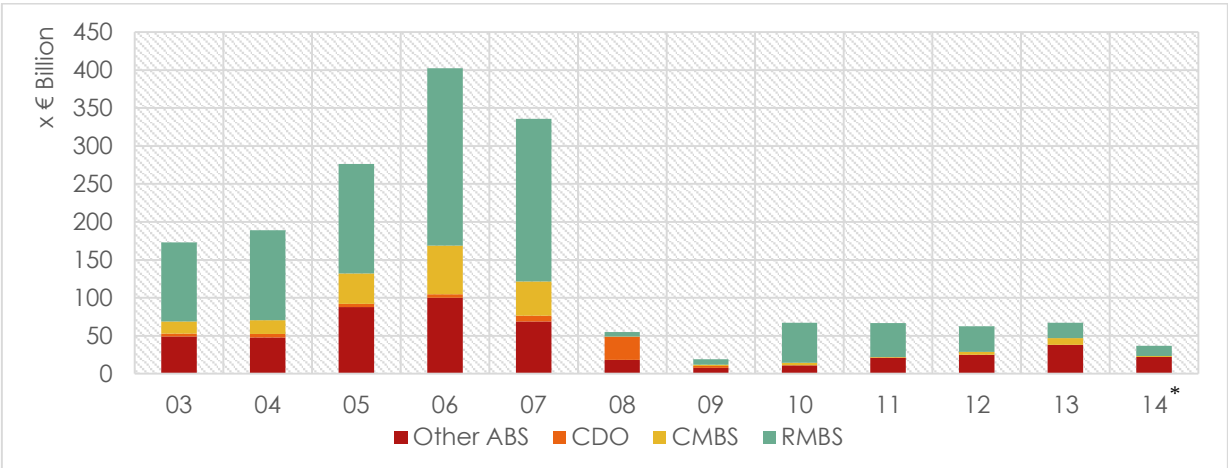


FIGURE 2: TOTAL (PUBLIC) ISSUANCE OF EUROPEAN ASSET-BACKED SECURITIES, CLEARLY SHOWING THE IMPACT OF THE CREDIT CRISIS STARTING IN 2008. *THE FIRST HALF OF 2014

Figure 3 displays the total value of outstanding European ABS transactions, in the circle on the left. Out of the total €1,420 billion outstanding collateral, RMBS has a market share of almost 60% (€872 billion outstanding). The circle on the right shows the distribution over the different jurisdictions of the outstanding RMBS transactions. Here the Dutch RMBS market totalled €247 billion of outstanding collateral, which represents about 95% of the total ABS market in the Netherlands. UK RMBS accounts for € 232 billion outstanding collateral, which represents almost 60% of the total UK asset-backed securities market.

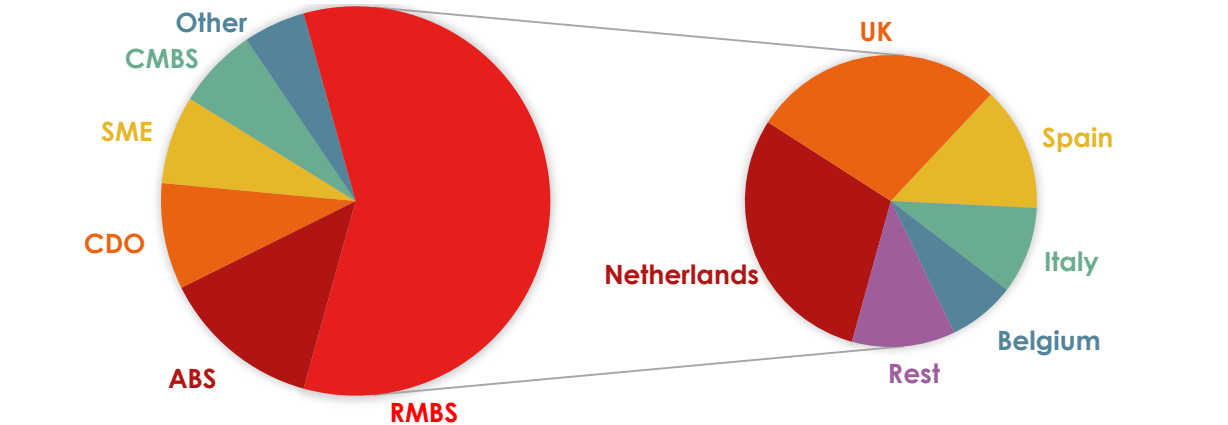


FIGURE 3: THE CIRCLE ON THE LEFT SHOWS THE TOTAL VALUE OF OUTSTANDING EUROPEAN ABS DEALS IN Q1 OF 2014. THE CIRCLE ON THE RIGHT SHOWS THE DISTRIBUTION OF OUTSTANDING RMBS DEALS OVER THE DIFFERENT JURISDICTIONS.

Thus, RMBS plays a large role in the European ABS market. The word "market" can have different meanings. The primary market refers to the market where securities are created, while the secondary market is one in which they are traded among investors.

1.1.1 Primary market

The securities are first launched in the primary market. In this market the RMBS notes are sold to the public for the first time. The price of a security is often fixed at issuance in the primary market. The most important measure of the value of a security is the spread. The primary market spread, or sometimes called launch spread, is the risk premium¹ demanded by investors buying new RMBS notes. Coupons on the notes are either fixed or floating rate. Floating rate notes are the most common in Dutch and UK RMBS. In this case, the total coupon to investors consists of the spread, in basis points (which equals one-hundredth of a percentage point), over the value of a reference rate, for example, the 3-months EURIBOR rate. Figure 4 shows an overview of the launch spreads for the different RMBS types in the Netherlands and the United Kingdom. The most obvious observation is the start of the financial crisis of 2008. Figure 4 shows that most new issues before this period were launched at a spread around 10 basis points. However, new deals issued after October 2007 had a risk premium of around 100 basis points. From this time up until September 2009, the RMBS market was deserted and only 13 new tranches were launched. The market revived in 2010, although new deals were launched at much higher spread levels compared to the pre-crisis period. It can also be identified that non-conforming and buy-to-let RMBS transactions are generally launched at higher spreads than Prime RMBS².

¹ The risk premium concept will be explained in chapter 2

² The different types of RMBS will be explained in chapter 2

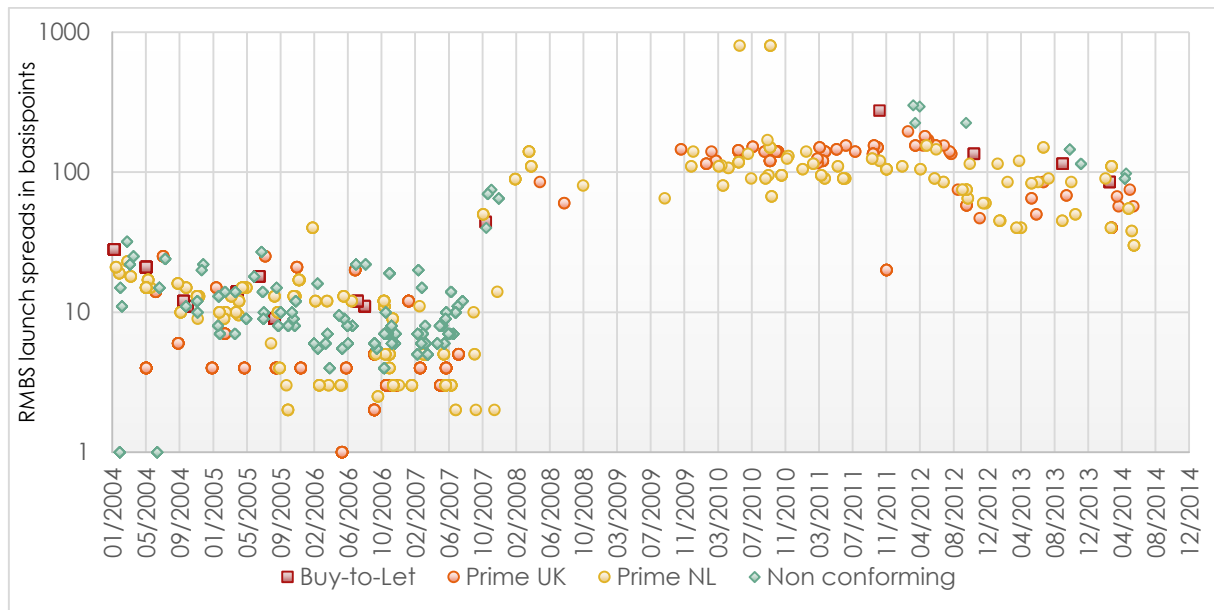


FIGURE 4: LAUNCH SPREADS PRIMARY RMBS MARKET (PLEASE NOTE THAT THE VERTICAL AXIS IS DISPLAYED ON A LOG SCALE) DISPLAYING HIGHER SPREAD LEVELS AFTER THE FINANCIAL CRISIS WHICH STARTED IN 2008.

1.1.2 Secondary market

After the RMBS notes are launched in the primary market, the securities can be traded in the secondary market. Here prices are dynamic and indicate the market value of the notes. One common method of measuring the potential return of a security employs the calculation of the discount margin. The discount margin can be calculated by the following four steps (Fabozzi, 2005):

- 1) Assume that the underlying reference rate will not change.
- 2) Select a margin (spread above the reference rate)
- 3) Discount the cash flows found in step 1 by the current value of the reference rate plus the margin selected in step 2.
- 4) The discount margin is found if the present value of the cash flows is equal to the current price of the security.

This means that if the price of a security is above par then the discount margin will be lower than the initial spread. Secondary market spread also, indirectly, influence decisions made by banks. These banks can use secondary market spreads of similar products as an indication to price new issues. Figure 5 displays spreads of secondary market indices for senior unsecured (AAA and AA rated), covered bond (CB) and RMBS funding sources. The value on the vertical axis shows the discount margin, in basis points, above a corresponding reference rate (6-months or 3-months EURIBOR).

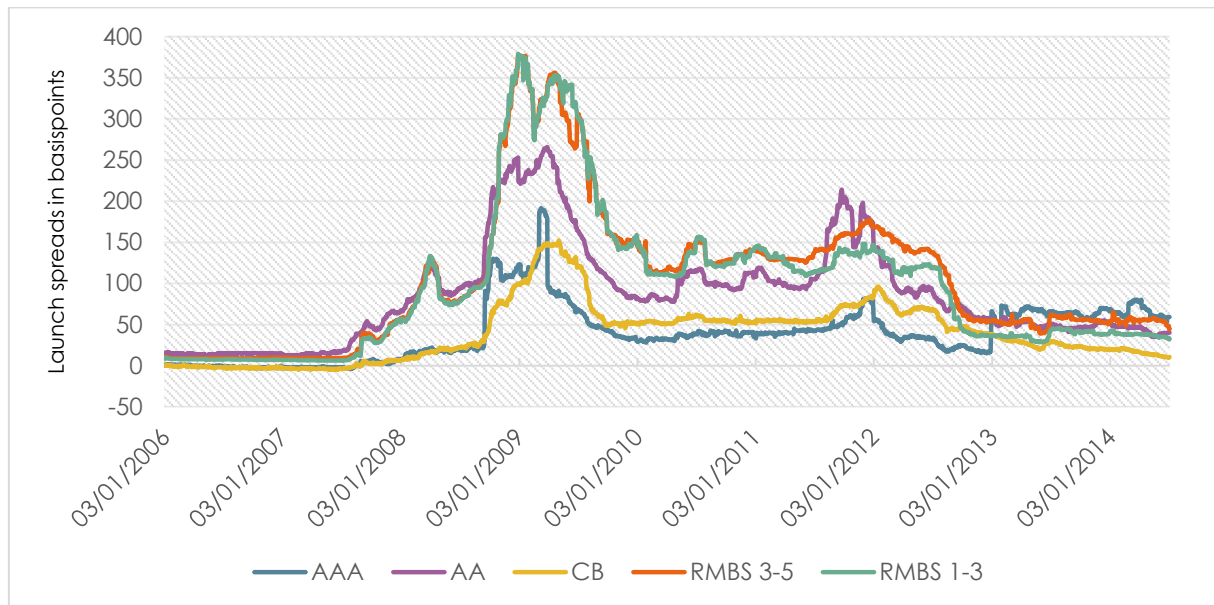


FIGURE 5: SECONDARY MARKET SPREAD MOVEMENT OF SEVERAL FINANCIAL INSTRUMENTS SHOWING THAT RMBS HIT THEIR HIGHEST LEVEL IN THE FINANCIAL CRISIS OF 2008.

Figure 5 clearly presents the impact of the financial crisis. It also shows that the funding costs differ widely between the various funding instruments. In the post crisis years, spreads have decreased significantly. The graph shows a peak around the end of 2011, which was mainly caused by the possibility of a Eurozone collapse. Interestingly, the differences between the spreads change often. It can be noted that the products respond differently to uncertainty in the market. For example, the RMBS market was among the first to respond to the financial crisis and consequently it showed the highest spreads during the crisis.

1.2 Problem definition

Research in the RMBS field often focuses on the primary market spread. There are many variables that could be influencing this spread for RMBS. However, the precise effects of these different risks on the launch spread of RMBS are unknown in both academic literature and among experts. It would be interesting to identify the influence of different risks on the launch spread levels for two main reasons. First, investors and issuers could better assess the spread of RMBS notes if they have better understanding of the risks involved. Second, this explanatory research contributes to an academic field where little research has been done, after the credit crisis, towards the spread determinants of RMBS notes.

The main research question of this thesis is: “Which factors influence the launch spreads for RMBS in the UK and the Netherlands?”

The 2008 crisis and the huge price and in some cases even principal losses incurred by investors, even on the highest rated securities, surely changed the RMBS market. As shown earlier, issuance levels are lower and spread levels are higher. This research wishes to determine the effect of different risks on launch spreads for RMBS, in the Netherlands and the United Kingdom. Although we could examine spread variation of RMBS worldwide, this research is limited to the Netherlands and the UK. In contrast to other European markets, the UK and Dutch mortgage-backed markets have been more active in the post-crisis period. Also, performance transparency and liquidity are much better enabling more accurate data. The academic purpose to conduct this research is the deficiency of recorded knowledge explaining primary market spread in RMBS. Most research that has been done in the field is focused on the, much different, mortgage-backed securities in the US. Still, some research has been done on the European markets but mostly focussed on the effect of credit risks. Further, as most research uses data up to 2008, almost no research has been done with post-crisis data. After the crisis issuance fell significantly restricting the amount of data available. However, it would be interesting to indicate the changes in the RMBS market caused by the credit crisis.

1.3 Research objective

This research is carried out at the Rabobank. The bank is directly active in the RMBS market through its subsidiary Obvion. However, the Rabobank is also active in many roles in other RMBS deals. This research will help the Rabobank to assess the current status of the RMBS market. This research will point out important determinants to RMBS pricing and might indicate a change of focus for investors. Furthermore, at the time of this research there was no good database containing information and characteristics of RMBS deals readily available at the Rabobank. During this research a database is created to analyse the effect of several variables on RMBS launch spreads. However, this database will also be used for other purposes at the Rabobank in the future. The objective of this research is to empirically research different risks influencing the primary market spread for RMBS in the UK and the Netherlands.

1.3.1 Research questions

We have identified several questions regarding the launch spreads of residential mortgage-backed securities.

Research question 1:

How has reliance on credit ratings, for investors of Dutch and UK RMBS, changed after the credit crisis?

Many researchers have argued that a securities' credit rating largely explains the variation in spread margins. (Fabozzi & Vink, 2012). However, often this research is focused on pre-crisis data. During the credit crisis substantial losses were suffered on several RMBS notes, sometimes up to the most senior ones. In response the rating agencies downgraded a lot of RMBS transactions. More importantly, the market questioned the ability of the rating agencies to assess the quality of RMBS structures. We argue that the credit crisis has made investors more focused on other factors influencing RMBS transactions and therefore rely much less on credit ratings.

Research question 2:

How do market conditions influence the spread of post-crisis Dutch and UK RMBS transactions?

We believe that market conditions have a major influence on the spread levels. The credit crisis has changed investors' views on the RMBS market completely. We therefore state that it is possible that more uncertainty in the market is driving the spreads of RMBS higher.

Research question 3:

How do variables related to the underlying collateral pool and the deal's structure influence the spread of post-crisis Dutch and UK RMBS transaction?

It can also be noted that RMBS sellers and originators have become more transparent in the post crisis years. The ECB has played a huge role in this by enforcing more collateral and performance transparency for asset-backed securities (ECB, 2010). The implementation of

this standardization of information has improved transparency for investors, making it easier to analyse different transactions.

Research question 4:

How do currency specific features influence the spread of post-crisis Dutch and UK RMBS transactions?

This research will focus on RMBS in two specific regions: the Netherlands and the United Kingdom. A dominant difference in these countries is local currency. All collateral in UK RMBS are denominated in £, whereas Dutch RMBS collateral are € based. Also, the issued tranches are sold in different currencies. This could cause currency risk for investors in a different local currency than the underlying RMBS pool. Further, notes of a RMBS can be issued in multiple different currencies. This feature could make the securities more appealing to a larger investor base and therefore drive launch spreads lower.

Research question 5:

How do country-specific macro-economic variables impact on the spread margin of post-crisis Dutch and UK RMBS transactions?

Besides a currency difference there are also many macro-economic differences between the Netherlands and the UK. We believe that these factors also influence investors' sentiment and therefore the spreads of RMBS notes.

Research question 6:

How do regulatory variables influence the spread of post-crisis Dutch and UK RMBS transactions?

Literature has pointed out that new regulatory policies may significantly influence primary spreads. Especially RMBS is receiving a different regulatory treatment compared to other investment products. However, so far there has not been any research to the precise effect of regulation on RMBS spreads.

1.4 Structure of this thesis

In this last paragraph of this first chapter we will outline the rest of this thesis. Chapter 2 will give an overview of residential mortgage-backed securities characteristics and points out the differences between the Dutch and UK RMBS structures. Chapter 3 describes the existing literature on spread determinants for fixed income securities. Chapter 4 describes the methodology applied in this research. Chapter 5 will discuss the dataset and will describe the variables tested in this research. Chapter 6 introduces the analysis, in which we will apply the regression models to identify significant explanatory variables. In Chapter 7 we discuss conclusions of our research. Finally, Chapter 8 draws the limitations of our research and gives recommendations on further research towards RMBS spreads.

2 Residential mortgage-backed securities

RMBS are securitised debt obligation whose cash flows come from residential mortgages. These RMBS structures can take different shapes and structures. In the coming chapter we will discuss the general characteristics.

2.1 Securitisation

The creation of RMBS is called securitisation. In this process, the originator (often a bank or an insurance company) owns a portfolio of residential mortgages on its balance sheet and sells them to a special purpose vehicle (SPV). A SPV is a legally independent and bankruptcy remote entity, which is created for the purpose of the securitisation process. One major advantages of the SPV is the disconnection between a bank's credit risk and the collateral pool's credit risk.

For the residential mortgage originators there can be several reasons to issue RMBS. First, the process transforms relatively illiquid assets (residential mortgages) into liquid and tradable market instruments. Second, the originator can use RMBS as a funding instrument, for which the cost might be lower than borrowing directly in the capital markets. This is often the case for low rated banks which can create higher rated RMBS deals. Third, securitisation allows the issuer to diversify their financing sources, by offering alternatives to the traditional forms of debt financing. Fourth, securitisation can be used as a balance sheet relief tool, which can help to improve various capital ratios and reduce the exposure risk.

2.2 Structure

The SPV raises funds by issuing notes to investors. The notes are structured as multiple tranches with different characteristics to meet the different risk and return appetites of investors. Different tranches have different seniority, ranging from most senior tranche (typically rated AAA) to equity (with a low rating or unrated). The tranches refer to the same underlying mortgage pool but have different risk profiles. Investors in the more junior tranches bear more risk are likely to earn a higher return.

In most RMBS structures, there are two different cash flows from the SPV to investors; interest payments and principle repayments. As the mortgage borrowers (in the underlying

collateral pool) pay their mortgages they generate cash flows to the investors. The senior note holders will receive payments first until all payments for this tranche have been made, after which the next tranche in line will receive its coupon, up until the lowest tranche. In case of any losses the structure will work the other way around and the lowest tranche will incur the first losses. The principle repayment cash flows cause uncertainty about the lifetime of the notes. If borrowers are repaying their mortgages faster (for example, refinancing in case of relocation or foreclosures, the investors will receive their principle back faster. In case of low prepayment rates, the weighted average lifetime of a note can be longer than expected. Figure 6 gives a graphic overview of the structure including the several cash flows.

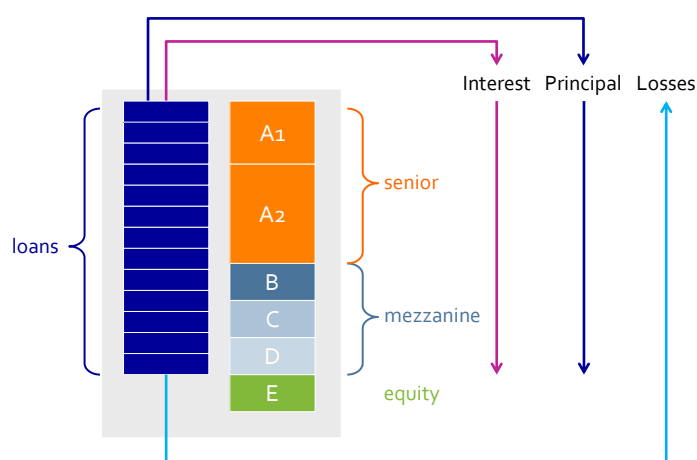


FIGURE 6: OVERVIEW SIMPLE RMBS STRUCTURE DISPLAYING THE CASH FLOW STREAMS FROM THE MORTGAGE POOL TO INVESTORS.

2.2.1 Principal waterfall

Principal repayments made to investors are distributed according to the principle waterfall and consists of collateral principal repayments and also foreclosure proceedings. Principal can be paid either on a pass-through or on a pro-rata basis. Pass-through payments directly flow from mortgage borrowers through amortisation or mortgages prepayments, to the note holders. Principle payments are paid on subordinate basis meaning that the senior notes receive their principle payments first. Only after the senior notes investors are fully repaid, principal payments are paid to subordinated notes. Principal waterfalls in which principal is distributed on a pro rata (predetermined fixed basis), often incorporates triggers to protect senior notes. These can be triggered, for example, by a high level of defaults, after which a switch is made from pro-rata payments to pass-through basis.

It is also common for RMBS transactions to have multiple senior notes. For example, a transaction can have a slow-paying senior and a fast-paying senior note. In this case the fast-paying note will receive repayment of principle faster than the other notes. If the portfolio of assets starts to experience default losses, these losses are first allocated to the lowest tranche (often equity) by reducing the outstanding principle amount of this tranche.

2.2.2 Total return swap

The interest waterfall takes care of the distribution of interest received from the mortgage collateral pool to note holders. RMBS notes are often paying floating rates, while the mortgage collateral interest payments consist of a mixture of fixed and floating interest rates. Therefore, to hedge the resulting interest rate risk, most RMBS transactions use a total return swap before distributing interest payments to investors. In general the SPV pays the swap counter party the scheduled interest on the mortgages plus prepayment penalties. The swap counter party pays the SPV scheduled interest on the notes plus an excess spread, if applicable. Dutch RMBS transactions typically feature the loan originator acting as a swap counterparty, which receives all of the mortgage payments and in exchange pays the required amounts to the note holders and typically guarantees an amount of excess spread (net mortgage interest less coupons due on the notes) in the transaction. The seniority structure of the interest waterfall is comparable to the principle waterfall, coupon payments made first to the senior notes.

2.2.3 Credit enhancement

Credit enhancement is the percentage loss that can be incurred on the underlying collateral before a tranche will start to make a loss. Credit enhancement is built into the structure to give more certainty (less risk) of losing money. This feature is often built from one or more of four different techniques. Firstly, subordination often brings the most credit enhancement in an RMBS transaction. A tranche will only start to experience losses after the subordinated tranches cannot absorb losses any more. For the most senior notes this buffer is created by all other non-senior notes. Secondly, a reserve account can be created to reimburse the SPV for losses. Often a target is set which the reserve account will reach over the lifetime of the notes. Thirdly, excess spread can come from interest payments in the underlying mortgage pool or from the total return swap structure. If these yield a higher interest income than the average

coupon of the notes (minus costs) some of this excess can remain trapped in the SPV. However, excess spreads can also be used to replenish the reserve account, if necessary. Fourthly, overcollateralisation occurs when the underlying collateral pool has a face value higher than the issued notes. In this case the SPV owns more assets than it has liabilities to the note holders, creating extra certainty for investors.

2.2.4 Other possible features

In the paragraphs above we have described the basis structure of RMBS transactions. However, many possible features can be added. The issuer has in general some freedom in determining extra features in RMBS transactions, for example, adding a call option. The call option will set an optional date on which the issuer can buy back outstanding notes. This call feature acts as a redemption date and gives investors more certainty on the possible lifetime of their notes. If the issuer decides not to redeem at the first optional redemption date (FORD), a step-up margin will often be triggered. The step-up increases the coupon that has to be paid to the note holders and incentivizes sellers to exercise the call option.

2.3 Differences UK and Dutch RMBS

There are two main types of RMBS structures: standalone issues and master trust issues. Standalone structures are in one trust which hold non-revolving and discrete pools of assets backed individual series of securities. Principal repayments are usually pass-through, meaning that repayments on mortgage loans will directly be transferred to note holders. This type of structure was used in all RMBS transactions until First National Bank of Chicago introduced master trust structuring technology in its First Chicago Master Trust transaction in 1988. Master trusts allow issuers to sell multiple series of securities from the same trust, all backed by the same collateral pool of receivables. Pools of these trusts are revolving and therefore dynamic. When further financing is needed, the issuer transfers receivables from additional accounts to the same trust and issues new securities. However, substitution of loans occurs under strict rules. The receivables are not segregated in any way that would indicate which series of securities they support; instead, all receivables support all series of the securities. It also enables them to issue tranches with features specifically tailored to investor preferences, such as bullet repayments, as well as scheduled and controlled amortisation principal repayments. Furthermore, the substitution of redeemed loans with new loans also extends the

programme life. In master trusts, note principal repayments are made in a number of different ways: on a pass-through basis, similar to standalone transactions, via pre-set amount on scheduled dates, through a controlled amortisation of principle up to a maximum amount every period or in bullet form (pay-off in a lump sum at the end)

Mortgages in the UK are logically denominated in £, while Dutch mortgage are denominated in €. Different RMBS notes from the same transaction can also be denominated in different currencies. Almost all tranches in Dutch RMBS in our dataset are issued in € but UK tranche are often issued in both the € and the £. This can causes an extra risk for investors if, for example, foreign investors in UK RMBS receive € based coupons but interest payment on the underlying mortgages is based on £. However, this risk can easily be hedged by a currency swap.

2.3.1 Mortgage market differences

The following paragraphs will describe the differences between the mortgages markets in the UK and the Netherlands.

2.3.1.1 Third-party credit protection

Different from mortgages in the United Kingdom, some Dutch mortgage loans are protected by NHG (Nationale hypotheek garantie). NHG is managed by the WEW (Stichting Waarborgfonds Eigen Woningen) which is triple-A rated by Moody's and Fitch and is a government backed institution. NHG can be a guarantee for both lenders and borrowers and thus also for investors in RMBS. If a borrower is unable to make its mortgage payments the WeW will cover most losses for the lender. In some cases, for example in case of unemployment or a divorce, NHG will also cover for the residual debt of the borrower. However, the coverage amortises on a full annuity basis and therefore does not always fully cover losses made by borrowers.

2.3.1.2 Tax advantage

A significant risk in the Dutch RMBS compared to other markets is the encouragement of interest-only mortgage loans. Interest paid on these loans is tax deductible but the loans are

also riskier because borrowers tend to take out mortgages with higher loan-to-value ratios. However, new tax legislation prohibits new borrowers to take out full interest-only loans.

2.3.1.3 Buy-to-let and non-conforming structures

Buy-to-let mortgages have been popular in the United Kingdom. This mortgage type is specifically created to rent out properties. Mortgage interest payments can be offset against rental income for investment properties, but are not deductible for owner-occupied properties. Another common type of RMBS transactions in the UK are deals backed by non-conforming loans. The underlying mortgages in these transactions do not meet the required underwriting standards set for prime mortgages. Typically these mortgages have higher interest rates, and may carry additional upfront fees and insurance requirements. Also, as performance is expected to be weaker, non-conforming RMBS need more additional credit enhancement to reach the same credit ratings as prime RMBS deals.

2.3.1.4 Interest type

UK mortgage loans are typically based on floating rates whereas Dutch mortgages interest rates are typically fixed between 5 and 25 years.

2.3.2 Risk premium

This paragraph will describe which risks both Dutch and UK RMBS transactions are subject to. The spread represents the risk premium that investors demand on their investments. Several important risks for fixed income securities are: credit risk, liquidity risk, interest-rate risk (pre-payment risk and extension risk), inflation risk, currency risk and political risks (Fabozzi, 2005). However, it should be noted that these risks are described in US literature and that European fixed income securities might face different risks (or less risk). The literature review of this thesis (Chapter 3) will point out some differences between the US MBS market and the European RMBS market and also focuses on market changes due to the credit crisis.

Credit risks are the risks associated with probability of defaults and loss-given defaults. Typically credit agencies assess these risks by assigning a credit rating to a tranche. A credit rating is an evaluation of the credit worthiness of the debtor of the underlying mortgage loans.

Liquidity risk is the risk arising from the lack of marketability of an investment that cannot be bought or sold quickly enough to prevent or minimize a loss. And thus refers to risk that an investor will have to sell a MBS below its fair value. For investors who plan on holding their assets until maturity this risk is not really a problem. However, if an investor holding the asset and plans to sell it in the secondary market, lack of liquidity can push the price down.

Interest rate risk is caused by an increase or decrease of the interest rate. An interest-rate decline could cause prepayment risk. This risk arises when the borrowers in the loan pool of an MBS pay off their mortgage earlier than expected. The investors will receive their coupons and principle payments earlier than expected and will be unable to reinvest in securities with the same yield.

Extension risk can be a result of increasing interest-rates; higher rates could lower the rate of prepayments and thereby increasing the duration of the security. This could cause prices of an investor's securities to fall and limit reinvestment options with the same yield. To avoid the lifetime of a MBS note to be equal to the longest maturities of the underlying loans, a call option feature can be embedded. However, rising interest-rates could prevent the seller of the MBS to exercise this option. However, in European RMBS this call feature is typically not exercised economically. Historic data on these transactions shows that issuers almost always exercise this option in order to prevent reputation damage.

Inflation risk arises when inflation rapidly increases and influences the coupon received by investors. However, for floating rate MBS, inflation risk will have a smaller impact for investors than fixed-rates bonds.

Currency risk can occur when investors are holding assets which are denominated in a different currency than their domestic currency. If such, payments are dependent on the current exchange rates. Currency risk can also occur when the seller of a MBS gives out tranches denoted in a foreign currency compared to the payments made by the underlying loans.

After the crisis political risk has become very important. Political risks include changes in regulation. These regulatory changes can vary from rules regarding the legal entity of the seller (the SPV) or could prohibit certain investors groups from investing in risky assets. Regulation for European RMBS has changed significantly over the last few years and there is still much uncertainty about specific features such as risk weights or the inclusion in the liquidity coverage ratio regulation. More information about regulation will be described in chapter 3.

3 Literature review

This chapter describes the determinants to credit spreads found in our literature study. We have experienced that only little RMBS specific empirical research is available. Moreover, the research that has been conducted is often focused on the US market where conditions differ from the European RMBS markets. Therefore, this literature review will also include papers from other related fields. For example, extensive research has been written about corporate bond pricing. Although these bonds have different features than RMBS transactions we believe that determinants to price these products can resemble RMBS pricing. Further, the chapter will explain the difference between the US and European RMBS market.

3.1 Literature search in other fields

Little empirical research is available about the spread determinants of RMBS notes. Therefore we have researched related fields such as corporate bonds, covered bonds and other types of securitisation, which are far more explored. These enable us to better understand important spread determinants. These areas can be different because they do not involve asset securitisation. However, according to Firla-Cuchra (2005), the underlying assets in securitisation transactions are considerably more uniform than in the case of corporate bonds. Structured finance issues are less ‘noisy’ in terms of issuer-specific factors that might influence the spreads. Factors found in other bond literature might also be relevant for RMBS pricing. Similar to this research, a paper by Firla-Cuchra (2005) also tries to explain launch spreads on structured bonds. The paper describes several important pricing factors related to market placement of different securities issued. Firla-Cuchra concludes that that factors found are comparable to pricing determinants in the case of corporate bonds, such as credit rating and market liquidity. In searching for determinants of corporate bond credit spreads, researchers also find other factors to be important, such as: liquidity, systematic risk, incomplete accounting information and taxes.

3.1.1 Literature from the US market

Most research in the MBS field has been done in the US. This market is substantially different from the European market. Most mortgage-backed securities originated in the US are agency-related. These are securities consisting of conforming mortgages with a credit guarantee from

Fannie Mae, Freddie Mac or Ginnie Mae (government-sponsored organisations). Because of this, academic literature has a different focus on mortgage-backed securities in the US. MBS transactions are much more standardised compared to European RMBS market (Coles & Hardt, 2000). European residential MBS (RMBS) are non-agency securitisations and therefore subject to different risks. There is no national or European government agency issuing RMBS transactions. Banks are free to choose how to structure a deal and the underlying collateral pools may vary much. One of the biggest differences with US MBS is that European RMBS are often floating rate based (or swapped to floating rates). With a floating rate note the investor does not face interest rate risk, hence the investor does not have prepayment risk (re-investment risk). (Alink, 2002)

3.2 Spread determinants

The following section will describe variables found in existing literature which can be used as determinants for RMBS spreads. The different categories represent the different research questions set in Chapter 1.

3.2.1 Credit rating

Credit risk is perhaps the most covered topic in scientific literature on bond pricing. However, little analysis has been done with post-crisis data. In a pre-crisis data sample it is often concluded that the credit rating has the most impact on RMBS pricing. The same effect can be seen in corporate bond pricing literature. Almost all of the empirical studies on corporate bond credit spreads have found credit ratings to be one of the most important determinants. Some papers describing the importance of the credit ratings include: Arvantis, Gregory, and Laurent (1999), Duffie and Singleton (2012), Elton et al. (2004), Collin-Dufresne, Goldstein and Martin (2001), Hull, Predescu and White (2004) and Gabbi and Sironi (2005). Firla-Cuchra (2005) argues that credit rating is the most important pricing factor for asset securitisation at issue. This idea is collaborated by Gorton and Souleles (2007), who find that the sponsor's credit rating has an impact on the primary spread of senior tranches of credit card backed securities. Research by Fabozzi and Vink (2012) comes closest to our research. Their research is focussed on UK RMBS in the pre-crisis period and suggest that credit ratings are statistically significant and explain up to 74% of the spread variation. Firla-Cuchra (2005) states that the composite rating variable can explain as much as 72% of the total

variation in launch spreads for floating rate issues and as much as 78% in the case of fixed-rate issues.

3.2.2 Market conditions

Pricing factors might be related to market conditions such as liquidity. According to credit rating agencies, such factors are not typically part of the credit rating analysis. Nevertheless, they might be important from the investors' perspective and hence might be explicitly priced. Liquidity or lack of liquidity is regarded as a large influencer of spread levels. Hu and Cantor (2006) argue that structured financial securities are less liquid than corporate bonds and that this has an impact on credit spreads. Gupta et al. (2008) examine the impact of liquidity on syndicated loan spreads. They show that loans with higher expected liquidity – bonds that are likely to be traded at secondary markets – have significantly lower primary spreads. Thus, the introduction of a proxy for market liquidity on our models could be interesting. Rothberg et al. (1989) argue that liquidity significantly affects the pricing of pass-through securities. Firla-Cuchra (2005) also reports a positive but small effect of the implied interest rate volatility on spreads. Similar to other studies, Firla-Cuchra (2005) finds the coefficient of the log of the tranche size to be negative and very significant and conclude that tranche size is likely to proxy for liquidity. In order to test the effects of any such lenient variables not observed, Firla-Cuchra proxies the liquidity market conditions with the number of tranches from the same 'family'. Each 'tranche family' is defined by combining tranches of the same currency, rating, and WAL bucket issued in the same, previous or next month to the date of issue. This approach could be useful in our research as well, however, we argue that it is better to only take transactions into account issued in the previous month as future information is not available at the time of pricing.

3.2.3 RMBS structure and collateral pool

Current literature is lacking research on the influence of collateral pool composition to RMBS spreads. One reason for this is the asymmetric information on securitised products in the pre-crisis period. Much of the literature on collateral pool characteristics (particularly the empirical literature) have focused on the relationship between collateral and the riskiness of the underlying firm. Little is known about how and why spreads vary with collateral and loan characteristics.

With US data, Pinto et al. (2013) identified that MBS have an average credit spread lower than other ABS because the collateral of MBS transactions is less subject to price volatility than collateral of ABS mainly due to the implicit government guarantees. However, this does not reflect the spread differences between different RMBS transactions.

More research has been done toward the structure specifics of RMBS transactions. Firla-Cuchra (2005), states that the coefficient on the log of the weighted average lifetime is positive and significant indicating that investors charge a premium for longer dated tranches. Several authors e.g., Sarig and Warga (1989), He et al. (2011), Duffie and Singleton (2012), and Sorge and Gadanecz (2008) also argue that lenders get a higher premium for being exposed to risk for a longer period of time; on average, the term structure of credit spreads for investment grade bonds appears upward-sloping.

A paper by He, Qian & Strahan (2011) tests whether issuer size affected the pricing of MBS. Overall, they conclude that there is a robust relation between issuer size and the market prices of mortgage-backed securities conditional on ratings. Guttler, Hommell and Reichert (2011) research the influence of sponsor, servicer and underwriter characteristics on RMBS performance. They find that securitisation transactions underwritten by reputable banks performed worse than those underwritten by less reputable underwriters.

Vink and Thibeault (2007) describe explanatory variables for ABS, MBS and CDO launch spreads in a non-US setting. They identify three different categories influencing the primary market spread; default and recovery risk characteristics, marketability characteristics and systemic risk characteristics. These include different variables; the default and recovery risk group contains: credit rating, loan-to-value, weighted average lifetime and credit enhancement. Marketability is defined as: size of the tranche, size of transaction, number of tranches, number of lead managers, number of credit rating agencies, whether the issue is retained or not, and type of interest rate. Fabozzi and Vink (2012) also state that subordination level, seniority, external credit enhancement and non-conforming collateral significantly influence the primary spread variation. Firla-Cuchra (2005) includes placement (either private or public) as a significant dummy variable in its analysis. However, the factors described above are mainly related to credit risks and the structuring of a RMBS transactions. We believe that other collateral factors also influence the spread significantly.

3.2.4 Currency risk

Currency risk occurs when loan tranches (and its currency of payments) are denominated in a currency different from the currency in the borrower's home country (Pinto et al, 2013).

Fabozzi and Vink (2012) research the influence of currency risk on RMBS pricing but conclude that this has little effect. However, Gatti et al. (2008) find that loans with currency risk have statistically lower spreads, longer term loans have more stable spreads and that spreads differ across industries.

3.2.5 Macro-economic factors

Macro-economic factors have become more important over the last few years for RMBS transactions as rating agencies are using stressed macro scenarios to determine the risks of RMBS notes. The macro-economic factors are also included to capture the different environment of Dutch and UK RMBS. Research by Kleimeier and Megginson (2000), Altunbas and Gadanecz (2004), Gatti et al. (2008), Sorge and Gadanecz (2008), and Vink and Thibeault (2008), correct for macro environmental differences in their analysis. These papers conclude that macroeconomic conditions (e.g., level of interest rates, volatility, and slope of the Euro swap rate) influence the results of analysis. Pinto et al. (2013) additionally suggest the use of a country risk and credit accessibility variables. Collin-Dufresne et al. (2001) argue that the slope of the term structure provides a measure of uncertainty in the economy. At the same time, a negative slope should indicate expectations of cuts in interest rates in the future associated with worsening economic climate and higher credit risk premiums. Firla-Cuchra (2005) incorporate an index of the total number of transactions per country (to proxy for country-market development) as well as country-specific dummies. At the time of this research, rating agency Standard and Poors (S&P) also reports about the macro-economic factors effecting credit quality. S&P (2014) identified five macro-economic variables that influence credit quality: GDP growth, unemployment, property prices, bank equity returns, and corporate credit risk premia. GDP growth is crucial to structured finance credit quality because it represents an overall measure of the region's economic health. Fluctuations in GDP growth reflect the fortunes and creditworthiness of various economic agents, including borrowers backing European structured finance transactions. Unemployment is also identified as a key determinant of credit quality because it directly affects household creditworthiness. S&P believes it is a good proxy for collateral pool credit performance in transactions backed by loans, such as RMBS. European property prices have a strong relation with structured

finance credit quality. Lower property values could be seen as credit risk in outstanding loans secured by property, such as those backing RMBS. Sharp falls in property prices in certain countries over the past few years have had repercussions for RMBS ratings.

As fifth influencer S&P identifies the difference in bond yields. This partially reflects the bond market's consensus on corporate credit risk, as well as the degree of liquidity stress and credit availability for corporations. (S&P, 2014) We argue that these variables might be lagging regarding the economic status at the time of issue. Therefore, we believe that this list can be complemented with other country specific economic measures such as an economic sentiment indicator. This might be more accurate in displaying the actual economic status at the time of a new RMBS transaction.

3.2.6 Regulation

As Pinto et al (2013) states, it would be very interesting to understand the impact of the new Basel III requirements on asset securitisation's credit spreads. There has been much attention from regulators to revive the European securitisation market. A paper by the European Central Bank (ECB) and the Bank of England (BoE) states that concerted action, involving a range of policymakers and regulators, is needed to increase issuance of asset-backed securities (BoE & ECB, 2014). AFME has also argued that securitisation has the potential to unlock the funding needed for Europe's economic recovery.

Banks holding RMBS notes are subject to regulations set by the Basel committee. Two important factors in Basel III are the new liquidity coverage ratio and not yet determined risk weights. The liquidity coverage ratio is supposed to require a bank of holding enough high quality liquid assets (HQLA) to cover its net cash outflows over a 30 day period. Until December 2012, RMBS were not included as a HQLA. The Basel committee's new proposal at this date stated that RMBS, under certain conditions, may be included in Level 2B HQLA, subject to a 25% haircut. However, the proposals also include a constraint of an average 80% loan-to-value ratio on the underlying mortgages. That cap excludes a large share of Dutch RMBS deals, one of the best performing European asset classes even though its loan-to-values typically exceed 80%. The use of RMBS as HQLA is limited by a maximum of 15% with a haircut of 25% over the market value.

New European proposals were released in December 2013. Interestingly, these proposals do not mention a loan-to-value cap of 80% on RMBS, thus including Dutch RMBS. Therefore it might be the case that the change in legislation has also affected spread levels for RMBS transactions with a loan-to-value above 80%.

4 Methodology

This chapter will discuss the research methodology. The methodology is a plan for collecting, organising and integrating data so that the research questions can be answered. The chapter starts with the discussion of the research strategy. After which, the ordinary least square regression model will be discussed. Finally, the chapter will elaborate on the data collection process.

4.1 Research strategy

This research undertakes a quantitative empirical research approach. This means collecting (numerical) data and analysing it using statistical methods by looking for patterns in historical data. This approach is selected because of the lack of scientific research in the RMBS field and the large quantity of (numerical) data available. The goal of this approach is to find a relation between the tested independent variables and the dependent variable.

A first point of discussion is the nature of the dataset. The data analysed varies over time as the observations are made at the RMBS transaction's launch date. Therefore, only one observation date is made per transaction. However, one could regard the observations as a time series dataset, assuming that the different transactions are influenced by the previous transactions. In this process we could assume that all the transactions have the same structure, based on different variables, and could argue that our data could indeed be analysed as if it behaves according to the time series characteristics. A problem here is the time between the different transactions. The observations are not made on regular basis because the launch of RMBS transactions does not follow a fixed schedule. This also means that the influence of a previous transaction, on the current transaction, differs as the time period between the different transactions becomes larger. Another problem is selecting a previous transaction that influences the current transaction. For example, does an inaugural transaction influence the pricing of a strong brand name that returns to the market every year? Because of these problems with time series analysis we have decided to handle our observations as a cross-sectional dataset. Therefore, we assume that investors make a fundamental analysis of every transaction even if a similar transaction is launched recently.

4.2 Research method

Heij (2004) argues that there are three steps that have to be taken to answer the research questions.

Step 1: Choice of variables. Choosing the dependent variable and the explanatory variables have been done in the first chapter. The dependent variable in our research are the primary market spreads in Dutch and UK RMBS. A proposal of the explanatory variables are given at the end of this chapter.

Step 2: Collect data. We have collected 974 observations for which data was collected. More information on the data collation will be described in this chapter.

Step 3: Compute the estimates. Compute the least squares estimates by the OLS formula by using Eviews. The results of this analysis can be found in chapter 6.

4.2.1 Ordinary least square regression

All the data is gathered into one database. Subsequently, the database enables the use of quantitative analysis. First we will test the variables relation with the dependent variable by applying a single variable analysis. The independent variables are analysed in relation to the corresponding spreads by means of ordinary least square regression, which has the following formulae:

$$Spread_i = \beta_0 + \beta_1 * Factor_i + \varepsilon_i$$

In this formulae β_0 is the intercept, β_1 is the slope parameter (coefficient) and ε_i is the error term. The coefficients (β_0 and β_1) will be determined so that they minimize the sum of the squared vertical distance between the points and the line (minimizing the sum of squared residuals).

$$\sum_{i=1}^N \varepsilon_i^2$$

Here N is the number of observations in the sample and ε_i is the error term per observation.

A positive β_1 will mean that a factor is positively related to spread levels. Meaning that if the value on the explanatory variable increases then the value of the dependent variable also increases. A higher value on this factor will indicate a higher spread level per unit increase in the explanatory variable. If the coefficient is negative then the related effect will be the opposite. The objective of this least-squares method is to minimise the sum of squared residuals of the model.

As a second step we will test the variables in a multivariate regression model. Instead of using only one factor, we use multiple factors minimising the sum of the squared residuals. From the single variable analysis we selected factors that seem to be relevant in their relation the spread. Subsequently, the model takes the form of:

$$\begin{aligned} \text{spread} = & \beta_0 + \beta_1(\text{Credit rating}) + \beta_2(\text{collateral related variable}) \\ & + \beta_3(\text{Structure characteristics}) + \beta_4(\text{market conditions}) \\ & + \beta_5(\text{currency characteristics}) + \beta_6(\text{regulatory conditions}) + \epsilon_i \end{aligned}$$

Here β_0 is the intercept, β_x represents the slope parameters for every variable, and ϵ_i is the error term and again includes the assumption of normality and independent errors.

4.2.2 Goodness of Fit and Hypothesis Tests

The “goodness of fit” of a regression model is denoted by R^2 . This is the proportion of the variance of the dependent variable that is explained by the regression variables. A value of $R^2 = 1$ would mean that all the variance in the dependent variable is explained. However a disadvantage of the R^2 is that adding more variables to the regression will always increase the value of R^2 . The Adjusted R^2 offers a better indication in case of many explanatory variables because it adjusts for the number of included variables.

Hypothesis tests can be performed to assess whether the parameter estimates are statistically significant. The null hypothesis often proposes the coefficient to be 0, indicating that this variable does not remove any variation in the dependent variable. The alternative test would be that the coefficient is significantly (under a defined p-value) different from 0 and thus explains a part of the dependent variable. A small p-value indicates more confidence that a particular variable X is a good explanatory variable. For example, a p-value of 0.05 would indicate that with 95% percent certainty the explanatory coefficient is different from 0. A p-value above 0.05 would indicate that we cannot reject the null hypothesis (H_0 : explanatory

coefficient = 0) and that the explanatory coefficient is not significantly different (we do not have 95% certainty) from zero.

With our model we will try to simulate the real world situation. It is good to remember the words of a famous statistician, George Box (1978): “All models are wrong, but some are useful.” We do not believe that the linear model is a true representation of reality; rather, we think that perhaps it provides a useful representation of reality.

4.2.3 Assumptions

To analyse the statistical properties with least squares estimation, we will have to keep in mind the five assumptions of the regression model.

- Assumption 1: The expected value of the error term is zero.
- Assumption 2: There is no autocorrelation/ multicollinearity between the errors. It is not allowed for two or more variables to be highly correlated.
- Assumption 3: Homoskedasticity. The variance of ε_i for each X_i is some positive constant number equal to σ^2 . (Huber-White correction)
- Assumption 4: The covariance between ε_i and X_i is zero. This implies that there is no correlation between the error term and the explanatory variables. If these were to be correlated it would not be possible to assess the individual effect on Y .
- Assumption 5: Correct specification parameters. Make sure no important variables are omitted from the model.

4.3 Variable selection

The independent variables tested in this research will come from three sources. First, variables mentioned in the literature review are tested. Second, to gain a better understanding of important independent variables which could influence RMBS launch spreads, this research started by using unstructured interviews with several experts in the field. Third, variables arising from common sense are also included.

4.4 Data collecting

The main sources of data used in this research are ConceptABS, Bloomberg, Markit and investor reports. ConceptABS is a subscription data service which reports all new transactions and is used to gather data on structures and launch spreads. This database also contains information on: size, credit enhancement, weighted average lifetime, counter parties involved and placement. Bloomberg is used to obtain collateral performance data of these securitisations and macro-economic data. Markit data is used for all analysis on secondary market data. Finally, investor reports on deal performance are used to compliment any missing data.

4.4.1 Variable transformation

Some variables are not numeric or it might be the case that the numeric increase of the variable does not reflect a linear change in the dependent variable. Dummy variables are introduced to cope with these problems. This is a binary variable in the regression which will indicate the presence of a certain condition. For example, a dummy variable can be used to distinguish and test between pre-crisis and post-crisis transactions. Specific transformations are described, per variable, in chapter 5.

4.4.2 Missing data and duplicate data

Fortunately, most data on the independent variables was available. All ConceptABS data was linked to Bloomberg data (by a manual matching process) to double check the data and to minimise the probability of having missing data. In the exceptional cases that some data was missing in ConceptABS the information was looked up in Bloomberg. If data was still missing, prospectus have been consulted to find the missing data. In the cases that some data was still not available after this extensive process, the first released investor reports, after launch, have been used as an indication of the launch data. After this process, out of the 193 transactions, only 2 transactions contained missing data, namely: 'Equity Release Funding No 5' and 'Cronos RMBS Funding Limited'. These transactions are removed from the dataset due to a lack of reliable data available.

Four transactions in our dataset are remarketed. These transactions are already issued but re-sold to investors. Spread levels of these transactions are often unreliable due to lacking data. The spread is calculated as a discount margin at which the security is currently trading in the secondary market. However, at the time of sale a remarketed tranche could be sold below par (which results in a higher DM). Therefore, remarketed transactions are removed from our data sample.

Some duplicates have occurred in the dataset because ConceptABS records two entries if a tranche is partly privately placed and partly publicly offered. To fix this, the public placement is selected, because we believe that these spreads are more reliable than private placed deals, to prevent double counting transaction tranches.

4.5 Model validity and reliability

An important feature when applying a regression model is to validate the model.

Methods to determine the validity of regression models include the comparison of the model predictions and coefficients with theory, collection of new data to check model predictions and data splitting or cross-validation in which a portion of the data is used to estimate the model coefficients, and the remainder of the data is used to measure the prediction accuracy of the model (Snee, 1977). First, we will compare our results with the (limited) existing literature to assure validity of the results. Second, the option of checking the models prediction on new data is hard because of absence of new Dutch or UK RMBS issuance in the period of writing this research. Third, the option of splitting the data to generate a model generation data sample and a testing data sample is possible and will be applied. However, the limited size of our research sample could interfere with the results. Draper and Smith (1966) also discuss an interesting variation on using time to split the data. In the case of four years of data, they recommend that the model be fitted to each year of data separately and the coefficients be examined for stability.

Several precautions are made to the regression models to assure that the results are as reliable as possible. To remove systematic heterogeneity from the error term, a heteroskedasticity-consistent variance-covariance matrix is used (White, 1980). Since the ordinary least squares assumptions of independent errors are unlikely to be satisfied in regression, the computed t-statistics are potentially overstated.

An examination of the model coefficients and associated variance inflation factors (VIF) can also provide clues concerning the validity of a model. The VIFs, which are the diagonal elements of the inverse of the correlation matrix, measure the collective effect of the correlations among the variables on the variances of the estimated coefficients. As a general rule, a VIF larger than 5 or 10 is an indication that the associated coefficient is likely to be poorly estimated because of the correlations among the variables (Snee, 1977). Testing for multicollinearity in the regression models, by using the variance inflator factor test and the coefficient variance decomposition test, indicate no serious problems. However, testing for correlation between the variables indicated that the consumer confidence and construction confidence variables are highly correlated. This problem is easily solved by replacing these variables with a new variable. The new variable, economic sentiment indicator (ESI) is a composite indicator made up of five sectoral confidence indicators with different weights: industrial confidence indicator (40%), services confidence indicator (30%), consumer confidence indicator (20%), construction confidence indicator (5%) and retail trade confidence indicator (5%).

4.6 Variable overview

Category	Independent variable	Data source
<i>Credit ratings</i>	- Rating	Rating agencies
<i>Market conditions</i>	- Recent deals - Volatility index - Secondary market spread - CDS index volatility	ConceptABS Bloomberg Markit Bloomberg
<i>Collateral pool variables</i>	- Loan-to-value ratio - Governmental guarantees (NHG) - Seasoning - Interest-only loan ratio	ConceptABS/Prospectus ConceptABS/Prospectus ConceptABS/Prospectus ConceptABS/Prospectus
<i>Currency variables</i>	- Currency mismatch - Multi currency	ConceptABS ConceptABS
<i>Macro-economic variables</i>	- Unemployment levels - GDP growth levels - House price index - Economic sentiment	Bloomberg Bloomberg Bloomberg Bloomberg
<i>Regulatory variables</i>	- Change in LCR requirements - Difference secondary market covered bonds vs RMBS.	Regulation updates Markit
<i>Structure specific variables</i>	- WAL - Credit enhancement - Size - Type (Prime/BTL) - Master issue	ConceptABS/Prospectus ConceptABS/Prospectus ConceptABS/Prospectus ConceptABS/Prospectus ConceptABS/Prospectus

5 Variables

This chapter will describe the variables selected and the expected behaviour of the explanatory variables. The first paragraph will explain the dependent variable. The second paragraph will focus on constraints to our dataset. Finally, the third paragraph will describe all the independent variables tested in our research.

5.1 Primary market spread

The primary spread is the dependent variable in this research. The reason for using launch spreads is that these are often more reliable than secondary market spreads which have to be obtained from third-party market quotes. Launch spreads give an accurate indication of the actual costs of debt for the issuing party or the risk premiums demanded by investors. Figure 7 shows the spread levels for all the issues in our dataset. The figure shows a clear difference between issued launched before and after 2009. To identify the effect of the different variables on the spread we have made the assumption that the clearly visible gap in the chart marks the credit crisis. Because of this assumption it will be possible to analyse the variables for both the post-crisis and pre-crisis period. An official break-point test will be applied in the next chapter to determine the effects of the financial crisis.

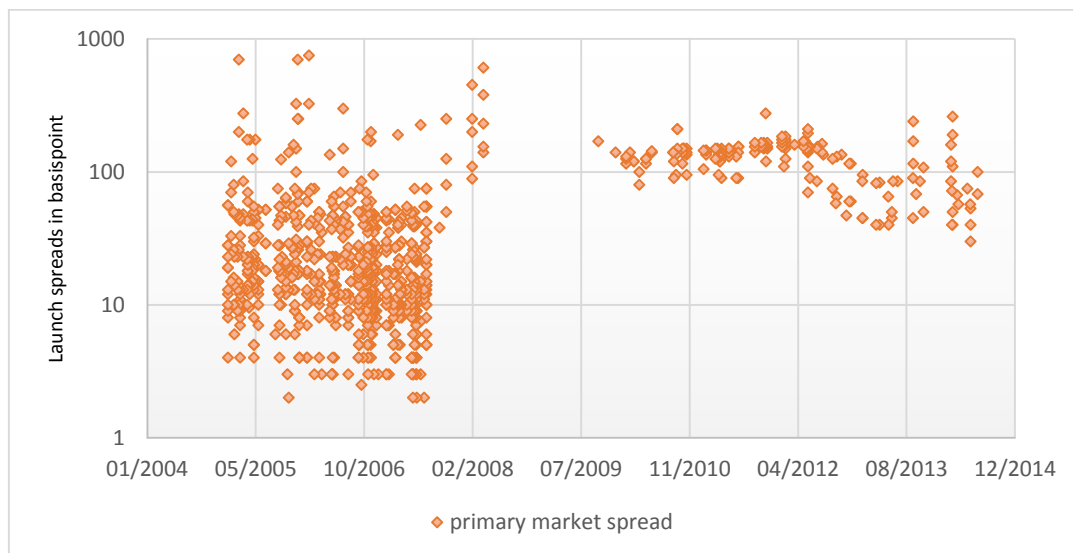


FIGURE 7: THE GRAPH ABOVE SHOWS THE LAUNCH SPREADS OF ALL THE TRANCHES IN BASIS POINTS OVER ITS REFERENCE RATE (PLEASE NOTE THAT THE VERTICAL AXIS IS DISPLAYED ON A LOG SCALE).

5.2 Variable constraints

Credit rating

To analyse the influence of the credit rating on spread levels, tranches in our sample are required to have at least one credit rating from rating agencies: Standard & Poor's (S&P), Moody's or Fitch. If tranches have multiple ratings, the lowest rating is selected because in our view that is what investors would rely on.

Placement and type.

As mentioned before, there are basically three types of RMBS transactions. First, prime RMBS are regarded as the "safest" transactions as these have the highest underwriting standards. Second, Buy-To-Let deals are not owner occupied but still have high underwriting standards. Third, non-conforming RMBS structures rely on mortgages with lower underwriting standards (more similar to sub-prime mortgages in the US). The problem with the non-conforming mortgages is that information is not transparent and the underlying pools differ too much to be compared. To avoid distortion of the data all non-conforming deals have been removed from the analysis.

Tranches can either be publicly sold, privately sold or retained by the seller. In our analysis we will discard all the retained tranches as these are not priced to be sold to investors. Thus these margins will not reflect risks taken by investors. After the analysing our data sample we have also decided to remove the privately-sold tranches. Although these margins were often in line with the marketed spread, we questioned their reliability as private placed notes also caused most of the outliers in our dataset.

Floating coupons and reference rates

Tranches can either be priced fixed or floating. The coupon of fixed-rate notes are estimated by selecting a suitable benchmark for the country where the deal is issued. Because of the difficulty of making these tranches comparable, we further restrict our sample by excluding the nine fixed-rate tranches. Therefore, only floating rate notes remain in our sample. Floating rate notes are based on the reference rate. This is a rate that determines pay-offs in a financial contract that is outside the control of the contract parties and changes over the time of the contract. Different reference rates can also have different resets. For example, the 3mEURIBOR has a reset every 3 months. To compare different reference rates with different

resets a basis swap can be used to calculate all the resets back to the same frequency. However, because we did not have the appropriate basis swaps available and because we believe that the, uncommon, one month or six month reference rates do not represent our sample well we have decided to remove these tranches. In total 38 tranches have been removed: sixteen 1m\$L, nine 1mE, ten 1mL, one 1mCDOR, one 1mBBSW and one 6mE. In our sample all the three month reset based reference rates remain. This includes: 3mE (487), 3mL (239), 3m\$L (237), 3mYL (3) and 3mBBSW (1).

Time frame

We expect that the credit crisis has significantly influenced investors' ideas about the risks of RMBS transaction and therefore we will try to identify important variables that determine the primary spread levels. As we would like to investigate both the pre-crisis and post-crisis developments we have selected a timeframe from 1st of January 2005 until 7th of July 2014. Often, data before 2005 was unavailable from our data sources. The regressions performed will also test for differences between pre and post crisis data. For now we will assume that pre-crisis data will be regarded as issued launched between the first of January 2005 up to September 2008 (Lehman brothers bankruptcy) and the post-crisis data will start from January the 1st of 2009 up to the time of this research (7th July 2014). Note that Figure 7 shows this time frame as a distinct period in which no new RMBS transactions were issued.

5.3 Variables tested

The following paragraphs will describe how the different variables are measured or denoted and gives an overview of the expected relation.

5.3.1 Credit rating

The credit rating is a major component of our first research question: “*Investors of Dutch and UK RMBS still heavily rely on credit ratings, post-crisis*”. A credit rating is an estimate by a rating agency on the default probability (S&P, Fitch) or expected loss (Moody's) of a loan. Thus, higher rated notes should result in lower spreads. Credit rating should capture the difference in both issuers' creditworthiness, the bonds' seniority and the risks arising from the transactions' structure. Because there are three different rating agencies in the market we have chosen to take the lowest rating assigned to a tranche. Also, we have excluded unrated

tranches in our analysis. In our sample 66 tranches were ‘not rated’ and we believe that these tranches do not represent reliable spread data. The ratings are converted to dummy variables to capture any non-linear influences of the ratings on spread levels. The ratings are categorised in six different dummy variables ranging from AAA to B. The highest rated tranches (AAA) represent the prime segment while the lowest rated (B) tranches are highly speculative. Appendix A shows an extensive overview of the rating categorisation. Figure 8 gives an overview of the spread levels for the different rating dummies in the pre-crisis and post-crisis samples. From the figure we can make several observations. First, pre-crisis spread levels were generally lower, for every rating category, compared to the post-crisis spreads. Even some lower rated pre-crisis issues were priced tighter than the highest rated post-crisis tranches. Secondly, the rating spectrum is more limited for the post-crisis sample as the lowest rated post-crisis tranches fall inside the ‘BBB’ dummy while in our pre-crisis sample much lower rated tranches were in the market. Finally, Figure 8 indicates that credit rating is indeed an explanatory variable towards the spread. The figure shows that lower rated tranches tend to have higher spreads. Therefore, we expect the sign of the coefficients of the different dummy variables to be positive and increasing for lower rated tranches.

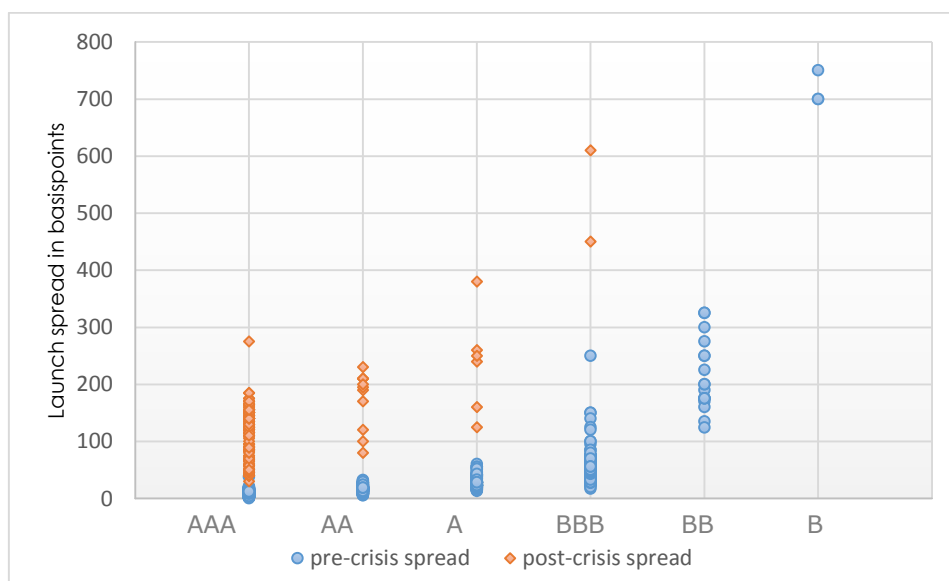


FIGURE 8: RATING DUMMIES PLOTTED AGAINST THE SPREAD, CLEARLY INDICATING THAT LOWER RATED TRANCHES HAVE HIGHER SPREADS IN BOTH THE PRE-CRISIS AND POST-CRISIS SAMPLE.

5.3.2 Market conditions

Market liquidity is one of the market conditions. This research uses a similar approach as Firla-Cuchra to proxy the market liquidity. Market liquidity is estimated as the total size of

tranches from the same ‘family’ issued. A tranche ‘family’ is defined as combining all tranches issued, in the same currency, rating, and WAL bucket, in the same month or in the previous month to the date of issue. We expect that a period with many issues might indicate a more liquid market and therefore results in lower spreads.

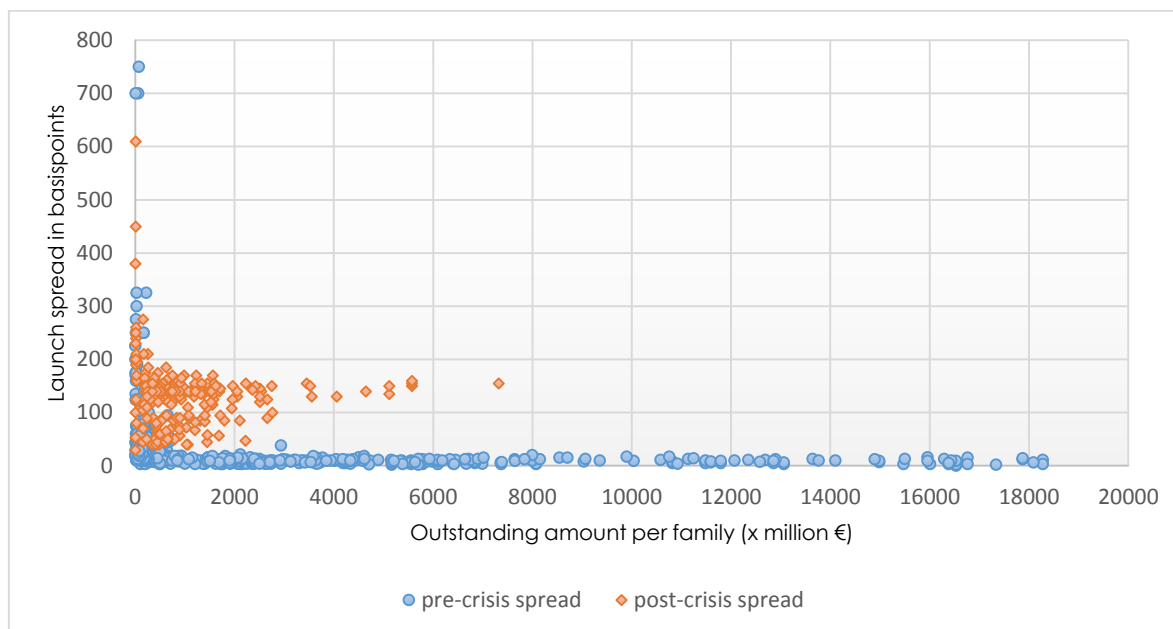


FIGURE 9: LIQUIDITY PROXY PLOTTED AGAINST THE SPREAD DISPLAYING UNCLEAR RELATIONS.

Volatility is also stated in literature to be a good proxy for market conditions. We will use a volatility indicator often used in equity markets. The VIX index represents a measurement of the market's expected volatility over the next month. We believe that this index gives a proper indication of the overall market uncertainty, which also influences the primary ABS markets. Figure 10 below shows a clear trend for the post-crisis issues. We expect that a higher volatility would indicate a higher risk and therefore a higher spread for new issues.

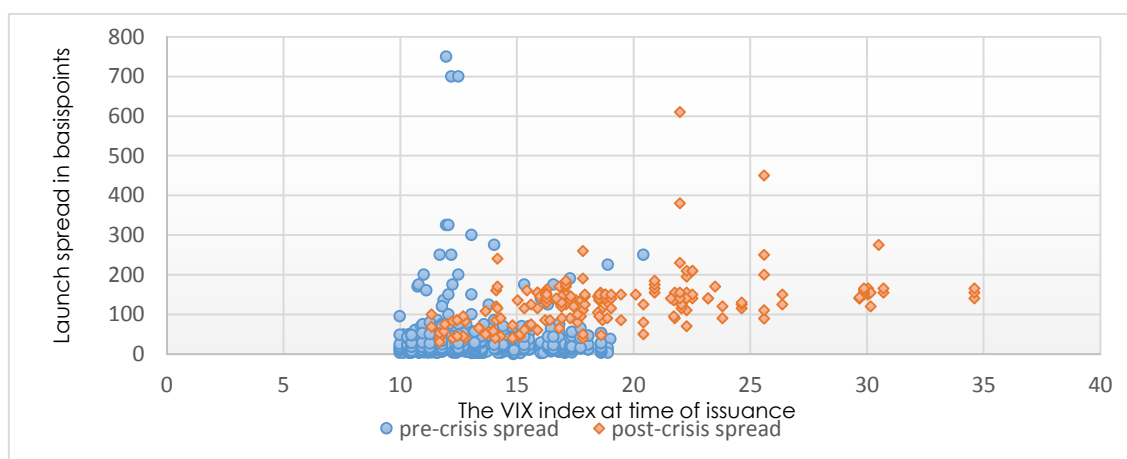


FIGURE 10: VIX INDEX PLOTTED AGAINST THE SPREAD, DISPLAYING A SOMEWHAT POSITIVE RELATION FOR THE POST-CRISIS SAMPLE.

The VIX index seems to be a good estimator in pricing RMBS notes. However, we will test whether credit default swap (CDS) index volatility might work even better. A credit default swap is designed to transfer the credit exposure of fixed income products between parties. A credit default swap index is often used by bond investors to hedge default risks. We believe that the CDS index could give an indication of the market conditions. As reference CDS index we have selected the iTraxx Senior Financials CDS index with a maturity of 5 years. This index is expected to be the best suited to our dataset because it is the most liquid index and because it keeps track of CDS spreads in the financial industry. To gain more insights in the changing market conditions we have calculated the volatility of this CDS index over the last month. We expect that if the CDS index volatility is higher than the market conditions are riskier and thus spreads on RMBS notes are also expected to be higher.

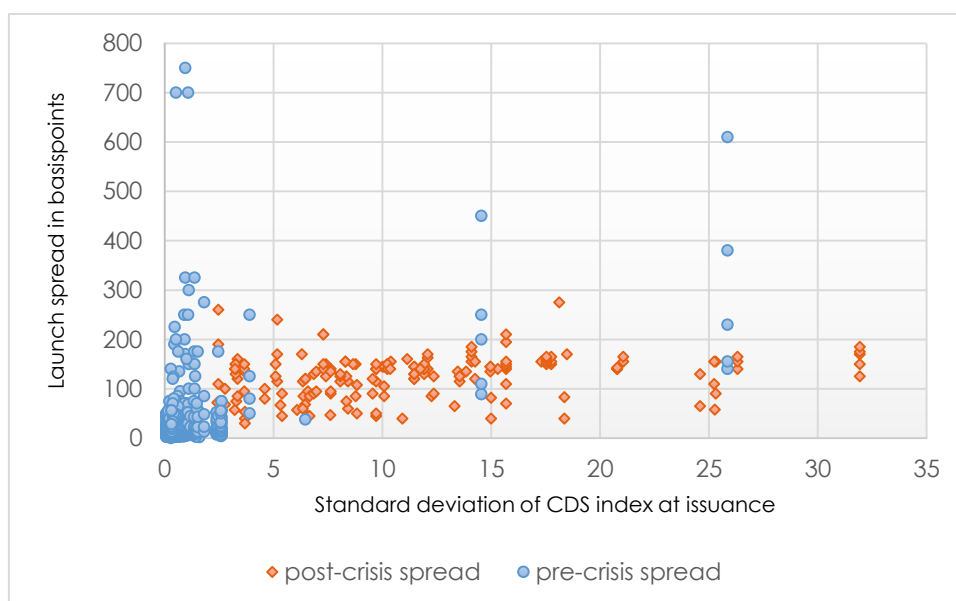


FIGURE 11: CDS VOLATILITY PLOTTED AGAINST THE SPREAD, SHOWING A POSSIBLE POSITIVE RELATION FOR THE POST-CRISIS SAMPLE.

It is generally known that investors price new RMBS transactions by comparing them to the discount margin of similar assets on the secondary market. Unfortunately, this data is often unreliable or even unavailable for some deals. However, Markit (a financial information and services company) keeps track of indices created from benchmark issues grouped by the weighted average life (WAL), rating and currency. By using this data it is possible to identify certain market conditions assuming that the secondary market is efficient and that the traded prices incorporate fundamental changes. The transactions' launch dates are matched to the discount margins at the secondary market from the previous day. The matching is done by

applying two different criteria: the country or origination (either UK or Netherlands) and matched for weighted average life, where 1-3 years represent short-dated securities and longer than 3 years to represent long-dated issues. Figure 12 shows mixed results for the pre-crisis and post-crisis sample. The pre-crisis sample does not show a clear relation between the secondary market discount margins and the launch spreads. However, the post-crisis sample does show a relation between secondary market discount margins and primary market spreads. If the secondary market is trading at higher discount margins it is expected that the spreads of new issues on the primary market will also be higher.

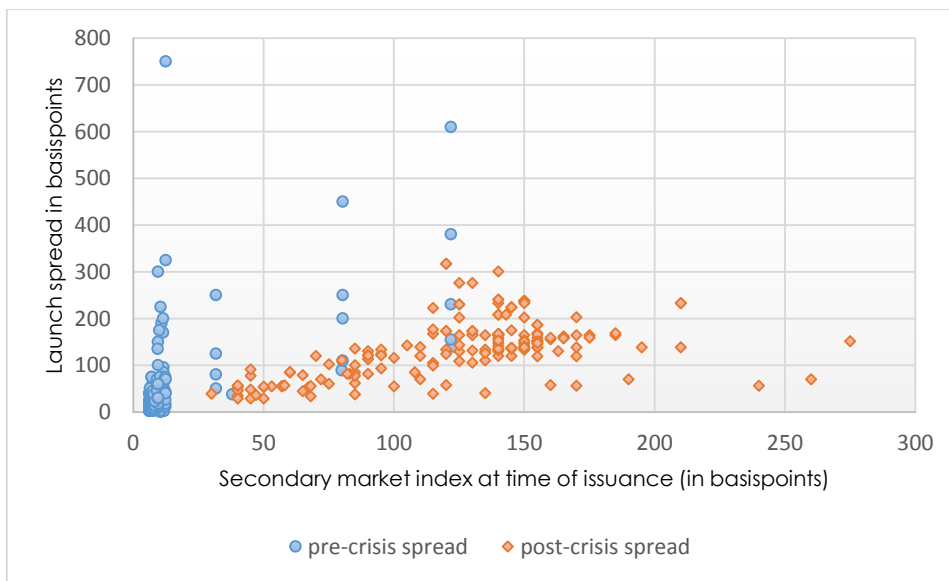


FIGURE 12: SECONDARY MARKET SPREADS PLOTTED AGAINST THE SPREAD, SHOWING A POSSIBLE POSITIVE RELATION IN THE POST-CRISIS SAMPLE.

5.3.3 Collateral related variables

The third set of explanatory variables possibly affecting spreads are arising from the underlying collateral pools of the RMBS transactions. We have selected the following factors to represent the fundamentals: *current loan-to-value*, *governmental guarantees (NHG)*, *seasoning* and *portion of interest-only mortgage loans*.

The current loan-to-value (CLTV) of a transaction is an indication of the collateral coverage. A CLTV ratio of 1 means that the loan and collateral have exactly the same value. The formulae to calculate the weighted CLTV is show on the next page, where variable i indicates each individual loan in the collateral pool of a transaction. The current value indicates the value at the RMBS transaction's launch date.

Weighted Average Current Loan to Value

$$= \sum_{i=1}^N \frac{\text{Current mortgage value } i}{\text{Current collateral value } i} * \frac{\text{Current mortgage value } i}{\text{Total collateral pool size}}$$

Loan-to-value could potential influence RMBS spread levels because a lower ratio indicates that collateral is more likely to be sufficient to cover for the loan in case of default. Figure 13 shows an overview of the CLTV ratios against the spread levels. The picture does not clearly indicate the effect of CLTV ratios on spread levels. However we estimate that a higher CLTV in the underlying collateral pool of a security will cause higher spreads due to an increased risk of default losses. If this is the case then the CLTV coefficient will be positive.

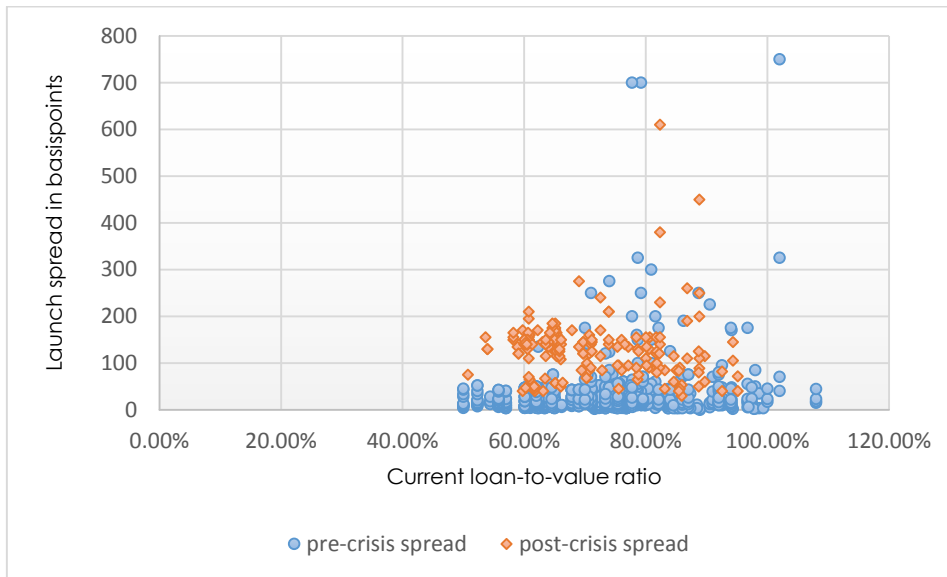


FIGURE 13: CURRENT LOAN-TO-VALUE PLOTTED AGAINST THE SPREAD.

Some Dutch mortgages are guaranteed by NHG (nationale hypotheek garantie). We have already explained briefly how this works in a previous chapter. The NHG acts as a partial guarantee for RMBS investors. Therefore, it is expected that RMBS transactions with guaranteed underlying mortgages have a lower risk of losses from defaults. Thus it should represent a negative coefficient in the regression analysis. However, Figure 14 does not indicate a clear direction on the influence of NHG backed loans towards the spread.

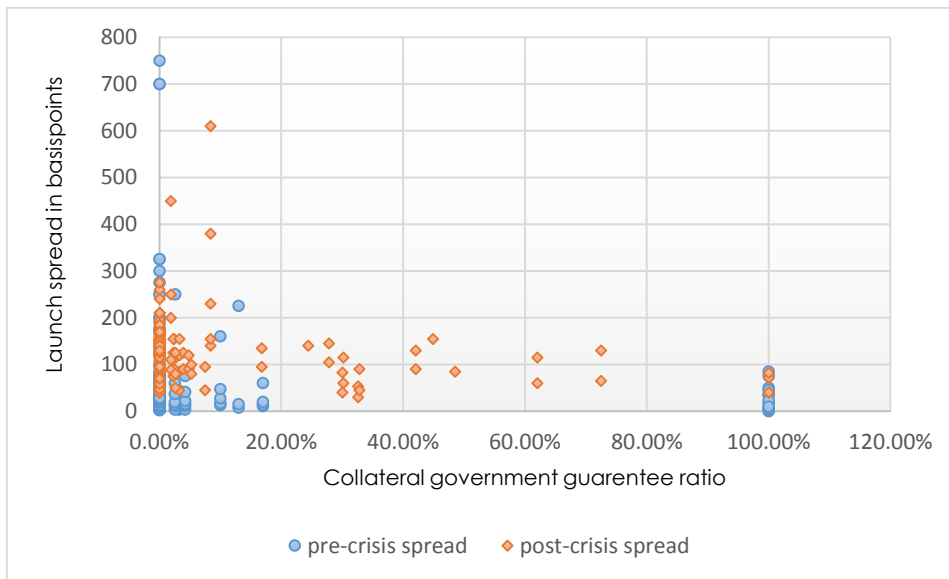


FIGURE 14: GOVERNMENT GUARANTEES PLOTTED AGAINST THE SPREAD.

Seasoning is the length of time, in months, since a mortgage in the underlying pool has been originated and the first payment has been made. Thus the weighted average seasoning levels give an indication for how long the mortgage borrowers in the cover pool are already paying their liabilities. This creates a track record of payments, arrears and defaults and thus can be a performance indicator. However, historic data shows that seasoned mortgage loans have higher pre-payments rates. This makes sense because homeowners do not take out mortgage loans with the expectation that they will relocate soon. Also, they may find it cumbersome to refinance and will not do so. The graph below does not clearly indicate a relation between seasoning and the launch spread.

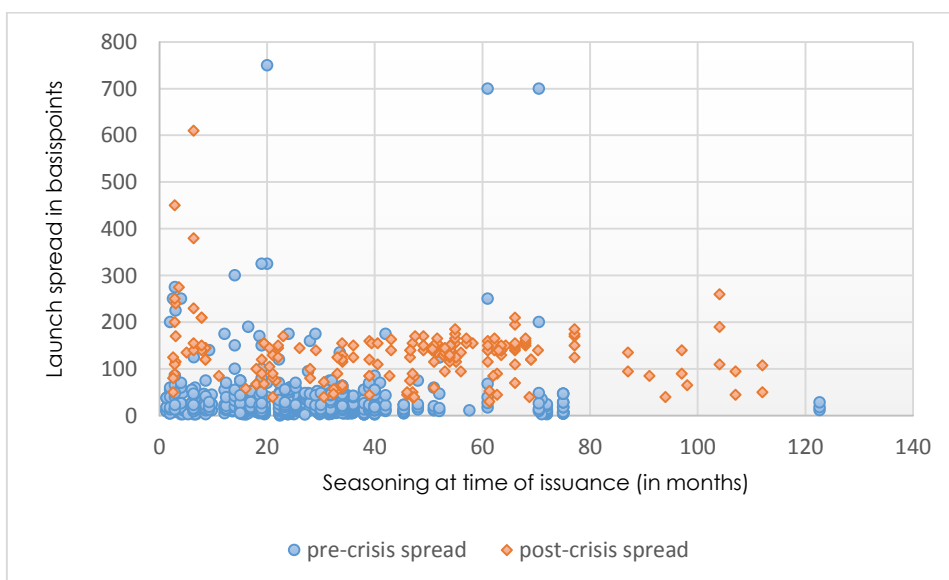


FIGURE 15: SEASONING PLOTTED AGAINST THE SPREAD.

The principle payback scheme of a loan can be structured in several ways. Interest-only principle repayment is a very common redemption type in the Netherlands. Tax regulation enabled borrowers to defer repayment of principal as much as possible to have maximum tax deductibility. This also caused relatively high loan-to-value ratios and minimised principle repayment. This means that higher risks are involved. We expect that a high portion of interest-only loans in the underlying collateral pools of a RMBS could lead to higher spreads.

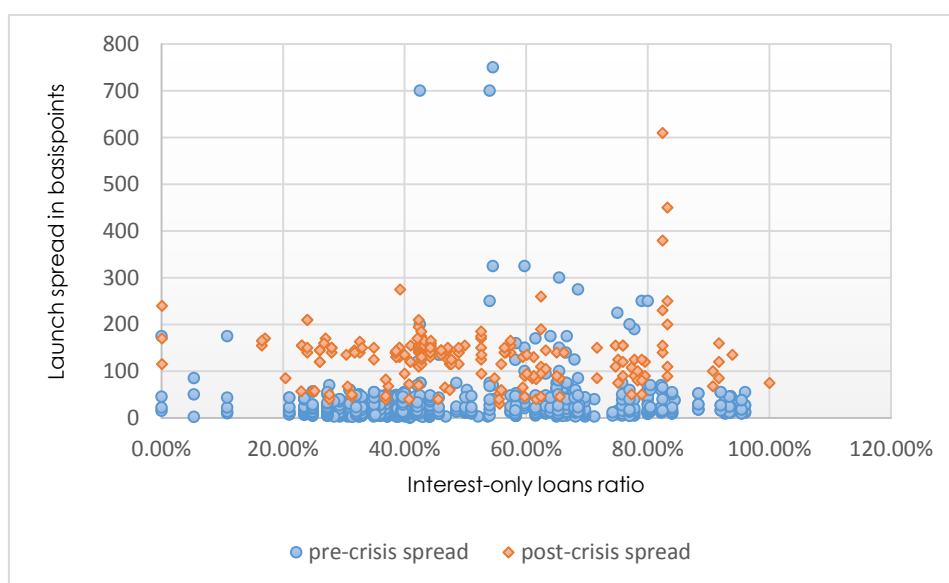


FIGURE 16: INTEREST-ONLY LOAN RATIO PLOTTED AGAINST THE SPREAD.

5.3.4 Structure specific features

This part will describe the variables selected which relate to structure specific features. The weighted-average life gives the expected maturity of a tranche based on assumptions in repayment rates of the underlying mortgages. If a transaction incorporates a call feature the weighted average life can be significantly shorter than the legal maturity. Note however that the weighted-average life of a tranche is a model-based estimation. Changing circumstances regarding repayments or defaults can substantially influence the expected lifetime of a note. It is generally expected that longer-dated issues have a spread premium compared to short-dated issues. Thus we expect the variable to have a positive coefficient in the regression.

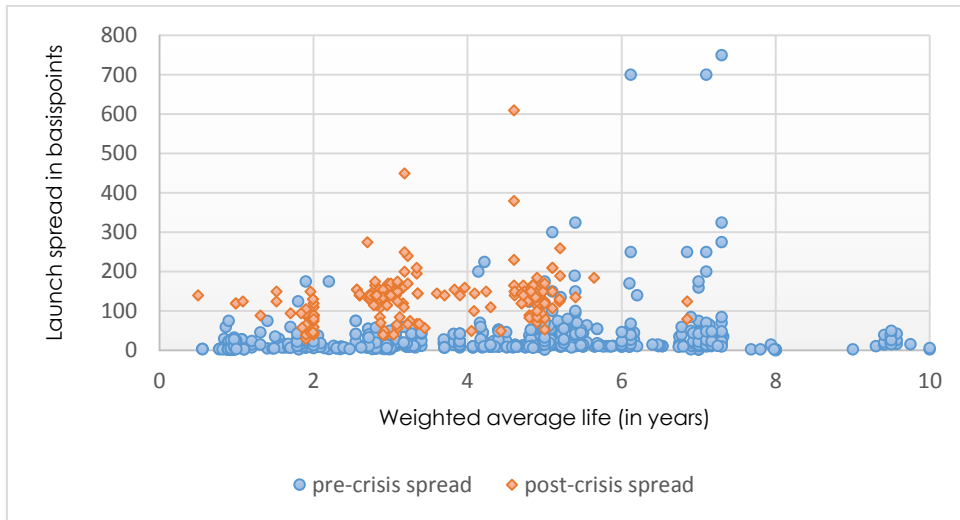


FIGURE 17: WEIGHTED AVERAGE LIFE PLOTTED AGAINST THE SPREAD.

Credit enhancement is the percentage loss that can be incurred, on the underlying collateral, before a tranche will start to make a loss. The definition of credit enhancement used in our research is the result of summing: subordination, reserve account, excess spread and overcollateralization.

$$\begin{aligned}
 \text{Credit Enhancement} = & \frac{\sum \text{amount subordinated tranches}}{\text{Total transaction amount}} + \text{Reserve account amount (\%)} + \text{excess spread (\%)} \\
 & + \frac{\text{Underlying Collateral amount} - \text{transaction amount}}{\text{transaction amount}}
 \end{aligned}$$

We believe that the effect of credit enhancement on the primary spread is negative. This means that more credit enhancement would indicate less risk for investors and therefore lower spreads. Figure 18 shows an interesting picture. It seems as if the effect of credit enhancement is opposite for the pre-crisis and post-crisis sample. For the pre-crisis sample we identify a downward trend, meaning that a higher credit enhancement does indeed lead to lower spread. However, for the post-crisis sample we can see a positive trend, meaning that a higher credit enhancement would cause higher spreads.

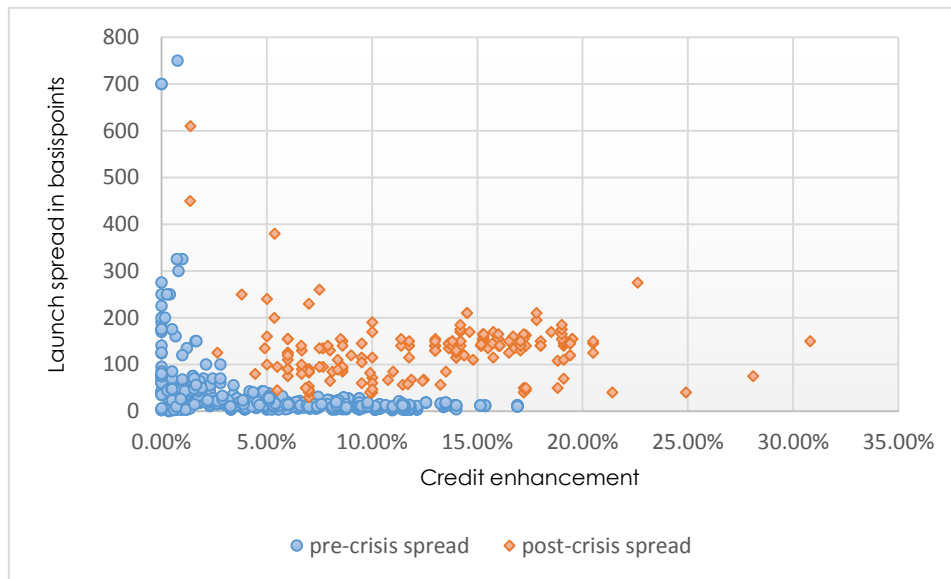


FIGURE 18: CREDIT ENHANCEMENT PLOTTED AGAINST THE SPREAD SHOWING A SOMEWHAT NEGATIVE RELATION IN THE PRE-CRISIS SAMPLE AND THE OPPOSITE EFFECT FOR THE POST-CRISIS SAMPLE.

The transactions in our sample differ much in size. Moreover, these can be issued in several different currencies. ConceptABS, the source for our transaction and tranche size data, often describes the tranche size in its issued currency. However, the data supplier records the total size of a structure in its most dominant currency issue form. To take away any confusion and to make the different sizes more comparable we have converted the different sizes back to €. For this procedure we have used Bloomberg's historical data to find the corresponding currency exchange rates at the day of the RMBS issuance. We can measure tranche size in multiple ways. We will test two approaches, first we will start with unmodified sizes. Second, if the first method does not work, it is also possible to measure the size based on dummy variables. The first dummy variable equals one if the size of the tranche lies between €0 up to and including €500 million. The second dummy variable equals one if the tranche size corresponds to an amount between €500 million up to and including €1 billion, and a third dummy could be used for tranches larger than €1 bn. Figure 19 does not display a clear effect of the size of a tranche on the spread at issuance.

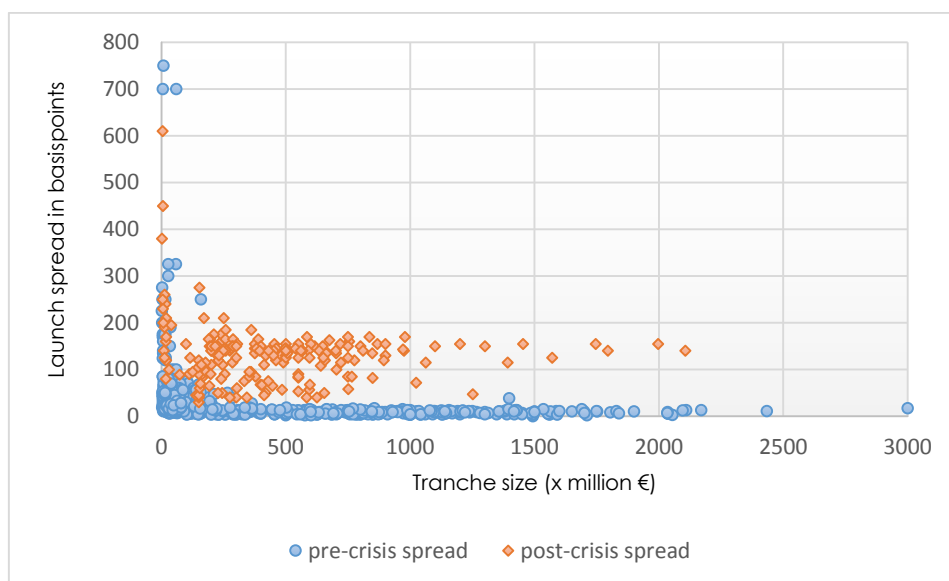


FIGURE 19: SIZE PLOTTED AGAINST THE SPREAD.

Buy-to-let mortgages are a popular type of mortgages in the UK. These mortgages might behave significantly different when securitised because the homeowners often have little incentive to relocate. Buy-to-let is also representing a rising credit risk, with mortgages often approved under relatively easy lending practices. We expect that buy-to-let RMBS transactions have higher spreads, to cope with the underlying risk, compared to a prime collateral pool. To capture any differences between prime RMBS transactions and BTL transactions a dummy variable will be used. A value of 1 means that a transactions collateral pool consists, for more than half, of buy-to-let loans.

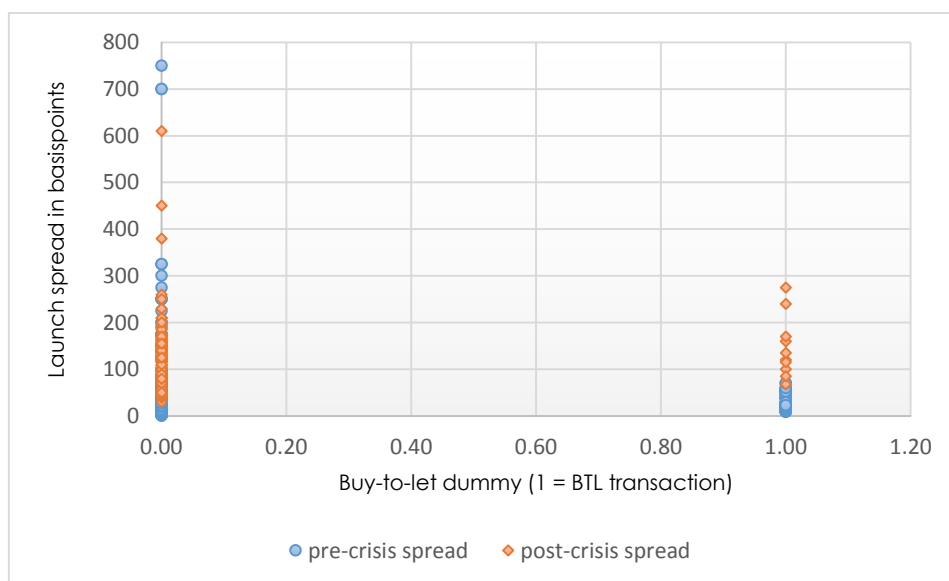


FIGURE 20: BUY-TO-LET DUMMY PLOTTED AGAINST THE SPREAD.

As mentioned before, there is a difference between master trust issues and stand-alone transactions. The most prominent difference is the soft-bullet maturity feature in master trust issues. This gives somewhat more certainty to investors about the life of their investment. Another feature of the master trust are the dynamic collateral pools which also creates more certainty for investors. A dummy variable is introduced to identify this difference. The value of 1 is assigned to master trust issues. We believe that a master trust issues will have a spread discount compared to stand-alone issues.

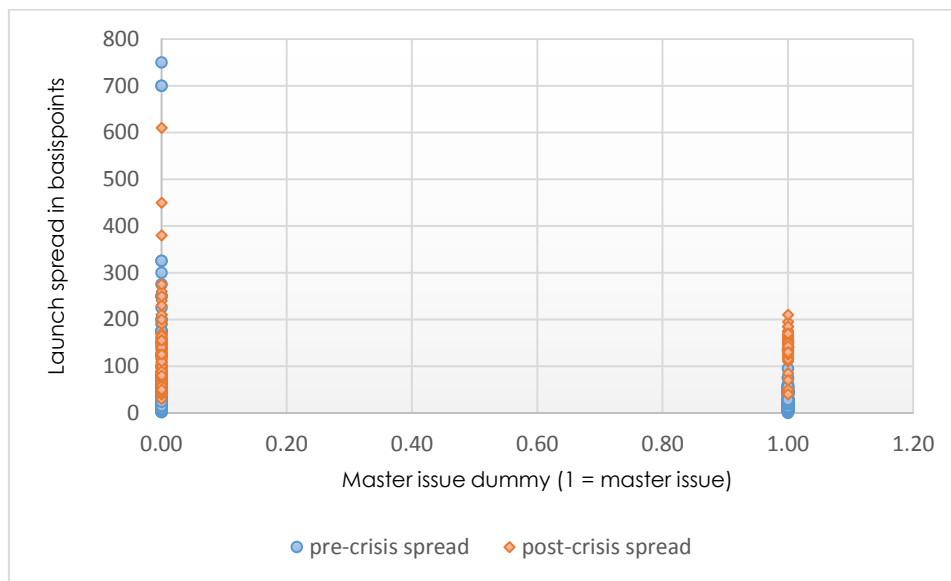


FIGURE 21: MASTER ISSUE DUMMY PLOTTED AGAINST THE SPREAD.

5.3.5 Currency risks

We have identified two possible currency features. Currency mismatch risk and multi-currency issuance. Currency mismatch risk is exposed to investors when the base currency of collateral payments differs from the currency in which the notes are paid. In our analysis this is often the case with UK RMBS transactions which have issued € denominated notes. Although this mismatch risk is typically mitigated by a swap and is taken into account by rating agencies, we suspect that this risk could lead to higher spread levels. In our regression currency mismatch risk is measured as a dummy variable where the value of 1 indicates currency mismatch risk and 0 indicates no currency mismatch risk. Figure 22 does not show direct evidence of higher spreads for the mismatched currencies. If an effect is present it should have a positive coefficient, meaning that the mismatched currencies are sold at a higher premium.

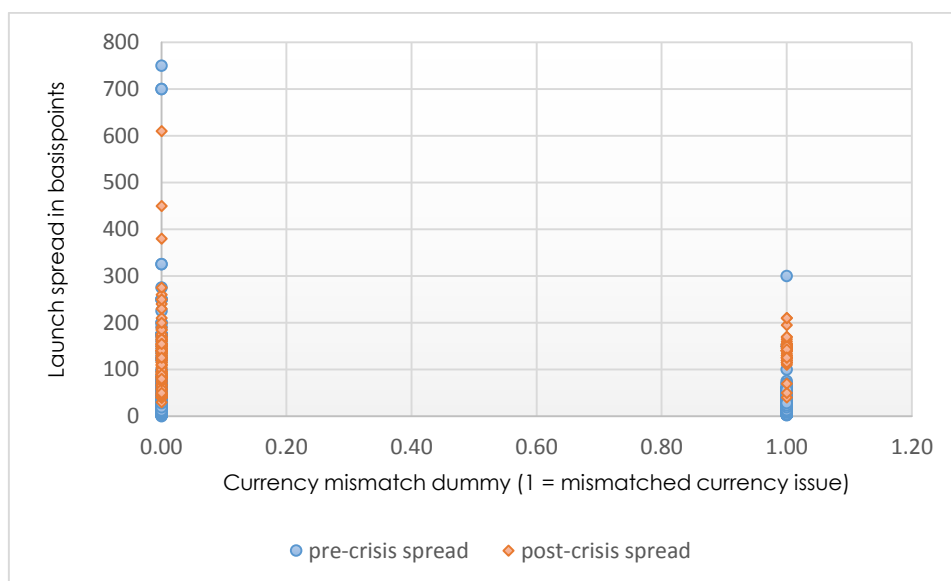


FIGURE 22: MISMATCH CURRENCY PLOTTED AGAINST THE SPREAD.

The second currency effect which could influence the launch spreads are multi-currency issues. These transactions sell multiple notes in different currencies, which could be appealing to a larger investor base. To test this possible effect we have included a multi-currency variable dummy. This dummy indicates (with 1) that a tranche is issued from a multi-currency transactions. We expect that this feature could result in lower spreads.

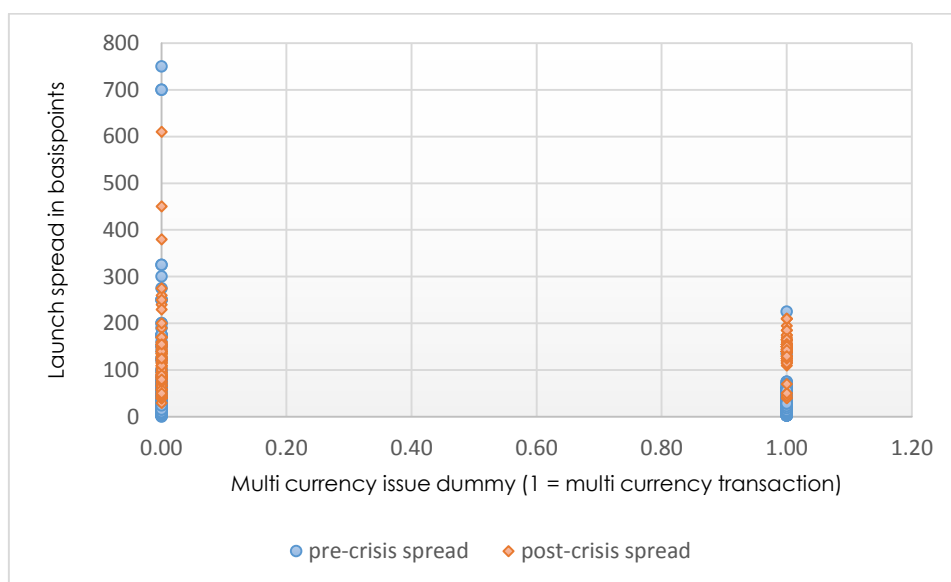


FIGURE 23: MULTI CURRENCY PLOTTED AGAINST THE SPREAD.

5.3.6 Country-specific macro-economic variables

Several country specific variables will be taken into account to identify their influence on differences between the macro-economic environment in the Netherlands and the United Kingdom. All of the macro-economic variables are collected from the Eurostat database. We have selected this database because it calculates the variables according to the same methodology for different countries. Also, we have selected the seasonally adjusted data to make the data more comparable. Unfortunately, macro-economic variables are only reported on monthly or quarterly basis. Most often RMBS transactions are not launched exactly on the same date as the release of these numbers. Therefore, there is a mismatch between the issue date and the exact level at issuance date. To cope with this problem, new RMBS deals are matched to the latest available macro-economic variables at time of issuance.

Unemployment levels are regarded as an indicator of economic conditions. An unemployed person is defined by Eurostat, according to the guidelines of the International Labour Organization, as someone aged 15 to 74 without work during the reference week who is available to start work within the next two weeks and who has actively sought employment at some time during the last four weeks. The unemployment rate is the number of people unemployed as a percentage of the labour force (Eurostat, 2014). We expect that a higher unemployment level would indicate higher risks of defaults in the collateral pool and thus higher spread levels.

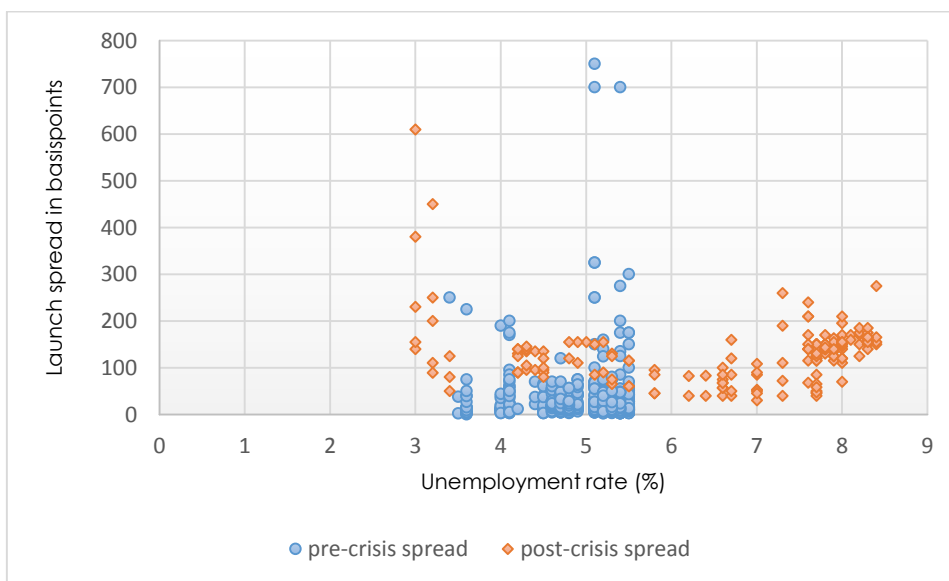


FIGURE 24: UNEMPLOYMENT PLOTTED AGAINST THE SPREAD.

Another macro-environmental indicator is a country's gross domestic product (GDP) growth. An analysis of GDP growth per capita removes the influence of the absolute size of the population, making different countries comparable. GDP per capita is a broad economic indicator of living standards and performance of an economy (Eurostat, 2014). The graph below shows that most deals are launched in periods of time with GDP growth. However, it does not show a clear effect of GDP growth on spreads.

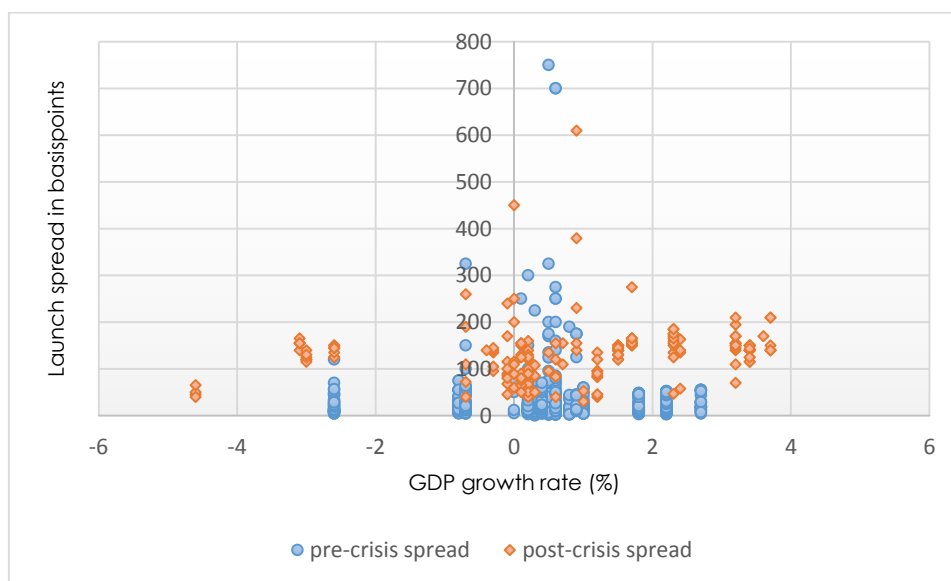


FIGURE 25: GDP GROWTH PLOTTED AGAINST THE SPREAD.

A relevant macro-economic indicator could be the house price index. This index gives the average house price in a country. The House Price Index (HPI) describes the price developments of all residential properties purchased by households (flats, detached houses, terraced houses, etc.). It includes both newly built and existing houses, independently of their final use and independently of their previous owners (Eurostat, 2014). The graph shows an increasing trend for the post-crisis data. This indicates that house prices would have a positive effect on spread levels. We expect that if the house price index is higher than RMBS spread will also be higher.

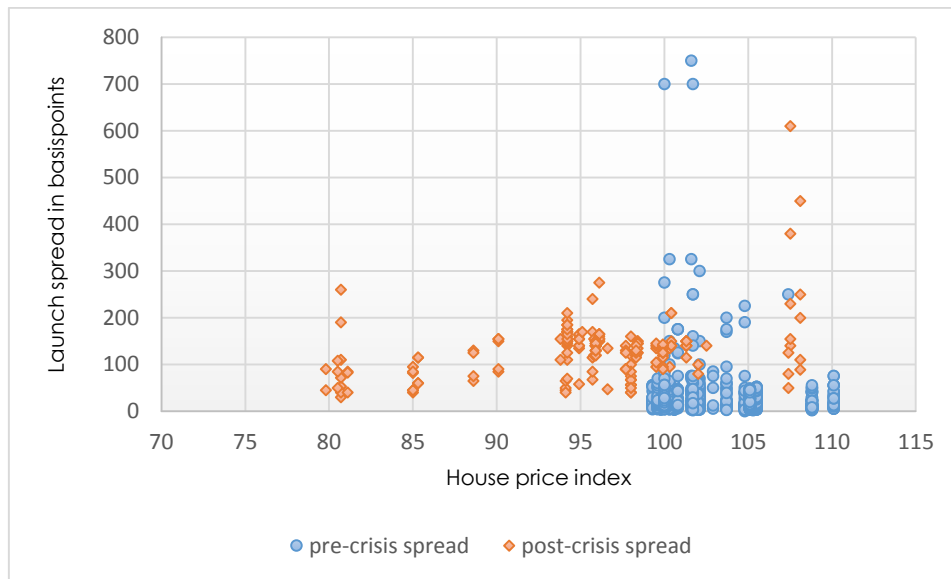


FIGURE 26: HOUSE PRICE INDEX PLOTTED AGAINST THE SPREAD.

Finally, this paper will test whether the economic sentiment variable has influence on the RMBS spreads. This indicator consists of six qualitative surveys which are conducted on a monthly basis in the following areas: manufacturing industry, construction, consumers, retail trade, services and financial services. This is one of the best and timely indicators for the business cycle. We expect that a higher economic confidence would lead to lower spread levels.

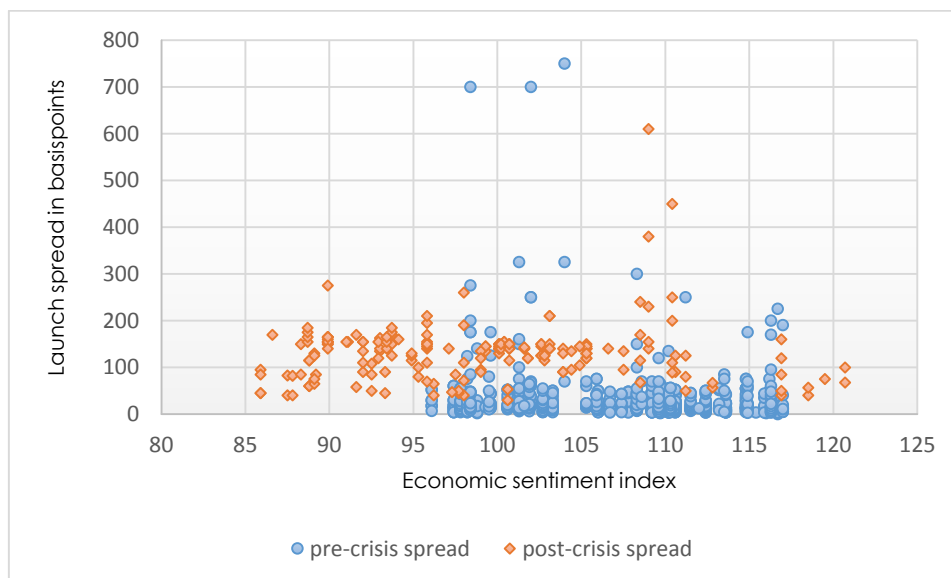


FIGURE 27: ECONOMIC SENTIMENT PLOTTED AGAINST THE SPREAD.

5.3.7 Regulation variables

As mentioned in the literature review, regulation is expected to play an important role in pricing RMBS transactions. However, due to the ongoing uncertainty in this field it is hard to test the direct effect in a quantitative manner. We have identified two different measures. Both will focus on the LCR regulation. Regulatory proposals made in December 2012 included a constraint of 80% loan-to-value levels on the underlying mortgage pool for RMBS transactions. That cap therefore excludes most Dutch RMBS deals, one of the best performing European asset classes even though its loan-to-values typically exceed 80%. New proposals were released in December 2013. Interestingly these proposals did not mention a loan-to-value cap of 80% on RMBS, thus potentially reintroducing the inclusion of most Dutch RMBS. Therefore, it could be expected that transactions with a loan-to-value exceeding 80% issued between this period would trade at a higher margin due to uncertainty of regulatory inclusion. A dummy variable will be assigned to test whether this had effect on issues between December 2012 and December 2013 with a Loan-to-value level above 80% (1) and zero otherwise.

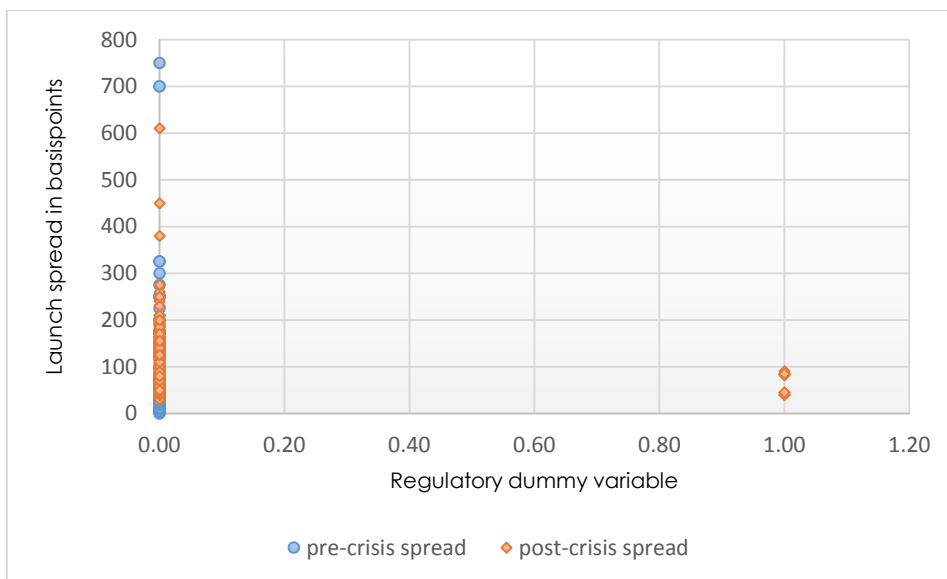


FIGURE 28: REGULATION (LTV > 80%) PLOTTED AGAINST THE SPREAD.

Because it is hard to measure the impact of regulation exactly we will introduce a second measure. This variable is calculated by taking the difference, in basis points, between the secondary market discount margins for covered bonds and RMBS. As mentioned before, secondary market data is not always available or reliable. Therefore we have calculated the difference between the Dutch covered bond index and the Dutch RMBS index as we believe

these indices are the most reliable regarding secondary market prices. We have also corrected for the different reference rates by calculating all the reference rates back to 3-month Euribor reference using the basis-swap. Covered bonds are selected because of the similarities with RMBS transactions. Covered bonds are also a type of secured funding and in theory it should not matter much if a financial institution funds itself via either covered bonds or RMBS, if the respective cover pools are exactly identical (van Leeuwen, 2014). In reality, covered bonds trade at lower spreads mainly due to regulatory differences. Both indices make the same movements regarding uncertainty in the market. However, changes in regulation for RMBS, while not changing covered bond regulation, could show a change of the secondary market index difference. Figure 29 shows the difference between the, secondary market, covered bond index and RMBS index. Six different areas have been highlighted. First, The pre-crisis is a period in which spread differences between covered bonds and RMBS are relatively small and little volatility is present (Blue in Figure 29). Second, the red part in Figure 29 indicates the crisis period, where we can identify that the secondary RMBS market was harder hit than covered bond markets. Third, the orange area in the Figure indicates the introduction of the BIS III LCR regulation. In this first version covered bonds do qualify as high quality liquid assets but RMBS does not. The yellow area in Figure 29 indicates the second version of the BIS III liquidity coverage ratio in which RMBS also qualify as HQLA but under strict requirements. Finally, the green area shows proposals made after a consultation paper for the BIS III LCR regulation. Under these proposals RMBS regulation improved further. We believe that the secondary market comparison between covered bonds and RMBS has the expected outcome. The graph shows that the difference between the two markets is larger in periods of stricter RMBS regulation and smaller in the more favourable RMBS regulation periods.

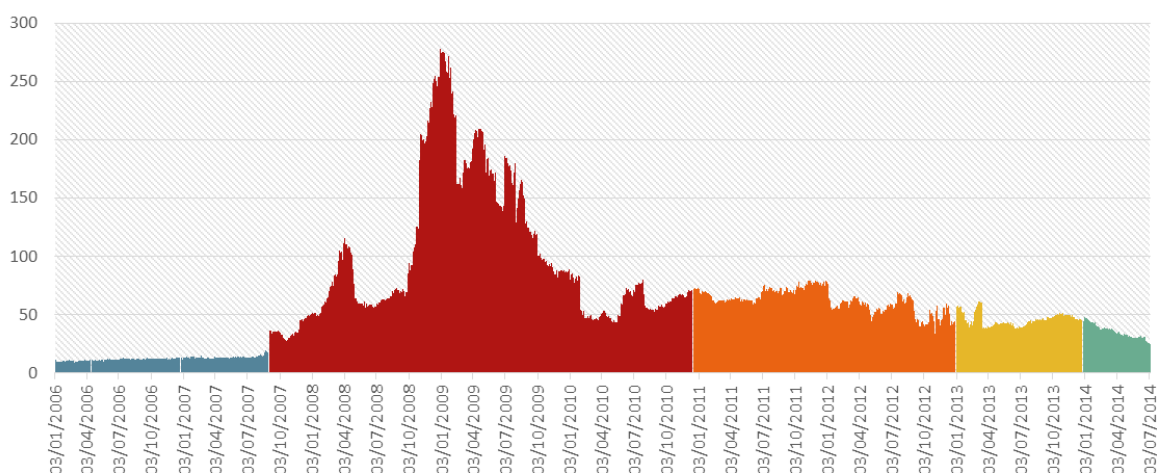


FIGURE 29: DIFFERENCE COVERED BONDS/ RMBS SPREADS SECONDARY MARKET.

We expect that a higher difference would lead to higher spreads for new RMBS issues. Figure 30 supports this expectation as the post-crisis sample shows an upward trend.

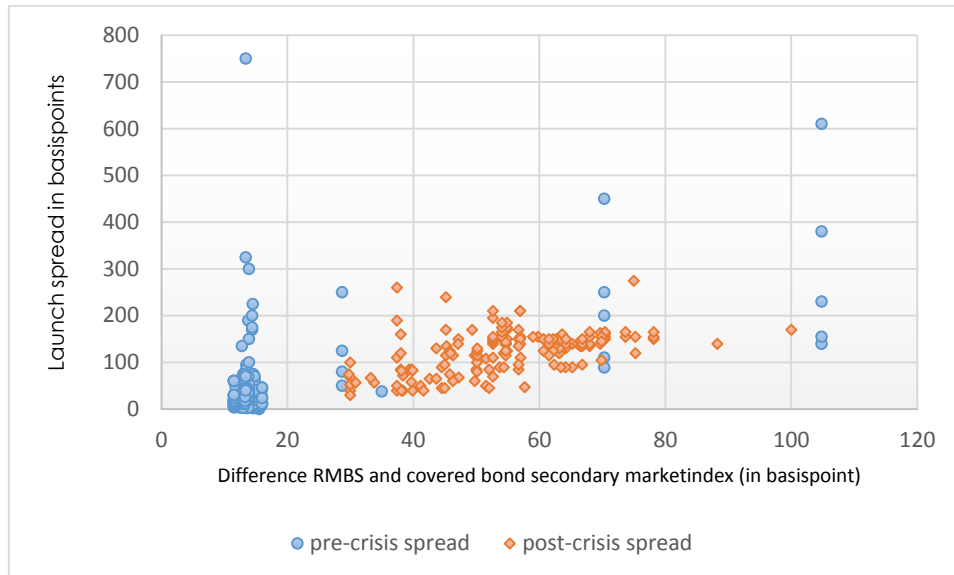


FIGURE 30: DIFFERENCE COVERED BONDS VS RMBS, PLOTTED AGAINST THE SPREAD.

6 Results

This chapter will describe the results of the data analysis. The first part will focus on the difference in reliance on credit ratings before and after the crisis. After which the analysis will focus on other variables influencing the post-crisis sample.

6.1 The credit rating

To analyse the effect of credit ratings on spreads we have regressed the rating dummies against the RMBS spread levels. Here, the ‘AAA’ rating dummy is omitted to prevent the formation of a singular matrix. The regression output show a remarkable result. All of the rating dummies, except for the BBB rating dummy, are significant at the 95% confidence level. Also, the R^2 for this regression is 41.1% indicating that credit ratings are important determinants of the spread levels. However, the regression results show that ‘AA’ and ‘A’ variables have a negative coefficient, indicating that the spread levels of these lower rated tranches would be lower than ‘AAA’ rated deals (everything else being equal). This does not make sense but the regression’s residual graph below might explain this phenomenon.

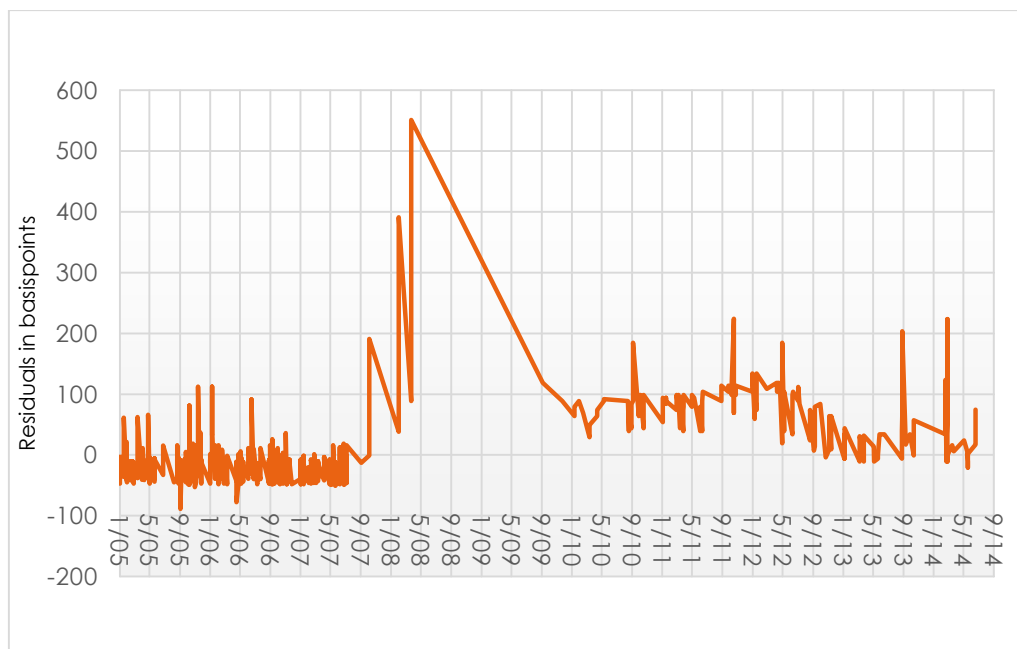


FIGURE 31: RESIDUAL GRAPH OF CREDIT RATING REGRESSION SHOWING A PEAK BEFORE THE FINANCIAL CRISIS OF 2008 BUT ALSO INDICATES THAT THE RATING DUMMIES ARE DIFFERENT FOR THE PRE-CRISIS AND POST-CRISIS SAMPLE.

The graph shows the launch date of the observations on the horizontal axis while residual levels are displayed at the vertical axis. Figure 31 would suggest a break around observations in 2008. Most observation before this point show overestimation (actual spread is lower than

the fitted spread) and observations after this point show underestimation (actual spread is higher than the fitted spread). The observations are sorted by date, the last observation is the latest RMBS deal (Paragon Mortgages 20, 7-Jul-2014) while the first observation is the oldest deal in our dataset (Granite 2005-1, 19-Jan-2005). The observations around the peak correspond with the start of the credit crisis in the US (end 2007). Before the crisis RMBS tranches were generally more diverse, especially rating wise, but spread levels were very low in general. This completely changed after the crisis, most deals originated after 2008 are ‘AAA’ rated but also have spread levels far above the pre-crisis levels. An overview is displayed in Table 1.

TABLE 1: ISSUES AND AVERAGE SPREADS PER YEAR SPLIT OVER CREDIT RATING DUMMIES.

Issues/ years	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
AAA	73	108	99	4	2	33	54	41	21	14
Average spread	10.8	8.7	8.6	123.5	155.0	128.3	141.3	131.3	68.9	60.3
AA	53	76	47	2	-	2	-	2	1	3
Average spread	18.6	15.5	16.0	215.0	-	210.0	-	202.5	170.0	136.7
A	37	69	40	2	-	-	-	-	1	2
Average spread	31.1	27.7	29.2	315.0	-	-	-	-	240.0	210.0
BBB	50	70	45	2	-	-	-	-	-	-
Average spread	60.1	51.1	48.8	530.0	-	-	-	-	-	-
BB	10	6	2	-	-	-	-	-	-	-
Average spread	210.9	217.5	207.5	-	-	-	-	-	-	-
B	2	1	-	-	-	-	-	-	-	-
Average spread	700.0	750.0	-	-	-	-	-	-	-	-
Total issues	225	330	233	10	2	35	54	43	23	19

A breakpoint test is conducted to formally test the impact of the crisis. The Quandt-Andrews breakpoints test is applied under the null hypothesis (H0: no breakpoints exist) within a trimming region of 15%. The test statistics which are based on the maximum statistics, expected statistic and the average statistic (Andrews and Ploberger, 1994) are shown in Table 2. All statistical measures indicate that the null hypothesis cannot be accepted. So the null hypothesis of no structural breaks within the period considered is rejected and the alternative hypothesis (H1) that a break exists is accepted. The test also shows that the strongest break is found at observation 191, which corresponds with the E-MAC Program II 2007-4 transaction

on the 23th of October 2007. Not coincidentally, the transaction's seller is GMAC, whose credit defaults swap spreads already showed an upward trend at the time of launch. Eventually, GMAC was bailed out by the US Government a few months later.

TABLE 2: OUTPUT BREAKPOINT TEST

Quandt-Andrews unknown breakpoint test
Null Hypothesis: No breakpoints within 15% trimmed data
Equation Sample: 1 974
Test Sample: 148 828
Number of breaks compared: 681

Statistic	Value	Prob.
Maximum LR F-statistic (Obs. 191)	474.7259	0.0000
Exp LR F-statistic	230.9771	0.0000
Ave LR F-statistic	100.0253	0.0000

Note: probabilities calculated using Hansen's (1997) method

Further investigation of the credit ratings' effect towards the launch spreads shows more interesting information. After splitting the total population into two samples (pre and post-crisis) the rating dummies are again regressed against the launch spreads. The results show that, in the pre-crisis sample, the rating dummies (corrected for weighted average lifetime) heavily influence the dependent variable ($R^2 = 0.937$). This confirms the results found in existing literature researching the effects of credit ratings on spreads. However, the same regression on a post-crisis sample results in a much lower R^2 of 0.497.

TABLE 3: OVERVIEW RATING REGRESSION PRE/POST CRISIS.

Pre-crisis					Post-crisis				
R^2 : 0.93					R^2 : 0.47				
variable	Coef.	Std. error	t-stats	p value	Coef.	Std. error	t-stats	p-value	
C	2.02	0.81	2.50	0.013	100.06	10.73	9.33	0.000	
AA	6.76	0.43	15.74	0.000	49.74	15.12	3.29	0.001	
A	17.99	0.81	22.22	0.000	111.03	33.63	3.30	0.001	
BBB	42.56	1.60	26.64	0.000	308.99	87.18	3.54	0.001	
BB	201.42	13.98	14.41	0.000	-	-	-	-	
B	703.03	13.36	52.60	0.000	-	-	-	-	
WAL	1.70	0.21	8.20	0.000	5.66	2.87	1.97	0.049	

It can be concluded that investors of RMBS do not solely rely on credit ratings in our post-crisis sample and therefore we will investigate other variables influencing the spread of RMBS transactions in the primary market.

The rest of this chapter will focus on testing variables on the post-crisis sample. As credit ratings (adjusted for weighted average life) already explains 93.7% of spread levels in the pre-crisis sample and because of the limited range of different credit ratings assigned to post-crisis deals, it would be interesting to research other variables influencing the spread of post-crisis RMBS transactions further.

Figure 32 shows the launch spread levels over time after the tested breakpoint. The fourteen dots on the left hand side of the figure show the E-Mac transactions which were mentioned earlier. We believe that these transactions are not representative for the post-crisis sample as they are launched in the prelude of the financial crisis. The graph clearly shows a period, between April 2008 and September 2009, in which no new RMBS deals were issued. Regressions with these E-Mac observations included showed distorted residuals. Therefore, we have decided to remove these observations from our analysis.

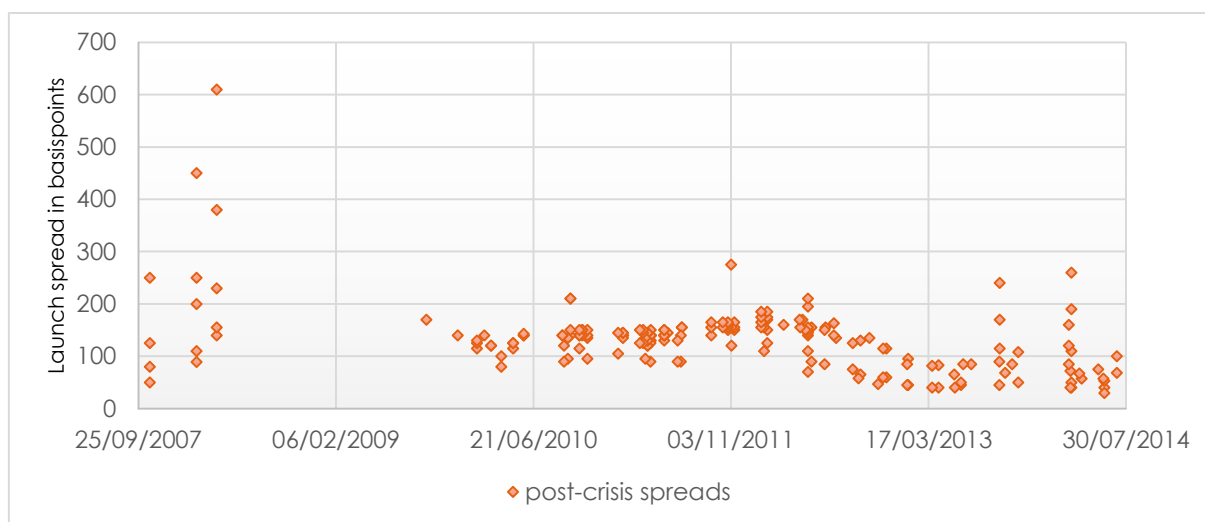


FIGURE 32: SPREADS OF TRANCHES LAUNCHED AFTER THE BREAKPOINT (OCTOBER 2007), THE GRAPH DISPLAYS THE OMITTED OBSERVATIONS WHICH ARE IN THE MIDDLE OF THE FINANCIAL CRISIS.

6.2 Single variable regression results

The following paragraphs will display the results from the single variable regression. The chapter will then elaborate the results from the multivariate regression and a reduced form model is developed.

6.2.1 Structure related variables

The size of a tranche and the buy-to-let dummy are not significant. This indicates that the size of a tranche or whether a structure is buy-to-let or prime does not significantly differ in our tested sample. The third variable, weighted average life, is significant at a 99% confidence level and has an R^2 of 11.3%. This indicates that longer-dated issues are indeed demand a higher risk premium to issue compared to short-dated issues. The fourth variable, credit enhancement, is significant and has an explanatory value of 6.7%. The credit enhancement variable also has a positive sign, indicating that a higher credit enhancement causes a higher launch spread. Finally, the master issue variable also significantly influences the launch spreads. However, the variable has an unexpected positive effect on spread levels. This indicates that master issues would require higher spreads.

6.2.2 Collateral related variables

Three out of the four tested collateral variables show significant results. The NHG ratio is highly significant and has the highest explanatory value ($R^2=12.6\%$) with an expected negative sign. This means that transactions with a high portion of NHG protected loans, which are perceived as safer loans, lead to lower launch spreads. The current-loan-to-value ratio variable is also significant but with a negative sign. It was expected that a collateral pool with a high loan-to-value ratio would trade at a higher spread because these loans are more prone to losses. The seasoning variable is nowhere near significant. Finally, the interest-only ratio is significant within the 99% confidence interval. The negative coefficient indicates that tranches with collateral pools holding a higher portion of interest-only loans would trade at a lower spread. This is an unexpected result as well.

6.2.3 Macro-economic variables

Testing the macro-economic variables indicates that only the economic sentiment variable is insignificant. GDP growth levels are significant in the post-crisis sample (with a 99% confidence) but the coefficient has an unexpected positive sign. According to the results, a higher GDP growth would increase the spread. The house price index also shows positive significant effect (with a 99% confidence) which states that a higher house price index would

lead to higher post-crisis spread levels. The unemployment variable is significant and has the expected positive coefficient. A higher unemployment rate would lead to higher spreads.

6.2.4 Currency variables

Two important currency features that are tested as potential currency risks are multi-currency issuance and currency mismatch. The single variable regression results shows that the effects of currency variables on the post-crisis sample are both significant. The multi-currency issue variable is significant and indicates that transactions with multiple different currencies notes trade at a higher spread than single-currency issues. However, this feature is predominantly applied in UK master trust issues which could mean that other variables heavily influence the effect. Second, the currency mismatch variable is also significant ($p\text{-value} < 1\%$). This indicates that a currency mismatch does lead to higher spread levels.

6.2.5 Market conditions variables

Most market condition variable are significant in our single-variable regression analysis. The VIX index represents a measure of the expected stock market volatility over the coming month. The regression results show that the VIX is highly significant with, as expected, a positive coefficient sign. This would indicate that a higher VIX value (thus a higher expected volatility) results in a higher spread. The R^2 for the VIX variable is 21.4%.

Another product closely related to market conditions are credit default swaps. The results indicate that the credit default swap volatility could be good estimator of the spread. The credit default swap index volatility has a positive effect on launch spreads. This indicates that if the variables are higher (more volatile) that the launch spreads are also higher. This is expected because more volatility in the credit default swaps index indicate riskier market conditions.

Estimators based on secondary market conditions are also significant indicators. The secondary RMBS market index is significant with a positive coefficient and an R^2 of 27.8%. This implies that a higher value (higher risk compensation) in secondary market index for RMBS results in higher primary spreads.

The only insignificant variable is our liquidity estimator. The estimator created by examining the volumes outstanding for certain ‘families’ does not hold explanatory power towards the dependent variable. This could be explained by the relative small sample size. We have tried different configuration of combining characteristics, however, we could not come up with a liquidity estimator based on outstanding RMBS amounts.

6.2.6 Regulation impact

We believe that regulation has a big impact as well. The two variables that we have tested on their impact on the spread are the difference between the secondary market discount margins for covered bonds and RMBS and our regulation (loan-to-value>80%) dummy.

The difference between the secondary RMBS and covered bond market variable is highly significant in the single-variable regression and has an R^2 of 26.7%. This indicates that if the secondary market spread difference between covered bonds and RMBS is getting larger then primary spread will also be higher. This difference could capture the relative attractiveness of RMBS and could, for example, indicate favourable or less favourable regulatory changes made to RMBS.

Our regulation dummy is also significant but with a negative coefficient sign. This would indicate that RMBS notes backed by a collateral pool with a loan-to-value ratio greater than 80% would issue at lower spreads. It could be the case that the whole market tightened during this period and that the regulation dummy incorrectly captures other effects, lowering the spreads.

Single variable regression results

Variable	General statistics					Regression results				
	Mean	Median	Max	Min	Std Dev	Coeff.	Std Error	t-stat	P-value	R ²
<i>Market characteristics</i>										
- Recent deals	1174.86	845.57	7316.94	0.00	1202.10	0.00	0.00	1.23	0.22	0.004
- Volatility index ***	18.95	17.48	34.60	11.33	5.15	3.94	0.55	7.12	0.00	0.214
- Secondary market spread ***	135.18	136.95	317.40	28.80	60.74	0.38	0.06	6.57	0.00	0.277
- CDS index volatility ***	11.26	9.86	31.93	2.41	6.92	1.68	0.46	3.61	0.00	0.070
<i>Collateral ratio's</i>										
- Loan-to-value ratio ***	0.70	0.66	0.95	0.51	0.10	-129.49	34.30	-3.77	0.00	0.084
- Governmental guarantees (NHG) ***	0.07	0.00	1.00	0.00	0.20	-79.19	11.94	-6.63	0.00	0.126
- Seasoning	48.95	51.30	112.00	3.00	23.88	-0.02	0.18	-0.10	0.92	0.000
- Interest-only loan ratio ***	0.48	0.44	1.00	0.00	0.19	-55.12	16.92	-3.26	0.00	0.054
<i>Currency variables</i>										
- Currency mismatch ***	0.35	0.00	1.00	0.00	0.48	23.68	5.76	4.11	0.00	0.066
- Multi currency ***	0.49	0.00	1.00	0.00	0.50	31.71	6.16	5.15	0.00	0.131
<i>Marco-economic variables</i>										
- Unemployment levels ***	7.00	7.70	8.40	4.20	1.31	11.78	2.01	5.86	0.00	0.123
- GDP growth levels ***	0.81	1.10	3.70	-4.60	2.00	6.16	1.47	4.20	0.00	0.078
- House price index ***	94.65	95.90	102.50	79.80	5.75	2.37	0.65	3.66	0.00	0.096
- Economic sentiment	98.46	98.00	120.70	85.90	7.92	-0.61	0.46	-1.33	0.18	0.012
<i>Regulation variables</i>										
- Change in LCR requirements ***	0.05	0.00	1.00	0.00	0.22	-61.53	7.86	-7.83	0.00	0.096
- Difference secondary markets CB/RMBS. ***	55.30	54.86	100.00	29.74	12.18	1.86	0.25	7.42	0.00	0.267
<i>Structure variables</i>										
- WAL ***	3.48	3.09	5.64	0.99	1.20	12.32	2.44	5.04	0.00	0.113
- Credit enhancement ***	0.13	0.14	0.31	0.05	0.05	228.80	80.15	2.85	0.00	0.067
- Size	491.34	415.74	2105.26	11.79	369.23	0.00	0.01	0.51	0.61	0.001
- Type (Prime/Buy-To-Let)	0.06	0.00	1.00	0.00	0.23	23.65	20.36	1.16	0.25	0.098
- Master issue ***	0.42	0.00	1.00	0.00	0.49	21.18	6.22	3.40	0.00	0.057

6.3 Multivariate analysis

This chapter will continue with a multivariate regression analysis. This model is acquired by combining all the different variables tested in the previous paragraphs.

The multivariate analysis shows interesting results. First, the credit rating dummies are significant with 99% confidence. Second, among the structure variables: the weighted average life, the credit enhancement and the buy-to-let dummy are significant (at 95% confidence). Third, we also identify that the collateral based variables: current loan-to-value, government guarantee and interest-only ratio are significant (at 95% confidence). Forth, of our Macro-economic variables only the GDP growth variable is significant (at 95% confidence). Fifth, the significant (at 95% confidence) market conditions are the CDS volatility and the secondary market price levels. Finally, the difference between covered bonds and RMBS variable is significant (at 95%) confidence as regulation variables. The R^2 for this regression is 0.836 and the adjusted R^2 is 0.814.

Looking at the residual graph we identify that the residuals are evenly distributed and no sustained periods of overestimation or underestimation are present.

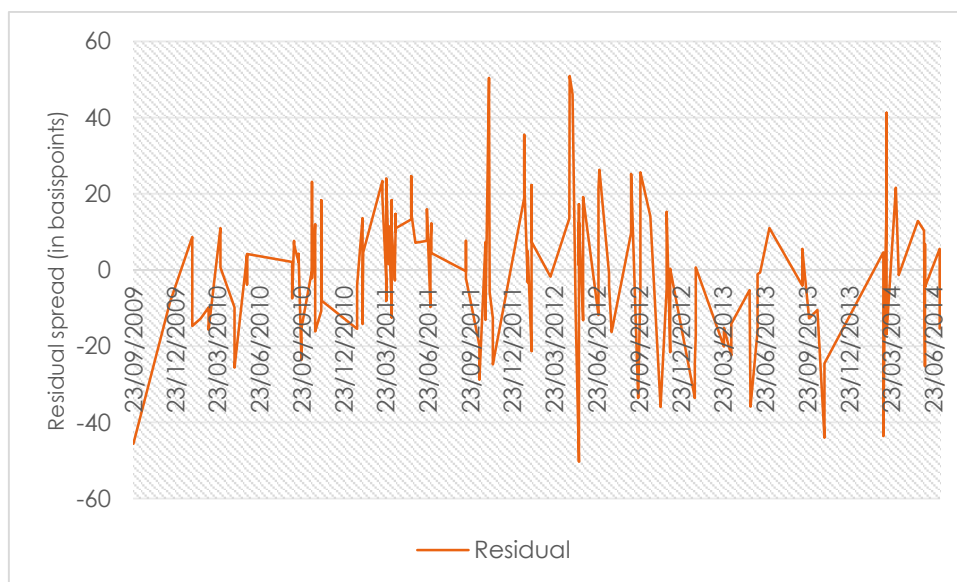


FIGURE 33: RESIDUAL GRAPH MULTIVARIATE ANALYSIS, SHOWING THAT THE RESIDUALS ARE EVENLY DISTRIBUTED.

Also, a Jarque-Bera test is applied to test whether the series is normally distributed. The test statistic measures the difference of the skewness and kurtosis of the series with those from the normal distribution. The reported probability is the probability that a Jarque-Bera statistic

exceeds (in absolute value) the observed value under the null—a small probability value leads to the rejection of the null hypothesis of a normal distribution. In our case the Jarque-Bera test indicates that we cannot reject the null hypothesis and thus accept that the residuals are normally distributed.

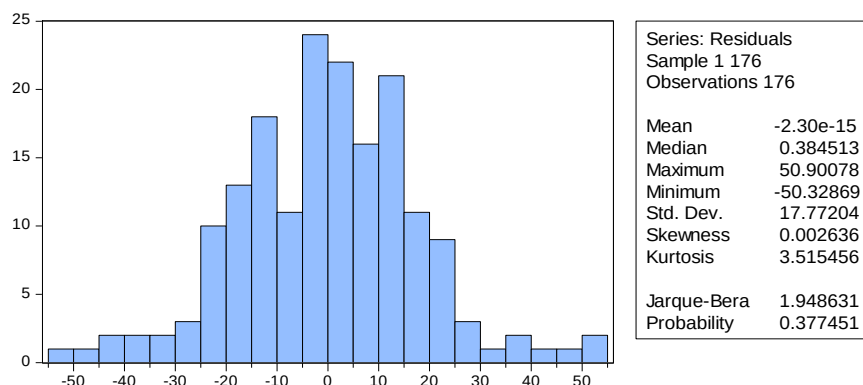


FIGURE 34: THE JARQUE-BERA TEST FOR NORMALITY INDICATES THAT THE RESIDUALS ARE NORMALLY DISTRIBUTED.

To validate our model an in sample back-test has been performed. To back-test the multivariate regression results we have fitted the model over the sample from the 1st of September 2009 until the 19th of September 2013 (150 observations). With this model we have estimated the spread levels of the transactions between the 13th of September and the 7th of July 2014 (26 observations). This range is selected because this is the only configuration including all the dummy variables in both the model estimation period and the model testing period. Figure 35 shows the fitted model sample and displays the difference with the actual spread levels. In this sample we identify some over and underestimation but the model behaves appropriately. The R^2 over the fitted sample is 0.829 with an adjusted R^2 of 0.801 which are in line with the regression results from the multivariate analysis.

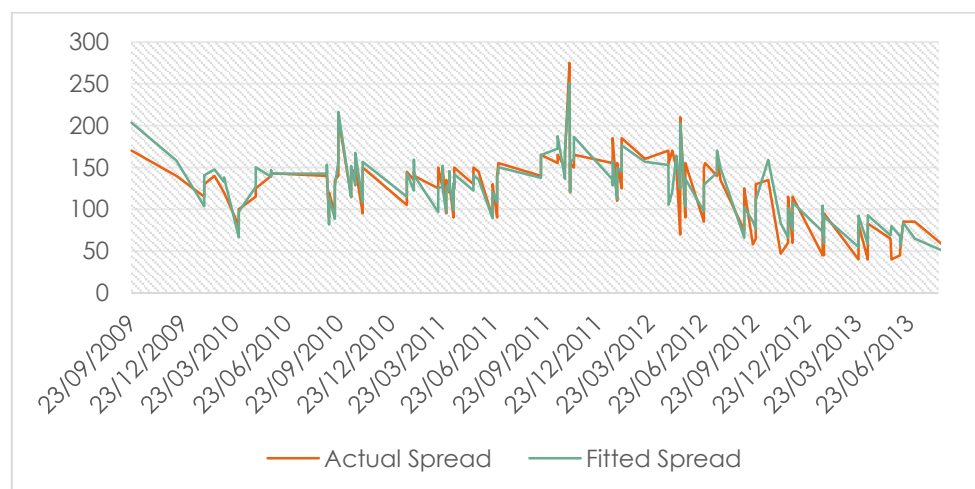


FIGURE 35: RESULTS OF THE REGRESSION OVER THE FITTING PERIOD, THE GRAPH SHOWS THAT THE FITTED RESULTS ARE CLOSE TO THE ACTUAL SPREADS.

Figure 36 shows the back-testing results. The spreads are estimated by the fitted model, developed in the fitting period, against the actual spreads. Here we can also identify over and underestimation but no unexpected results. The R^2 of our back-test is 0.667 which is lower than the multivariate analysis results or the fitted period. However, we believe that the model performs as expected.

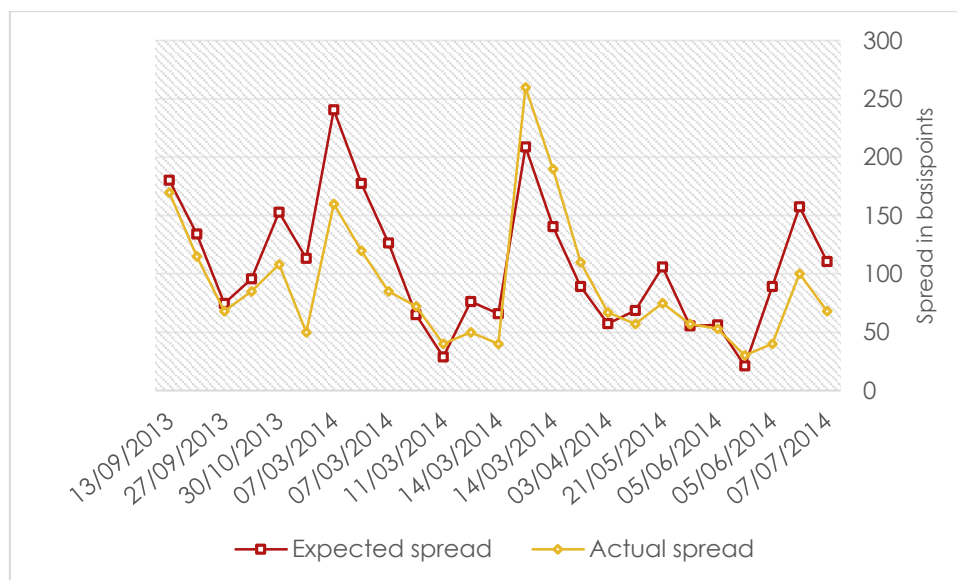


FIGURE 36: RESULTS OF THE BACK-TEST . HERE THE FITTED MODEL IS APPLIED TO AN UNFITTED PART OF SAMPLE AND COMPARED AGAINST THE ACTUAL SPREADS. WE IDENTIFY THAT THE MODEL COMES CLOSE TO THE ACTUAL SPREADS AND THAT THE RESIDUALS ARE EVENLY DISTRIBUTED.

6.4 Final model in reduced form

Our multivariate analysis consists of 23 different variables. It would be interesting to see if a reduced form model could perform just as well as the full model. We have used Eviews to perform automatic variable selection using a stepwise regression. This regression allows some of the variables in a standard linear multivariate regression to be chosen automatically, using various statistical criteria, from a set of total variables. Four different option are tested: uni-directional, stepwise, swapwise and combinatorial selection. (Griffiths, Hill & Lim, 2008)

The uni-directional method can be applied in two directions, either forward or backwards. This method will add (forwards) or delete (backwards) variables until the stopping criteria (a set p -value) is reached. We have chosen the stop criteria for the p -values of 10% where applicable.

The stepwise (forwards) method is a combination of the uni-directional forwards and backwards method. The stepwise method begins with adding the variable with the lowest p-value. The variable with the next lowest p-value given that the first variable has already been chosen, is then added. Next both of the added variables are checked against the backwards p-value criterion. Any variable whose p-value is higher than the criterion is removed. The stepwise-Forwards routine ends when the lowest p-value of the variables not yet included is greater than the specified forwards stopping criteria. The stepwise backwards procedure reverses the stepwise forwards method.

The swap-wise method starts by adding the variable which achieves the highest R^2 individually. The variable that leads to the largest increase of the R^2 is added next. After this process the two variables that have been included in the model are compared individually with all other variables. Changes are made if other variables result R-squared could be improved by swapping the variables. If there exists more than one swap that would improve the R-squared, the swap that yields the largest increase is made. Once a swap has been made the comparison process starts again. Once all comparisons and possible swaps are made, a third variable is added and the process continuous swapping for the variables resulting in the highest R^2 . This process continues until the number of variables added to the model reaches the user-specified limit. The min R^2 swapwise method is very similar to the max R^2 swapwise method. In the case that the number of variables has to be chosen we have tested different settings (8, 9, 10, 11 variables) and we have selected the regressions with the highest adjusted R^2 .

The combinatorial method evaluates every possible combination of added variables, and selects the combination that leads to the largest R^2 . This method is more thorough than the previous methods, since the combinatorial methods compares more possible configurations of the variables but also requires additional computation.

The results from the different methods selecting the reduced form model are shown in Table 4. From the different model selection methods we can conclude that the R^2 of all reduced regressions models are close to the R^2 of the full regression model. Also, three different methods result in the same variable selection. The rating dummies, the regulation variable, the secondary market, credit enhancement, weighted average lifetime, CDS volatility, buy-to-let variable and GDP growth are significant at 99%. The master issue dummy is significant at

95% and the economic sentiment variable and currency mismatch dummy are significant at 90%. The reduced form model takes the form (in order of significance) of:

Primary spread = $-29.92 + 63.02 * AA \text{ rated dummy} + 146.33 * A \text{ rated dummy} + 1.52 * \text{Difference CB/RMBS (in basis points)} + 0.20 * \text{Secondary market index (in basis points)} + 2.55 * \text{Credit enhancement (\%)} + 10.20 * \text{Weighted lifetime (in years)} + 1.25 * \text{CDS volatility (index)} + 31.63 * \text{Buy-to-let dummy} + 2.33 * \text{GDP growth (\%)} - 0.46 * \text{Economic sentiment (index)} - 9.69 * \text{Master trust dummy}$.

The reduced form model has an R^2 0.821 (adjusted R^2 of 0.809) compared to an R^2 of 0.836 (adjusted R^2 of 0.814) in the multivariate analysis. The reduced form model is tested according to the same procedures as applied in the multivariate analysis to check for heteroskedasticity and normally distributed residuals. The reduced form model is also back-tested as described for the multivariate analysis, resulting in an R^2 of 0.661. The results are very similar to the results shown in the multivariate analysis. Therefore we believe that the reduced form model behaves appropriately.

TABLE 4: RESULTS FROM THE REDUCED FORM REGRESSION MODELS.

	Stepwise forwards	Stepwise backwards	Swapwise - Max R-squared	Combinatorial Method
<i>C</i>	-29.91878 (24.06285)	-69.7947 (36.27534)	-29.91878 (24.06285)	-29.91878 (24.06285)
<i>AA rated</i>	63.01823 *** (9.774786)	62.01684 *** (7.599142)	63.01823 *** (9.774786)	63.01823 *** (9.774786)
<i>A rated</i>	146.3235 *** (25.11004)	142.1753 *** (12.40913)	146.3235 *** (25.11004)	146.3235 *** (25.11004)
<i>Difference CB/RMBS</i>	1.518182 *** (0.164902)	1.524105 *** (0.151266)	1.518182 *** (0.164902)	1.518182 *** (0.164902)
<i>Secondary index</i>	0.2021 *** (0.028647)	0.209836 *** (0.032905)	0.2021 *** (0.028647)	0.2021 *** (0.028647)
<i>Credit enhancement</i>	255.7287 *** (35.1339)	271.2845 *** (41.84325)	255.7287 *** (35.1339)	255.7287 *** (35.1339)
<i>Weighted lifetime</i>	10.20061 *** (1.14504)	9.157065 *** (1.280319)	10.20061 *** (1.14504)	10.20061 *** (1.14504)
<i>CDS volatility</i>	1.251032 *** (0.243847)	1.260768 *** (0.244942)	1.251032 *** (0.243847)	1.251032 *** (0.243847)
<i>Buy-to-let_</i>	31.63269 *** (11.90971)	33.61998 *** (7.650545)	31.63269 *** (11.90971)	31.63269 *** (11.90971)
<i>GDP growth</i>	2.329089 *** (0.705393)	2.506506 ** (0.761647)	2.329089 *** (0.705393)	2.329089 *** (0.705393)
<i>Current loan-to-value</i>	-	69.51041 ** (25.18551)	-	-
<i>Economic sentiment</i>	-0.456901 ** (0.236876)	-0.447277 * (0.229751)	-0.456901 ** (0.236876)	-0.456901 ** (0.236876)
<i>Interest-only ratio</i>	-	-17.9402 * (9.247243)	-	-
<i>Governmental Guarantee</i>	-	-23.49629 ** (10.31424)	-	-
<i>Master issue</i>	-9.685549 *** (3.503216)	-	-9.685549 *** (3.503216)	-9.685549 *** (3.503216)
<i>R-squared</i>	0.820824	0.83069	0.820824	0.820824
<i>Adjusted R-squared</i>	0.808807	0.815967	0.808807	0.808807
<i>S.E. of regression</i>	19.18459	18.82191	19.18459	19.18459
<i>Sum squared resid</i>	60359.95	57036.53	60359.95	60359.95
<i>Log likelihood</i>	-763.442	-758.458	-763.442	-763.442
<i>F-statistic</i>	68.3003	56.42268	68.3003	68.3003
<i>Prob(F-statistic)</i>	0	0	0	0

Regression results for different variable selection methods. Notes: Omitted category is the triple A rating dummy and other rating dummies are always included. ***, ** and * stand for significance at 1%, 5%, and 10%, respectively. The sign "—" denotes not included. coefficient and standard error in parentheses.

Issues with Stepwise Estimation

The set of search variables may contain variables that are linear combinations of other variables in the regression. EViews will drop those variables from the search set. In a case where two or more of the search variables are collinear, EViews will select the variable listed first in the list of search variables. Following the Stepwise selection process, EViews reports the results of the final regression, i.e. the regression of the always-included and the selected variables on the dependent variable. The p-values listed in the final regression output and all subsequent testing procedures do not account for the regressions that were run during the selection process. One should take care to interpret results accordingly. Invalid inference is but one of the reasons that stepwise regression and other variable selection methods have a large number of critics amongst statisticians. Other problems include an upwardly biased final R-squared, possibly upwardly biased coefficient estimates, and narrow confidence intervals. It is also often pointed out that the selection methods themselves use statistics that do not account for the selection process. There is a fairly large literature describing the benefits and the pitfalls of stepwise regression. For more information on the methods applied and the pitfalls of these methods we refer to the Eviews user manual. (Schwert, 2010).

7 Conclusion

This chapter discusses the conclusions that arise from the conducted research. Here each paragraph will answer the research questions stated in chapter one.

We will start this chapter with our conclusions towards the first research question: “*How has reliance on credit ratings, for investors of Dutch and UK RMBS, changed after the credit crisis?*”

We can answer this question by stating that there has been a big shift of reliance on credit ratings for investors when pricing Dutch and UK RMBS transactions post-crisis compared to the pre-crisis period. In Chapter 6 we have shown that the credit rating single variable regression resulted in an R^2 of 0.497 for the post-crisis sample, compared to an R^2 of 0.937 for the pre-crisis sample. Omitting the credit rating dummies from our post-crisis multivariate regression lowers the R^2 to 0.684 (Adjusted R^2 of 0.645) from 0.836 (Adjusted R^2 of 0.814). These results are supported by the fact that spreads are higher and more volatile in the post-crisis period, even conditional on rating (see Table 4 & Figure 37). However, the credit rating dummies (AA & A) are still significant (at 99% confidence) in the multivariate analysis, thus the effect of credit ratings is still present in the post-crisis sample but to a much lesser extent than in the pre-crisis sample.



FIGURE 37: SPREAD LEVELS CONDITIONAL ON CREDIT RATING DUMMIES, INDICATING THAT MOST POST-CRISIS OBSERVATIONS ARE AAA RATED TRANCHES AND THAT THE POST-CRISIS SAMPLE SPREADS ARE MUCH HIGHER THAN THE PRE-CRISIS SAMPLE SPREADS.

TABLE 5: SPREAD CHARACTERISTICS PER CREDIT RATING DUMMY

Rating	Mean		Median		Max		Min		Std dev	
period	pre-crisis	post-crisis	pre-crisis	post-crisis	pre-crisis	post-crisis	pre-crisis	post-crisis	pre-crisis	post-crisis
AAA	9.05	120.28	9.00	135.00	38.00	275.00	0.00	30.00	4.40	40.36
AA	16.19	175.63	16.00	192.50	32.00	210.00	5.00	100.00	5.05	43.05
A	28.28	220.00	27.00	240.00	60.00	260.00	13.00	160.00	9.51	52.92

Secondly, we have examined the effects of market conditions. Our research question states:

“How do market conditions influence the spread of post-crisis Dutch and UK RMBS transactions?”

Both the credit default swap volatility variable and the secondary market index variable are significant in our multivariate analysis. The CDS volatility indicates that in times of market uncertainty (higher volatility) RMBS spreads will be higher. The secondary market index variable indicates that higher secondary spread level lead to higher primary spreads.

Removing these market conditions variables from the post-crisis regression lowers the R^2 to 0.7749 (Adjusted R^2 0.7490) from 0.8359 (Adjusted R^2 0.8135). We can conclude that the market conditions do in fact influence the post-crisis Dutch and UK RMBS spreads.

Next we would like to answer the following research question: *“How do variables related to the underlying collateral pool and the deal’s structure influence the spread of post-crisis Dutch and UK RMBS transactions?”*

Credit enhancement has a surprising effect on spreads, with a positive coefficient in our post-crisis sample. We have identified two reasons for this. First we indicate that our post-crisis sample consists of 165 AAA rated tranches out of the 176 total observations. Thus the difference in credit enhancement from subordination disappears. Second, credit rating agencies specify an amount of credit enhancement necessarily to obtain a specific rating depending on several credit risk characteristics. Therefore, acquiring a triple-A rating for a tranche covered by a weaker collateral pool could only be obtained by applying more credit enhancement. Thus we would argue that investors see this as an increased risk and thus require a higher risk premium.

Governmental guarantees and current loan-to-value are also showing interesting relations with spread levels. Both variables have a significant (with a negative coefficient) effect on the

spreads in the single variable analysis. Our multivariate analysis shows that the current loan-to-value variable is significant with a positive coefficient and the government guarantee is insignificant at a 95% confidence interval but significant with 90% confidence and has a negative coefficient. As mentioned before, guarantees such as the “Nationale Hypotheek Garantie” are only available to mortgage borrowers in the lower segment of the housing market (cap of €265.000 at the time of writing). This means that these borrowers are often first-time buyers with high loan-to-value mortgages due to the lack of bringing in own equity. Figure 38 shows the relation between the current loan-to-value ratio and the spread levels for different levels of governmental guarantees in transactions collateral pools. It can be noted that guaranteed transactions have higher current loan-to-value ratio compared to non-guaranteed transactions. Also, the guaranteed transactions tend to have lower spreads. This means that the governmental guarantee variable influences the current loan-to-value variable. We would conclude that, both variables have a minimal influence on the spread.

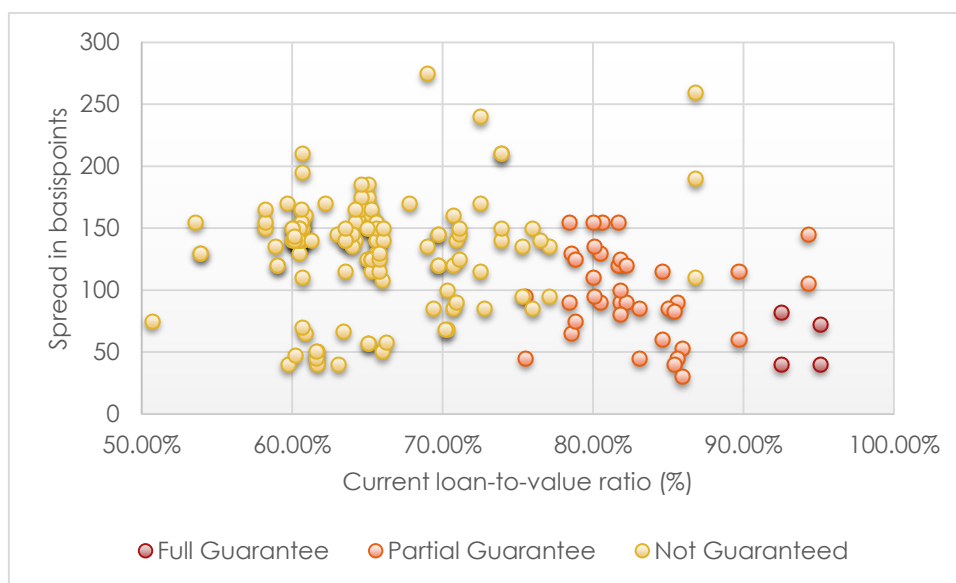


FIGURE 38: CURRENT LOAN-TO-VALUE RATIO AGAINST THE SPREAD FOR DIFFERENT TYPES OF GUARANTEES. THE GRAPH INDICATES THAT THE GUARANTEED DEALS HAVE HIGHER LOAN-TO-VALUE RATIOS.

Guarantee	Average CLTV	Average Spread
Non Guarantee	65.4%	134.2
Partial Guarantee	83.2%	94.4
Full Guarantee	93.8%	58.5

The average lifetime of a tranche is, as described in literature, also significant in our multivariate regression. This means that the spread on notes with a longer expected lifetime is higher.

The interest-only dummy is just significant (at a p-value of 5%) in our multivariate regression analysis. Figure 39 below shows the interest-only ratios for Dutch and UK RMBS issued post-crisis.

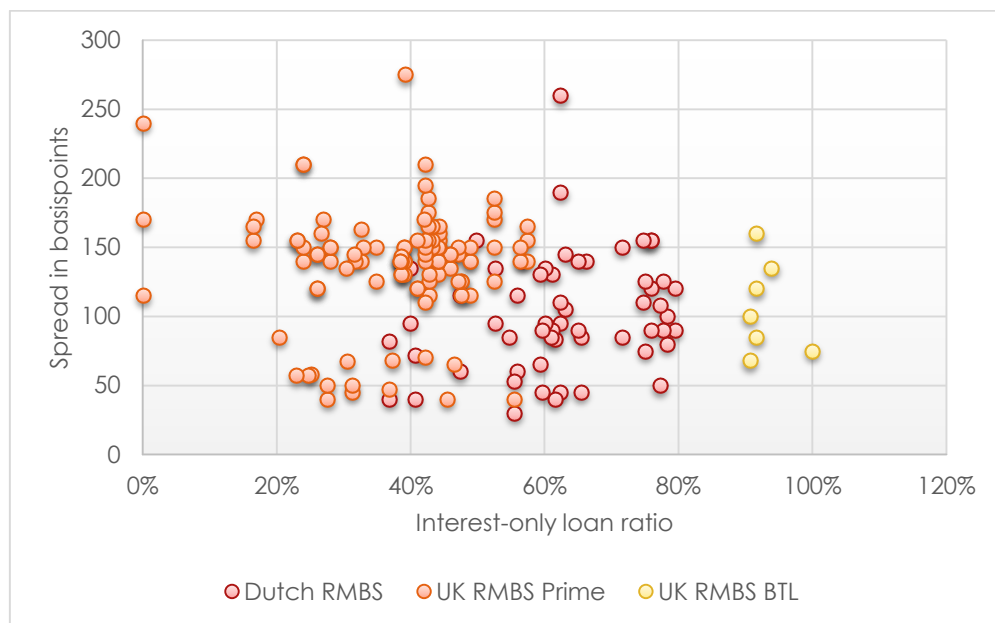


FIGURE 39: INTEREST-ONLY LOAN RATIOS AGAINST SPREAD LEVELS FOR DUTCH/UK RMBS. THE GRAPH SHOWS THAT BUY-TO-LET DEALS HAVE HIGHER PORTIONS OF INTEREST-ONLY LOANS AND THAT DUTCH RMBS TRANSACTIONS HAVE RELATIVELY HIGH INTEREST-ONLY RATIOS DUE TO PAST TAX-INCENTIVES.

From Figure 39 we can conclude that Dutch RMBS holds, probably as a result of tax regulation and financial innovation, a higher portion of interest-only loans on average. However, we can also conclude that the buy-to-let RMBS transactions hold even higher interest-only ratios. Removing these buy-to-let transactions from the regression eliminates the significant effect of the interest-only variable. We therefore conclude that this variable does not heavily influence the spreads.

Fifth, the significant buy-to-let dummy indicates that transactions covered by buy-to-let mortgages also need an additional risk premium. However, removing the buy-to-let dummy from our multivariate analysis only lowers the R^2 to 0.820 (adjusted R^2 of 0.797) from an R^2 of 0.8359 (Adjusted R^2 of 0.8135). This significance is important because it points out that the difference in spreads between prime and buy-to-let transactions is not completely described by the shared and tested variables.

Sixth, the size variable is not significant in our multivariate analysis. This would indicate, in contrast to the literature, that it is irrelevant how large a transaction is in determining the spread.

Finally, the seasoning variable is insignificant in our multivariate regression indicating that the seasoning of the underlying mortgage loans is relatively unimportant. The master issue dummy is also insignificant in our multivariate analysis showing little difference between stand-alone and master trust issuance. However, the factor is significant in our reduced form model. Indicating that master trust RMBS issues trade at a risk discount compared to stand-alone RMBS issues.

The fourth research question we would like to answer is: *“How do currency specific features influence the spread of post-crisis Dutch and UK RMBS transactions?”*

Both the currency mismatch variable and the multi-currency issue variable are insignificant in our multivariate analysis. This means that our currency related conclusion coincides with research by Fabozzi and Vink (2012), who also identify insignificant currency effects. However, we also notice that most multi-currency issues come from the master trust issues. Also the multi-currency dummy is correlated with the currency mismatch dummy. Correcting for correlation for these variables the multi-currency dummy becomes significant (at a 90% confidence level). However, removing the multi-currency variable from the regression only lowers the R^2 to 0.827 (adjusted R^2 of 0.806) from an R^2 of 0.8359 (Adjusted R^2 0.8135). We conclude that the currency effects towards to spreads are very limited

The fifth research question states: *“How do country-specific macro-economic variables impact on the spread margin of post-crisis Dutch and UK RMBS transactions?”*

The economic sentiment, unemployment rate and house price index variables are insignificant in our multivariate regression. The only significant variable is GDP growth. This variable indicates that when GDP growth is positive, spreads will be higher.

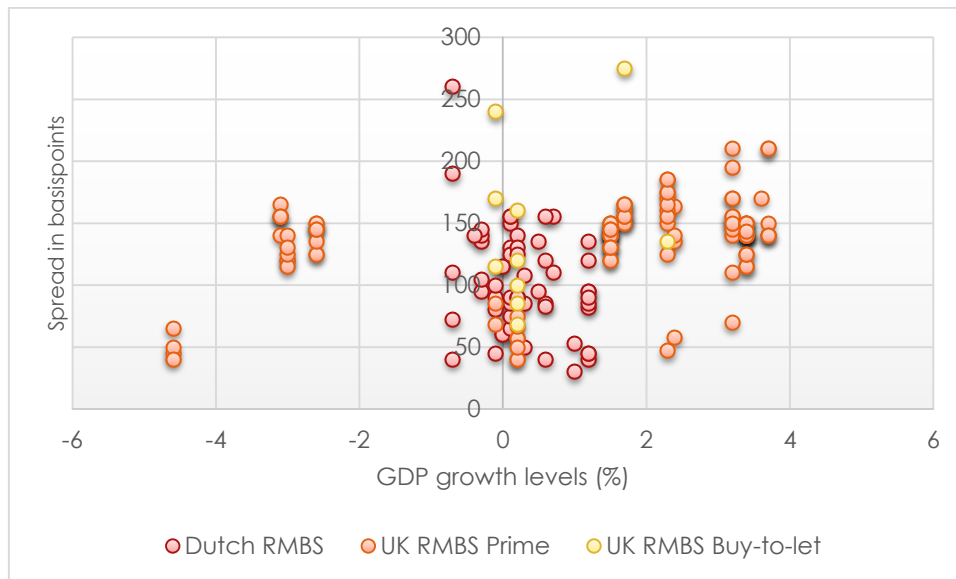


FIGURE 40: GDP GROWTH AGAINST SPREADS FOR DIFFERENT TYPES OF RMBS. THE GRAPH IS SHOWING HIGHER SPREAD LEVELS IN PERIODS OF HIGHER GDP GROWTH.

From Figure 40 we can conclude that most deals are launched in periods of positive growth. Especially in periods of high growth, spreads tend to be higher. One explanation for this could be that in these times more risky deals are launched.

Other macro-economic factors are not significant in our multivariate regression model. We believe this is caused by the fact that other variables, such as the market condition variables, the secondary index variable, the VIX index and the CDS volatility, also represent same characteristics as the macro-economic environment. To obtain more clarity on the influence of macro-economic, we have also analysed the variables with a correlation correction. We have corrected all the insignificant macro-economic variables (unemployment rate, house price index and economic sentiment) against the market condition variables (secondary market, credit default swap volatility index and VIX index). The results show that after this correction, the economic sentiment variable becomes very significant (at a 99% confidence level) and the house price index variable becomes just significant (with a 90% confidence level). However, removing these variables from the multivariate regression only lowers the R^2 to 0.801 (adjusted R^2 0.780) from an R^2 of 0.8359 (Adjusted R^2 of 0.8135). We conclude that macro factors have a significant but minimal influence toward the spreads.

Our sixth and last research question states: “How do regulatory variables influence the spread of post-crisis Dutch and UK RMBS transactions?” We believe that post-crisis regulatory changes had a large impact on RMBS spreads. Omitting the regulatory variables from our

post-crisis multivariate regression significantly lowers the R^2 to 0.759 (Adjusted R^2 0.728) from 0.835 (Adjusted R^2 of 0.813). If our assumption holds, and the difference between the covered bond secondary market and the RMBS secondary market does indeed largely represent changes in regulation, then we can conclude that the regulatory impact has been significant in our post-crisis data sample. Figure 41 shows the regulatory variable (difference secondary covered bond market difference with secondary RMBS market) against the launch spread levels of newly issued RMBS transactions. The figure clearly shows similarity in the path of both lines making it acceptable that the variable influences the spreads.

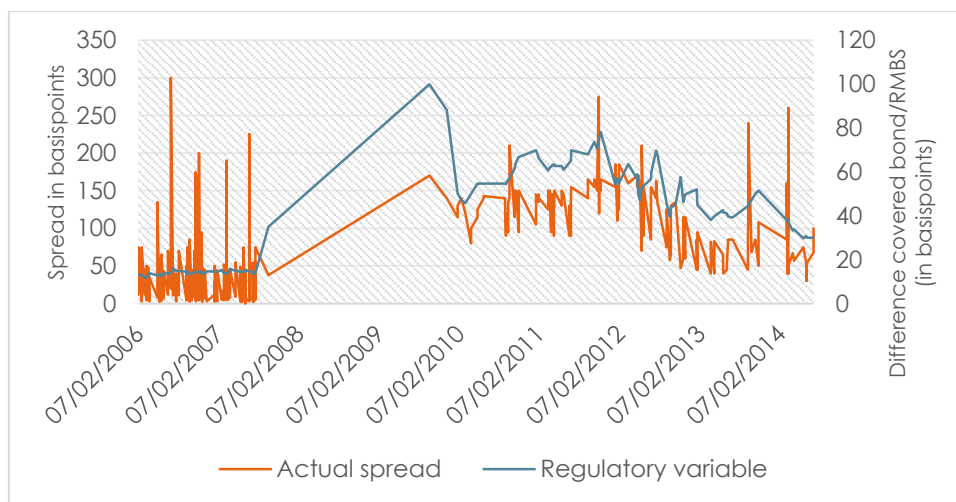


FIGURE 41: REGULATORY VARIABLE & SPREAD DEVELOPMENT OVER TIME INDICATING THAT THE REGULATION VARIABLE MOVES IN-LINE WITH THE ACTUAL SPREAD LEVELS.

8 Discussion and further research

This final chapter will outlay a discussion towards our research and the conclusions. It will also identify topics for further research.

Discussion

Although we are convinced that our conclusions made towards our post-crisis sample are correct, we do have to sketch some limitations in our research. In the results of the regression analysis we found relevant relations, but we should be careful with stating causal relationship. Assumptions for using the least square regression are mentioned in Chapter 4.

Next, because our regression analysis is based on 176 transactions, some dummy variables are represented by only a few deals. For example, the buy-to-let deals only present 10 cases out of our sample and non-AAA rated tranches only represent 11 observations. While we found relevant results in our sample, we should be careful with generalizing and extrapolating these results. The results hold for Dutch and UK RMBS issued between September 2009 and July 2014. Although our regression residuals show normal behaviour it could be possible that important factors might still be excluded in this research. Finally, please keep in mind that the objective of this thesis is not to accurately price new RMBS transactions but to gain more insights towards factors influencing the spreads.

Further research

As mentioned before, little research exists on primary market RMBS spread for post-crisis transactions. We argue that it would be interesting to compare the different ABS structures and transactions. However, for this research more transactions would be needed. Ongoing changes in regulation are bound to influence the RMBS markets. Especially the upcoming ABS purchase program by the ECB could be an interesting topic in the RMBS field. Also the investor base has changed before and after the crisis, we have not discussed this in our research but it could be interesting to research this aspect further.

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Appendix A

Moody's	S&P	Fitch	rating description (Dummy)
Long-term	Long-term	Long-term	
Aaa	AAA	AAA	Prime (AAA)
Aa1	AA+	AA+	High grade (AA)
Aa2	AA	AA	
Aa3	AA-	AA-	
A1	A+	A+	Upper medium grade (A)
A2	A	A	
A3	A-	A-	
Baa1	BBB+	BBB+	Lower medium grade (BBB)
Baa2	BBB	BBB	
Baa3	BBB-	BBB-	
Ba1	BB+	BB+	Non-investment grade speculative (BB)
Ba2	BB	BB	
Ba3	BB-	BB-	
B1	B+	B+	Highly speculative (B)
B2	B	B	
B3	B-	B-	

Appendix B

Multivariate regression model output:

Dependent Variable: SPREAD

Method: Least Squares

Date: 09/10/14 Time: 12:25

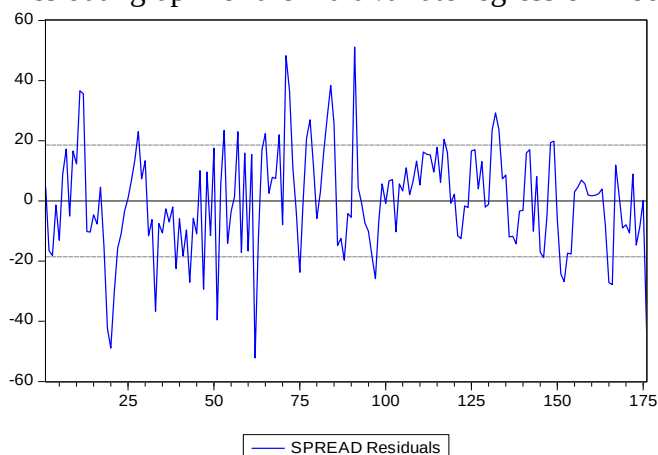
Sample: 1 176

Included observations: 176

White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-118.3216	80.01072	-1.478822	0.1412
AA	63.12338	8.429598	7.488302	0.0000
A	142.3239	22.65111	6.283311	0.0000
SEASONING__MONTHS__	0.113583	0.092219	1.231668	0.2200
INTEREST_ONLY_LOANS	-20.33782	10.21229	-1.991505	0.0482
WAL_ORIGINAL	9.241143	1.192469	7.749584	0.0000
CLTV__ADV_RATE	74.94174	34.77765	2.154882	0.0327
SIZE_IN_EUR_MN__	0.005544	0.004658	1.190140	0.2358
GOVT_LOAN_SUBSIDY	-20.47380	10.59974	-1.931537	0.0553
MASTER_TRUST__1_YES__	-7.648028	5.983299	-1.278229	0.2031
CE_ORIGINAL	283.7088	58.93196	4.814176	0.0000
ECONOMIC_SENTIMENT	-0.417883	0.264415	-1.580403	0.1161
HOUSEPRICE_INDEX	0.313927	0.586256	0.535477	0.5931
GDP_GROWTH	2.507633	0.722868	3.469006	0.0007
UNEMPLOYMENT	0.786445	2.897901	0.271385	0.7865
MULTI	-0.760499	9.085429	-0.083705	0.9334
CURR_MISMATCH	-8.950548	5.387165	-1.661458	0.0987
CDSVOL	1.327709	0.259468	5.117036	0.0000
IS_BTL__1_YES__	35.46674	12.28795	2.886302	0.0045
SECONDARY	0.215228	0.035049	6.140813	0.0000
DIFF_CB_RMBS	1.487746	0.203560	7.308646	0.0000
VIX	0.058303	0.352289	0.165498	0.8688
R-squared	0.835925	Mean dependent var	124.4943	
Adjusted R-squared	0.813551	S.D. dependent var	43.87489	
S.E. of regression	18.94506	Akaike info criterion	8.837432	
Sum squared resid	55272.94	Schwarz criterion	9.233742	
Log likelihood	-755.6940	Hannan-Quinn criter.	8.998173	
F-statistic	37.36167	Durbin-Watson stat	1.271126	
Prob(F-statistic)	0.000000			

Residual graph for the multivariate regression model:



Reduced form model regression output:

Dependent Variable: SPREAD

Method: Least Squares

Date: 10/30/14 Time: 00:46

Sample: 1 176

Included observations: 176

White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-29.91878	24.06285	-1.243360	0.2155
AA	63.01823	9.774786	6.447018	0.0000
A	146.3235	25.11004	5.827289	0.0000
DIFF_CB_RMBS	1.518182	0.164902	9.206561	0.0000
SECONDARY	0.202100	0.028647	7.054734	0.0000
CE_ORIGINAL	255.7287	35.13390	7.278687	0.0000
WAL_ORIGINAL	10.20061	1.145040	8.908512	0.0000
CDSVOL	1.251032	0.243847	5.130393	0.0000
IS_BTL__1_YES_	31.63269	11.90971	2.656043	0.0087
GDP_GROWTH	2.329089	0.705393	3.301830	0.0012
MASTER_TRUST__1_YES_	-9.685549	3.503216	-2.764759	0.0063
ECONOMIC_SENTIMENT	-0.456901	0.236876	-1.928859	0.0555
R-squared	0.820824	Mean dependent var		124.4943
Adjusted R-squared	0.808807	S.D. dependent var		43.87489
S.E. of regression	19.18459	Akaike info criterion		8.811838
Sum squared resid	60359.95	Schwarz criterion		9.028007
Log likelihood	-763.4417	Hannan-Quinn criter.		8.899515
F-statistic	68.30030	Durbin-Watson stat		1.159198
Prob(F-statistic)	0.000000			