Modelling Credit Spreads on Commercial Mortgage Loans

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Abstract

The focus of the paper is to offer empirical evidence on the factors that influence the credit spread on commercial mortgage loans. We extend existing work on the pricing of commercial mortgage loans and adverse lender selection. We examine the relative significance of a range of factors on loan pricing that are lender, asset and loan specific. Theory suggests that mortgages secured on property types that are perceived to be riskier should be priced higher. Empirically our model examines the impact of mortgage endogenous factors such as loan-to-value ratios, property types, loan size together with exogenous factors including lender and origination date on the commercial mortgage credit spreads. Furthermore, using an event study framework, we exploit the credit premium changes after global incidents including the 2008 financial crisis. Given the dearth of studies in this field in Europe, this paper provides the basis for useful comparisons with the US literature. More importantly, it represents a valuable investigation for institutions engaging in commercial real estate lending in the search for yield.

Keywords: Credit Spreads, Commercial Mortgages, Risk weighted assets, relative risk pricing, GFC

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1. Introduction

The number of bank closures had sharply risen particularly during the most recent financial crisis in the United States (Shin 2019). In the US the Federal Deposit Insurance Corporation (FDIC) reported that 465 insured U.S. commercial banks failed between January 2008 and December 2012, while only 27 banks closed from October 2000 to December 2007. In the UK the most important casualties of the GFC were Northern Rock and Bedford & Bingley. The Great Recession may have ended in the mid-year of 2009, but the effects of the bank failures and retarded lending of the banking system severely plagued the recovery. Politicians and regulators claim that the concentration on commercial real estate loans is among the contributing factors that led to an increased likelihood of recent bank closures across all large financial markets. Bank crisis, and bank overlending has often been related to property price bubbles, real estate company failures. Collyns and Senhadji (2002) point out that increases in the price of real estate may increase the value of real estate collateral, leading to a downward revision of the perceived risk of real estate lending. Consequently, an increase in real estate prices may increase the supply of credit to the real estate industry, which in turn, is likely to lead to further increases in the price of real estate.

This has led to demands from regulators that in the case of real estate lending, banks need to be stricter with loan management and apply tight lending standards. There is reasonable argument that real estate loan pricing did not adequately reflect loan risk prior to 2008, which can ultimately be seen in the pricing of subprime loans. Dingell (2002) has raised questions about the pricing of loans and specifically the lending risk premium, claiming that “commercial banks may be winning high service fees by underpricing credit facilities as a loss leader to their clients. An early strand of the literature exists, which analyses the optimal behaviour of bank lending and interest margin setting (Klein, 1971; Monti, 1972; Ho and Saunders 1981). These studies show how factors such as credit risk and interest risk affect bank interest margins.

Since the GFC regulatory changes require banks to hold higher amounts of capital against loans for alternative lending, which includes commercial mortgages. Our research addresses two key questions, firstly to what extent are real estate loans adequately priced and secondly what has been driving loan margins since the GFC. The hypothesis is that with a tougher definition and increased level of capital, the new capital requirements have greatly inhibited commercial banks ’credit expansion and may swallow their profits, leading to a decline in return on assets and return on capital, which in turn will increase pressure for banks to pass on the increased costs to borrowers resulting in higher loan margins. This paper examines the cross-sectional and time-series determinants of commercial mortgage loan margins and credit spreads as well as the impact of the originating bank. We examine the time-series variation in spreads and mortgage characteristics by looking at two different periods prior to the GFC (2004 – 2011) and post GFC (2012 – 2018). Although the crisis happened in 2008, many banks were closed for new financing in 2009/2010 and many loans were relating to restructuring of old loans which were not necessarily priced to market. In addition key regulatory changes took effect from 2012 onwards, while the period 2009 – 2011 was a transitioning period. Regulatory changes meant implementing higher capital requirements for commercial real estate loans from a bank’s perspective, which is expected to result in higher credit costs which will be passed on to the borrower. Thus economic capital is an important component of a loan pricing framework. It measures the contribution of a loan to the total credit risk of a loan portfolio. It can be

viewed as a capital buffer that is needed to absorb unexpected losses of a loan portfolio. It is assumed that a bank has implemented a framework for economic capital calculation. Depending on its sophistication this calculation can be based on the simple credit portfolio model underlying Basel II (Gordy 2003) or on a more advanced approach along the lines of Gupton et al. (1997), or Wilson (1997a) and Wilson (1997b). The literature on loan pricing is scarce and the approaches applied in practice are still quite simplistic compared to other areas like financial derivatives. The main available literature examines the impact of real estate related aspects on loan pricing such as loan-to-value ratios, income interest coverage, found in Titman et al. (2005). Much less literature covers the impact of the originator on loan pricing, and important practical aspects like economic capital are completely missing in all these approaches. Some ideas on a more general loan pricing framework based on RAROC (risk-adjusted return on capital) are presented in Aguais and Forest (2000), Aguais et al. (1998), and Aguais and Santomero (1998), and hence addressing the issue of risk adjusted pricing under different capital requirement regimes. Our research uses the credit spread between the loan margin and the risk-free instrument to indicate the loan pricing differential across different originators and time horizon.

When examining commercial mortgages, different spreads can be observed for CMBS bonds, which are publicly rated instruments but are much more difficult to be observed within private debt markets such as balance sheet loans. This research will examine the differences in credit spreads in private real estate loans held on banks' balance sheets. The paper specifically addresses the issue of heterogeneity of real estate loans as an alternative asset class to determine differences in credit spreads and loan pricing and addresses the question of relative risk pricing before and after the global financial crisis GFC 2008/2009.

We believe our paper offers some new crucial insight into the pricing of commercial mortgage loans not designated for securitisation. Beyond the findings in differences of credit spreads it discusses the market inequality and inefficiency found in private debt market despite regulatory interference.

2. Methodology & hypothesis

For our analysis we are using a panel regression approach which allows a cross section analysis of the data throughout time. There are many parameters reflected in the final loan price, which covers all costs and adequately compensates for the risks associated with a loan. For bank internal purposes, it is important to split the loan price into its components, i.e. which part of the loan margin reflects funding costs, which part reflects expected losses. We use the risk adjusted loan price where the loan is priced using a fixed spread over a floating benchmark such as LIBOR and the risk adjusted price is the spread between the loan price and the risk-free rate. This all-in credit spread is assumed to indicate the level of risk in debt instrument or loan, without distinguishing between internal funding costs and credit associated costs. For rated debt instruments such as CMBS bonds the average yield spreads within a particular rating class characterizes the dynamics of credit spreads. For the purpose of this research the credit spread is defined as the difference in yield between a five year commercial mortgage loan and the five year UK gilt rate.

When comparing yields of different debt instruments, we have to keep in mind that interest rates vary for various types of bonds and are not necessarily in sync. For example, if there is a lot of uncertainty

in the market, investors tend to park their funds in safe havens like government bonds causing the yield to fall. This has been observed especially during 2008-2009. On the other hand, the yields of corporate bonds and other assets will increase due to an increased level of uncertainty. Depending on the nature of the uncertainty this might only affect particular sectors, but in a general economic downturn all sectors will be correlated.

We not only analyse the difference in spread between commercial mortgage loans and UK gilts, but also between mortgage loans secured by different asset types. This also allows us to compare mortgage loans of different credit quality such as mortgages secured on prime office property versus mortgages secured by secondary industrial property, which are believed to be of different credit quality. Hence the widening of credit spreads indicate growing concern about the ability of borrowers to service their debt on this particular asset class. Narrowing credit spreads indicate improving creditworthiness, but it can also raise concerns over adequate risk pricing if one asset class suddenly experiences narrowing credit spreads in comparison to other similar assets.

Examining US mortgage loans empirical evidence by Titman et al (2005) indicates that mortgages on property types that tend to be riskier and have greater investment flexibility generally exhibit higher spreads. Our results confirm these findings. More importantly Titman et al (2005) are also investigating the endogeneity of the mortgage contract and examine the choices of individual originators. They find that different originators have different risk preferences; some originators attract riskier clienteles, attracting mortgages with higher LTV ratios as well as mortgages on properties that are riskier. Also in our analysis we use a qualitative dummy variable to distinguish between different types of originators and find that the ability and quality of the originator has an impact on final credit spread at same LTV level.

The aim of the cross-sectional analysis is to determine the impact of individual lenders' business models and loan characteristics on credit spreads. In more detail the following hypothesis will be tested:

1. Higher margins are associated with higher LTV lending reflecting the higher risk in higher LTV loans. Titman and Torous (1989) find that mortgage characteristics, such as the LTV ratio, the mortgage amortization rate and mortgage maturity are important determinants of mortgage risk. Their results indicate that an important determinant of the LTV ratio and the amortization rate is the NOI/Value ratio. They find that properties with higher NOI/Value ratios have mortgages with higher LTV ratios and higher amortization rates. One explanation for the first observation is that a higher NOI/Value ratio permits the borrower to satisfy debt coverage ratios with mortgages with higher LTV ratios. The higher amortization rate can be explained by the fact that properties with higher NOI/Value ratios are likely to experience less income growth and may be riskier. While it is true that higher yielding properties can sustain a higher level of debt, often allowing for mezzanine lending ranking behind a senior loan, average LTV by property types shows that LTV ratios are generally lower for secondary property than for prime.

2. Loan pricing is a function of the risks of different property types. Titman and Torous (1998) find that properties like hotels, which are likely to be both riskier and have the greatest investment flexibility, have significantly higher spreads than warehouses and multifamily housing, which are likely to be less risky and have less investment flexibility.

3. Loan pricing is driven by the business model and underwriting capability of the originator. An examination by Black et al (2012) of US commercial mortgage loans find there is considerable heterogeneity in the organizational structures of CMBS loan originators that may influence originators' underwriting incentives. They find significant differences in the propensity to become delinquent depending upon whether a loan was originated by a commercial bank, investment bank, insurance company, finance company, conduit lender, or foreign-owned entity. These differences hold both before and after controlling for key loan characteristics. The link to overall return is made by Lepetit et al. (2008) for a set of European banks, which shows that banking risk is mostly located in small banks and is caused by commission and fee generating activities. The findings of Demirgüc-Kunt and Huizinga (2010) indicate that an expansion into non-interest income-generating activities increases the rate of return on assets (ROA), while wholesale funding lowers the ROA.

Secondly, we focus on time varying effects on loan pricing:

4. We examine the impact of pre and post crisis effects. Lenders are more regulated since 2009 and real estate is considered specialised lending and attracts higher risk costs aka capital charges.

We investigate the relationship of lender and loan characteristics on loan spread by using the following model including different measures of loan credit quality:

$$(1)\ Loan\ spread_{a,i,t} = c + \beta Asset + \alpha Origin + \gamma Type + \delta LTV + \tau Region + \rho size$$

Where loan spread is the reported spread for asset a by lender i and time t. The spread is a function of asset type, bank origin, bank type, LTV, regional loan exposure and loan size. We use time-demeaned panel regression. In all the empirical tests, the standard errors are clustered at the lender level.

3. Data description

The research is using a unique data set that has been collected by the Cass Lending survey presenting portfolio level data of loan portfolios by different lenders during 2004 – 20018 on an annual basis. The survey is tracking the secured commercial mortgage lending market in the UK. Loan data is collected on a portfolio level for each lender hence the cross sectional analysis approach considers the limitations of portfolio level data. In total our sample includes 139 bank portfolios on secured commercial mortgages.

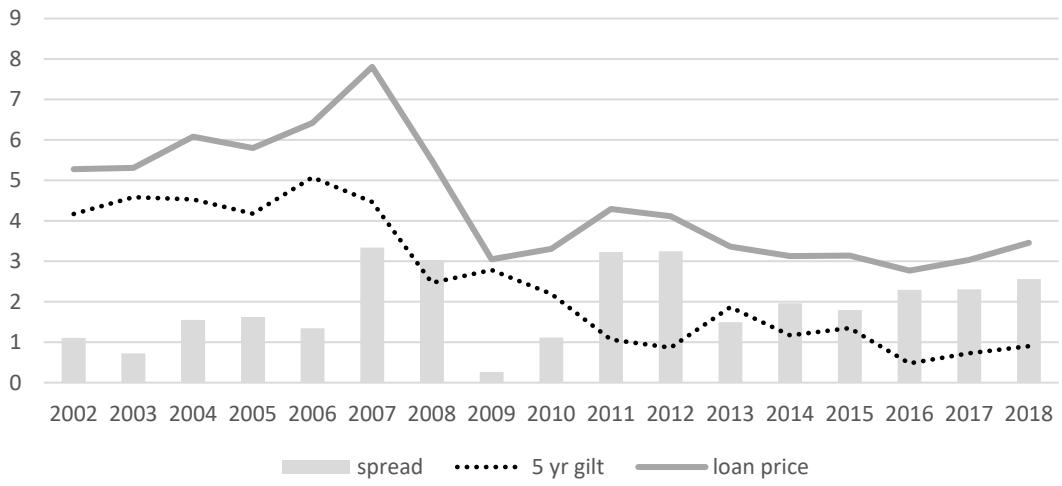
Loan pricing information reflects price quotes received for standardised loans by several lenders in the market; as such they are offer prices at which level borrowers can expect to obtain financing for specific types of projects. These may differ from the contractually agreed loan price after full credit approval.

Pricing terms are quoted for a specific LTV level and property type, including margin, ICR/DSCR covenant levels required, arrangement fee, amortisation terms. The typical loan term is 5 years, depending on the day one LTV level the loan might be interest only or have some limited amortisation usually ranging from 3-5% over a period of 5 years. We analyse the loan spread as

$$(2)\quad loan\ credit\ spread_{\alpha,\beta,t} = (margin_{\alpha,\beta,t} + libor_t) - gilt_t$$

Where loan spread is the reported spread for asset α by lender β and time t. The spread is a function of margin by lender b, for asset a, at time t, plus the 3 months libor rate for that period less the gilt rate over the same tenor at the specific period. Figure 1 shows the average historic loan spread across all property types. The 5-year gilt rate shows the effect of quantitative easing in 2008, when gilts rates dropped substantially and then for the second monetary policy intervention in 2012. While during the first drop in gilt rates in 2008 also loan pricing dropped due to the change in variable interest rates.

Figure 1: Average historic loan spread



Source: Bloomberg, Cass loan database

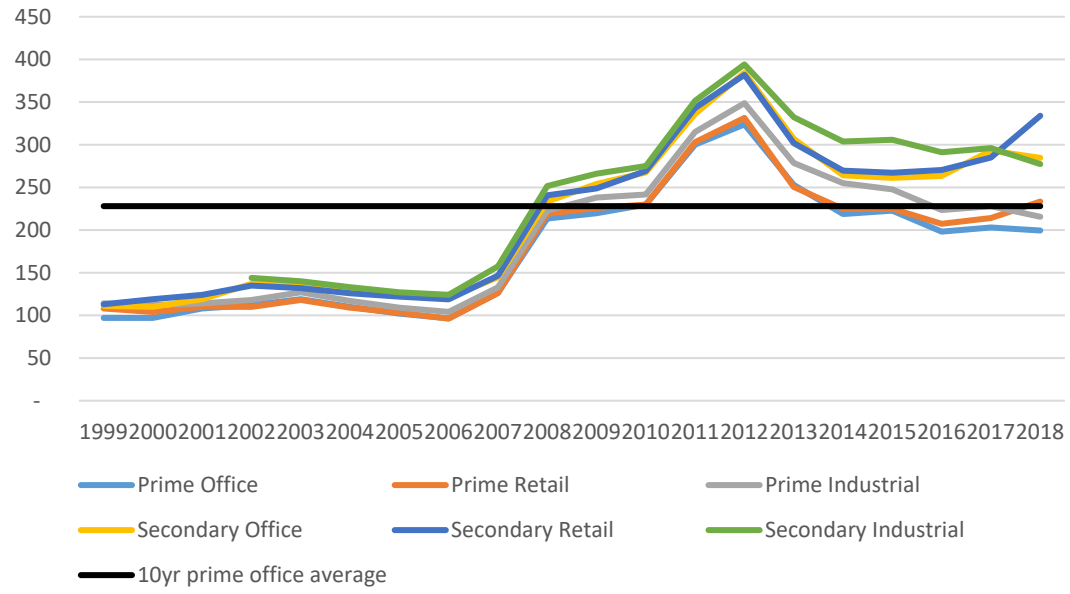
The data collected from each lender includes loan portfolio information on their regional distribution, LTV ranges, type of projects financed and maximum loan sizes. Between the different periods prior to GFC and post GFC the spread moved from an average of 162bps to 235bps post GFC indicating that overall conditions have changed between the two different periods.

Asset type characteristics

Property types include office, retail, industrial and residential investment property in prime and secondary cities. While there is information on alternative asset types such as hotels the data set is still very limited. Hence this analysis is only concentrating on the main property types. Findings by Titman et al. (2005) suggest that property types are important in determining loan risk and credit spreads. For example that relatively safe property types, such as multifamily apartment complexes

and anchored retail properties, have higher LTV ratios and lower amortization rates, while riskier properties, such as limited- and full-service hotels, have lower LTV ratios and higher amortization rates. All of which impacts on final loan pricing and spreads. In the UK investors' perception of property systemic risk differs from the US. Overall the safest property class is considered to be prime office, followed by residential property. Retail property in the UK is considered more volatile than in the US while industrial property is a niche property class with typically attracts higher yields. Operating properties, with no fixed NOI this includes hotels, student housing, pubs, casinos are considered specialty property which require special management knowledge, therefore they are a niche class associated with higher risk. Figure 1 shows the historic loan pricing margins which are priced over 3 months libor for the main property types. While during the pre-crisis period there was little to no differentiation in risk pricing between different property types.

Figure 2 Loan margins over time by property type



Source: Cass CRE Lending Survey

Figure 2 also shows the compression of margins up to 2006 followed by the increase in loan spreads from 2008 onwards and the turning point in 2012. The historic UK data by property type shows that secondary property is priced significantly above prime property types and some distinction is made between asset types such as discussed above.

Originator/lender characteristics

The distinction by originator business type serves the analysis of our hypothesis that loan pricing differs by lender's business type and regulatory regime. Due to the diversity of lenders in the UK, banks and other lenders are identified first by their country of origin. The country of origin serves as a proxy for the regulatory regime the lender is controlled by.

- Origin 1: UK banks
- Origin 2:German banks
- Origin 3:International banks
- Origin 4:US banks
- Origin 5: Insurers
- Origin 6: Debt funds

The way each bank finances itself depends on regulatory requirements which can differ by country. For example German banks may manage large covered bond programs, which allows them to include various property assets into the cover pool and hence lowers their loan pricing substantially from those who do not benefit from covered-bond issuance programmes. We have classified each lender according to the country of the location of their headquarter for example Deutsche Bank is classified as German bank and Santander as International bank. On the other hand HSBC group with head office in London is classified as UK bank.

Regulatory supervision has also driven banks to adopt different internal rating and risk models to determine their capital requirements as discussed in various literature above. Hence effectiveness of common risk-weighting schemes that translate borrower risk into bank capital requirements differs for each lender depending on their economic capital calculation method.

Since Basel II was introduced in 2008, two approaches to calculating bank capital requirements have co-existed: lenders' internal models, and a less risk-sensitive standardised approach (SA). All UK banks are subject to a standardized prescribed slotting approach, while non UK banks may apply their own internal models including advanced IRB and standardized IRB. This has arguably resulted in arbitrage opportunities between lenders in loan pricing.

We have detailed information on all lenders in our sample. Between 2004 and 2018 the data has included 30% UK banks, 18% German banks, 20% international banks, 5% North American banks, 12% insurance companies, and 15% debt funds. Insurance companies and debt funds are not regulated in the same way as banks and compete against bank lenders on loan pricing.

While country of origin is a good proxy to identify which capital burden of lenders through regulatory supervision, different methodologies for setting risk weights co-exist in the same market under Basel II & III. The "internal ratings based" (IRB) approach, as the use of internal models is more formally known, is costly to set up and manage. So while most of the largest lenders have adopted IRB, smaller banks tend to rely on the simple metrics set by regulators, formally known as the "standardised approach" (SA). For example Benetton et all (2015) find that the divide in IRB models cause lenders to specialize, which leads to systemic concentration of high risk mortgages in lenders with less sophisticated risk management. Hence large possibly more sophisticated lenders have access to more efficient IRB pricing models. In order to reflect these difference our model distinguishes between types of lending institutions. We classified entities as commercial, investment, mortgage bank or regional bank.

Table 1: Type of lending institution

Type of lender	Share of total
retail bank	13%
commercial bank	26%
Mortgage bank	18%
Regional bank	5%
Investment bank	12%
small fund	8%
large fund	7%
Insurance	12%
Total	100%

Source: Cass lending survey

When classifying the data set by type of lender the majority of lenders were commercial banks with a share of 26%, a further 18% were specialised mortgage banks. This classification provides an inside of the different strategies of each lender, for instance investment banks originate loans to distribute afterwards in the secondary market or via securitisation, while commercial banks hold the loan on their balance sheet to earn all fee income themselves. Funds typically have different target IRR's depending on their investment strategy. Retail banks benefit from a large branch network and might refer retail clients to their commercial lending teams, while regional banks only serve a specific region where they might be the local dominant lender in the market. Overall, the data on originators allows us to study clientele effects by constructing variables corresponding to average mortgage characteristics per originator. In our final model we have combined country of origin and business models into 10 categories, reflecting the dominant types for each region present in our sample.

- UK Commercial bank
- UK Mortgage bank
- UK regional bank
- German commercial bank
- German mortgage bank
- International retail bank
- International commercial bank
- Investment bank
- Insurance
- Debt fund

Loan portfolio specific variables

In order to examine any specialization effects, we include geographic loan exposure, loan size and LTV ratio by asset type into our model. Lenders' loan portfolios can be split by geography into portfolios with a proportion of loans in:

- Central London
- South East UK
- North England
- Midlands
- Scotland
- Portfolio across UK

Approximately half of all loan portfolios are located in London and the rest of UK South East, these reflect the most prosperous regions of the UK.

4. Results and discussion

The following section presents the results of our analysis. The credit spread is calculated as the sum of 3-month Libor and quoted margin by the individual lender minus the risk-free rate (gilt) measured in basis points. All standard errors are clustered at the lender level. Our first model (1&2) tests the differences in credit spreads for different asset types and our key variable LTV with year and lender fixed and non-fixed affects. First, we examine how LTV and property type affects the credit spread following equation 3:

$$(3)\ Loan\ credit\ spread_{a,i,t} = c + \beta Asset + \delta LTV$$

As shown in Column 1 & 2 in table 1, the LTV ratio has a significant positive impact on credit spread showing that an increase in LTV ratio by 1%, will result in a credit spread increase by 33.6 bps. Our findings are consistent with other literature by Titman et al (2005). We further find that lenders did differentiate the credit risk of different asset types. For example prime office loans are priced significantly below those of other asset types. There is also a distinction between secondary and prime assets.

This is consistent with our theory and previous studies. The LTV ratio per lender has a strong positive relationship with credit spreads, which is consistent with the idea that lenders specialize in mortgages with either high or low levels of risk, and that high LTV mortgages require substantially higher spreads.

Examining the effect of different asset types, we find that loan pricing spread is significant for most property types. Loans secured by prime office property are priced lower by 43 bps on average,

indicating the prime office loans are safer. As for loans secured by primary retail properties, the credit spread is narrower with 33 bps and primary industrial properties have an even lower spread by 19 bps. On the other hand, secondary offices, secondary retail and secondary industrial properties all have higher spread, which indicates higher risk.

In the specification of Column 2 in table 1, we add on the lender fixed effect. The improved R square suggests that a better way to model the data would be to allow each lender group (business type) to have its own intercept. A further extension is to allow the intercept to vary across the different time periods (two way fixed effects model) according to formula 4, which is used in column 2.

$$(1)\quad y_{it} = \sum_{i=1}^{n} a_0 D_{it} + \sum_{t=1}^{T} a_{2i} T_{it+a_1} x_{it} + u_{it}$$

We can find that the coefficients are robust to that of column 1 and that the risk order of properties remains constant, which further indicates the robustness of our results.

As mentioned previously lenders are exposed to different regulatory regimes and internal risk models. Our classification of lender types and business models tries to take specifically these differences into account. Table 1 column 3 shows the impact of 10 lender types.

Using UK commercial banks as a benchmark, results show significant differences in loan pricing for UK mortgage banks and regional retail banks. Especially regional retail banks price their loans 93bps above UK commercial banks, which is consistent with other empirical findings and assumptions that commercial banks have more sophisticated models and better access to highly trained staff as well as access to better borrowers. The same assumption applies to international retail banks, which price loans with a 42bps premium. While German commercial banks showed low significant differences with UK commercial bank pricing, German mortgage banks clearly present the lowest loan pricing with 31bps below UK commercial banks. Also significantly different was the pricing from debt funds which is amongst the highest with 58bps above UK commercial banks. Investments banks, who arguably have access to securitization and other distribution did not offer significantly different pricing neither did insurers and other international commercial banks.

Table 1: panel regression output

	(1)	(2)	(3)	(4)	(5)
VARIABLES	spread	spread	spread	spread	spread
LTV	336.3***	169.6***	276.1***	319.7***	321.9***
	(56.23)	(41.82)	(45.26)	(47.49)	(46.69)
Prime office	-43.03***	-22.17***	-33.95***	-32.31***	-31.12***
	(7.970)	(4.370)	(7.090)	(9.971)	(11.37)
Prime retail	-33.33***	-13.41***	-24.73***	-20.54**	-18.74*
	(7.609)	(4.362)	(6.728)	(9.642)	(10.91)
Prime industrial	-19.33**	-3.492	-10.52	-3.796	-2.054
	(7.754)	(4.369)	(6.566)	(9.269)	(10.14)
Secondary office	15.06*	20.07***	19.28**	30.92***	32.09***
	(8.369)	(5.363)	(7.525)	(10.40)	(11.50)
Secondary retail	18.60**	27.43***	24.14***	40.72***	42.61***
	(8.266)	(5.921)	(7.362)	(10.09)	(11.18)
Secondary industrial	29.00***	33.92***	32.36***	50.91***	55.24***
	(8.746)	(6.026)	(7.991)	(11.39)	(12.71)
UK Mortgage bank			20.95**	21.00*	15.45
			(9.832)	(11.78)	(14.61)
UK Regional bank			92.85**	177.1***	167.6***
			(40.92)	(45.29)	(42.01)
German commercial bank			-15.48*	-13.52	-19.55
			(8.154)	(11.14)	(13.44)
German mortgage bank			-31.23***	-37.53***	-45.92***
			(8.522)	(12.99)	(13.95)
International retail bank			41.71**	61.03**	62.15**
			(19.63)	(26.77)	(26.78)
International commercial bank			2.746	8.891	6.847
			(13.01)	(20.97)	(25.35)
Investment bank			-0.868	-0.940	-2.147
			(7.824)	(12.01)	(15.64)
Insurance			-10.01	-8.048	-11.12
			(9.331)	(14.13)	(14.10)
Debt Fund			58.10***	67.64***	80.31***
			(18.97)	(24.43)	(29.65)
CLondon				-35.20	-63.15*
				(30.11)	(36.09)
Rest of South East				-47.46	-87.35*
				(38.48)	(44.34)
West England				-3.198	-156.9
				(137.6)	(137.6)
Midlands&Wales				47.55	45.21
				(45.54)	(43.41)
North England				-22.65	-6.190
				(52.20)	(53.04)
Scotland				-19.41	-84.87
				(41.53)	(83.63)
MaxLoan					-0.0135

					(0.0331)
Constant	-4.283	91.42***	21.06	30.46	68.16
	(34.75)	(28.79)	(29.49)	(38.42)	(40.95)
Observations	4,237	4,235	4,237	2,338	1,983
R-squared	0.629	0.859	0.701	0.693	0.648
Year FE	Yes	Yes	Yes	Yes	Yes
Lender FE	No	Yes	No	No	No
Robust standard errors in parentheses					
***** p<0.01, ** p<0.05, * p<0.1**					

We can add two more variables to our model which tests the impact of regional exposure and loan size. As shown in column 4 in table 1, compared to other regions, banks with a bigger share in central London will have a lower pricing. Ceteris paribus, a 1% increase in central London share, the bank will decrease spread by 35bps on average. However, we find that regional effects on loan pricing are not significant at the 5% level.

Our last variable to be tested in loan size. We don't have information of the specific loan size of each deal. We turn to maximum loan reported for each period by lenders as a proxy. Because some of the banks do not report this information (MaxLoan), our number of observations is lower from the previous specifications (shown in column 5 in table 1). We find that the negative coefficients indicate that the bigger loans attract smaller margin. This verifies our primary hypothesis. But the coefficient is not significant. It may due to the limit of data and imperfect proxy by MaxLoan.

In addition to the above, the next part repeats the same steps for two different time periods, a) the period leading up to the crisis including the crisis period 2004 – 2011 and the post crisis period 2012 – 2018 respectively. It becomes apparent now that pricing differentiation with regards to LTV has been significant in loan pricing for the post crisis period, but during the earlier period lenders made little distinction in pricing different LTV risk (Table 2, column 1). Especially in the period from 2012 – 2018 further pricing differentiation was made between loan pricing for loan secured for primary versus secondary assets. Loans secured against secondary retail was prices on average 56bps higher and secondary industrial 50bps. This shows further the changes and effectiveness of regulatory pressure on lenders' loan pricing for specialist assets.

Table 2: Pricing effects pre and post crisis

	(1)	(2)	(3)	(4)
VARIABLES	spread	spread	spread	spread
LTV pre GFC	-63.16*	-37.21	-50.40	-60.65
	(32.99)	(33.37)	(82.34)	(95.16)
LTV post GFC	324.7***	407.9***	388.3***	386.1***
	(58.03)	(62.79)	(97.57)	(110.1)
Prime office pre GFC	-20.00***	-25.69***	-38.50***	-40.04***
	(3.551)	(4.146)	(8.739)	(9.556)
Prime office post GFC	-0.0430	-2.600	12.85	14.32
	(6.591)	(9.768)	(12.55)	(13.69)
Prime retail pre GFC	-19.74***	-24.92***	-34.64***	-35.93***
	(3.352)	(3.967)	(8.194)	(8.792)
Prime retail post GFC	14.64**	10.79	22.23*	23.61*
	(6.652)	(9.498)	(12.11)	(12.91)
Prime industrial pre GFC	-13.89***	-17.68***	-24.14***	-27.21***
	(3.459)	(4.164)	(7.348)	(8.501)
Prime industrial post GFC	18.36***	19.75**	28.64**	32.11**
	(6.301)	(9.184)	(11.36)	(12.38)
Secondary office pre GFC	-1.980	-3.789	-9.198	-9.988
	(3.557)	(4.147)	(6.985)	(9.069)
Secondary office post GFC	38.60***	40.33***	47.91***	47.39***
	(8.136)	(10.67)	(13.13)	(15.01)
Secondary retail pre GFC	-2.134	-3.962	-6.119	-5.426
	(3.536)	(4.114)	(7.282)	(9.348)
Secondary retail post GFC	56.66***	55.15***	56.96***	54.43***
	(8.538)	(10.12)	(12.89)	(14.59)
Secondary industrial pre GFC	4.542	1.795	2.857	7.553
	(3.991)	(5.078)	(8.328)	(9.912)
Secondary industrial post GFC	50.18***	51.14***	56.04***	52.10***
	(9.521)	(11.96)	(14.44)	(16.82)
UK mortgage bank pre GFC		15.40***	17.59	46.51**
		(4.651)	(16.42)	(20.15)
UK mortgage bank post GFC		41.01**	25.36	-29.47
		(16.80)	(30.57)	(29.19)
UK regional bank pre GFC		25.51*	-12.99	38.54
		(12.98)	(20.32)	(27.81)
UK regional bank post GFC		170.3***	233.9***	159.2***
		(60.37)	(46.95)	(50.37)
German commercial bank pre GFC		0.934	20.96	12.69
		(8.320)	(16.37)	(21.38)
German commercial bank post GFC		-27.65***	-50.96***	-46.44**
		(8.568)	(12.39)	(19.80)
German mortgage bank pre GFC		-16.64***	-13.20	-20.55
		(5.013)	(16.57)	(21.57)
German mortgage bank post GFC		-37.47***	-39.58**	-41.66*
		(7.536)	(17.54)	(22.55)
International retail bank pre GFC		36.62***	26.89	66.85**

		(11.08)	(18.00)	(26.47)
International retail bank post GFC		21.03	43.58	-7.300
		(37.64)	(31.81)	(36.01)
International commercial bank pre GFC		15.92*	27.16	76.51***
		(8.622)	(20.43)	(26.40)
International commercial bank post GFC		-17.98	-26.87*	-84.06***
		(12.74)	(14.92)	(18.04)
Investment bank pre GFC		5.307	-14.08	-12.59
		(5.436)	(22.00)	(24.67)
Investment bank post GFC		-1.300	14.91	11.68
		(10.50)	(20.74)	(23.46)
Insurance pre GFC		-1.812	-26.16*	-8.921
		(8.138)	(13.25)	(20.02)
Insurance post GFC		-3.407	21.07	-2.545
		(12.32)	(15.14)	(18.96)
Debt fund pre GFC		32.87***	87.57***	190.1***
		(12.01)	(14.68)	(22.22)
Debt fund post GFC		35.79	-22.67	-117.6***
		(25.13)	(27.79)	(35.22)
Central London pre GFC			-16.98	-56.29**
			(32.12)	(26.46)
Central London post GFC			-10.55	12.47
			(40.70)	(44.96)
South East UK pre GFC			-44.40	-134.7***
			(29.17)	(42.02)
South East UK post GFC			5.935	70.30
			(49.29)	(64.35)
Midlands & Wales pre GFC			-1.002	-44.71
			(40.64)	(32.01)
Midlands & Wales post GFC			35.45	101.2*
			(59.53)	(60.05)
North UK pre GFC			68.37	58.68
			(51.44)	(55.32)
North UK post GFC			-67.05	-42.78
			(58.25)	(61.39)
Scotland pre GFC			-42.90	-392.0***
			(51.93)	(140.9)
Scotland post GFC			57.81	378.6**
			(69.66)	(162.9)
MaxLoan pre GFC				0.195***
				(0.0458)
MaxLoan post GFC				-0.234***
				(0.0490)
Constant	143.6***	94.10***	62.25*	85.00**
	(20.41)	(18.56)	(33.49)	(37.96)
Observations	4,235	4,237	2,338	1,983
R-squared	0.872	0.763	0.732	0.692
Robust standard errors in parentheses				
***** p<0.01, ** p<0.05, * p<0.1**				

When examining the differences in lenders' business models on loan pricing for both periods, results do not differ much from our previous findings. UK regional and mortgage banks show higher pricing compared to UK commercial banks and differences have widened significantly for the post crisis period. The advantage of German mortgage bank loan pricing as well as German commercial bank loan pricing has also widened further in the post crisis period.

A further change can be found when adding geographic portfolio aspects in combination with loan size. Portfolios concentrated in Central London achieve lower pricing compared to other regions. If the bank has a higher exposure (market share) in Rest SE, the spread will also decrease. Market power in other places such as West E, Midlands/Wales, North, Scotland doesn't have significant difference in spread pricing. Our explanation is that since 2012 lenders have concentrated their lending activity in London and the South East, which has significantly increased competition especially with new lenders entering the UK market or re-entering after the crisis. This has helped to suppress loan pricing in London portfolios.

5. Discussion and conclusion

While our analysis aimed at the cross sectional aspect of the data, there are multiple other factors such as general interest rate environment, economic market performance etc. all of which will impact on the performance on real estate loans. For example Titman et al. (2005) also finds that spreads increase following periods when real estate markets perform poorly, which is consistent with the idea that the supply of mortgage capital declines when the financial institutions that provide the mortgages are financially weaker. This can clearly be seen in the widening of credit spreads in 2008. Currently our model has not taken macroeconomic effects into account to be separated from loan and lender specific credit effects, which is an area of further analysis and improvement. For example Nichols and Counningham (2008) find that given that most commercial mortgages involve large balloon payments at the end of their terms, sudden declines in the value of commercial property may significantly increase default risk, and hence widens spreads. Hence a property price index or REIT might be used as proxies for default risk.

Furthermore there is a common misconception that credit spreads are the single largest factor in determining credit risk of bonds. However, there are multiple other factors which determine the 'spread premium' of bonds over other treasuries. Especially for private debt there is an illiquidity premium indicating possible difficulties in selling the bonds once purchased as there is not an active market for bonds. This will make investors expect a higher yield than otherwise thereby increasing the credit spread for private debt instruments such as commercial mortgage loans versus other publicly rated debt instruments. At present our model uses the risk free asset as a reference to calculation credit spread, we have not examined the effect of illiquidity of real estate loans over other corporate bonds spreads.

Despite some limitations using loan portfolio based data our model shows robust results and confirms findings from previous literature. It is also confirms that commercial mortgage pricing methodologies are comparable between US and UK mortgage loans. We confirm that LTV has been an important variable to differentiate loan pricing and has become even more important from 2012 onwards.

Further our model confirms that in addition to LTV the highly heterogeneous nature of property has be taken into account when determining credit quality and loan pricing as well as the experience, business model or quality of the originator. At the same time the originator is strongly influenced by its internal models approved by the regulator. Especially after the crisis the influence of regulatory changes translating into higher risk weighting for real estate loans and hence higher capital charges have translated into higher pricing. Thus these extra credit costs have ultimately been passed on to the borrower. While Bridges (2014) find that capital requirements affect lending with different responses in different sectors of the economy – in the year following an increase, banks tend to cut (in descending order) lending to commercial real estate, to other corporates and household secured lending, hence they consider the effect temporary, we cannot confirm the temporary nature.

6. Literature

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