The Determinants of Mortgage Debt Flows in Dutch Commercial Real Estate Transactions

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Abstract

The aim of this thesis is to quantify the effect multiple commercial real estate characteristics have on commercial real estate transactions in terms of mortgage debt flows. With respect to the adjusted LTV ratios, consisting of the registration value of the mortgage loan on the one hand and the related transaction price on the other hand, the effect determinants have on commercial real estate transactions over time from 2005 until Q3 2018 are assessed. Utilising GLM univariate analyses enables to test the effects of different determinants on the means of several groupings of LTV ratios. Results suggest a larger positive effect of industrial real estate on LTV ratios than offices, retail stores and residential real estate respectively. Concerning the different types of investors, institutional investors have the most substantial negative effect on the level of LTV ratios. In addition, the fact that an investor is of Dutch origin drives an LTV ratio. With regard to regulatory measures, whereas a negative effect has been observed for the Basel Accords, the ECBs overnight interest rate positively affects LTV ratios.

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Preface and Acknowledgements

The idea for this thesis results from my interest in both real estate and debt financing. The global financial crisis and the role (commercial) real estate debt played in it in terms of the mortgage backed securities, had stemmed my interest in conducting research in this field. With CBRE as my employer, I took my chance to do research commissioned by a real estate consultancy firm. In order to enable a study on LTV ratios, the Kadaster could provide for data on mortgage loans, as well as on commercial real estate transactions, in addition to the real estate investment data of CBRE. As a result, I started my research internship at the Kadaster. During the time of my internship, I remained employed by CBRE. So, I was able to include the data of CBRE in my research. The data collection process proved to be the most challenging part. After identifying the relevant commercial real estate transactions, the mortgage loan data needed to be matched. Accordingly, I was required to match the data of the Kadaster and CBRE. Months of hard work paid off and resulted in two unique datasets comprising adjusted LTV ratios of commercial real estate transactions in The Netherlands. Subsequently, I managed to conduct a thorough research on the determinants of the mortgage loan debt flows in the Dutch commercial real estate market.

My thesis would not have been completed without the aid and support of several people. I would like to express my gratitude to Matthieu Zuidema, my mentor at the Kadaster, not only for his continuing enthusiasm and sharing his immense knowledge, but also for the pleasant cooperation. I would also like to thank Frank van der Harst and Sander van der Veen for their support concerning the data collecting and editing process. I would like to express my appreciation to Jannes van Loon for his support in the run-up of the thesis process, as well as for his insightful comments along the way, and to Raphaël Rietema for enabling me to work with the data of CBRE and thus providing me with the opportunity to conduct this study in the first place. I would like to thank my supervisor Hans Haanappel for his continuing support, guidance and patience along my thesis process. Last but foremost, my special thanks are extended to my family: my parents for their love and unconditional support, and my brother for his encouragement and invaluable advice.

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1 Introduction

Over the last decade the real estate market has been a widely discussed topic in economics. What originally came into existence as the US subprime mortgage crisis, ended up being the onset of the global financial crisis. Driven by the US housing bubble and subsequently the dramatic devaluation of property prices and thus mortgage-related securities on the one hand and the interconnectedness of the financial system on the other hand, this crisis became one of the most severe in history. Hellwig (2009) mentioned the role of systemic risk in his research on the elements that led the US subprime mortgage crisis into the global financial crisis. The risks that are accompanied by a globally interconnected financial system, stimulated the debate to further develop macroprudential policy frameworks. Lim et al. (2011) looked at the successfulness of macroprudential instruments across different markets until 2011. Findings include that instruments of effect in diminishing systemic risk are caps on both the loan-to-value (LTV) ratio and the debt-to-income ratio, more restrictions on credit (growth), reserve requirements and capital requirements on a countercyclical basis. In other words, caps on LTV ratios are seen as an important tool in order to decrease procyclical movements of economies. Apart from more general economic policy measures, Crowe, Dell'Ariccia, Igan and Rabanal (2011) specifically looked into the real estate market. The authors argued that LTV ratio caps, in combination with other macro prudential tools such as reserve requirements, help mitigating the effect of a real estate boom and an eventual bust.

However, in order to come up with regulatory measures, a thorough understanding of – in this case – the commercial real estate market is needed. As due to its relative intransparency little is known about the commercial real estate market with regard to LTV ratios, especially in comparison to the residential market, this thesis focuses on commercial real estate transactions.

Over the last couple of years, more emphasise has been put on the financing structures that are of use within the commercial real estate market. The Dutch Central Bank (DNB), as well as the European Central Bank (ECB), is interested in the structure of real estate loans and the financial risks accompanied by it. The DNB already has a thorough overview of the mortgage debt of Dutch households and now the focus is on developing the same overview for the commercial real estate market, as well as the investors involved. More specifically, the DNB is interested in the extent to which commercial real estate exposes banks to financial risks. During and in

the aftermath of the global financial crisis, the (commercial) real estate sector had suffered substantially. However, over the past few years the real estate market shows signs of overheating. As a consequence, more banks have got involved in this market. This might result in banks taking risks into their balance sheets for relatively high prices, which might accordingly lead to severe losses in times of an economic downturn (DNB, 2017). The Dutch government has established a new legislation in which the LTV ratio limit for new mortgage loans has decreased one percentage point each year from 106% in 2012 to 100% in 2018. To be more specific, this measure is mainly for private investors that invest in a residence for the sole purpose of living there themselves only. According to Wong, Li and Choi (2011), putting a maximum on the LTV ratios is an effective macroprudential tool with regard to diminishing the systemic risk that step forward due to the boom-and-bust cycle of property markets. However, the authors argue that the effect of putting limits to the LTV ratios is larger for households than for (commercial) property market activities.

The Dutch Central Statistical Office (Centraal Bureau voor de Statistiek), together with the Kadaster, the Dutch Land Registry Office, has already established a price index for the housing market in The Netherlands. Recently, in line with the views of the DNB, the demand has increased for a similar price index for commercial real estate. Therefore, the CBS and the Kadaster have initiated a price index for commercial real estate (Kadaster, 2017).

This study focuses on the levels of debt real estate investors hold in order to finance their investment projects. As in the residential market the main and often only source of financing for households are mortgage loans, for real estate investors the liability structure often is of different nature. As mortgage lenders are usually only willing to partially cover such investments, investors have to shift their focus to other types of loans or financing transcending mortgage loans and senior debt. However, Gau and Wang (1990) argue that mortgage loans are still the main type of financing for commercial real estate investors. This study centres around the extent to which mortgage loans are addressed in commercial real estate debt financing. More specifically, the registration value of mortgage loans is used as the loan component and the transaction price as the value component in the adjusted LTV ratio. With regard to the transaction and mortgage loan data, three datasets are utilised. The Kadaster has information on the real estate market in The Netherlands, of which commercial real estate transactions can be specifically derived. Also, the Kadaster has data on the registration value of mortgage loans of properties. By merging these two datasets, the LTV ratios can be determined. In addition,

the CBRE data allows to specifically target investment transactions. Therefore, the CBRE data in combination with the comprehensive information on commercial real estate transactions of the Kadaster provides for a unique insight into the commercial real estate (investment) market in The Netherlands from 2005 until Q3 2018. For this period the real estate transactions in which business entities have been involved are assessed in combination with the registration value of mortgage loans that have been put on the one or more properties concerning the transactions. Assuming the LTV ratio as given, this thesis aims at clarifying determinants of it.

As the LTV ratios might have been affected by the period of time a transaction has taken place in, it is valuable to look at how the LTV ratios have developed over the years in the field of commercial real estate. In addition, the effect the different types of real estate have had on the LTV ratios will be assessed. Also, respectively the city and province a property is situated in will be examined. Furthermore, this study will focus on the influence foreign investors, as well as different types of investors, have on the market. In order to take into account the general development trend of the LTV ratios, there will be controlled for factors concerning regulation (i.e. Basel Accords), the ECB's overnight interest rate, the euro area business cycles and economic growth factors on both a macroeconomic (real GDP growth) and a microeconomic (commercial real estate market development) level. Appendix **A** provides for an overview of the to be assessed factors with regard to the LTV ratios.

This leads to the following research question: What factors have – and how have these factors – affected the development of LTV ratios in the Dutch commercial real estate market from 2005 until Q3 2018?

In order to test the determinants of interest for this study, GLM univariate analyses have been utilised. This procedure enabled to test the effects of different factors on the means of several groupings of the LTV ratios. Concerning these factors, the types of real estate, residential real estate, industrial real estate, and offices and retail stores show a positive effect on the LTV ratios. This effect is the largest for industrial real estate. With regard to the provinces, cities and period of time, no effects have been found. With respect to the different types of investors, the most substantial negative effect has been observed for institutional investors, followed by other collective vehicles (e.g. investment funds), private investors and property companies (e.g. REITs). Furthermore, Dutch investors positively affect LTV ratios. Additional results show a positive relation between the ECBs interest rate and the LTV ratios. A negative effect has been

observed with respect to Basel II and Basel 2.5. Furthermore, the fact that a commercial real estate transaction takes place in Friesland or Limburg drives an LTV ratio. For all the tested models the F-statistics are strongly significant. However, as the R-squared is predominantly low, the variance of the LTV ratios is only to a minor extent explained by the observed explanatory variables in this study.

As little research has been conducted on this matter (yet), after this research more is known about the development of the direct loan-structures of commercial real estate transactions among different investors. This study gives an in depth and transparent overview of how debt flows into the Dutch commercial real estate market and a better understanding about the processes at work around commercial real estate debt. In addition, this thesis provides for a thorough understanding of how, in general, the LTV ratio has developed over the years. More specifically, it contributes to the literature by means of showing interesting insights into the commercial real estate market before, during and in the aftermath of the global financial crisis, as well as how the loan structures have behaved since the ECB has initiated more regulatory constraints. Consequently, it enables policy makers to understand the commercial real estate market and subsequently helps them in determining effective regulatory measures. As stated in the research of Sørensen and Lichtenberger (2007), there are quite some differences between mortgage interest rates throughout European countries. This has on its turn effect on the capital structure of banks. This study contributes to the European-wide mortgage and commercial real estate market research by assessing the Dutch market, in which foreign investors have been increasingly involved over the years.

This thesis is organised as follows. After the Introduction in Section **1**, Section **2** continues with an overview of related research and a determination of the factors of interest. Section **3** defines the variables of interest. Section **4** reports the empirical research methodology and hypothesis formulation in order to assess the LTV ratios. Section **5** consists of an outline of the data editing and processing. In Section **6** the LTV ratios have been broken down into the explanatory variables. Section **7** provides for the data description and the tests with respect to the parametric assumptions. In Section **8**, the empirical results and further exploratory results have been denoted. Section **9** concludes and provides for the discussion and limitations of this research.

2 Literature Review

With regard to the LTV ratios used in commercial real estate transactions with respect to the different types of investors and real estate, not much research has been conducted. However, research has been published about capital structure decisions in real estate investments (Gau & Wang, 1990; Cannaday & Yang, 1996) and in real estate investment trusts (REITs) (Brown, 2000; Harrison, Panasian & Seiler, 2011; Feng, Ghosh & Sirmans, 2007; Brown & Riddiough, 2003; Pavlov, Steiner & Wachter, 2018). These studies focus on how investors structure both their financing operations and capital in order to acquire income producing properties. Every major (real estate) investment has to some extent effect on a companies' capital structure choice. Therefore, as the choice for mortgage loans in debt financing is highly related to the overall capital structure decision-making, below the theory underlying it is outlined.

2.1 Capital Structure Theory

Concerning the capital structure, a few main theories are considered. The first theory that was recognised as the capital structure theory is the Modigliani and Miller capital structure irrelevance proposition. Initially, this theory suggested that there is no difference between debt and equity regarding firm value. More specifically, all a firm does when deciding on its financing operations is reorganising cash flows among its stakeholders. Important feature is that both the firm and the investors potentially have the same options in the financial markets. Subsequently, the investor can adjust its leverage and preferences with regard to the firm's actual capital structure. Hence, firm value is not affected by capital structure (Modigliani & Miller, 1958). In general – as described by Modigliani and Miller (1958; 1963), which was later used by, among others, Jensen and Meckling (1976), DeAngelo and Masulis (1980), Myers and Majluf (1984) and Baker and Wurgler (2002) in their capital structure studies with regard to respectively agency costs, tax advantages, pecking order theory and market timing opportunities – the consensus is that the capital structure of a firm is most efficiently based on a trade-off between debt and equity, in which the cost of capital is lowered, the firm value is maximised and there is understanding that differences exist between equity and debt financing.

As markets tend to be imperfect at times, the above-mentioned irrelevance theorem in general does not hold. The initial theory may not be an actual representation of a firm's capital structure decision-making. So, other than Modigliani and Miller suggest, asymmetric information, agency costs and taxes have to be taken into account. However, Modigliani and Miller's

irrelevance proposition does serve as a recognition providing evidence for the relevance of financial structure choice. In succession of these authors' work, some main theories regarding capital structure have been published over the past decades. These theories, of which the trade-off, pecking order, market timing and signalling theory are considered to be the main theories, have each been built upon Modigliani and Miller's work. The trade-off theory is based on corporate taxes and potential bankruptcy costs, the pecking order theory follows adverse selection in its capital structure predictions, the market timing theory does not assume the existence of an optimal capital structure, but rather looks at the pattern of accumulated market timing of financing decisions in the past in order to generate a predictive capital structure and the signalling theory involves the assumptions markets make regarding a firm´s future performance with respect to a firm´s capital structure decision-making (Luigi & Sorin, 2009).

2.1.1 Trade-Off Theory

The trade-off theory considers an efficient capital structure consisting of an optimal trade-off between the benefits and costs of debt financing on the one hand and equity financing on the other. This is after adjusting for, among others, agency costs and bankruptcy costs. This theory is closely related to the Modigliani and Miller's irrelevance proposition. In contrast to the latter, the trade-off theory includes taxes that lead to more benefits regarding debt financing. Putting all other factors aside, such a strategy would end up with an optimal capital structure that would consist of debt financing only. Kraus and Litzenberger (1973) then came up with bankruptcy costs that arise with debt financing. The trade-off theory now comprises of the tax benefits of debt and the bankruptcy costs, which on its turn led to a more realistic view on the capital structure debate (Frank & Goyal, 2007). According to Myers (1984), costs of financial distress indeed have their share in the capital structure debate. Costs associated with an actual bankruptcy such as legal costs together with costs that might occur when default is close by but eventually averted, in general, are known as costs of financial distress. Generally, more risky firms, in terms of how their capital structure is organised, tend to use less financing. Also, less risky firms are considered to be able to finance more, or borrow against more pleasant rates, until the costs of financial distress balance out the tax advantages associated with borrowing. The standard trade-off theory is a useful tool to decide on capital structure. Due to the tax deduction capabilities of a firm's debt payments, in general debt financing is more appealing than equity financing. However, the more debt a company takes on, the more bankruptcy costs arise (Myers, 1984).

2.1.2 Pecking Order Theory

Another phenomenon that is involved in capital structure decision-making is the pecking order theory. Unlike the trade-off theory, the pecking order theory is not fixated on creating or replicating the best trade-off between equity and debt financing only. Myers and Majluf (1984) argued that firms, driven by adverse selection, prefer internal financing above issuing debt, consider equity issuance at last and thus tend to use internal over external financing. Starting point is that firms lean towards internal instead of external financing. Whenever a firm has run out of internal sources, it continuous its search by looking at external financing options. However, at all times the aim is to reduce the costs associated with asymmetric information. Something, that might in turn lead to adverse selection or moral hazard. Myers and Majluf (1984) state that firms have to decide carefully on what financing to use, as debt issuance might show that the stock prices are undervalued and vice versa. Part of the pecking order theory is determining the investment opportunities by means of the market-to-book ratio. But, as Myers (1984) outlined, in the initial pecking order theorem there is no consideration for the market-to-book ratio, the associated investment opportunities and the specific timing regarding the capital structure decision-making. Particularly, one would expect that a high market-to-book ratio in the past would have corresponded with more investments and thus external financing in current times. On the contrary, research shows that when during past times firms have a higher market-to-book ratio, the leverage ratio tends to be lower (Helwege & Liang, 1996).

2.1.3 Signalling Theory

Closely related to the pecking order theory is signalling theory, in which the market assumes a firm's future performance to be closely related to the firm's capital structure decision-making. A firm that is issuing debt, is comfortable to meet the interest payments, and is considered to have undervalued stock prices (Ross, 1977; Harris & Raviv, 1991). And so, firms tend to leave equity issuance aside as long it is not needed. In case at a certain point a lack of investment opportunities arises, firms often seek opportunities to save money in order to have less need for external financing in future investments. This is in line with research of Ooi (1999), in which the author outlines that firms having good news ahead tend to take on more short-term debt: evidence that supports the signalling theory.

2.1.4 The Market Timing Hypothesis

Lastly, a theory that has been developed more recently by Baker and Wurgler (2002): market timing. Within this theory, it is assumed that overvalued firms issue shares and undervalued firms conduct share repurchases. Basically, the capital structure can be predicted by looking at a firm's past behaviour regarding their share issuance and buybacks. When diving into the market timing, economic agents are either assumed to be rational or irrational. Rational agents, of which the theory was initiated in the model of Myers and Majluf (1984), suppose that a firm directly acts when relevant information has been published. This way information asymmetry is diminished, which eventually leads to higher stock prices. Irrational agents, who were part of the research of Baker and Wurgler (2002), assume stock prices to be mispriced from time to time as a consequence of irrational behaviour. So, the key feature is not anymore to predict stock prices rightfully. Firms now try to time the market itself as the market does not act rationally, which makes the (ir)rational behaviour of economic agents on itself irrelevant. To conclude, market timing is an important factor in determining the capital structure of a firm. Baker and Wurgler (2002) apply the market-to-book ratio to decide on what market timing opportunities there are for firms. Apparently, the actual changes in capital structure can be traced back to the market timing opportunities that the authors derive from the market-to-book ratio. In other words, capital structure is, to a large extent, the cumulative result of previous attempts to time the market (Baker & Wurgler, 2002).

2.2 Capital Structure in Commercial Real Estate

Above, the standard capital structure theories have been outlined. After all, capital structure comprises the total outstanding debt and equity a firm has in order to finance its operational activities. Leaving out equity, mortgage loans still only play some part in debt financing. However, within the real estate sector, mortgages play a major role in financing the investments. In this thesis, only the (registration value of) mortgage loans of commercial real estate investors are assessed in combination with the transaction price of a specific property. The question remains to what extent the capital structure theory relates to the commercial real estate market, what role mortgage loans play in the debt financing operations of real estate investors and what factors affect these debt levels.

2.2.1 Mortgage Loans

Gau and Wang (1990) state that in real estate investment, the primary source of debt financing is the mortgage market. Apart from using the underlying value of the property as collateral, also the income that can be generated from it is used as collateral by the lender of a mortgage. When mortgages are taken on, lenders typically look at both the LTV ratio and the debt coverage ratio. The latter resembles to what extent the mortgage payments put pressure on the net operating income a property is expected to generate. In 1985, the average LTV ratios for REITs that were traded on US stock exchanges was (only) 38%. However, the larger the price the larger the amount of debt financing that was used in the transaction (Gau & Wang, 1990).

2.2.2 Value and Leverage

In the literature, there is consensus concerning the positive relation between leverage and asset returns. Giacomini, Ling and Naranjo (2015) tested this for the public real estate market and found that the same positive relation between leverage and performance holds for REITs. But, REITs with a higher leverage ratio also showed more volatile returns. Hence, during the global financial crisis higher leverage led to sharper decreases in share prices. Cvijanović (2014) showed that an increase in prices of real estate, leads to higher leverage ratios for firms in general. More specifically, an increase of one standard deviation of the value of the underlying property, leads to a 3% increase in leverage. This results in lower costs of debt financing and more appealing terms regarding the issue of debt. For real estate investment funds, this effect would be even larger. In conclusion, the underlying value of, in this case, real estate, affects to a large extent the capital structure of a firm (Cvijanović, 2014).

Like Gau and Wang (1990), Feng, Ghosh and Sirmans (2007) claim that little research has been conducted on the capital structure of REITs, which is mainly caused by the regulatory environment such firms operate in. As REITs are listed, the authors looked into what extent the market-to-book ratio is related to the leverage ratio for these kinds of trusts. The authors conclude that a high market-to-book ratio corresponds with a higher leverage ratio, a process that continues in and holds for the longer term as well. However, like the earlier mentioned Helwege and Liang (1996) research, Artegiani and Morri (2015) find that the growth factor, in terms of the market-to-book ratio, has a negative effect with regard to the trade-off theory and thus that more growth opportunities do not automatically lead to more leverage. Profitable firms, who have more retained earnings, do act in line with the pecking order theory as they use less debt financing.

Jou and Lee (2011) also looked at capital structure decisions of real estate investors, but then from a real options approach. That is, instead of assuming that an investment opportunity has to happen at a certain point in time or not, like in the model of Gau and Wang (1990), now there is also an option to delay the decision and thus the investment. This approach has led to the finding that investors have the tendency to postpone an investment, other than adjusting the LTV ratio, when additional costs or higher risk associated with the investment appear.

2.2.3 Tax Deduction

Gau and Wang (1990) further argue that capital structure plays a different role in the commercial real estate sector. According to the authors, many non-corporate ownership – or sole proprietorship – firms are involved in real estate transactions. As a non-corporation is not required to pay income tax, tax deductions are not beneficial. This is the case especially in comparison to general corporate borrowers. The latter, as argued by Howe and Shilling (1988), leads as well to a reserved behaviour of REITs regarding debt financing. Since both the disappearance of the tax advantage of issuing debt, as they do not pay corporate income tax, and the competition with other debt issuers, i.e. corporations that do have beneficial lower after-tax interest costs, result in less debt financing by REITs. On the other hand, as non-corporates have limited sources available in order to raise capital, there is no option to issue shares and thus non-corporates are depending on the owner to finance its business. Also, they are confronted by capital constraints in the equity markets and thus might need to take on more debt in order to finance commercial real estate transactions (Gau & Wang, 1990). This is also acknowledged by Barclay, Heitzman and Smith (2013), who looked at the relationship between taxable and non-taxable real estate firms. More specifically, part of the research were listed firms such as REITs, but also firms that are organised as publicly traded partnerships and other real estate firms that have tax obligations. As aforementioned, real estate investors who lack the tax deduction ability are expected to take on significantly less debt. The authors argue that the leverage ratios used in taxable real estate firms are close to 5% higher than for their non-taxable equivalents. Therefore, the tax deduction abilities of firms play a minor role. According to the authors, reason for this relatively high difference is that the main drivers of the debt obligations of firms are the assets that are currently at hand and the investment opportunities. Increasing tax deductions by taking on more debt stand in the shadow of those factors (Barclay, Heitzman & Smith, 2013). This view is supported by Jou and Lee (2011) who argued that both higher tax rates and non-beneficial tax deductions lead to a higher LTV ratio and a postponed

investment. In addition, real estate investors who are subject to extra borrowing costs, are less in need for a high return, have lower past performance in which debt was included, use less debt financing in general and postpone investment projects (Jou & Lee, 2011).

2.2.4 The Global Financial Crisis

In their study about the impact the global financial crisis has had on the capital structure of real estate investors in Europe, Artegiani and Morri (2015) used the trade-off and pecking order theories to interpret the capital structure of firms before, during and in the aftermath of the global financial crisis. Findings of their study include that the size of a company positively affects the usefulness of the trade-off theory, as the larger the company the more riskless the investment is for moneylenders and because of the benefits of economies of scale when issuing debt. According to the authors, leverage ratios had increased dramatically since the onset of the global financial crisis, mainly driven by the large drop in property prices. Also, where the cost of debt has a negative effect on the willingness to take on leverage in general, after the global financial crisis this correlation turned out to be positive. Reason is that companies that were already paying higher interest rates, which thus had more debt in their books, have seen their LTV ratios increasing relatively faster due to the decline in property prices. In addition, debt refinancing is more expensive for such companies. Which led to a positive relation between the cost of debt and the amount of debt financing. Other interesting outcomes arise when looking at the post crisis period. The size factor withstands despite the fact that debt has become more expensive and real estate portfolios are in general less profitable. The rationale behind it is that the larger the assets the cheaper it is to take on debt financing, which remains in a period of economic downturn (Artegiani & Morri, 2015).

Like Artegiani and Morri (2015), Sun, Titman and Twite (2015) also conducted research on REITs' returns during the global financial crisis. They argue that the share prices of REITs were more volatile than the value of the commercial real estate during the global financial crisis. Therefore, the authors studied the risks involved in capital structure choice. The higher the leverage and the higher the share of short-term debt, the more a REIT is subject to capital structure risk. Sun, Titman and White (2015) found that REITs with more capital structure risks had a steeper decline in share prices during the global financial crisis. Also, REITs with a higher debt-to-asset ratio were more likely to sell properties and issue equity in the year 2009, a period in which real estate prices were at a depressed level. So, capital structure risk had a continuing effect on REITs in the longer run as well.

Subsequently, Pavlov, Steiner and Wachter (2018) studied whether reducing capital structure risks ahead to the global financial crisis, would have led to higher cumulative total returns for US REITs during the global financial crisis. The authors found that a reduced capital structure risk of REITs, by decreasing the debt-to-asset ratio and extending the maturity of outstanding debt in the year 2005, would have led to higher returns in the following years. In other words, REITs that altered their capital structure prior to the global financial crisis had a higher performance than REITs that did not (Pavlov, Steiner & Wachter, 2018).

2.3 Factors Affecting the Capital Structure in Commercial Real Estate

This thesis assesses several factors that are of effect in the capital structure decision-making of commercial real estate investors. More specifically, this research targets the effect of such factors on the LTV ratios in commercial real estate transactions. Below, evidence from other studies is outlined with regard to the determinants evaluated in this thesis.

2.3.1 Type of Real Estate

In a recently published outlook with regard to the environment for commercial real estate investors, Bouwinvest Real Estate Investors, a real estate asset manager, stated that there is a beneficial development in the Dutch real estate market over the years 2019 to 2021 (Bouwinvest, 2018). In general, the Dutch economy shows continuous growth and the demographical foundations are substantial as well. Especially, in comparison to other European countries. However, this process is mainly driven by urban areas. With regard to the different types of real estate, the following types have been assessed in the report: residences, retail stores, offices, hotels and healthcare real estate. For all the different real estate categories, the general view is that the growth flattens out. But, the demand for real estate by investors is still increasing. Particularly, the housing market, due to a shortage of residences, the office market, due to the growing demand for office space, the hotel market, due to a growing tourism sector and the health care market, due to the ageing of the population, drive the Dutch reals estate investment market upwards. Only the development in the retail sector is more uncertain, mainly due to growth in the online retail sector. However, driven by the expected economic growth also this subcategory is expected to positively affect the Dutch commercial real estate market (Bouwinvest, 2018). As a result, the increasing demand for these different types of real estate and thus commercial real estate in general, the LTV ratios increase as well. In some cases, a

transaction concerns a yet to be developed plot of land. As the adjusted LTV ratios are determined at the time the transaction takes place, the property status highly affects the level of the LTV ratios. Therefore, this study also assesses LTV ratios with respect to a property being either existent or new.

2.3.2 Regulation

With regard to regulation, the Basel Accords have significant effect on the business model of financial institutions throughout the financial sector. According to Gup (2004), Basel II was not going to have a substantial effect on the risk-taking behaviour of banks. In retrospective, there can be argued that the author was right as the Basel II Accord was quickly updated with the Basel 2.5 variant. However, the main point of Gup (2004) is that in the previous Basel Accords the focus is mainly on the risk weighted assets and an underlying equity capital standard. However, several off-balance sheet activities were not subject to these regulatory measures. Therefore, among others, real estate loans and subprime loans were not part of the risk weighted assets as formulated in the Basel Accords. In Basel 2.5, initiated shortly after the onset of the global financial crisis, such off-balance sheet activities were included in the regulatory measures (Gup, 2004). In the subsequent Basel Accords, the (commercial) real estate sector has been increasingly targeted with limitations with regard to the minimum equity capital standards financial institutions have to meet.

Accordingly, Cosimano and Hakura (2011) conducted research on the effect Basel III has had on bank behaviour. The global financial crisis has revealed weaknesses in Basel II rules with regard to regulation of financial institutions. Especially firms, that met de requirements of Basel II, with some loss-making off-balance sheet activities turned out to have more liquidity problems than expected. Basel III was introduced in order to make the regulations suitable again with regard to the economic environment. Findings of the authors include banks increasing their loan rates after the introduction of Basel III. However, this depended on the economy (on a country level) a bank was situated in, specific capital constraints it was subject to and equity raising costs (Cosimano & Hakura, 2011).

2.3.3 Location

DiPasquale and Wheaton (1996) argue that the location of a property is a main driver in terms of the value of a certain property. In short, the authors look at how, among other factors, location

specifications within metropolitan areas have a price effect on properties and find that locational characteristics, driven by population and economic growth factors, have a significant influence on a properties' rent and price.

Most certainly, the location effect is also present in the Dutch real estate market. Whether a property is located in a rural or urban area, an economically more developed province or city, it all contributes to the value the market assigns to a specific property.

Artegiani and Morri (2015) found no significant differences between the capital structures of firms in different European countries. In other words, with regard to the LTV ratio, it does not matter in which country a firm operates in or is registered in. Most likely, this is due to the fact that countries in the euro area are to a large extent subject to similar tax laws and regulations (Artegiani & Morri, 2015). Harrison, Panasian and Seiler (2011), as well as Zarebski and Dimovski (2012) and Westgaard, Eidet, Frydenberg and Grosås (2008), have come up with similar results for the markets in the US, Australia and the UK respectively. In other words, there seem no differences in the effects some determinants have on the capital structure of firms. The evidence regarding the negative relation between profitability and growth opportunities on leverage on the one hand and the positive correlation between size and leverage on the other hand, holds for the euro area, the US and Australia.

2.3.4 Investor Type

Artegiani and Morri (2015) looked into different types of investors in the real estate market. More specifically, they introduced a 'type' factor that separated REITs and traditional property companies. Regarding the REITs and other property companies, there can be concluded that REITs are less appealed to debt financing, as a result of less tax deduction benefits, no matter what environment the economy is in.

Another type of investor within the commercial real estate sector is a private equity real estate investment fund. Alcock, Baum and Colley (2013) dug into the potential effect leverage has on the performance of such funds. Other than most REITs, as previously discussed, private equity funds do have tax benefits from debt financing. The authors examine whether a high level of leverage increases excess fund returns and conclude that, on average, this holds for private equity real estate funds. However, the performance of such funds is to a large extent correlated with the returns generated in the underlying real estate market. In addition, as suggested by the

negative performance of Jensen's alpha, the returns diminish as a result of market frictions such as fees and transaction costs. Also, the authors found that leverage is not enhancing performance in the longer run, as well as in the short run where the excess returns of such funds do not benefit from leverage adjusted to expected market conditions (Alcock, Baum & Colley, 2013).

Apart from REITs, private equity real estate funds and other (listed) real estate funds, institutional investors also play a significant role in in the commercial real estate market. Certainly, since institutional investors invest an increasing share of their portfolio in alternative assets such as real estate. Worldwide, about three-quarter of the pension funds invests in real estate, with the share being even larger in The Netherlands. From the real estate investments of pension funds, a part goes into REITs, but also directly in fixed assets. In addition, larger pension funds tend to earn a higher return than their smaller equivalents. The main reason for this is that the larger funds invest a larger share internally, thus directly, in real estate (Andonov, Eichholtz & Kok, 2015). Consequently, the share of direct real estate investments is expected to increase in future times.

As in a transaction there is an acquirer and a transferor, apart from the type of investor the type of vendor also takes part in the assessment of the LTV ratios. Since the same subcategories are recognised between these investors, differences are not expected in composition of transactions with regard to the acquirers and the transferors. However, changes might appear in the exchange between these investors with respect to the development of the LTV ratios over time.

2.3.5 Nationality of Investor

According to Lieser and Groh (2014) in international commercial real estate investing, regulatory limitations affect the supply of capital on the one hand and the demand conditions on the other of a particular real estate market. Hence, countries that have an attractive regulatory regime tent to have more involvement of foreign investors in their real estate market.

Over the past few years, both foreign investors and moneylenders seem to be highly interested in the Dutch commercial real estate market. According to ABN Amro (2015), as published in their report on the fund flows in the Dutch commercial real estate market, the share of foreign investors has increased dramatically over the last couple of years. In comparison to other European countries, The Netherlands has increased interest from foreign investors. The main

reason is the difference between the initial yield on real estate and the yield on the Dutch 10-year government bond of about 5.7% in 2014. Where in the period between 2004 and 2012, Dutch investors were responsible for 70% of the Dutch real estate transactions, in 2013 and 2014, foreign investors took care of 66% of the transactions. Hence, the share of Dutch investors in the real estate market has decreased dramatically from 70% to 34%. (ABN Amro, 2015). With the entrance of more foreign influence, the LTV is expected to shift upwards accordingly.

2.3.6 Economic Environment

Chin, Dent and Roberts (2006) argue that countries having both a stable property market and a stable economic environment, appeal to foreign real estate investors. This holds the same for growth of the gross domestic product, as this is an important determinant for commercial property performance and thus the overall attractiveness of a commercial real estate market (Hoskins, Higgins & Cardew, 2004). In this study the real GDP growth is utilised as a control variable with regard to the effect of overall economic growth on developments in the commercial real estate market.

McCue and Kling (1994) conducted research on real estate returns and its relation to the economic environment. From the factors that were included in the research, the nominal interest rates had the greatest effect on the variance that was shown in the real estate returns. Therefore, the overnight interest rate of the ECB is a valuable measure to control for in this study.

The Centre for Economic Policy Research (CEPR) assesses different business cycles in the euro area economy. As, besides the economic growth, the real estate market is also affected by the more broadly focused business cycles an economy is in, these cycles of the CEPR have been added to the research. With regard to the time-period of the research, it is primarily interesting to look at the data before, during and in the aftermath of the global financial crisis. Especially, since the price levels as well as the number of transactions in the commercial real estate markets are influenced by the general state an economy is in. Therefore, the CEPR has been consulted. The CEPR Euro Area Business Cycle Dating Committee determines when an economy, or economic activity, is either in a ‘peak’ or a ‘through’. The period between a peak and a through is classified as a recession and the phase between a through and a peak is recognised as a period of expansion. When defining the economic cycles, there are no specific determinants used by the Committee. In other words, indicators ranging from GDP measures to employment rates are considered in order to provide for the business cycle data of the Committee. The findings

of the Business Cycle Dating Committee of the CEPR are based on the euro area economy (Centre for Economic Policy Research, 2018).

2.3.7 Time and Trend Development

Since the number of transactions and the subsequent transaction prices and mortgage loans are time dependent, the state of an economy, the trend development of the real estate markets and thus the time have effect on these factors. The number of transactions therefore is highly biased by the time the transactions have taken place in, adding the development trend contributes to the assessment of the LTV ratio. Both the transaction volume and the number of transactions represent the development trend of the LTV ratio, as these factors affect the LTV ratios directly. These two factors will be retrieved from the commercial real estate investment database of CBRE. In addition, The STOXX Europe 600 Real Estate Cap index acts as an explaining factor for publicly traded real estate securities and thus controls for the overall development of the real estate markets. The index comprises the main real estate companies, REITS, listed property trusts and companies involved in real estate holding and development. In other words, the index covers most of the publicly traded commercial real estate investors and therefore is expected to, in addition to the commercial real estate volumes and number of transactions, act as a valuable predictor of the development of the LTV ratios.

2.4 Conclusion

Section **2** provides for an introduction to the capital structure theory specifically aimed towards the commercial real estate market. Also, it introduces factors that are of influence in the capital structure decision-making of real estate investors and subsequently how these factors affect the LTV ratios in the commercial real estate market.

At first the Modigliani and Miller capital structure irrelevance proposition has been outlined, followed by the main capital structure theories that were based thereon. The trade-off theory, pecking order theory, signalling theory and market timing theory were respectively assessed to the commercial real estate market by looking at how the value of assets and tax deduction abilities affect debt financing decisions in commercial real estate. The higher the value of a property the higher the debt levels in general. As not all types of real estate investors have tax obligations, in certain cases tax deduction is not a relevant consideration in the decision for debt financing for real estate investors.

In addition, different determinants in the capital structure decision-making process of commercial real estate investors are further explained with a specific aim towards the extent to which the mortgage markets are addressed in commercial real estate investments. According to the reviewed literature, factors on both the microeconomic and macroeconomic level eventually affect LTV ratios in commercial real estate. Factors such as the investor type and nationality, the type of real estate and the location all directly affect the extent to which a mortgage loan is part of a certain real estate investment. Subsequently, the LTV ratios are also subject to determinants as regulatory measures and the economic environment. Factors with respect to the economic environment include economic growth, in terms of real GDP growth, the overnight interest rates of the ECB and the business cycle an economy is in at the time a commercial real estate transaction takes place.

This Section has clarified the theory underlying capital structure decision-making in the commercial real estate market. In the remainder of this thesis the above-mentioned factors will be assessed and utilised in order to explain fluctuations of LTV ratios of commercial real estate transactions that have taken place between 2005 and Q4 2018. In accordance with the literature in Section **2**, Section **3** provides for an overview of the variables of interest with regard to this thesis.

3 Variables

Apart from the transaction price and mortgage loan data in order to determine the LTV ratios, other information has been retrieved from the respective databases of the Kadaster and CBRE. These determinants are all related to the LTV ratios in a certain way and are therefore of relevance concerning the evaluation of the LTV ratios. Section **3** provides for an overview of the to be assessed dependent variable and independent variables.

3.1 LTV Ratio

The dependent variable is this study is the LTV ratio. In general, the LTV ratio is referred to as the mortgage loan amount as percentage of the appraised value of the property. Where the mortgage amount is the exact amount of the mortgage loan on a property and the appraised value of the property is the appraised value at the time of determining the LTV ratio. A definition that is used, among others, by the ECB (ECB, 2018).

For this thesis an adjusted LTV ratio is utilised, since in general the exact amount of the mortgage is not (publicly) available and the appraised value of a property is hard to use as measure due to the fact that it is impractical to appraise a property every time the LTV ratio is determined. Therefore, the registration value of mortgage loans is used instead of the appraised value. This data is available at the Kadaster. Also, the transaction price of a property is used instead of the appraised value. This data is available, for the commercial real estate transactions specifically, at CBRE and the Kadaster.

This results in the following formula:

$$Loan\text{-}to\text{-}Value\ Ratio = \frac{Registration\ Value\ of\ a\ Mortgage\ Loan}{Transaction\ Price\ of\ a\ Property} \quad \textbf{(1)}$$

3.2 Kadaster Type of Real Estate

The LTV ratios are expected to differ among the different types of real estate. From houses or apartments, to offices or retail stores, financial institutions address a different risk profile to them which affects the level of the LTV ratios. In combination to other factors such as the location of a property, this variable provides for more insights on the LTV ratios with respect to the different types of real estate. Generally speaking, the different types of reals estate can be divided in to the following scales of LTV ratios: commercial buildings between 35% and 50%, retail stores between 50% and 60%, offices between 60% and 70% and residences between 70% and 80%. These values represent the LTV ratios over the past few years. However, in previous years the LTV ratios have been significantly higher. Especially, in the pre-crisis period. Nevertheless, over all the years the type of real estate is determinative in the level of the LTV ratios. In this study, the different types of real estate of the Kadaster dataset have been defined as follows:

i) industrial (industrial, glass house, utility property, commercial, agricultural, waterworks buildings and other structures);
ii) offices and retail stores (offices, food and beverage industry and retail stores;
iii) residential (apartments, recreation and a residence including a commercial building);

iv) other (storage facility, special object, cultural, health care, religious, education, public transport, parking facility, police and fire brigade, recreation and sport, and funeral)

3.3 CBRE Type of Real Estate

Similar to the previous variable concerning the type of real estate as registered by the Kadaster, CBRE also appoints functionalities to their registered investment transactions. The same kind of effects are expected for the types of real estate of both the Kadaster dataset and the Kadaster-CBRE dataset. The types of real estate of the Kadaster-CBRE dataset have been divided as follows:

i) hotel;
ii) industrial
iii) office;
iv) residential;
v) retail;
vi) any combination of i), ii), iii), iv) and v);
vii) other.

3.4 Property Status

The property status variable states whether a property is either new or existent. In other words, this variable clarifies if the acquired plot of land is to be developed or if an actual property has been purchased. Since the eventual Kadaster and Kadaster-CBRE datasets have been subjected to a limited range of LTV ratios, mostly existing properties are expected to take part in the research. However, this variable might still provide for an assessment of the LTV ratio with regard to the property status.

3.5 Period of Time

Since the number of transactions and the subsequent transaction prices and mortgage loans are time dependent, the state of an economy and thus the time has effect on these factors. This variable explains how the time factor affects the LTV ratio and assesses the LTV ratio on a yearly basis.

3.6 Regulation

The variable regulation will be assessed by means of a dummy variable. This dummy variable on regulation examines the influence regulation has had on the LTV ratios, by looking at different time frames in the sample period. This is measured as a dummy for the period new regulation has become active in. In this thesis, with regard to regulation, Basel II, Basel 2.5 and Basel III are utilised as cut-off points for the respective time frames. By assessing the Basel Accords, the influence the capital and liquidity requirements have on the operations of financial institutions are determined. Basel IIs release date was in 2004, with 2007 as implementation date. Basel 2.5, an updated version of Basel II, was initiated right at the onset of the global financial crisis in 2009 and had as ultimate implementation date in the beginning of 2011 (BIS, 2014). The implementation of Basel III has become effective at the start of 2013 and the implementations of all requirements need to be in place at the latest in 2019 for all member states (BIS, 2010). Member states are ranging from the US to basically all countries in the euro area including The Netherlands and are all, in principle, subject to the regulatory requirements as set by the Basel Committee on Banking Supervision (BCBS). Consequently, the following cut-off points will be used in this study:

i) Basel II: from January 1, 2007 to January 1, 2011;
ii) Basel 2.5: from January 1, 2011 to January 1, 2013;
iii) Basel III: from January 1, 2013 until now.

These sample periods are considered to be in the sphere of influence of the respective Basel Accords. Basel IV, the informal term for the latest adjustments of the post-crisis reforms of Basel III, only materialises from 2022 on (BIS, 2017).

3.7 Location

The location variable gives insights into the different developments in the market in several regions in The Netherlands. Real estate transactions from the G4, Amsterdam, Rotterdam, The Hague and Utrecht, will be compared to the rest of the country. Also, the different provinces will be assessed. It is valuable to examine how the LTV ratios translate into the different parts of The Netherlands, keeping in mind the popularity in the different regions in terms of transactions. By means of this variable, a clear distinction can be made between the debt levels in the different regions. In this study the following distinctions have been made with regard to the location:

i) G4: a dummy variable identifying a transaction in a G4 city;

ii) City: a variable stating whether a transaction has taken place in Amsterdam (1), Den Haag (2), Utrecht (3), Rotterdam (4) or other and thus not G4 (5);

iii) Province: a variable assigning a province to the transactions: Drenthe (2), Flevoland (3), Friesland (4), Gelderland (5), Groningen (6), Limburg (7), Noord-Brabant (8), Noord-Holland (9), Overijssel (10), Utrecht (11), Zeeland (12) and Zuid-Holland (13).

3.8 Type of Investor

This variable will show how the LTV ratios differ among the investors in the market and thus how that has influence on the level of the LTV ratios. As aforementioned in the literature review, capital structure-choice is a decision-making process that is unique to the economic environment, but also to the kind of investor and the specific investment project. Investors ranging from institutional investors such as pension funds, insurance companies, sovereign wealth funds and REITs, to family offices, private investors and private equity funds, have different investment goals and beliefs. Pension funds invest their money in order to meet their future obligations with regard to their liabilities, whereas private equity funds invest in order to gain a high return in the short run in order to meets its investors' expectations. The one mainly uses the capital at hand in its outstanding investments, where the other utilises leverage to expand its investment capital and portfolio. In other words, the different types of investors that play their part in commercial real estate, have different debt financing structures. This relation, between the type of investor and the LTV ratios, is to be further assessed. The different types of investors have been divided into the following subgroups:

i) institutional investors: institutional fund, insurance company, pension fund and souvereign wealth fund;

ii) all other collective vehicles: property fund, investment fund, limited partnership, closed-ended fund, open-ended fund and special fund;

iii) private investors: private investor, bank and syndicate;

iv) property company: developer, REIT, private property company, property company, unlisted property company, housing association, listed property companies;

v) other: occupier, corporate, public sector, asset manager, hotel operator and repossession.

3.9 Nationality of Investor

The nationality of the investor allows to assess to what extent the involvement of foreign investors (and subsequently lenders) has increased in the Dutch commercial real estate market and whether this has had effect on the LTV ratio. As previously mentioned, ABN Amro (2015) stated that the share of foreign investors has increased dramatically in the Dutch commercial real estate market. With the entrance of more foreign investors, the extent to which this has effect on the level of the LTV ratios can be assessed. The variable concerning the nationality of the investor has been regrouped into two categories:

i) The Netherlands;

ii) other: Austria, France, Germany, Ireland, Sweden, the UK and the US.

The dummy variable concerning the nationality of the investor, states whether the investor is from The Netherlands or from a different country.

3.10 Type of Vendor

The type of vendor is a variable of interest as it controls for the exchange between acquirers and transferors. As it might not directly affect the LTV ratio, it does have effect on the extent to which a certain type of investor is involved in a particular transaction at a certain point in time. Since the different vendor types directly match with the types of investors, this relation could have effect on the timing and composition of transactions, and thus eventually on the LTV ratio. In addition, this variable provides for an overview of the extent to which certain types of vendors and investors are involved in commercial real estate transactions at a certain point in time and is thus able to evaluate the commercial real estate markets in terms of both the transferors and the acquirers.

3.11 Real GDP Growth Rate

This control variable is included in terms of quarterly percentage changes. It provides for an Indication of overall economic growth. As used by, among others, Barro (1991), (real per capita) GDP growth is considered to be an appropriate reference for economic growth. The latter is especially acknowledged at a country level. By means of the GDP growth the development of the LTV ratios can be assessed to the economic environment a certain transaction has happened in. The data has been retrieved from Eurostat (Eurostat, 2019). Appendix **B** shows the real GDP growth per quarter over the years 2005 until Q3 2018.

3.12 The ECBs Interest Rate

This control variable comprises the interest rates concerning the main refinancing operations (MRO) of the ECB. As account settlement is costlier for banks when the overnight interest rate is at a higher level, banks adjust their rates in order to compensate for it. Hence, this affects mortgage rates and thus the LTV ratios as well. McCue and Kling (1994) conducted research on real estate returns and its relation to the economic environment. From the factors that were included in the research, the nominal interest rates had the greatest effect on the variance that was shown in the real estate returns. Therefore, the overnight rate is a valuable measure to control for. In Appendix **C** the interest rate decisions on the MRO of the ECB have been outlined for the period of concern in this study. The data has been retrieved from the ECB (ECB, 2019)

3.13 The CEPR Business Cycles

The business cycles, as determined by the CEPR Euro Area Business Cycle Dating Committee, are utilised as a control variable in order to assess how a certain state an economy is in, either a period of expansion followed by a peak or a recession followed by a through. The CEPR recognises the first quarter of 2008 as a peak, when after a recession started, which lasted until the second quarter of 2009, after which a period of expansion started. This through lasted until the next peak in the third quarter of 2011, which was followed by another through in the first quarter of 2013. From 2013 on, the euro area economy is in a period of expansion. Starting from January 2005, in which the economy was in a through, these peaks and throughs will be incorporated in this study by means of a dummy variable for a period of expansion (1) and a period of recession (0) respectively. (CEPR, 2018).

3.14 Commercial Real Estate Investment Volume

This control variable enables to evaluate to what extent the transaction volume affect(s) the LTV ratio. As stated by Cvijanović (2014), there is a positive relation between prices of real estate and leverage ratios for firms in general. Therefore, the higher the transaction volume and thus the transaction price, relative to the number of transactions, the more investors are expected to have taken on debt financing. As the transactions are already subject to the certain period in time the deal took place, this variable enables to control for the trend in the commercial real

estate market in terms of the total transaction volume with regard to the LTV ratio. The data for this variable has been gathered on a quarterly basis from the CBRE database.

3.15 Commercial Real Estate Number of Transactions

Similar to the variable concerning the commercial real estate investment volume, this control variable assesses the LTV ratios with regard to the number of transactions registered in the commercial real estate investment market. As the number of transactions tend to differ over time, affected by the general state of the economy, this variable explains how the trend of the number of transactions has effect on the LTV ratio. The data has been assembled on a quarterly basis from the CBRE database.

3.16 STOXX Europe 600 Real Estate Cap

The development of the financial markets with regard to real estate (investment) companies comprise to a large extent the general state of the economy and the real estate market in particular. Therefore, this control variable is a valuable predictor of the LTV ratio in terms of controlling for the development trend of the real estate markets. The STOXX Europe 600 Real Estate Cap is a real estate index containing major real estate firms with publicly traded securities. This index consists of real estate companies, REITS, listed property trusts and stocks of firms involved in real estate holding and development. The variable comprises the percentage change in the quarterly price returns of the STOXX Europe 600 Real Estate Cap (STOXX, 2018).

3.17 Conclusion

Section **3** has provided for an overview of the to be assessed dependent variable and independent variables. Section **4** continues with the methodology by describing the model specification, the resulting hypotheses and the specified to be analysed models concerning the assessment of the determinants of the LTV ratios.

4 Methodology

Section **4** discusses the methodology of use in this thesis. In addition, this Section provides for a specification and formulation of both the models and hypotheses in order to assess the LTV ratios in the commercial real estate market with respect to the literature review in Section **2**.

For this study, a general linear model (GLM) univariate analysis has been used. This procedure allows to apply both a regression analysis and an analysis of variance, with regard to only one dependent variable and multiple explanatory variables. The LTV ratios in this study are subject to several characteristics as location and the period of time. Therefore, the different dependent variables can rather not be seen as individual units but as grouped cases of LTV ratios. As the dependent variable in this study is highly affected by the data structure, a GLM univariate analysis enables to test the effects of different factors on the means of several groupings of the LTV ratios. In other words, due to the division of the factors affecting the LTV ratios, grouped cases of LTV ratios help explain the caused variation. Without controlling for groupings of the LTV ratio, unexplained variation will emerge. By means of grouping the dependent variable, a clearer understanding appears of whether the LTV ratios differ (at certain points in time) due to the independent variables or due to the level of the LTV ratios in general. As a result, the GLM univariate analysis will lead to a clearer assessment of the LTV ratio.

For both the Kadaster dataset and the Kadaster-CBRE dataset respectively Formulas **(4)** and **(5)** comprise the variables of effect in the analysis. Only adjustments are being made with regard to the composition of the models, meaning that there are exchanges between fixed factors and covariates in order to explain the effects of different variables on the means of varying groupings of LTV ratios. In other words, the outlined models differ in terms of the independent variables of interest, the fixed factors, and are further explained by other observed (control) variables, the covariates.

Adding year effects to the model, prevents the outcomes of a regression from being affected by time(-series) trends that are not necessarily being recognised by the model itself. Variables might seem causally related but are in fact highly influenced by other forces than the ones explained in the model. Also, with regard to this study, as the LTV ratio (the dependent variable) decreases over time since the global financial crisis, controlling for year effects mitigates the influence of this downward trend on the explanatory variables and thus the outcome of the model. Therefore, in this study there will be controlled for the variable concerning the period of time as a fixed factor, Model **3**, and as covariates, in Models **4**, **5** and **6**. According to Lu and White (2014), it is valuable to look at how the main regression coefficient estimates react whenever one or more regressors are left out of the equation. In this

light, several exchanges have been made between fixed factors and covariates in the different models. This has led to the various models as outlined below in Section **4.2**.

In order to examine the validity of the outcomes concerning the factors of interest with regard to the level of the LTV ratios, there will be checked for linearity, independence, normality and equal variance of the residuals with regard to the dependent variable.

4.1 Model Specification

Now the determinants of the LTV ratios have been outlined, as well as their theoretical influence on the capital structure of real estate investors and thus the LTV ratio, the next step is to conduct quantitative analysis on these factors with regard to the level of the LTV ratios over time.

Firstly, the LTV ratios (dependent variable *Yi*) have been determined in order to give an overview of how the LTV ratios of Dutch real estate transactions have developed over time since 2005 until Q3 2018. Secondly, the factors affecting the LTV ratios are assessed. The assessment of the LTV ratios will be conducted by multiple GLM univariate analyses, which will be applied to the Kadaster dataset and Kadaster-CBRE dataset respectively. The following variables comprise the evaluation of the LTV ratios in the Kadaster dataset:

> *LTV ratio = f (Kadaster type of real estate, period of time, regulation (Basel II, Basel 2.5 and Basel III), location (G4, city and province), real GDP growth rate, the ECB interest rate, CEPR business cycles, commercial real estate investment market volume, number of transactions in the commercial real estate investment market and the STOXX Europe 600 real estate cap).* **(2)**

Subsequently, the variables below will be assessed from the Kadaster-CBRE dataset:

> *LTV ratio = f (CBRE type of real estate, regulation (Basel II, Basel 2.5 and Basel III), location (G4, city and province), real GDP growth rate, the ECB interest rate, CEPR business cycles, commercial real estate investment volume, number of transactions in the commercial real estate investment market and STOXX Europe 600 real estate cap, property status, type of investor, nationality of investor and the type of vendor.* **(3)**

So, the starting point is the LTV ratio of commercial real estate transactions. A GLM univariate analysis procedure is used to assess the factors that affect the LTV ratio. The GLM univariate model for the Kadaster dataset may be specified as:

$$Yi = \beta_0 + \beta_1 X1i + \beta_2 X2_i + \gamma_3 D3_i + \gamma_4 D4_i + \gamma_5 D5_i + \gamma_6 D6_i + \beta_7 X7_i + \beta_8 X8_i + \beta_9 X9i + \beta_{10} X10_i + \beta_{11} X11i + \beta_{12} X12_i + \beta_{13} X13i + \beta_{14} X14_i + \varepsilon_{i.} \quad \textbf{(4)}$$

The GLM univariate model for the Kadaster-CBRE dataset may be specified as:

$$Yi = \beta_0 + \beta_1 X1i + \beta_2 X2_i + \gamma_3 D3_i + \gamma_4 D4_i + \gamma_5 D5_i + \gamma_6 D6_i + \beta_7 X7_i + \beta_8 X8_i + \beta_9 X9i + \beta_{10} X10_i + \beta_{11} X11_i + \beta_{12} X12_i + \beta_{13} X13_i + \beta_{14} X14_i + \beta_{15} X15_i + \beta_{16} X16_i + \beta_{17} X17_i + \beta_{18} X18_i + \beta_{19} X19_i + \varepsilon_i \quad \textbf{(5)}$$

Where:

β_0	is the Y-intercept;
$\beta_1 - \beta_2$	are the coefficients of Kadaster type of real estate and period of time;
$\gamma_3 - \gamma_5$	are the coefficients of the regulation variables Basel II, Basel 2.5 and Basel III respectively;
γ_6	is the coefficient of the G4;
$\beta_7 - \beta_8$	are the coefficients of city and province;
$\beta_9 - \beta_{14}$	are the coefficients of real GDP growth rate, ECBs overnight interest rate, CEPR business cycles, commercial real estate investment volume, number of transactions in the commercial real estate investment market and STOXX Europe 600 real estate cap.
$B_{15} - \beta_{18}$	are the coefficients of CBRE type of real estate, property status, investor type, nationality of investor and vendor type.
$X1 - X2$	are the predictive variables of the type of real estate and period of time;
$D3 - D5$	are the dummy's concerning the period of regulation a transaction is subject to;
$D6$	is the dummy variable with regard to whether transactions take place in a G4 city or not;
$X7 - X8$	are the predictive variables of city and province;
$X9 - X14$	are the control variables of real GDP growth rate, ECBs overnight interest rate, CEPR business cycles, commercial real estate investment

volume, number of transactions in the commercial real estate investment market and STOXX Europe 600 real estate cap.

X15 – X19 are the predictive variables of CBRE type of real estate, property status, investor type, nationality of investor and vendor type.

ε_i is the stochastic error term of a particular LTV ratio with respect to a certain transaction.

4.2 Hypotheses Formulation

According to the literature in Section **2**, several factors are of interest in the assessment of the LTV ratios. Different grouped cases have been observed in the varying types of real estate, the location in terms of the province, city and whether the property that is part of a transaction is located in the G4 or not. In addition, the time and trend development are expected to define the level of LTV ratios over time. Therefore, the period of time will also be further assessed. Hence, the following hypotheses will be tested by means of the Kadaster dataset:

H1a Residential real estate has a positive effect on the LTV ratios.

H1b Industrial real estate has a positive effect on the LTV ratios.

H1c Offices and retail stores have a positive effect on the LTV ratios.

H2 The period in time has a positive effect on the LTV ratios.

H3 The provinces Noord-Holland, Zuid-Holland and Utrecht have a larger effect on the LTV ratios than the other provinces.

H4 The positive effect of Amsterdam, 's Gravenhage, Utrecht and Rotterdam on the LTV ratios are larger than in the other cities.

H5 The positive effect of the combined G4 cities on the LTV ratios is larger than non G4 cities.

Hypotheses **H1a**, **H1b** and **H1c** have been formulated in accordance with the literature in Sections **2.3.1** and **5.4.4**. **H2** corresponds with Section **2.3.7** and **H3**, **H4** and **H5** relate to the theory in Section **2.3.3**.

The GLM univariate analyses Models **1** to **6** below will be used in order to test the above-mentioned hypotheses **H1** to **H5**. These models, in which all variables are included as outlined in Formula **(2)**, correspond to Formula **(4)**. Only in Models **1** and **2**, the variable period of time has been excluded.

With regard to the Kadaster dataset, the following models will be tested:

*Model **1*** with Kadaster type of real estate as fixed factor;

*Model **2*** with Kadaster type of real estate and location in terms of province as fixed factors;

*Model **3*** with Kadaster type of real estate, location in terms of province and period in time as fixed factors;

*Model **4*** with Kadaster type of real estate and location in terms of province as fixed factors and period in time added as covariate;

*Model **5*** with Kadaster type of real estate, location in terms of province and city as fixed factors and period in time added as covariate;

*Model **6*** with Kadaster type of real estate, location in terms of province and the G4 as fixed factors and period in time added as covariate.

With respect to the above-listed models: all remaining variables, other than the mentioned fixed factors, have been included in the models as covariates.

In addition to the previous models, the Kadaster-CBRE dataset enables to assess the nationality and type of investor with respect to the LTV ratios. Also, as CBRE registers different types of real estate, the CBRE type of real estate will also be further evaluated. As a result, the hypotheses below will be tested utilising the Kadaster-CBRE dataset:

H6 The CBRE type of real estate has a positive effect on the LTV ratios.

H7 The provinces Noord-Holland, Zuid-Holland and Utrecht have a larger effect on the LTV ratios then the other provinces.

H8 The positive effect of the combined G4 cities on the LTV ratios is larger than non G4 cities.

H9a The nationality of the investor has a positive effect on the LTV ratios.

H9b The Dutch nationality of the investor has a positive effect on the LTV ratios.

H10a The investor type has a positive effect on the LTV ratios.

H10b From the types of investor the positive effect of all other collective vehicles > property companies > private investors > institutional investors.

From the above-listed hypotheses, **H6** has been formulated with respect to the literature in Sections **2.3.1** and **5.4.4**. **H7** and **H8** concern the theory in Section **2.3.3**. Hypotheses **H9a** and

H9b have been drawn up in accordance with Section **2**.**3**.**5**. **H10a** and **H10b** relate to the theory in Section **2**.**3**.**4**.

The GLM univariate Models **7** to **11** will be used in order to test hypotheses **H7** to **H10**. The models correspond to Formula **(5)**, of which the explanatory variables have been outlined in Formula **(3)**.

Concerning the Kadaster-CBRE dataset, the following models will be tested:

*Model **7***	with G4 as fixed factor;
*Model **8***	with location in terms of province as fixed factor;
*Model **9***	with nationality of investor as fixed factor;
*Model **10***	with investor type as fixed factor;
*Model **11***	with CBRE type of real estate and investor type as fixed factors.

Concerning the above-mentioned models: apart from the fixed factors, all remaining variables have been included as covariates.

4.3 Conclusion

This Section has provided for a description of the methodology by providing for an outline of the GLM univariate analyses of use in this study, as well as specifying the models and formulating the hypotheses in order to assess the determinants of the LTV ratios with respect to the literature.

As the LTV ratios in this study are subject to several characteristics, the different dependent variables can rather not be seen as individual units but as grouped cases of LTV ratios. Therefore, general linear model (GLM) univariate analyses have been used. Such a procedure allows to apply both a regression analysis and an analysis of variance, with regard to only one dependent variable and multiple explanatory variables. In order to test the hypotheses as specified in Section **4**.**2**, GLM univariate analyses have been conducted on the different models as specified in Sections **4**.**1** and **4**.**2**.

As the data is not publicly accessible, Section **5** continues with an overview of the data collection process, as well as a breakdown of the steps taken in order to generate datasets that are fully applicable with respect to the commercial real estate transaction market.

5 Data

At this point, the relevant literature has been reviewed and accordingly the variables of interest have been described. In addition, the models have been specified and the hypotheses have been formulated concerning the assessment of the LTV ratio. Section **5** provides for an outline of the data collection and editing process and specifies the series of steps that have been taken in order to assemble the eventual Kadaster dataset and Kadaster-CBRE dataset.

As the data is not fully publicly available, i.e. there are no databases comprising relevant data for this study, the sample data for this study has been collected manually. Initially, the data consists of three databases: data on commercial real estate transactions since 2005 in The Netherlands, a database containing the registered mortgages with regard to commercial real estate transactions in The Netherlands and a transaction database of commercial real estate transactions that are labelled as investment transactions in The Netherlands since 2005. The former two databases are from the Kadaster and the latter one is from CBRE.

The Kadaster registers from the plots of land and thus from real estate throughout The Netherlands which (ownership) rights belong to whom. A change of ownership, or transaction, needs to be shared with the notary. The latter establishes and conveys the deed of sale to the Kadaster, where the transaction is then registered. Only when a business entity that owns one or more properties is traded on itself, a transaction is not registered. Certain transactions are not regarded as a real estate transaction, as there is no legal change in ownership. Consequently, the Kadaster has information on real estate transactions. Subsequently, the mortgages that belong to a certain property are registered as well. Each transaction has a unique identification code. The difficulty lies in collecting and grouping both the transaction and mortgage data into one compiled row of information, leaving aside matching the transaction and mortgage databases in order to determine the LTV ratios.

All data has been merged in order to generate two datasets consisting of commercial real estate (investment) transactions, including transaction prices and mortgage loan data. The first dataset is built upon Kadaster data only and covers commercial real estate transactions. The second dataset comprises both specific commercial real estate transaction data and mortgage loan data of the Kadaster, as labelled by CBRE. Below, the data collection process is further specified.

5.1 Kadaster Data

The first database is the transaction database of the Kadaster. From this database relevant data on commercial real estate transactions in The Netherlands have been retrieved. In principle, the Kadaster registers a transaction when there is a legal change in ownership of the property. Meaning that most transactions are registered, but transactions in which the business entity that owns one or more properties is transferred itself including the underlying real estate portfolio are not. From all real estate transactions that have been registered since 2005, the non-commercial transactions are left out. More specifically, the following selection criteria have been made:

i) at least either the acquirer or the transferor is a business entity;
ii) it concerns a deed of sale with the property transfer being either voluntary or involuntary;
iii) the plot of land has either an indication that properties are already present, or the owner has the right to develop it.

Transactions between two natural or legal persons are only included when: more than five plots of land are part of the transaction or when part of the underlying real estate of a transaction is utilised for business activities. In other words, applying these selection criteria leads to the commercial real estate transaction database (OV20) of the Kadaster.

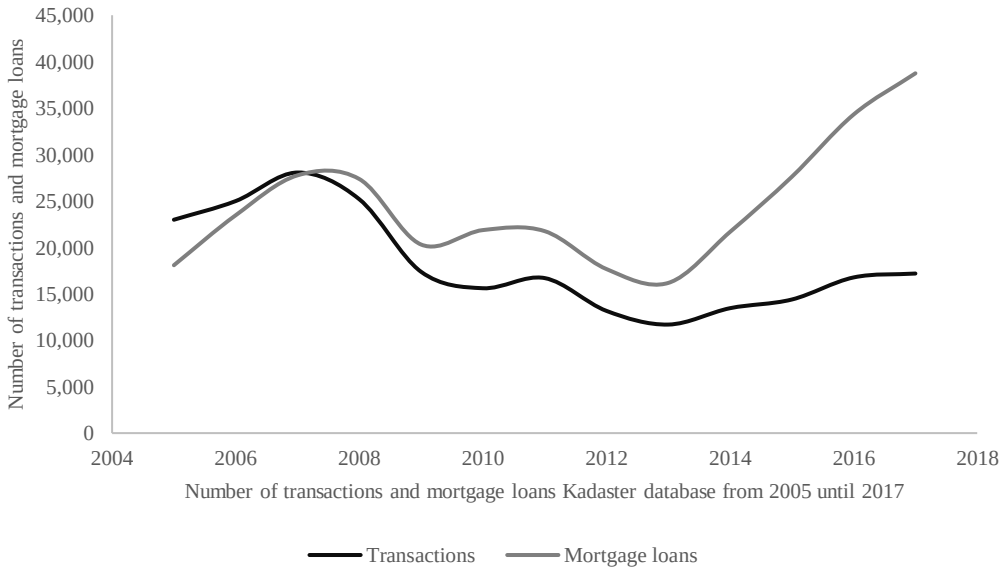
The second database is the mortgage loan database (HYK) of the Kadaster. This database is utilised to enrich the transaction data from the first database with data on the registration value of mortgage loans. The mortgage database comprises the mortgage registrations since 2005, with the same selection criteria as the commercial real estate transaction database.

Figure **1** shows the number of transactions and mortgage loan registrations that have taken place between 2005 and 2018. The development of the transactions shows an interesting yet expected trend. With an upward trend until 2007, the number of commercial real estate transactions decreased dramatically in the wake of the global financial crisis in order to recover only from 2013 onwards.

Another interesting feature of Figure **1** is the rapidly increasing number of registered mortgage loans from 2013 on. Although the real estate market has shown recovery since then, the latter cannot fully explain the substantial increase in mortgage loans. The explanation lies rather in the construction of the mortgage loan database than in the commercial real estate markets

themselves. In principle, when a mortgage loan is closed it is registered in the database. However, a mortgage loan that is either refinanced or put on a property that already has been financed with a mortgage loan is included in the mortgage loan database. Hence, in combination with a growing demand for mortgage loans over the past few years, the line comprising the number of registered mortgage loans shows an upward trend.

Figure **1**: Number of Transactions and Registered Mortgage Loans



Note: Figure **1** displays the number of transactions and registered mortgage loans over the years 2005 to 2017 derived from the commercial real estate transaction database (OV20) and the mortgage loan database (HYK) of the Kadaster respectively.

In Figure **2** the number of plots of land that formed the basis for both the transactions and the mortgage loans have been displayed. This figure shows a similar trend as Figure **1** since the number of plots of land involved in transactions and mortgage loans increased until 2007, declined all the way through to 2013, before recovering again in the following years. The homogeneous trend in Figure **2**, in comparison to the trend lines in Figure **1**, can be explained by the fact that Figure **2** shows the unique plots of land that have taken part in transactions (OV20) and the corresponding mortgage loan (HYK). Figure **1**, however, shows the unique numbers of transactions and mortgage loans. As multiple mortgage loans can be registered on the one or more plots of land in each transaction, the trend lines in Figure **1** show dissimilar patterns.

Figure **2**: Number of Plots of Land Transaction Database and Mortgage Loan Database

Note: Figure **2** represents the number of plots of land in the commercial transaction database (OV20) and the mortgage loan database (HYK) of the Kadaster over the years 2005 to 2017.

Initially, the transaction and mortgage databases of the Kadaster have been matched. The transaction database consists of 51 unique columns of information and the mortgage database of 17 unique columns. See Appendix **D** for more information on the corresponding columns of information. Information from transactions that is both available and relevant to this study includes: the transaction price and date, information on the acquirer and transferor, address details and other information such as the size and the functionality of the property. The mortgage dataset provides for information on the starting date of a mortgage, the potential end date of the mortgage (only when a mortgage loan is already terminated) and both the registration value and the interest rate of the registered mortgage loan.

5.2 Data Matching Key

The information of the two Kadaster datasets has been gathered by means of the specific property codes of the plots of land that take part in a transaction. Every plot in The Netherlands has a unique number, so that every property can be defined and the (ownership) rights on it can be assessed. This property code, or plot number, also provides for the matching key for the transaction and mortgage database of the Kadaster. Eventually, the match between the two datasets enables to determine the LTV ratios. As the plot number often does not contain all information, the Basisregistratie Adressen en Gebouwen (BAG ID; unique registration number for both addresses and properties) is used for detailed information per address. The BAG

contains a unique credential for every property with an own address, whereas the plot number only has a unique number for each plot of land at which multiple properties might be situated. As the BAG ID is a recently established registration number, it cannot be linked (yet) with all properties. Therefore, the plot numbers remain leading in determining the properties that take part in a specific transaction. However, the BAG is the matching key between the datasets of the Kadaster and CBRE.

5.3 Data Selection Criteria

At first all real estate transactions of business entities have been assembled between 2005 and Q4 2018. Thereafter, mortgage loan data has been matched of all plots of land that have taken part in one or more of the transactions. This has resulted in the Kadaster database, containing of 1.926.016 rows and 68 columns. Since, in the same period of time, 247.408 unique transactions have taken place, a substantial number of double records have emerged in the matched database. Reason for this expansion is the information that has been added to the databases with every column of data. More specifically, each transaction comprises one or more properties. Hence, there are one or more plot numbers in each transaction. Within one plot number, one or more properties, or addresses, can be part of the transaction. Multiple acquirers and transferors (in case there was more than one owner) can take part in a deal. On one such an address multiple property types or functionalities can be defined. The plot numbers can also be broken down in one or more BAG registration number, depending on how many BAG IDs on an address level fall underneath a BAG ID on a property level. The aforementioned breakdowns of the transactions, as well as the associated plot numbers, are with regard to the transaction database only. When enriching this dataset with the mortgage data, more rows of information arise. The plot numbers that are part of a transaction are not necessarily the same as the underlying of the mortgage loan. Typically, in commercial real estate transactions investors use mortgage loans, just like other types of loans, in order to free up capital for investments in general and thus not specifically for the transaction it is linked to. When possible, in times when real estate prices are rising, investors postpone taking on a (mortgage) loan since the registration value of mortgage loans will be higher at a later period in time (Researcher at a real estate advisory firm, 2018). Hence, the plot numbers that fall underneath a transaction, might be part of one or more mortgage registrations. Accordingly, one such mortgage registration consists of one or more plot numbers that do not necessarily match with the transaction data. However, since all this information is matched with respect to the plot numbers, this data takes an integral part in the matched database. As a result, the Kadaster dataset consists of multiple rows of

information belonging to only one transaction. So, the difficulty lies within assembling the relevant information in the rows of the total dataset into one unique record for each unique transaction.

Having assembled the initial Kadaster dataset, the irrelevant transactions need to be filtered out. As the transaction data of the Kadaster consists of real estate transactions in which a business entity is involved, or when at least five plot numbers are part of the deal in the case of a transaction between legal persons, to a certain extent there is irrelevant data involved. Examples of data that is included in the dataset are when a legal person acquires a property for business purposes, or when a business entity acquires a property for the single purpose of its business activities. As the aim for this study is to target the commercial real estate investments specifically, such transactions are not relevant for the research. In order to reach a selection of the relevant transactions that thoroughly define and explain the commercial real estate (investment) market, four criteria have been formulated:

- Criterion **I**: supplies for a selection criterion in terms of a positive indication stating that a transaction price involves multiple plots of land and thus assembles the total value of a particular transaction.
- Criterion **II**: provides for a quality improvement of the transaction data as it is an indicator that points out the transactions and the underlying prices that are certainly correctly registered and therefore reliable.
- Criterion **III**: allows to match, with a large degree of certainty, directly related transaction and mortgage loan data as it limits the time-period in between de registration date of the mortgage loan and the transaction date to less than seven days.
- Criterion **IV**: is a criterion that sets a boundary by only including LTV ratios with a minimum value of 35% and a maximum value of 105% in order to filter out extreme values that have not a direct relationship to a transaction and a value at the time of the transaction.
- Criterion **V**: serves as a further check on the reliability of the match between a transaction and a registered mortgage loan by only selecting the transactions of which the number of plots of land is equal to the count of the underlying plots of land of the mortgage loan.

5.4 Kadaster Dataset Selection Criteria

The five criteria, as well as the possible implementation of them, will be further explained in the remainder of Section **5.4** as applying them to the actual database provides for a more detailed clarification of the data selection process in addition to further legitimising the selection criteria. First, the different criteria will be assessed on the basis of the LTV ratio itself. When after the selection criteria will be further refined by breaking down the transaction prices and the transactions itself.

Appendix **E** shows the effect the multiple selection criteria have on the LTV ratio. In the columns, the results are displayed with regard to the different indicators. For each year the LTV ratios are shown without any restrictions or indicators as well as under the following conditions: criterion **II**, criteria **I** and **II** and criteria **II** and **V**. When looking at the LTV ratios in Appendix **E**, the values seem rather unrealistic. As for the determination of these LTV ratios the initial Kadaster database has been used, the raw data before introducing any criteria have been aggregated in Appendix **E**. Apart from selecting LTV ratios on the basis of the different indicators, the rows in Appendix **E** show how adjustments to the level of LTV ratios affect the average values. Apart from taking all LTV ratios, the average LTV ratios have also been selected on the basis of: excluding the 1% smallest and largest values, excluding the 5% smallest and largest values and with a maximum and minimum LTV ratio of 150% and 50% respectively. These three criteria concerning limited values for the LTV ratios have been applied to data selections that were subject to no criterion, criterion **V**, criterion **III** and a combination of criteria **III** and **V**. With regard to the above-mentioned boundary criteria, these values have been chosen in order to see the effect putting a limit to the LTV ratios has on the average LTV ratios. In no way the 150% and 50% represent representative maximum and minimum values. On the contrary, as aforementioned the minimum and maximum value of the LTV ratios have been set to 35% and 105% on the basis of the adjusted LTV ratio used in this study. As can be derived from Appendix **E**, the more indicators and the more restrictions are applied to the levels of the LTV ratios the more appropriate values remain. The label ‘appropriate’ is rather not the most clarifying term since none of the LTV ratios in Appendix **E** takes on reliable values. However, by adding the selection criteria, the LTV ratios are being pushed into values that come closer to realistic figures. In the final four columns of Appendix **E**, the average results of the total Kadaster database can be further assessed. In general, for every added indication the average LTV ratio goes down and for every added value restriction the LTV ratios decline as well. Starting from the median LTV ratio values from applying no

indication to criteria **I** and **II** combined, the median values go down. For respectively: a selection of all values, a selection on the basis of criterion **V**, a selection on the basis of criterion **III** and a selection on the basis of criteria **III** and **V** combined, the median LTV ratios decline after applying criteria **I** and **II** from 114% to 107%, 105% to 101%, 104% to 100% and 100% to 97%. These values correspond with the average median LTV ratios over the years 2005 until Q3 2018. To a large extent, the same results occur for the average values after applying limits to the level of the LTV ratio. However, excluding the 1% or 5% smallest and largest LTV ratios of the dataset does not have the desired effect. Only when introducing a limited level for the LTV ratios in terms of a maximum and minimum percentage, the LTV ratios take on values that are valuable for further assessment. Therefore, as aforementioned and invigorated in criterion **IV**, there has been chosen to select the LTV ratios with an upper limit of 105% and a lower limit of 35%.

Appendix **F** shows how applying the different criteria affects the development trend of the LTV ratios between 2005 and Q4 2018. For this selection overview a premature variant of criterion **IV** has been used, namely the aforementioned boundary levels of 50% and 150%. From Appendix **E** can be concluded that more appropriate values of the LTV ratios can only be approached by introducing a maximum and minimum value with respect to the LTV ratios. Therefore, all the LTV ratios shown in Appendix **F** are subject to a minimum level of the LTV ratio of 50% and a maximum level of 150%. Figure **F.1** displays the level of LTV ratios over the years, subject to no criteria, criterion **II** with a positive indication, criteria **I** and **II**, both with a positive indication and criteria **I** and **II**, with a negative and positive indicator respectively. Figures **F.2**, **F.3**, and **F.4** show the different LTV ratios after adjusting to the following criteria respectively: criterion **V**, criterion **III** and both criteria **III** and **V**. Overall, the lines in all figures of Appendix **F** representing the LTV ratios subject to criteria **I** and **II**, both with a positive indication, show the most realistic LTV ratios. Figures **F.2** and **F.4** show that adjusting the selected data to transactions of which the number of the underlying plots of land is equal to the underlying of the registered mortgage (criterion **V**) results in the most appropriate values.

However, hereafter criterion **V** is left aside. Although, the LTV ratios have the most reasonable values after applying criteria **I**, **II**, **III**, **IV** and **V**, the latter criterion is left out of the data selection process. As previously discussed, in commercial real estate the underlying of the mortgage loan often does not match with the properties involved in an acquisition. As a result,

using this criterion leaves out valuable data. Also, as criterion **III** provides for clarity with regard to a limited amount of time between the registration of the mortgage loan and the deed of sale, to a certain extent it can be concluded that a registered mortgage loan is for the purpose of a specific transaction. So, irrespective of the fact that the underlying of a mortgage loan does not completely match with a particular transaction in terms of plots of land, the acquired capital of the mortgage loan is most probably if not certainly used for a specific transaction. Therefore, criterion **V** has been excluded from the data selection process.

The line in Figure **F.3,** comprising the LTV ratios between 2005 and Q4 2018, subjected to a maximum and minimum value of the LTV ratio of 150% and 50%, criterion **I** with a positive indication, criterion **II** with a positive indication and criterion **III**, represents to a large extent the eventual LTV ratios of interest for this study.

Below the data selection process continues by assessing the consequences of applying criteria **I**, **II**, **III** and **IV** to the datasets by means of a breakdown into both the transaction price and the plots of land that are involved in a transaction. As commercial real estate transactions tend to have a higher transaction amount and consist of multiple plots of land, these are valuable factors to look at.

5.4.1 Criterion I

Criterion **I** is the indication that multiple properties are involved in a particular transaction price. When this indicator is positive for all properties within one transaction, it means that the transaction price applies to all plots of land and thus resembles the total sum of the transaction. Since the transactions that are subject to this indicator consist of multiple plot numbers, these transactions to a large extent can be classified as portfolio transactions. As portfolio transactions often are a result of an investment for the purpose of trade rather than single property transaction for the use of e.g. business activities, this indicator filters out a large amount of the irrelevant transactions for this study. This view is supported by the findings that in general the transactions with a higher value have this indicator. A positive indication, of a transaction with multiple properties involved, suggests that the transaction price is the total price for the properties together. Only when all properties in a particular transaction have this positive indication, this is the case. A negative indication assumes that the transaction price is only with regard to a certain plot of land.

Table **1**: Kadaster Database Subject to Criterion **I** (Y)

Volume (€)	330.177.988.123,00	
Transactions (#)	91.024	
Average transaction price (€)	3.627.372,87	
Plots of land (#)	Transactions per number of plots of land (#)	Transactions per number of plots of land (%)
1	9.289	10.21
2	40.468	44.46
3	14.087	15.48
4-10	17.840	19.60
>11	9.340	10.26
Total	91.024	100
Transaction price (€)	Number of transactions per price range (#)	Number of transactions per price range (%)
≤ 1.000.000	63.843	70.14
> 1.000.000 ≤ 10.000.000	22.571	24.80
> 10.000.000 ≤ 25.000.000	2.475	2.72
> 25.000.000 ≤ 100.000.000	1.627	1.79
> 100.000.000	508	0.56
Total	91.024	100

Note: Table **1** concerns the Kadaster database subject to criterion **I** (positive indication).

Tables **1** and **2** show how criterion **I** affects both the transaction price and the number of plots involved in a transaction respectively. Where on the one hand, the total volume of the transaction prices over the period between 2005 and Q4 2018 may not be the most interesting figure as it depends on the number of transactions, the average transaction price merely does on the other hand. The average transaction price with a positive indication is € 3.627.372,87 and the average price for transactions with a negative indication is € 728.110,23. As previously mentioned, the more relevant commercial real estate investment transactions in general have a higher value. Especially, looking at the breakdown of the transaction prices into the number of transactions that fall within a certain range, the differences in transaction prices can be observed. When looking at the different price scales with regard to the selected data that was either subject to a positive or negative indication of criterion **I**, the difference between the two average transaction prices can be further broken down. A positive indicator yields in 70.14% of the cases a transaction value of € 1.000.000 or less and for a negative indication this value is 89.88%. Considering transactions with a value larger than € 10.000.000, the shares are 5.06% and 0.55% for a positive and negative indication of criterion **I** respectively.

Table **2**: Kadaster Database Subject to Criterion **I** (N)

Volume (€)	112.337.943.342,00	
Transactions (#)	154.287	
Average transaction price (€)	728.110,23	
Plots of land (#)	Transactions per number of plots of land (#)	Transactions per number of plots of land (%)
1	147.494	95.60
2	4.137	2.68
3	1.145	0.74
4-10	1.235	0.80
11+	276	0.18
Total	154.287	100
Transaction price (€)	Number of transactions per price range (#)	Number of transactions per price range (%)
≤ 1.000.000	138.671	89.88
> 1.000.000 ≤ 10.000.000	14.760	9.57
> 10.000.000 ≤ 25.000.000	578	0.37
> 25.000.000 ≤ 100.000.000	209	0.14
> 100.000.000	69	0.04
Total	154.287	100

Note: Table **2** concerns the Kadaster database subject to criterion **I** (negative indication).

From Tables **1** and **2**, there can also be concluded that whenever a transaction has a negative indication with regard to criterion **I**, in 95.60% of the cases there was only one plot of land involved in the transaction (price). For transactions with a positive indication this was in 10.21% of the cases. In other words, in almost 90% of the transactions with a positive indication two or more properties were part of the deal. Also, in 10.26% of the transactions there were more than ten plots of land involved. For transactions with a negative indication, only in less than 0.18% of the transactions more than ten properties took part in the transaction. In addition, only in 5% of the cases more than two properties were involved.

To conclude, criterion **I** provides for a valuable selection criterion in order to substantiate a relevant commercial real estate dataset for this study. As a result, 91.024 transactions out of the 247.408 remain in the resulting dataset.

5.4.2 Criteria I and II

Criterion **II** comprises an indication that both the transaction and the transaction price are reliable. Rather than labelling the other transactions as not trustworthy in any case, this indicator

merely states that from the transactions with a positive indication the transaction price is known and verified for all properties involved in the transaction. In other words, the remaining transactions have a verified transaction price with respect to the one or more properties involved. This criterion mainly provides for improvement of quality and accuracy, which is certainly important considering the nature of (portfolio) transactions that remain in the selected data. Table **3** shows the effect criterion **II** has on the number of transactions and de average transaction price. The transaction price that has plummeted from € 3.627.372,87 to € 2.645.281,93 directly attracts attention. Apparently, in cases of relatively large transaction values, there is a higher chance that there are discrepancies between the transaction price and the underlying plots of land. However, in order to enhance the accuracy of the dataset, this indication is valuable for this study.

Table **3**: Kadaster Database Subject to Criterion **II** (Y)

Volume (€)	189.841.303.227,00
Transactions (#)	71.766
Average transaction price (€)	2.645.281,93

Note: Table **3** concerns the Kadaster database subject to criterion **II** (positive indication).

5.4.3 Criteria I, II and III

Criterion **III** consists of a selection indicator identifying transactions of which the time period between the deed of sale and the registration of the mortgage loan is limited to less than seven days. Whenever a transaction takes place the deed of sale and the mortgage deed need to be established and conveyed by the notary to the Kadaster. Since the registration date is leading in de documentation of both the transaction and the mortgage loan, in addition to the fact that the deed of sale and mortgage deed are registered separately, a difference can occur in the registration date of both. In other words, although the transaction and the registration of the mortgage loan takes place at the same day, the registered dates at the Kadaster might differ.

Introducing such a timescale as criterion would lead to a transaction database in which mortgage loans, to a certain extent, can be directly connected to the transaction. In the case of mortgage loans that have been closed on a certain property at an undefinable time, there is a substantial chance that the mortgage amount is used for other (investment) purposes. Also, the use of this criterion is supported by the findings, which show that more factual and appropriate LTV ratios remain after introducing a timescale between the deed of sale and the registration of the mortgage. Therefore, for this study, a time period of less than seven days has been chosen.

Table **4** shows the consequences of criterion **III** for the Kadaster dataset. From the previous dataset of 71.766 transactions, which were subject to criteria **I** and **II**, 42.568 transactions remain. The average transaction price seems to have recovered with regard to the average value after having applied criteria **I** and **II**. However, the value is still lower than the average price just after applying criterion **I**. Breaking down the transaction price again into different price ranges, shows percentage-wise the same values. In 69.87% of the cases the transaction price is € 1.000.000 or less and in 4.57% of the transactions the total value is more than € 10.000.000. After the application of criterion **I**, Table **1**, these values were 70.14% and 5.06% respectively. With regard to the number of plots of land per transaction, the differences between the dataset subject to criterion **I** only and the dataset after adding criteria **II** and **III** is relatively small. Where initially in 10.21% of the transactions only one property was involved, as specified in Table **1**, now in 11.10% of the cases only one plot of land took part in a transaction. In addition, these numbers for more than ten plots of land in a transaction were 10.26% after the first indicator and 7.90% in Table **4**.

Table **4**: Kadaster Database Subject to Criteria **I** (Y), **II** (Y) and **III**

Volume (€)	135.233.731.368,00	
Transactions (#)	42.568	
Average transaction price (€)	3.176.887,13	
Plots of land (#)	Transactions per number of plots of land (#)	Transactions per number of plots of land (%)
1	4.725	11.10
2	20.108	47.24
3	6.754	15.87
4-10	7.620	17.90
11+	3.361	7.90
Total	42.568	100
Transaction price (€)	Number of transactions per price range (#)	Number of transactions per price range (%)
≤ 1.000.000	29.743	69.87
> 1.000.000 ≤ 10.000.000	10.879	25.56
> 10.000.000 ≤ 25.000.000	1.100	2.58
> 25.000.000 ≤ 100.000.000	689	1.62
> 100.000.000	157	0.37
Total	42.568	100

Note: Table **4** concerns the Kadaster database subject to criterion **I** (positive indication), **II** (positive indication) and **III**.

After having applied the three above described criteria, a dataset of 42.568 transactions remains. However, as the starting point of the research is the adjusted LTV ratio, it is essential to look how the LTV ratios behave within this dataset. Therefore, again the LTV ratios will be further assessed. Below Table **5** and Figure **3** display the frequency table and the corresponding graph. Frequency Table **5** shows that more than 63.56% of the transactions have an LTV ratio that is smaller than 35% and larger than 105%. So, only 36.44% the transaction meet with the condition of criterion **IV**.

Table **5**: Frequency Table of LTV Ratios Subject to Criteria **I** (Y), **II** (Y) and **III**

Bin range LTV ratio (%)	Frequency (#)	Cumulative (%)
35%	789	1.85
45%	569	3.19
55%	965	5.46
65%	1254	8.40
75%	1913	12.90
85%	2649	19.12
95%	3051	26.29
105%	5109	38.29
>105%	26269	100

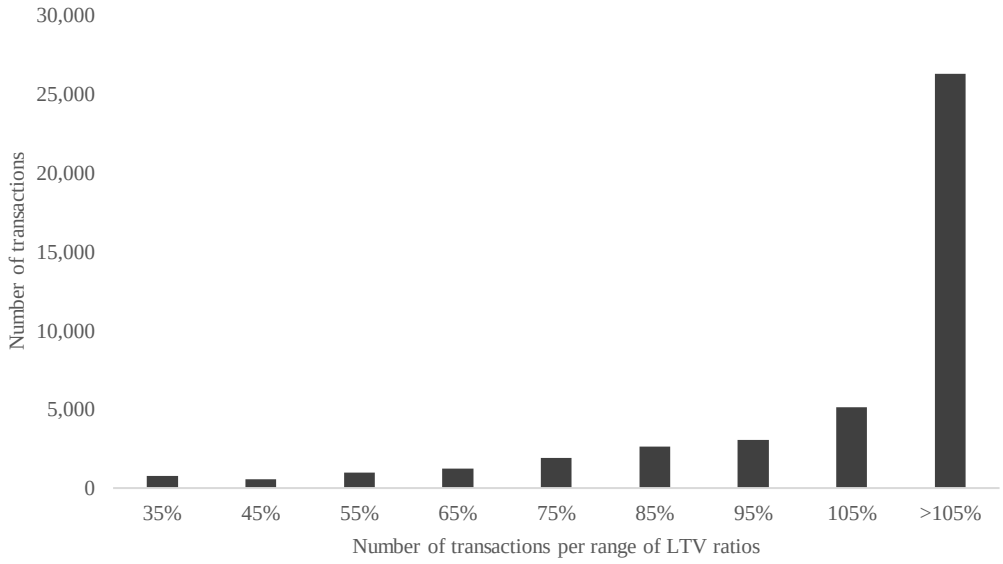
Note: Table **5** concerns the (cumulative) frequency table of LTV Ratios subject to criteria **I** (positive Indication), **II** (positive indication) and **III**

Figure **3** shows the figures as displayed in Table **5**. The main part of the transactions that do not fall within the limited level have an LTV ratio of more than 105%, a level of LTV ratios that moneylenders do not even come close to with their financing operations with regard to existing properties.

Reason for the existence of these inexplicable values lies in the match of the initial transaction and mortgage databases of the Kadaster on the one hand and the composition of the adjusted LTV ratio in this study on the other hand. The mortgage loan data is matched with transaction data on the basis of the plot number. The purpose for registering a mortgage loan is undefined, resulting in mortgage loans that have been closed in order to either develop, renovate or simply for other reasons that might not even have a link to a certain transaction at all. In addition, registering another mortgage loan on a property or refinancing on a property that has increased

in value might lead to unrealistic LTV ratios with the value being defined by the transaction price.

Figure **3**: Frequency Chart of LTV Ratios Subject to Criteria **I**, **II** and **III**



Note: Figure **3** shows the frequency chart of the number of transactions for certain ranges of LTV ratios, after the application of criteria **I** (Positive Indication), **II** (Positive Indication) and **III**, over the years 2005 until Q3 2018.

As previously discussed, in commercial real estate it is also common to free up capital for investment purposes by means of taking on a mortgage loan on possibly unrelated properties with regard to a particular transaction. In other words, whenever there has been found a match between a transaction and one or more mortgage loans it is the question to what extent the two are related and in what way a specific transaction and its LTV ratio should be interpreted. In addition, discrepancies exist due to the way the adjusted LTV ratio in this study has been built up. The appraisal value of a property changes over time, whereas the transaction price is the price that has been paid for a property at a certain date. In case of a transaction that is financed in order to renovate, other than the transaction price the appraisal value is adjusted to the current situation with a more proper estimate of the LTV ratio as a result. Also, as the data contains the registration value of the mortgage loan instead of the actual mortgage loan, the LTV ratio is systematically overestimated in any case.

5.4.4 Criteria I, II, III and IV

As the LTV ratios in this preliminary Kadaster dataset involves unexpected values, the decision has been made to make inquiries about maximum and minimum values of LTV ratios in the Dutch commercial real estate market. Therefore, by means of interviews with specialists in the field of commercial real estate, criterion **IV** has been established in order to exclude unrealistic LTV ratios. According to these specialists, on average, the LTV ratios range from 35% to 80% depending on, among others, the type of investor, the type of real estate, the location, and the type of lender. However, rather than indicating that LTV ratios cannot have a value of below 35% or above 80%, the aforementioned suggests that in most of the cases the LTV ratio of a transaction falls within this range. These ratios do not apply to development or renovation projects, but to investment projects of existing properties only. As endorsed by these specialists, the following types of real estate are ordered from more to less risky as indicated by the level of the LTV ratios: commercial buildings, retail stores, offices and residences. Roughly speaking, nowadays, commercial buildings have an LTV ratio of between 35% and 50%, retail stores between 50% and 60%, the LTV ratios of offices range between 60% and 70% and for residences between 70% and 80% (Commercial real estate specialists, personal communication, December 2018). However, these percentages are on the basis of current data. Consequently, previous LTV ratios have had a higher value. In addition, the LTV ratios can vary between the aforementioned subcategories. The LTV ratios also differ among the various financial institutions that act as lenders. The traditional banks in The Netherlands are to a certain extent reserved when it comes to real estate loans, whereas debt funds, for instance, provide for the higher LTV ratios in the market. However, since multiple Basel Accords have become effective, especially with regard to real estate loans, banks have to maintain relatively more capital at hand and therefore financial institutions are in certain cases reluctant, or simply unable, to provide for real estate (mortgage) loans. Also, since these policy measures have come in place over the past few years, merely in the aftermath of the global financial crisis, LTV ratios have decreased over time. Furthermore, this research is built upon an adjusted LTV ratio, where the registration value of mortgage loans and the transaction prices provide for a larger LTV ratio than the original LTV ratio. As a result, a certain margin has been taken into account in order to select the data for this study. Therefore, in this study the range of reasonable LTV ratios with regard to existing properties has been set to a minimum of 35% and a maximum of 105%.

The results of applying criterion **IV** to the Kadaster dataset are shown in Table **7**. With respect to the dataset before adding criterion **IV** to the selection criteria, the number of transactions is primarily interesting. Before introducing criterion **IV,** the number of transactions was 42.568, whereas there are 15.512 transactions left after applying it. In other words, the LTV ratios under the condition of criteria **I**, **II** and **III** only have numerous unrealistic values for the purpose of this study. As outlined before, this can have multiple reasons ranging from transactions where the plots of land still have to be developed to mortgage loan registrations that do not necessarily match with the corresponding transaction (price). With respect to Table **4**, there have been some changes. Where the share of transactions with a value of € 1.000.000 or lower was 69.87%, it is 65.07% now. Also, Table **7** shows that 5.78% of the transaction exceeded the € 10.000.000, where this value was 4.57% after the first three criteria. These values are also larger than the shares of the transactions per price range after the application of criterion **I**, with values of 70.14% and 5.06% for transactions with a value equal or smaller than € 1.000.000 and larger than € 10.000.000 respectively, as which is displayed in Table **1**.

Table **6**: Kadaster Database Subject to Criteria **I** (Y), **II** (Y), **III** and **IV**

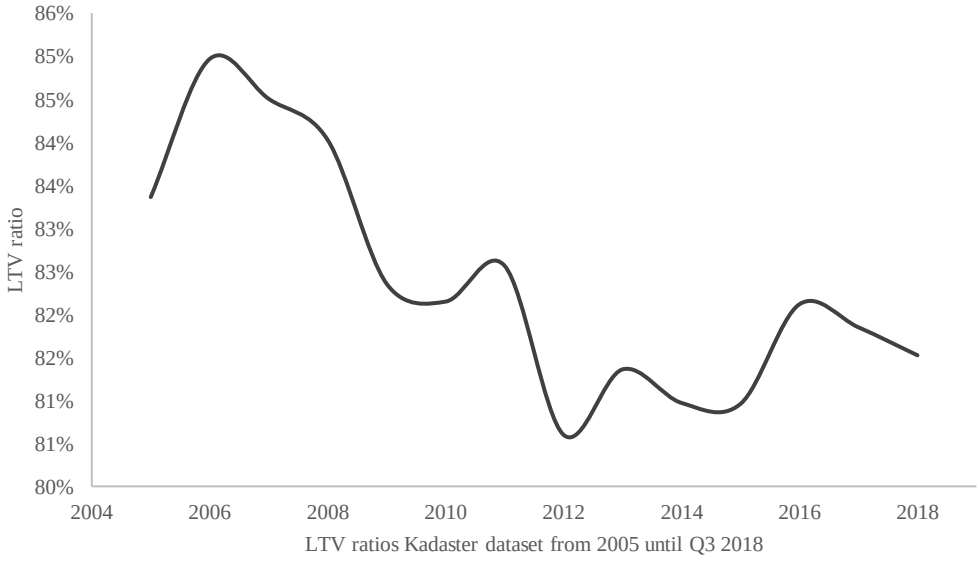
Volume (€)	52.473.152.654,00	
Transactions (#)	15.512	
Average transaction price (€)	3.382.745,79	
Plots of land (#)	Transactions per number of plots of land (#)	Transactions per number of plots of land (%)
1	1.934	12.47
2	7.014	45.22
3	2.435	15.70
4-10	2.766	17.83
11+	1.363	8.79
Total	15.512	100
Transaction price (€)	Number of transactions per price range (#)	Number of transactions per price range (%)
≤ 1.000.000	10.094	65.07
> 1.000.000 ≤ 10.000.000	4.521	29.15
> 10.000.000 ≤ 25.000.000	507	3.27
> 25.000.000 ≤ 100.000.000	324	2.09
> 100.000.000	66	0.43
Total	15.512	100

Note: Table **6** concerns the Kadaster database subject to Criteria **I** (positive indication), **II** (positive indication), **III** and **IV**.

In addition to the larger average transaction price of € 3.382.745,79, in comparison to the average price in Table **4**, these figures show that after the application of criteria **I**, **II**, **III** and **IV** transactions with a larger transaction value remain in the dataset. With regard to the number of plots of land involved in a transaction, in 12.47% of the cases only one plot of land took part in a transaction and in 8.79% of the transactions there were more than ten plots of land involved. Before applying criterion **I**, these values looked like the following: 10.21% and 10.26% after criterion **I** and 11.10% and 7.90% after criteria **I**, **II** and **III**, of which the figures are shown in Tables **1** and **4** respectively. These numbers show similar values, with the final Kadaster dataset having slightly less transactions with only one plot of land and little more transactions with more than ten plots of land involved.

To conclude, after applying the four above-mentioned criteria the Kadaster dataset has been transformed from a database containing real estate transactions in which business entities were involved to a dataset oriented towards commercial real estate investment transactions specifically. Since real estate transactions for investment purposes in general have higher transaction values and involve on average more plots of land than a regular real estate transaction, the eventual Kadaster dataset consists to a large extent of the commercial real estate transactions between 2005 and Q4 2018 in The Netherlands that are of relevance for this study.

Figure **4**: Average LTV Ratios of the Kadaster Dataset

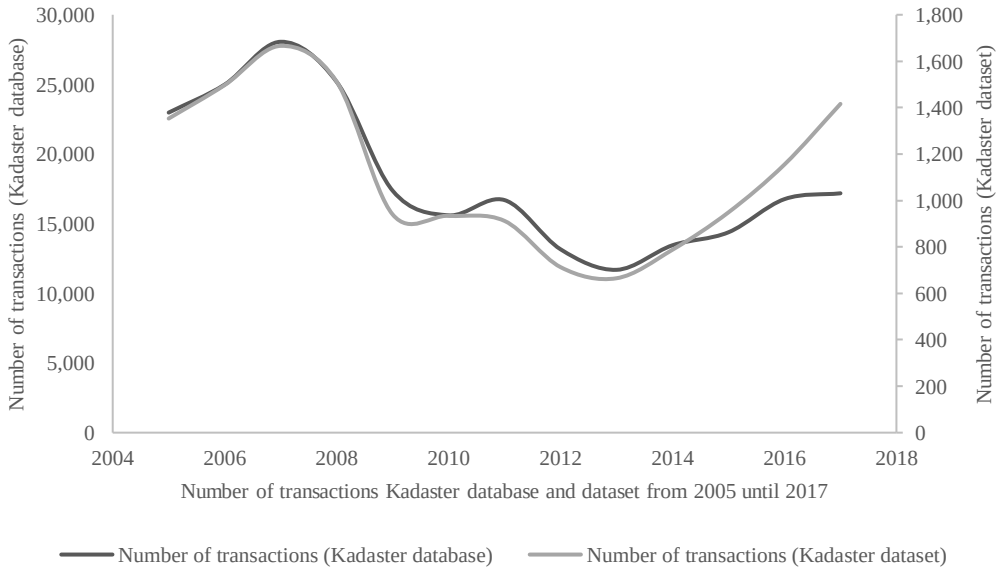


Note: Figure **4** displays the average LTV ratios of the Kadaster dataset from 2005 until Q3 2018 that are subject to Criteria I (Positive Indication), II (Positive Indication), III and IV.

Figure **4** shows the implications of applying criteria **I**, **II**, **III**, and **IV** for the LTV ratios over the years. Interestingly, the graph shows a downward trend of the LTV ratios from the peak years 2005, 2006 and 2007 all the way down through to 2012. Only after 2013 the levels of LTV ratios seem to show signs of recovery. This trend is in line with the business cycles of the general economy in the euro area, as the CEPR has recognised recession periods from the second quarter of 2008 until the second quarter of 2009 and from the fourth quarter of 2011 to the beginning of 2013. Apparently, these periods of recession are related to the commercial real estate market and the LTV ratios specifically.

The results of applying the criteria **I**, **II**, **III**, and **IV** are shown in Figure **5**. On the left the number of transactions of the initial Kadaster database are stated and on the right the number of transactions after applying the four criteria to the initial database are displayed. The development trend of both the Kadaster database and the Kadaster dataset shows similar patterns. In other words, applying the different criteria has not affected the relative count of transactions over the years significantly. Hence, the search for realistic and representative LTV ratios has not resulted in a dramatic change of the composition of the combined transaction and mortgage loan database of the Kadaster.

Figure **5**: Number of Transactions Kadaster Database and Kadaster Dataset



Note: Figure **5** concerns the development trend of the number of transactions of both the Kadaster database and the Kadaster dataset from 2005 to 2017.

Now the final Kadaster dataset has been determined, this dataset is used to match the Kadaster data to the CBRE database. In order to select all data on the same grounds, the final Kadaster dataset is used to enrich the CBRE real estate investment data. Below this process and the results are further outlined, but first the CBRE database is being introduced.

5.5 CBRE Dataset Selection Criteria

The third database is the commercial real estate investment database of CBRE. This transaction data is to be matched with the transaction and mortgage loan data of the Kadaster. The database of CBRE has been manually generated. Through (real estate) journals, websites and other sources, news is collected that touches upon large commercial real estate transactions in The Netherlands. As a result, it contains transactions of investors for investment purposes only. Since the focus of this study is primarily on the commercial real estate (investment) market, these transactions are particularly interesting. Apart from enriching the Kadaster transaction data with investment transactions, the CBRE database also supplies for more information on the main use of the property, as well as the type and nationality of both the acquirer and transferor. Also, the indication of property status, whether it is either an existing or new property, allows to better understand a transaction with regard to the LTV ratio. As the value of a property in the case of a to be developed plot is relatively low, and the mortgage loan often has been closed on the to be constructed property, the corresponding LTV ratio is expected to be inaccurate. Appendix **G** provides for more information on the corresponding columns of information of the CBRE database. The Kadaster-CBRE dataset consists of a combination of Kadaster transaction data and mortgage loan data of the Kadaster, combined with specific commercial real estate investment transaction data of CBRE.

As previously discussed, the BAG ID is used as the matching key between the Kadaster database and CBRE database. In general, the BAG ID provides for a unique credential per address. However, there can be two BAG IDs distinguished: a unique credential per property and one specifically per address. The property BAG ID provides for a property-wide credential. Since multiple addresses can be situated in a property, these different addresses cannot be distinguished. The BAG ID per address supplies for a unique code per ‘front door’. The BAG ID in the CBRE database is on a property level, meaning that the Kadaster dataset and the CBRE database can be matched in a fairly specific manner. As a result, it is more difficult to identify the investment transaction of the CBRE data in the Kadaster transaction and mortgage loan database. Since also in the eventually matched Kadaster-CBRE dataset the transaction

price and the registration value of the mortgage loan will be gathered from the Kadaster databases, this complicating factor does not necessarily affect the eventual dataset. In addition, since the investment transaction database of CBRE mainly consists of larger (portfolio) transactions with a higher value and multiple plots of land, for the transaction as a whole not many troubles are expected to arise while matching with the property BAG ID instead of the BAG ID on an address level. In order to match the Kadaster and CBRE data rightfully, the property BAG ID is utilised as matching key under the condition that these transaction records are matched with the smallest difference in days between the transaction date of the Kadaster and the registered transaction date of CBRE. As CBRE registers the transaction at the time of the publication, this date can be different than the actual transaction date (registered by the Kadaster) since publication of a sale often either happens before the actual deed of sale has been signed or after a transaction has taken place. Taking the property BAG ID matches with the smallest difference between the transaction (registration) dates of both the Kadaster and CBRE allows to generate the Kadaster-CBRE dataset coinciding closest with the specific CBRE investment transaction data on the one hand and the Kadaster transaction and mortgage loan data on the other hand.

As aforementioned, the Kadaster- CBRE dataset has been gathered on the same grounds as the Kadaster dataset. However, first the CBRE database on itself and the matching process between the two databases is being discussed. From 2005 until Q3 2018, CBRE has registered 9.634 investment transactions. From these transactions, 5.396 property BAG IDs have been registered. After matching these BAG IDs with the initial Kadaster database – with the condition that from every BAG ID that has more than one match the BAG ID is taken of which the difference in transaction dates between the Kadaster and CBRE data is the smallest – 3.458 transactions remain. Applying criteria **I**, **II**, and **III** to the matched data results in 1.741 transactions. Implementing criterion **IV** leads to the final Kadaster-CBRE datasets consisting of 713 transactions. The 3.458 BAG ID matches on the property level are on the basis of a match between the total Kadaster and CBRE database containing of 247.408 and 9.634 transactions respectively. The 1.741 property BAG ID matches are a result of linking the 42.568 transactions from the Kadaster dataset after applying criteria **I**, **II**, and **III**, and the CBRE database of 9.634 transactions. The decrease in matched transactions from 3.458 to 1.741 is limited, taking into account the number of transactions in the Kadaster data of 247.408 and 42.568 these values are linked with. However, when matching the final Kadaster dataset, consisting of 15.512 transactions, to the CBRE database, only 713 transactions remain.

5.5.1 Criteria: I, II and III

Table **7** shows the figures for the Kadaster-CBRE dataset after applying criteria **I**, **II**, and **III**. The selected 1.741 transactions represent an average transaction value of € 15.905.919,79. This value is vastly larger compared to the average transaction price of the Kadaster dataset of € 3.176.887,13 that was compiled under the same conditions. Since the CBRE transaction database consists of commercial real estate investment transactions specifically, the transaction prices are expected to have a higher total value. Therefore, the difference between the average transaction values turn out to be this extensive. Targeting the breakdown of this average transaction price with regard to the Kadaster dataset subject to criteria **I**, **II**, and **III** demonstrates the same results.

Table **7**: Kadaster and CBRE Database Subject to Criteria **I** (Y), **II** (Y) and **III**

Volume (€)	27.692.206.349,00	
Transactions (#)	1.741	
Average transaction price (€)	15.905.919,79	
Plots of land (#)	Transactions per number of plots of land (#)	Transactions per number of plots of land (%)
1	168	9.65
2	703	40.38
3	306	17.58
4-10	374	21.48
11+	190	10.91
Total	1.741	100
Transaction price (€)	Number of transactions per price range (#)	Number of transactions per price range (%)
≤ 1.000.000	324	18.61
> 1.000.000 ≤ 10.000.000	891	51.18
> 10.000.000 ≤ 25.000.000	258	14.82
> 25.000.000 ≤ 100.000.000	223	12.81
> 100.000.000	45	2.58
Total	1.741	100

Note: Table **7** concerns the matched Kadaster database and CBRE database subject to criteria **I** (Positive Indication), **II** (Positive Indication) and **III**.

Where in Table **4** in 69.87% of the cases the transaction has a value of € 1.000.000 or less and 4.57% of the transactions have total value of more than € 10.000.000, these values in Table **7** are 18.61% and 30.21% respectively. With regard to the number of plots of land for each transaction, the contrast is not that large. In the Kadaster dataset after applying criteria **I**, **II**, and **III** 11.10% of the transactions only had one plot of land involved, with 7.90% of the

cases containing eleven plots or more. Table **7** shows that the transactions in the preliminary Kadaster-CBRE dataset 9.65% of the transactions consist of only one plot of land and in 10.91% of the transactions more than 10 plots of land take part.

Table **8**: Kadaster and CBRE Database Subject to Criteria **I** (Y), **II** (Y), **III** and **IV**

Volume (€)	13.571.819.733,00	
Transactions (#)	713	
Avg. transaction price (€)	19.034.810,28	
Plots of land (#)	Transactions per number of plots of land (#)	Transactions per number of plots of land (%)
1	56	7.85
2	290	40.67
3	118	16.55
4-10	152	21.32
11+	97	13.60
Total	713	100
Transaction price (€)	Number of transactions per price range (#)	Number of transactions per price range (%)
≤ 1.000.000	124	17.39
> 1.000.000 ≤ 10.000.000	368	51.61
> 10.000.000 ≤ 25.000.000	99	13.88
> 25.000.000 ≤ 100.000.000	89	12.48
> 100.000.000	33	4.63
Total	713	100

Note: Table **8** concerns the matched Kadaster database and CBRE database subject to Criteria **I** (Positive Indication), **II** (Positive Indication), **III** and **IV**.

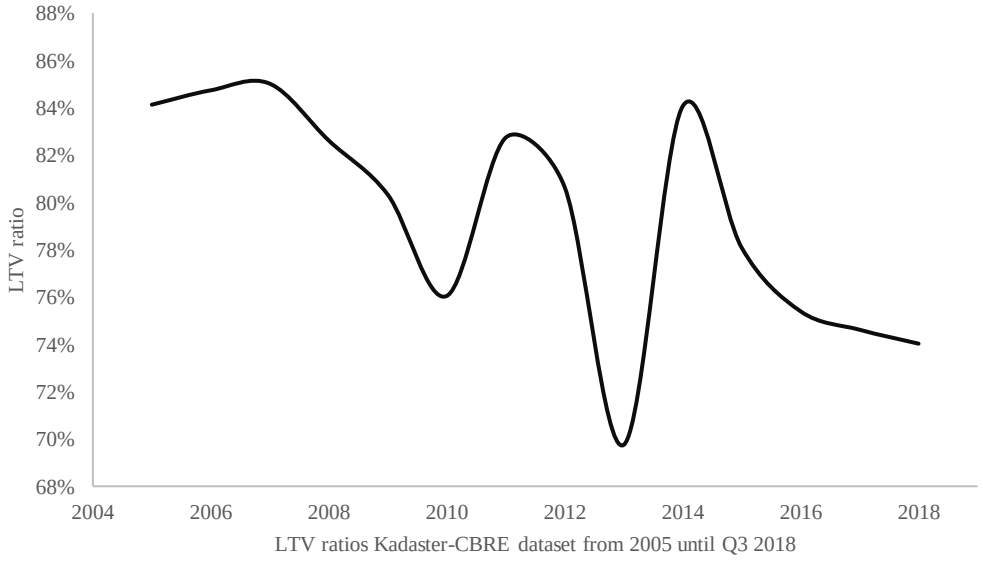
5.5.2 Criteria: I, II, III and IV

Table **8** shows how the figures look like for the eventual Kadaster-CBRE dataset. In the final dataset the average transaction price has taken on a value of € 19.034.810,28, which is significantly higher than in the previous selections. However, there are only 713 transactions left after controlling for criteria **I**, **II**, **III**, **IV**. Since in quantitative terms not many transactions remain, the challenge lies within the extent to which the Kadaster-CBRE dataset can be molded into a quantitative analysis. For this dataset, the transaction figures look like the following: 17.39% of the transactions have value of € 1.000.000 or lower and in 31.00% of the cases the transaction price is higher than € 10.000.000. In comparison to the previous values, from the Kadaster-CBRE dataset after applying criteria **I**, **II**, and **III**, the share of transactions within the lowest boundary has slightly decreased whereas the share of the transactions with a value of over € 10.000.000 has increased. In other words, the higher average transactions are carefully

explained by the breakdown into the different price ranges of the transactions. With regard to the number of plots of land playing a role in the transactions: in 7.85% of the cases there is only one plot of land involved and in 13.60% of the transactions more than ten plots of land take part. These shares were with 9.65% and 10.91% to some degree higher and lower in Table **7**. These findings are in line with the structure of the final dataset in terms of the transaction prices, since a higher share of the dataset outlined in Table **8** consists of multiple plots of land per transaction and thus the transaction price ends up with a higher value.

Figure **6** shows the effect of applying criteria **I**, **II**, **III** and **IV** to the Kadaster-CBRE dataset for the LTV ratios. As only 713 transactions are left, the LTV ratios on itself might even have less appropriate levels than in the eventual Kadaster dataset. However, Figure **6** displays an identical downward trend of the LTV ratios from the peak years 2005, 2006 and 2007 through to 2013.

Figure **6**: Average LTV ratios of the Kadaster-CBRE Dataset

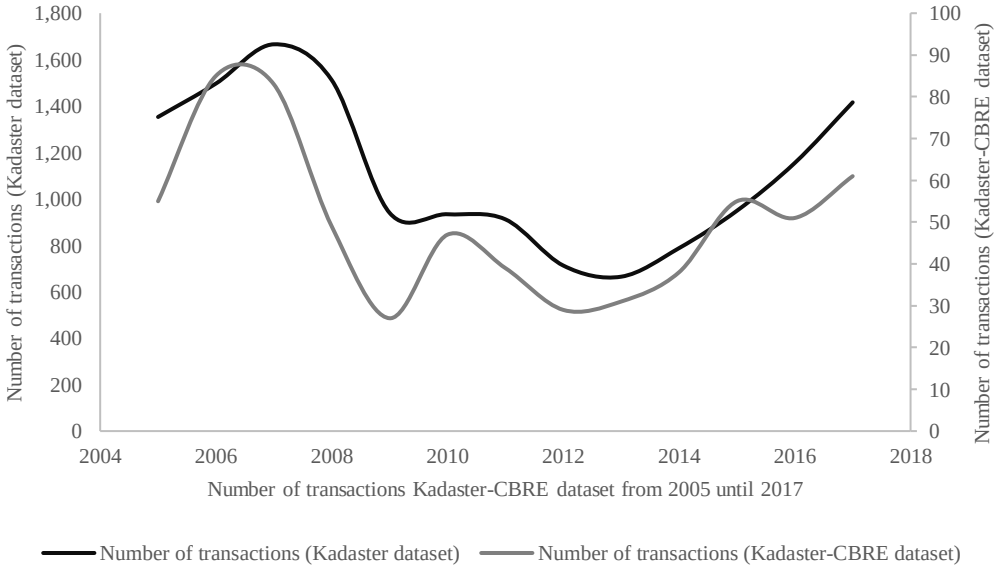


Note: Figure **6** displays the average LTV ratios of the Kadaster-CBRE dataset from 2005 until Q3 2018 that are subject to Criteria I (Positive Indication), II (Positive Indication), III and IV.

In Figure **7** the effect of conditioning the matched Kadaster and CBRE databases to criteria **I**, **II**, **III** and **IV** for the number of registered transactions in each year of the studied period. Like the development trends of the Kadaster database and dataset in Figure **5**, the trend line of the Kadaster-CBRE dataset shows a similar pattern. As a result, applying criteria **I**, **II**, **III** and **IV** to the combined Kadaster and CBRE databases seems to have a limited effect on the number

of transactions in each year. Hence, after selecting the specific commercial real estate transactions from the CBRE database, the composition of the selected data is comparable to the initial data sources of the Kadaster and CBRE respectively.

Figure **7**: Number of Transactions Kadaster Dataset and Kadaster-CBRE Dataset



Note: Figure **7** concerns the number of transactions over the period 2005 to 2018 of both the Kadaster dataset and the Kadaster-CBRE dataset.

5.6 Conclusion

Above the data selection process of both the Kadaster dataset and the Kadaster-CBRE dataset have been discussed and clarified with regard to transaction volumes and prices, as well as the quantity of transactions and the number of plots of land that take part in those transactions. During the application of the different criteria to the datasets, the initial Kadaster database containing 1.926.016 records has been merged into 247.408 unique transactions ranging from 2005 until Q3 2018. Eventually, this database consisting of 247.408 transactions has been molded into the Kadaster dataset that has resulted in 15.512 transactions. Subsequently, the Kadaster database has been merged into the Kadaster-CBRE dataset by on the one hand applying criteria **I**, **II**, **III** and **IV** and on the other hand matching both the Kadaster database and CBRE database. As a result, from the initial 9.634 transactions, 713 specific commercial real estate transactions remain.

Tables **1**, **2**, **4** ,**6**, **7** and **8** show how implementing the different criteria affects the data in terms of the transaction prices and compositions. Tables **1** and **2** support criterion **I** by showing how implementing a positive indication of criterion **I** leads to a data selection consisting of higher average transaction prices and more portfolio transactions. With criterion **II** being more of a reliability check regarding the transaction price and underlying plots of land, Table **3** shows how this criterion affects the average transaction price and the number of transactions. In Tables **4** and **7** the effects of applying criterion **III** have been displayed. Although this criterion is like criterion **II** a sanity check, it results in an increasing average transaction price and a more substantial transactions in terms of the number of plots of land involved. Finally, Tables **6** and **8** define the final composition of both the Kadaster dataset and the Kadaster-CBRE dataset by applying criterion **IV** to the data.

As shown in Figures **4**, **6** and **5**, **7** respectively conditioning the data to the different criteria leads to an adjusted development of the LTV ratios and a similar development trend of the number of transactions. In Figures **4** and **6** the downward trend of the LTV ratios from the peak years 2005, 2006 and 2007 through to 2013 are shown, when after a recovery of these values can be seen from 2013 onwards. This trend is in accordance with the defined business cycles of the CEPR and visible for both the Kadaster dataset and Kadaster-CBRE dataset. Figures **5** and **7** show the similar development patterns of the number of transactions in the Kadaster database on the one hand and the Kadaster dataset and Kadaster-CBRE dataset on the other hand. More specifically, after applying the criteria, which has resulted in a dramatic decrease of the number of transactions overall, the trend of the transactions over time in the two final datasets is similar to the initial Kadaster database which contains commercial real estate transactions in The Netherlands since 2005. To conclude, in the process of comprising the remaining Kadaster dataset and Kadaster-CBRE dataset, which consist of specifically targeted commercial real estate transactions, the composition of the data sources has only been affected to a minor extent.

To summarise, the data of both CBRE and the Kadaster combined provide for a thorough overview of the Dutch commercial real estate market. By means of multiple data selection criteria, two datasets have been generated that specifically resemble commercial real estate (investment) transactions in The Netherlands. The resulting Kadaster dataset and Kadaster-CBRE dataset will now be utilised in order to assess the LTV ratio.

In Section **5** the data collection and editing process has been described. Section **6** will continue with a further analysis on the explanatory variables by means of a breakdown into the determinants of the LTV ratios.

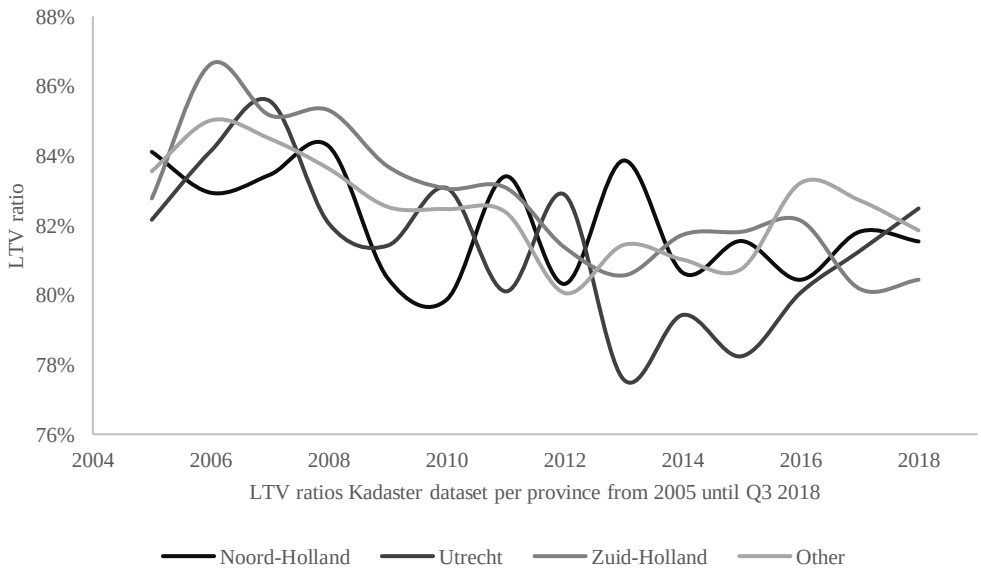
6 Breakdown LTV Ratios into Explanatory Variables

Now the data selection process has been outlined in Section **5**, the sample data has been set and the determinants of the LTV ratios have been formulated, Section **6** continues with a breakdown of the LTV ratios into the different explanatory variables.

6.1 Breakdown Kadaster dataset

Firstly, the LTV ratios with regard to the Kadaster dataset and the explanatory variables as outlined in Section **3** will be assessed. In other words, Section **6.1** provides for a breakdown of the LTV ratios from 2005 until Q3 2018 into the location factors province, city and G4, as well as the types of real estate as determined by the Kadaster.

Figure **8**: Breakdown LTV Ratios into Provinces



Note: Figure **8** displays the LTV ratios of the Kadaster dataset from 2005 until Q3 2018 broken down into the provinces Noord-Holland, Utrecht, Zuid-Holland and the remaining provinces combined as 'Other'.

Figure **8** shows the trend development of the LTV ratios of transactions in the different provinces in The Netherlands. More specifically, Noord-Holland, Utrecht, Zuid-Holland and the remaining provinces combined as Other, have been divided. Overall, the LTV ratios in the different provinces show a similar downward pattern as the LTV ratios in Figure **4** for the total Kadaster dataset. In Figure **8** Noord-Holland has relatively the highest level of LTV ratios. However, although the LTV ratios in the province Utrecht have suffered a large decline until 2012, these levels have recovered significantly since then.

Figure **H**.**1** in Appendix **H** displays the LTV ratios broken down into the cities Amsterdam, Rotterdam, 's-Gravenhage, Utrecht and a combination of all remaining cities in Other. With Amsterdam being the largest city in The Netherlands and thus in Noord-Holland, the LTV ratios as shown in Figure **8** for Noord-Holland is expected to be at relatively the same level for Amsterdam in Figure **H**.**1**. Indeed, the LTV ratios for Amsterdam are to a large extent more substantial than in other cities. Similar to Amsterdam and Noord-Holland respectively, the LTV ratios in the city Utrecht have a similar development trend over the years as the province Utrecht. Figure **H**.**2** shows the LTV ratios broken down into the G4 cities and the remaining cities combined in Other. On average both trend lines show a similar pattern with the LTV ratios in some years being higher in G4 cities and vice versa in other years.

Figure **9** shows a breakdown of the LTV ratios over the sample period into the types of real estate as determined by the Kadaster, which have been divided into the categories Industrial, Office and Retail, Residential and the remaining types of real estate combined in Other. Again, similar to the location factors as shown in Figures **8**, **H**.**1** and **H**.**2** and the overall development trend of the LTV ratios in Figure **4**, the LTV ratios per Kadaster type of real estate have a downward trend over the years. Interestingly, industrial real estate shows relatively the highest LTV ratios over the years 2005 until Q3 2018. Residential real estate predominantly has LTV ratios just below industrial real estate, and offices and retail stores. The types of real estate labelled as 'Other' show a steep decline between 2012 and 2014. However, as the Other type of real estate comprises all types of real estate other than the main types industrial, office, retail and residential, not much can be taken away from these relative values as displayed in Figure **9.**

Figure **9**: Breakdown LTV Ratios into Kadaster Types of Real Estate

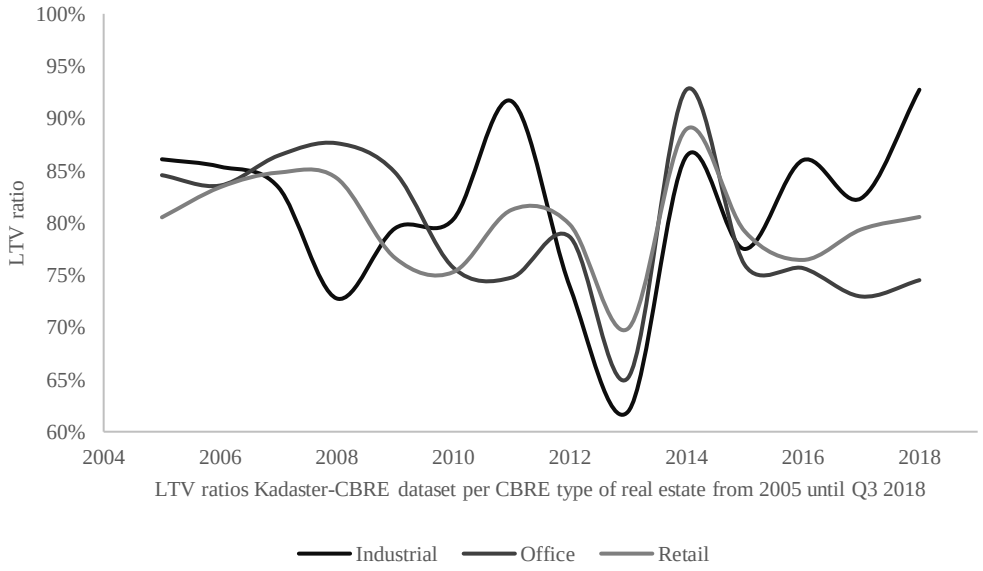
Note: Figure 9 concerns the LTV ratios of the Kadaster dataset from 2005 until Q3 2018 broken down into the Kadaster types of real estate Industrial, Office and Retail, Residential and the remaining types of real estate combined as 'Other'.

6.2 Breakdown Kadaster-CBRE dataset

Secondly, the LTV ratios with regard to the Kadaster-CBRE dataset will be assessed by means of breakdown of the dependent variable into the explanatory variables as derived from the Kadaster-CBRE dataset. The to be assessed factors have been outlined in Section **3** and concern the location factors, the CBRE type of real estate, the investor type and the nationality of the investor.

The graphs in Figures **H**.**3** and **H**.**4** have similar patterns with regard to the location factors province and G4, as Figures **8** and **H**.**2** respectively. Due to the limited amount of transactions in the overall Kadaster-CBRE dataset, a breakdown of the LTV ratios into the location factors needs to be carefully interpreted. Noord-Holland seems to have relatively higher LTV ratios than the other provinces. But, at the same time these levels highly fluctuate with respect to Utrecht, Zuid-Holland and the remaining provinces. Similar to Figure **H**.**2**, transactions in G4 cities, as outlined in Figure **H**.**4**, do not have notably higher LTV ratios than in the other cities.

Figure **10**: Breakdown LTV Ratios into CBRE Types of Real Estate



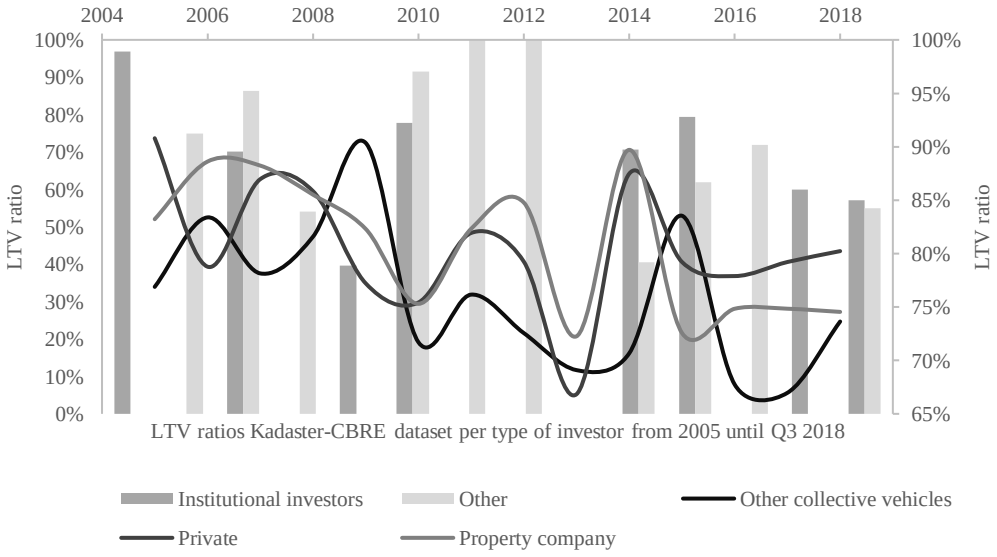
Note: Figure **10** represents the LTV ratios of the Kadaster-CBRE dataset from 2005 until Q3 2018 broken down into the CBRE types of real estate Industrial, Office and Retail.

Figure **10** shows how the CBRE types of real estate relate to the level of the LTV ratios. In Figure **H.5** all the different types of real estate as determined by CBRE have been gathered. As the categories Hotel, Residential, Multiple types and Other do not have values in each sample year, these types of real estate have been displayed using grouped columns for each year. The continuing trend lines over the sample period in Figure **10** in general demonstrate a slight decreasing trend from 2005 towards Q3 2018 with a steep decline in 2013 and a recovery since then. Similar to Figure **9**, Figure **10** shows a relative higher value for LTV ratios concerning industrial real estate. Apart from that, the three trend lines in Figure **10** have a similar development over time.

With regard to the different types of investors, Figure **11** shows the development trend of the LTV ratios with a breakdown per type of acquirer. Likewise, as in Figure **10** concerning the CBRE types of real estate, for this explanatory variable the limited number of data points in the Kadaster-CBRE dataset results in discontinuous trend lines for the investor types Institutional investors and Other. However, in the corresponding grouped column charts displayed in Figure **11** a downward trend can still be recognised. Concerning the types of investors labelled as Other collective vehicles, Private and Property company, the former group of investors seems to stand out in terms of the relative high levels of LTV ratios over the years. The category Other

collective vehicles comprises all sorts of property and investment funds including private equity funds. As such funds benefit to a large extent from tax deduction capabilities, as mentioned in Section **2**, the LTV ratios end up with a relative higher value. Subsequently, the category Property company, in which REITS have a predominant share, have slightly lower LTV ratios over time. Private investors seem to use less debt financing, according to the sample data in the Kadaster-CBRE dataset.

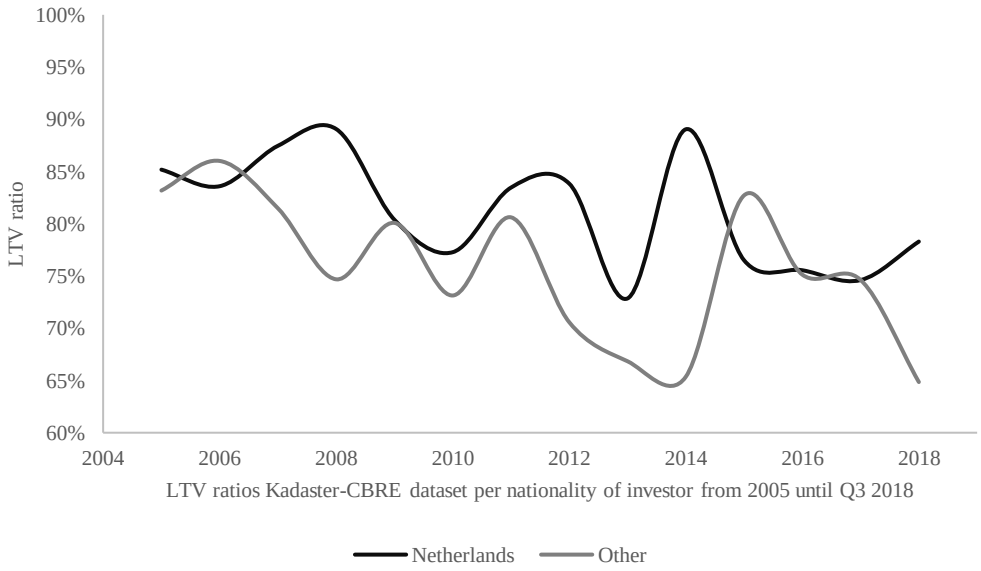
Figure **11**: Breakdown LTV Ratios into Types of Investors



Note: Figure **11** displays the LTV ratios of the Kadaster-CBRE dataset from 2005 until Q3 2018 broken down into the different types of investors Institutional investors, Private, Property company, Other collective vehicles and Other.

Figure **12** shows that on average investors from The Netherlands tend to take on relatively more debt in their commercial real estate investments than foreign investors. Regardless of the period of time in the sample period, the trend line of the Dutch investors in terms of the LTV ratios transcends the one of foreign investors, which is denoted in Figure **12** as Other. In addition, similar patterns can be recognised in terms of the LTV ratios with the peak years 2005, 2006 and 2007, followed by a decline until 2013 and a recovery since then.

Figure **12**: Breakdown LTV Ratios into Nationality of Investors



Note: Figure **12** concerns the LTV ratios of the Kadaster-CBRE dataset from 2005 until Q3 2018 broken down into the nationality of the investors: The Netherlands on the one hand and 'Other', comprising the remaining countries, on the other hand.

6.3 Conclusion

The breakdown of the LTV ratios into the specific years of the sample period on the one hand and the outlined explanatory variables in Section **3** on the other hand, supports the general view on the downward development trend from 2005 until Q3 2018 of the LTV ratios. Similar to Figures **4** and **6**, with regard to the Kadaster dataset and Kadaster-CBRE dataset, the breakdown into each explanatory variable demonstrates rather homogeneous trend lines.

With respect to the location factors, as can be derived from Figures **8** and **H.1**, the LTV ratios in Noord-Holland and Amsterdam seem relatively higher than in the other provinces and cities respectively. However, all provinces and cities tend to have the same development of the LTV ratios over time. Accordingly, the LTV ratios in the G4 and other cities show similar development patterns in Figure **H.2**.

With regard to the Kadaster and CBRE types of real estate, Figures **9** and **10** display the trend of the LTV ratios over time for this factor. In both figures the LTV ratios are decreasing over time and industrial real estate seems to be relatively more leveraged than other types of real estate.

Figures **11** and **12** demonstrate how the LTV ratios between the type and nationality of investors differ with respect to the type of investor and the country of origin. Interestingly, in general the LTV ratios of Other collective vehicles (e.g. private equity funds) have a relatively higher value in comparison to property companies (e.g. REITs). A reason for this difference is the degree to which tax deduction can be addressed. Also, Dutch investors seem to take on relatively more debt financing in terms of mortgage loans than foreign investors.

Now the explanatory variables have been further analysed by means of a breakdown with respect to the LTV ratios, Section **7** will continue with an outline of the descriptive statistics, tests of means and tests with respect to the parametric assumptions concerning the explanatory variables and both the Kadaster dataset and Kadaster-CBRE dataset respectively.

7 Descriptive Statistics, Test of Means and Parametric Assumptions

This Section provides, in accordance with the introduction of the variables in Section **3**, for a further overview of the data structure by means of the descriptive statistics. In addition, Section **7** involves mean comparisons of different explanatory variables of interest with respect to the LTV ratios. Lastly, parametric assumptions will be tested with regard to both the Kadaster dataset and Kadaster-CBRE dataset in order to ascertain sound results in Section **8**.

7.1 Descriptive Statistics

In Section **3** the dependent variables, as well as the explanatory variables, have been outlined in a theoretical manner. Tables **I.1** and **I.2**, Appendix **I**, show how the different variables of interest look like in numerical terms. In Table **I.1** the limited values of the LTV ratios of 35% and 105% can be observed from the minimum and maximum measures and the sample period of this study is from 2005 to 2018 can be recognised as well. In addition, the ECBs interest rate has a bottom – and current – value of 0% and the real GDP growth rate, as well as the STOXX Europe 600 Real Estate Cap, have a positive quarterly percentage change over time since 2005. Furthermore, the dummy variables Basel II, Basel 2.5, Basel III and G4 can be observed, as well as the categorical variables Kadaster type of real estate, city and province. In Table **I.2** in addition to the similar variables as shown in Table **I.1** the dummy variables nationality of investor and property status, in addition to the categorical variables CBRE type of real estate, type of investor and type of vendor have been displayed. Both the commercial real estate

investment market volume and commercial real estate investment market number of transactions variables show a relatively high standard deviation, indicating that the commercial real estate investment market changed over the course of the sample period.

7.2 Test of Means

A comparison of means enables to control whether grouped cases within an explanatory variable differ from one another with respect to the dependent variable. In other words, it clarifies to what extent the independent variables drive, in this case, the LTV ratios by looking into the different grouped cases within the variables and conclude whether these means differ significantly.

Table **I.3** displays the test of means of the Kadaster type of real estate with respect to the LTV ratios. The mean LTV ratio is significantly different for at least one of the Kadaster types of real estate ($F_{3,15508} = 22.675$, $p < 0.01$). Table **I.3** further shows to what numerical extent the means differ between the groups. In accordance with Figure **9**, industrial real estate transactions have the highest LTV ratios on average involved, followed by offices and retail, and residential real estate. In addition, as the Eta score equals Pearson's R in Table **I.3**, the variance of the LTV ratios is linearly explained by the Kadaster types of real estate. However, with an Eta-squared of 0.004 the variation of the dependent variable is only to a minor extent explained by this variable. Subsequently to Table **I.3**, Table **I.9** shows the mean comparison of the CBRE types of real estate. At least for one of the CBRE types of real estate, the mean differs significantly ($F_{6,706} = 3.890$, $p < 0.01$). In addition, similarly to the results from the Kadaster dataset, industrial real estate has on average the most substantial LTV ratio, followed by retail, office and residential. This is in line with Figure **10**. However, the Eta-squared is only 0.032.

In Table **I.4** the mean comparison of the different provinces has been displayed with respect to the LTV ratios. Between one or more provinces the mean LTV ratio differs significantly ($F_{11,15500} = 2.223$, $p < 0.05$). With regard to the Kadaster dataset, the LTV ratios in Friesland and Groningen have a higher level than in other provinces in The Netherlands. In addition, it seems that the provinces Noord-Holland, Zuid-Holland and Utrecht end up with predominantly lower LTV ratios on average than the other provinces. Similar to Figure **8**, Noord-Holland, Zuid-Holland an Utrecht have a closely related trend development over time. However, although Noord-Holland seems to transcend the other two provinces in terms of the LTV ratio in Figure **8**, due to the erratic development pattern over time the transactions in Zuid-Holland

have a higher mean LTV ratio. As the Eta-squared is low with a value of 0.002 and differs to some extent from the R-squared, the relationship between the provinces and the LTV ratios is not primarily linear and the explaining factor is minor.

Table **I.5** shows that at least between one, or more, of the sample years the mean is significantly different ($F_{13,15498} = 7.260$, $p < 0.01$). The output of the mean comparisons in Table **I.5** show similar figures and development trends over the sample years in terms of the LTV ratios and the number of transactions, as Figures **4** and **5** respectively. With an Eta-squared of 0.006, the explaining factor of the period of time with respect to the LTV ratio is rather low.

With regard to the G4, Table **I.6** displays the mean comparison with respect to the Kadaster-CBRE dataset. Between the G4 and the other cities the means differ significantly ($F_{1,711} = 5.460$, $p < 0.05$), with a higher LTV ratio on average in non-G4 cities. However, the Eta-squared is only 0.008.

Table **I.7** shows the test of means concerning the nationality of the investor. The means of Dutch investors on the one hand and foreign investor on the other hand differ significantly ($F_{1,711} = 8.547$, $p < 0.01$), with on average a higher LTV ratio for investors with a Dutch nationality. Figure **12** displays similar figures. The Eta-squared is only 0.012, meaning that variation of the LTV ratio is only slightly explained by the nationality of the investor,

In Table **I.8** the test of means of the types of investors has been displayed. For at least one of the different types of investors the mean is significantly different ($F_{5,707} = 7.434$, $p < 0.01$). In accordance with Figure **11**, on average the highest LTV ratios are observed for private investors and property companies. Whereas, the mean of institutional investors is substantially lower than the other categories. But, assuming an Eta-squared of only 0.050, the explaining factor of the types of investors is only little.

7.3 Parametric Assumptions

In order to control for the reliability of the results in Section **8**, both the Kadaster dataset and Kadaster-CBRE dataset are tested with respect to parametric assumptions. Below, the linearity, independence, normality and equal variance of the residuals concerning the dependent variable and the explanatory variables are tested. The outcome of the parametric assumptions helps interpreting the results. When the assumptions are met, a significant result can to a large extent

help testing the listed hypotheses in Section **4.2** and eventually contribute to answering the research question.

7.3.1 Linearity

In Figure **I.10** no evidence can be found for a nonlinear relation between the residuals on the one hand and the predictive values on the other hand. Hence, Figure **I.10** shows the random distribution of the Kadaster dataset.

Similar to Figure **I.10**, Figure **I.11** displays a linear pattern with regard to the residuals and the predictive values on the y axis and the x axis respectively. As the Kadaster-CBRE dataset does not show a curvilinear relationship, it is randomly distributed.

7.3.2 Independence

In order to check for (strong) intercorrelation, several models have been tested. No disturbing multicollinearity has been observed from Table **I.16**, with regard to the Kadaster dataset. Only in four cases there seems to be a problematic level in terms of correlation. However, with regard to these highly linearly related variables, the G4 (dummy) and the G4 (cities) variables, with a correlation of 0.901, are genuinely related. Likewise, the commercial real estate investment market volume and the number of transactions in the commercial real estate investment market variables have a high intercorrelation (0.899). In addition, the period of time variable is to a large extent correlated with the ECBs interest rate variable (-0.840) and the Basel III (dummy) variable (0.890). This could be explained by the fact that both of the latter variables are time dependent. Apart from these highly correlated variables, Table **I.16** shows no strong intercorrelation between the different variables and therefore there are no signs of problematic multicollinearity in the Kadaster dataset.

With regard to the variance inflation factor (VIF) and the corresponding degree to which the data shows evidence for multicollinearity, Table **I.12** displays predominantly unproblematic VIF values. Only the variables period of time and Basel III (dummy) have disturbing values of 32.387 and 31.427 respectively. However, since the associated variables do not have a significant effect on the dependent variable with regard to the different tested models, these VIF values do not have a disturbing effect. As a result, there are no problems concerning multicollinearity in the Kadaster dataset.

Concerning the Kadaster-CBRE dataset, Table **I.17** shows no signs of disturbing multicollinearity. For most of the variables, the intercorrelation is unproblematic. Similar to the high correlation in the Kadaster dataset between the variables commercial real estate investment market volume and the number of transactions in the commercial real estate investment market, in addition to the variables G4 and the G4 (cities), Table **I.17** also shows a high correlation of 0.901 and 0.885 between these variables respectively. As aforementioned, this is a result of these particular variables having overlap in terms of the data structure. To conclude, no disturbing multicollinearity has been observed in the Kadaster-CBRE dataset.

When controlling for multicollinearity with respect to the VIF values of the explanatory variables, no problems arise concerning the Kadaster-CBRE dataset. In other words, as can be observed in Table **I.13**, the VIF values remain below 10.

7.3.3 Normality

Table **I.1** shows that the data in the Kadaster dataset is normally distributed, as the skewness and kurtosis have taken on normal values. Only for the dummy variable Basel 2.5 and the categorical variable city, with discomforting values of 2.582 and 4.665, and -2.114 and 2.834 for the skewness and kurtosis respectively, the levels of the skewness and kurtosis are problematic with regard to normality. However, for the variables of relevance for this study, the data has a normal distribution.

For the Kadaster-CBRE dataset, the observed values of the skewness and kurtosis in Table **I.2** suggest that the residuals are normally distributed. Only the Basel 2.5 (dummy) variable with a skewness of 2.761 and a kurtosis of 5.639 and the CEPR Business Cycles variable with a skewness and kurtosis of -2.128 and 2.534 respectively, have taken on disturbing values. However, concerning the variables with problematically high values, these variables are not of concern in the tested models.

7.3.4 Equality of Variance

Based on Figure **I.10** in combination with a Durbin-Watson value of 1.974 (Table **I.14**), no heteroscedasticity was found in the data with regard to the Kadaster dataset. In other words, the variance of the predictive value remains stable for higher levels of the predicted value.

Concerning the Kadaster-CBRE dataset, no issue has been observed with regard to heteroscedasticity. In addition to a Durbin-Watson value of 1.897 (Table **I.15**), Figure **I.11** meets with the equal variance of residuals assumption, as no clear (triangular-shaped) pattern is observed.

7.3.5 Robustness

In order to check for robustness, multiple models have been tested with respect to the Kadaster dataset and the Kadaster-CBRE dataset. In other words, for all tested hypotheses, in addition to other exploratory results, the variables have been tested in different models with different composites. The parameter estimates of the variables of interest in this study remain similar with regard to the different tested models. Therefore, no problems have been detected concerning robustness for both the Kadaster dataset and the Kadaster-CBRE dataset.

7.4 Conclusion

This Section has provided for an overview of both the Kadaster dataset and Kadaster-CBRE dataset, in addition to Sections **3** and **6** respectively. Where in Section **3** the dependent variables, as well as the explanatory variables, have been outlined in a theoretical manner. Tables **I.1** and **I.2** show how the different variables of interest look like in numerical terms.

Through tests of means, there has been both observed and checked if and whether means differ significantly between grouped cases of explanatory variables with respect to the dependent variable. As a result, it clarifies to what extent the independent variables drive the LTV ratios. Significantly different means within the groups of independent variables, supports further analysis of the effect of these explanatory variables on the LTV ratios. This is the case concerning the variables of interest with respect to the hypotheses as outlined in Section **4.2**.

Figures **I.10** and **I.11** show a linear relation between the residuals and the predictive values of both datasets. Hence, the Kadaster dataset and Kadaster-CBRE dataset are normally distributed. From tables **I.16** and **I.17** no disturbing multicollinearity has been detected, as the only observed problematically intercorrelated variables do not have a significant effect on the dependent variable with regard to the tested models. In addition, these variables are predominantly genuinely related in that the data structure is partially similar. Tables **I.1** and **I.2** support the view of a normally distributed Kadaster dataset and Kadaster-CBRE dataset, as the

skewness and kurtosis show normal values for the variables of interest of the tested models. In terms of the equal variance of the residuals, no problems have been detected. Since no clear (triangular-shaped) pattern is observed in Figures **I.10** and **I.11** and the Durbin-Watson test has resulted in appropriate values of 1.974 and 1.897 for the Kadaster dataset and Kadaster-CBRE dataset respectively.

With regard to robustness, different models have been tested for the Kadaster dataset and Kadaster-CBRE dataset. No problems have been detected concerning robustness.

To conclude, for both the Kadaster dataset and the Kadaster-CBRE dataset the parametric assumptions are met concerning the variables of interest with regard to the tested models. In accordance with the specified models and formulated hypotheses in Section **4** and with the support of the tests of means and parametric assumptions, assuming differences between grouped cases of LTV ratios for the explanatory variables as specified in in Section **4.2** and no problems concerning the parametric assumptions, Section **8** continues with the results regarding the specified models in Section **4.2**.

8 Results

This Section provides for the results of the models as denoted in Sections **4.1** and **4.2**, by means of testing the hypotheses as formulated in Section **4.2**. In addition, in Section **8** the exploratory results are analysed, and the control variables are tested with respect to the LTV ratios.

8.1 Hypotheses Testing

For the Kadaster dataset six different models were estimated by means of a GLM univariate analysis. Subsequently, five separate models were tested with respect to the Kadaster-CBRE dataset. The models of the respective datasets, of which the composites differ in terms of the exchange between fixed factors and covariates rather than the embedded variables themselves, are utilised to test the hypotheses in Section **4.2**. The results are given in Tables **9** and **10**. In addition, Tables **11** and **12** provide for an overview of the models concerning the parameter estimates of the explanatory variables of the Kadaster dataset and the Kadaster-CBRE dataset respectively. The F-statistics as outlined in Tables **11** and **12** show strong significance for all models of the GLM univariate analyses.

8.1.1 Kadaster Dataset

As the Kadaster dataset provides for more information on the type of real estate and the location factors in terms of the province, G4, city and the effect of the period of time, the effect of these variables on the LTV ratios have been assessed.

Table **9**: Hypotheses Testing Results Kadaster Dataset

Hypothesis	Hypothesis testing	Model
H1a	(B = 0.011, p < 0.05)*	Model 1 - 6
H1b	(B = 0.031, p < 0.01)*	Model 1 - 6
H1c	(B = 0.024, p < 0.01)*	Model 1 - 6
H2	(B = 0.000, p = 0.986)*	Model 4 - 6
	(B = 0.003, p = 0.775)*	
	(B = 0.011, p = 0.271)*	
H3	(B = 0.000, p = 0.965)*	Model 2 - 6
	(B = -0.009, p = 0.345)	
	(B = -0.006, p = 0.551)	
H4	(B = -0.026, p = 0.064)	Model 5
H5	(B = 0.002, p = 0.584)	Model 6

* The result has been derived from the first model as specified in the model column. Table **11** provides for an overview of the effects of the variables for each model on the LTV ratios.

Hypotheses **H1a**, **H1b** and **H1c** comprise the extent to which the Kadaster types of real estate have effect on the LTV ratio. From **H1a** (B = 0.011, p < 0.05), **H1b** (B = 0.031, p < 0.01) and **H1c** (B = 0.024, p < 0.01) results that the Kadaster types of real estate residential, industrial, as well as offices and retail stores have a positive and significant effect on the LTV ratios. With respect to the Kadaster dataset, industrial real estate (0.031) has the largest effect on the LTV ratios, followed by offices and retail stores (0.024) and residential real estate (0.011) respectively. These coefficients are strongly significant in all six models. As in general, in accordance with the view of specialists of the commercial real estate market (Commercial real estate specialists, personal communication, December 2018), residential real estate is expected to have high mortgage loans involved this is an interesting feature. However, as logistics properties are part of the industrial real estate category and since these properties have a high

LTV ratio in general over recent years due to a strong demand, this might have driven the LTV ratios for industrial real estate in this research.

With regard to the period of time, as tested with hypothesis **H2** (B = 0.000, p = 0.986) by including the variable as both a covariate and as fixed factor broken down into the multiple sample years, no significant effect has been observed. Apparently, no results can be obtained from the Kadaster dataset with regard to the time effect. Similarly, there is no significant effect for the time-dependent variable the CEPR business cycles. However, as displayed in Section **6** concerning the LTV ratios broken down into multiple explanatory variables, significant differences in the levels of LTV ratios over the course of the sample period ranging from 2005 until Q3 2018 can be observed. Predominantly, a downward trend from the peak years 2005, 2006 and 2007 all the way down through to 2012 and a recovery from 2013 until Q3 2018 can be recognised in terms of the LTV ratios.

The effect of the location factors, in terms of province, G4 and city, on the LTV ratios have been tested by means of **H3**, **H5** and **H4** respectively. With regard to **H3**, for the provinces Noord-Holland (B = 0.003, p = 0.775), Zuid-Holland ((B = 0.011, p = 0.271) and Utrecht (B = 0.000, p = 0.965) no significant effect has been observed. With respect to **H4**, there is no significant effect of the cities Amsterdam (B = -0.009, p = 0.345), 's-Gravenhage (B = -0.006, p = 0.551), Utrecht (B = -0.026, p = 0.064) and Rotterdam (redundant) on the LTV ratios. Concerning **H5**, table **9** shows no significant effect of the G4 combined (B = 0.002, p = 0.584) on the LTV ratios.

8.1.2 Kadaster-CBRE Dataset

Apart from the corresponding location variables with the Kadaster dataset, the Kadaster-CBRE dataset allows to assess the CBRE type of real estate, both the nationality of the investor in general and broken down into Dutch and foreign, and the type of investor as a covariate and fixed factor.

As can be observed from Table **10**, no significant effect was detected from **H6** (B = -0.004, p = 0.298) concerning the CBRE types of real estate. Neither for the factor in general, nor for the broken-down types of real estate.

Table **10:** Hypotheses Testing Results Kadaster-CBRE Dataset

Hypothesis	Hypothesis testing	Model
H6	(B = -0.004, p = 0.298)*	Model 7 - 10
	(B = 0.056, p = 0.228)*	
	(B = 0.075, p = 0.106)*	
H7	(B = 0.064, p = 0.187)*	Model 7, 9 -11
H8	(B = 0.009, p = 0.329)*	Model 8 -11
H9a	(B = -0.061, p < 0.01)*	Model 7, 8, 10, 11
H9b	(B = 0.061, p < 0.05)	Model 9
H10a	(B = 0.024, p < 0.01)*	Model 7 -9
	(B = -0.121, p < 0.01)*	
	(B = -0.097, p < 0.01)*	
	(B = -0.107, p < 0.01)*	
H10b	(B = -0.124, p < 0.01)*	Model 10, 11

* The result has been derived from the first model as specified in the model column. Table **12** provides for an overview of the effects of the variables for each model on the LTV ratios.

With regard to the location variables province and G4, no significant effect was observed for **H7** and **H8**. With respect to **H7**, for the provinces Noord-Holland (B = 0.056, p = 0.228), Zuid-Holland (B = 0.075, p = 0.106) and Utrecht (B = 0.064, p = 0.187) no significant effect has been observed in Table **10**. Concerning the G4 with regard to **H8** (B = 0.009, p = 0.329), there is no significant effect of the G4 on the LTV ratios.

Both **H9a** (B = -0.061, p < 0.01) and **H9b** (B = 0.061, p < 0.01) show significant effects for the nationality of the investor in general and Dutch investors on the LTV ratios respectively. The coefficient for the nationality of the investor is negative, suggesting that irrespective of what country an investor is from it has a negative effect on the LTV ratios. However, the testing results from **H9b** indicate that when a Dutch investor is involved, the LTV ratios end up with a higher value. In other words, it might be that foreign investors drive down the LTV ratio in contrast to Dutch investors. As argued by Lieser and Groh (2014), regulatory limitations effect the supply of capital on the one hand and the demand conditions on the other hand in a particular real estate market. Hence, countries that have an attractive regulatory regime tent to have more involvement of foreign investors in their real estate market. Apparently, the involvement of foreign investors in the Dutch commercial real estate market negatively affects the level of LTV

ratios. Concerning the nationality of the investor, there is discrepancy between the coefficients in Models **7**, **8**, **10** and **11** as outlined in Table **12**. Nevertheless, the coefficients keep demonstrating both a strongly significant and negative effect on the LTV ratios.

With respect to the type of investor, **H10a** and **H10b** show significant effects of both the different types of investors combined and divided on the LTV ratios. **H10a** ($B = 0.024$, $p < 0.01$) indicates a positive effect of the type of investor factor in general on the LTV ratios, whereas a breakdown into the different types of investors results in negative coefficients. The types of investors other collective vehicles ($B = -0.121$, $p < 0.01$), property companies ($B = -0.097$, $p < 0.01$), private investors ($B = -0.107$, $p < 0.01$) and institutional investors ($B = -0.124$, $p < 0.01$) all have a strongly significant negative effect on the LTV ratios. It is not clear why the distinctive factors show a negative effect on the LTV ratios. However, the largest negative effect is for institutional investors, followed by all other collective vehicles (e.g. investment funds), private investors and property companies (e.g. REITs). This order makes sense, as institutional investors are expected to take on less amount of debt due to the fact that such investors have more access to other financial resources. But, as argued by Barclay, Heitzman and Smith (2013) and Howe and Shilling (1988), REITs tend to take on less debt financing due to a lack of tax deduction capabilities. This is not in accordance with the fact that the smallest negative effect has been observed for property companies. However, as developers are also part of the property companies, the question remains how the particular coefficient is driven.

Concerning the hypotheses testing: **H1a**, **H1b** and **H1c** correspond with **H6**, **H3** is equal to **H7** and **H5** is similar to **H8**. By means of testing these hypotheses, the corresponding results can be evaluated with respect to the Kadaster dataset and Kadaster-CBRE dataset. However, as the CBRE types of real estate show no significant effect and as for the location factors province, G4 and cities no significant effects on the LTV ratios have been observed with regard to both datasets, no direct conclusion can be drawn from the interrelated hypotheses as tested in the Kadaster dataset and Kadaster-CBRE dataset.

8.2 Control Variables and Exploratory Results

In addition to the results concerning the hypotheses testing as outlined in Tables **9** and **10**, Tables **11** and **12** provide for results that are on the one hand transcending the hypotheses but on the other hand involve relevant outcomes. Hence, these results involve both variables that

are not primarily included in the literature and variables that are related to both macroeconomic and microeconomic (control) factors.

In Table **11** the parameter estimates have been displayed of the variables concerning the Kadaster dataset, with respect to the six models. The ECBs interest rate has a minor positive effect on the LTV ratios ($B = 0.007$, $p < 0.01$), suggesting that an increase in the overnight interest rate of the ECB leads to higher LTV ratios. This is an interesting figure, as a higher interest rate would presumably lead to higher borrowing costs, subsequently a lower mortgage loan and thus a lower LTV ratio. However, apparently the negative effect of an increasing interest rate on the value or price of commercial real estate is larger than the extent to which interest rates affect the mortgage loan amount. According to McCue and Kling (1994), one of the main drivers of the variance of real estate returns are nominal interest rates. So, it supports the view of changing mortgage loan values and transaction prices affecting real estate returns and thus LTV ratios. With regard to the Basel Accords, Basel II ($B = -0.010$, $p < 0.05$) and Basel 2.5 (-0.015, $p < 0.05$) have negative significant effects on LTV ratios. In other words, increasing capital constraints leads to lower LTV ratios. These results are in line with research of Lim et al. (2011) and Crowe, Dell'Ariccia, Igan and Rabanal (2011), who stated that capital requirements help mitigating the procyclical movements of real estate markets. Hence, the LTV ratios drop. With respect to the different provinces, a commercial real estate transaction taking place in Friesland ($B = 0.031$, $p < 0.05$) leads to a higher LTV ratio. As no evidence has been found for the other provinces, no conclusion can be drawn from these results.

The F-statistics as displayed in Table **11** show strong significance for Models **1** to **6** with regard to the Kadaster dataset. However, the adjusted R-squared of these models equal only 0.010. The intercepts of Models **1** to **3** are significantly different from zero, assuming that when all the explanatory variables are either set to their reference levels or to zero, the mean of the LTV ratios is zero. As the independent variables in the models, of which the intercepts are subject to significance, provide for similar (significant) results as Models **4** to **6** no problems arise concerning these intercepts. The difference between Models **1** to **3** on the one hand and Models **4** to **6** on the other hand in terms of the significance of the intercepts, has occurred due to the composition of the respective models. Where in Models **1** and **2** the time factor has been excluded and in Model **3** the period of time has been included as a fixed factor, in the remaining models the period of time has been added as covariate.

Table **11**: (Significant) Parameter Estimates Kadaster dataset

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.805***	0.798***	0.787***	0.862	0.910	0.860
	(0.010)	(0.014)	(0.019)	(3.742)	(3.742)	(3.742)
CEPR business	-0.004	-0.004	-0.012*	-0.004	-0.004	-0.004
cycles	(0.005)	(0.005)	(0.007)	(0.005)	(0.005)	(0.005)
ECBs interest	0.007***	0.007***	0.008*	0.007***	0.007***	0.007***
rate	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)
STOXX						
Europe 600						
Real Estate	0.000**	0.000**	0.000	0.000**	0.000**	0.000**
Cap	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Commercial						
real estate						
number of	0.000*	0.000*	0.000	0.000	0.000	0.000
transactions	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industrial real	0.031***	0.031***	0.031***	0.031***	0.031***	0.031***
estate	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Offices and	0.024***	0.023***	0.023***	0.023***	0.023***	0.023***
retail stores	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Residential real	0.011**	0.010**	0.010**	0.010**	0.010**	0.010**
estate	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Friesland		0.031**	0.031**	0.031**	0.031**	0.031**
		(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Groningen		0.023*	0.023*	0.023*	0.023*	0.023*
(province)		(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Utrecht (city)					-0.026*	
					(0.014)	
Basel II	-0.010**	-0.010*		-0.010	-0.010	-0.010
	(0.005)	(0.005)	0a	(0.008)	(0.008)	(0.008)
Basel 2.5	-0.015**	-0.015**		-0.015	-0.015	-0.015
	(0.007)	(0.007)	0a	(0.012)	(0.012)	(0.012)
Basel III	-0.012	-0.012*		-0.012	-0.012	-0.012
	(0.007)	(0.007)	0a	(0.016)	(0.016)	(0.016)
F	12.627***	7.854***	5.768***	7.539***	6.856***	7.539***
R-squared	0.010	0.012	0.013	0.012	0.012	0.012
Adjusted R-Squared	0.010	0.010	0.010	0.010	0.010	0.010
No. Observations	15512					

Standard errors are reported in parentheses.

*, **, *** indicate significance at the 90%, 95%, and 99% level, respectively.

Table **11** comprises the significant parameter estimates of the variables of interest for this study. Table **J**.**1** in Appendix **J** displays an overview providing for all coefficients of the variables that were tested in the six models concerning the Kadaster dataset, irrespective from the fact whether sound conclusions can be drawn.

With regard to the Kadaster-CBRE dataset, Table **12** shows the parameter estimates of interest. In addition to earlier results on the different provinces, Table **12** shows a positive and significant effect for commercial real estate transactions in Limburg ($B = 0.115$, $p < 0.05$). In accordance with the positive effect in Table **12**, the ECBs interest rate ($B = 0.020$, $p < 0.05$) also has a positive effect on the LTV ratios with respect to the Kadaster-CBRE dataset. In other words, both the Kadaster dataset and Kadaster-CBRE dataset show a positive significant effect for the ECBs interest rate.

Concerning Models **7** and **9** the adjusted R-squared is 0.095 and the adjusted R-squared is 0.103, 0.100 and 0.098 for Models **8**, **10** and **11** respectively. For Models **7** to **11** of the Kadaster-CBRE dataset the F-statistic is strongly significant. In comparison to Models **1** to **6** of the Kadaster dataset, the R-squared has risen significantly for the models regarding the Kadaster-CBRE dataset. In other words, the explaining factor of the variables with respect to the Kadaster-CBRE dataset is notably higher than the variables comprising the Kadaster dataset. Presumably, the lower number of LTV ratios in combination with a higher count of explanatory variables for the Kadaster-CBRE dataset has led to this difference. Similarly, to Models **1** to **3**, the intercepts of Models **7** to **11** assume that when the explanatory variables are either set to their reference levels or to zero, the mean of the LTV ratios is zero. In general, as the models provide for significant results with regard to the explanatory variables, there is not a problem with the strongly significant intercepts of Models **7** to **11**.

In table **12** all explanatory variables and the related significant coefficients have been comprised. Table **J**.**2** shows all parameter estimates of the variables for the five tested models including the explanatory variables of which no conclusions can be drawn with respect to the Kadaster-CBRE dataset.

Table **12**: (Significant) Parameter Estimates Kadaster-CBRE Dataset

	Model 7	Model 8	Model 9	Model 10	Model 11
Intercept	0.759***	0.698***	0.684***	0.965***	0.894***
	(0.065)	(0.077)	(0.066)	(0.064)	(0.084)
Nationality of	-0.061***	-0.066***		-0.090***	-0.090***
investor	(0.014)	(0.014)		(0.019)	(0.020)
Nationality					
(dummy;			0.061***		
Dutch)			(0.014)		
Friesland		0.102*			
		(0.060)			
Limburg		0.115**			
		(0.054)			
Noord-Brabant		0.087*			
		(0.046)			
Type of	0.024***	0.024***	0.024***		
investor	(0.006)	(0.006)	(0.006)		
Institutional				-0.124***	-0.115**
investors				(0.043)	(0.044)
Other (type of				-0.143***	-0.146***
investor)				(0.053)	(0.053)
All other					
collective				-0.121***	-0.121***
vehicles				(0.025)	(0.025)
Private				-0.107***	-0.107***
investors				(0.030)	(0.030)
Property				-0.097***	-0.097***
company				(0.029)	(0.029)
ECBs interest	0.020**	0.020**	0.020**	0.022**	0.021**
rate	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
F	5.674***	4.156***	5.674***	4.964***	4.112***
R-squared	0.115	0.136	0.115	0.125	0.130
Adjusted R-Squared	0.095	0.103	0.095	0.100	0.098
No. Observations	713				

Standard errors are reported in parentheses.

*, **, *** indicate significance at the 90%, 95%, and 99% level, respectively.

8.3 Conclusion

Section **8** has provided for the results of the models as outlined in Sections **4.1** and **4.2**, by testing the hypotheses as formulated in Section **4.2**. In addition, the exploratory results, as well as the control variables, have been analysed.

Concerning the Kadaster type of real estate, **H1a** ($B = 0.011$, $p < 0.05$), **H1b** ($B = 0.031$, $p < 0.01$) and **H1c** ($B = 0.024$, $p < 0.01$) show a significant and positive effect of this variable on the LTV ratios. With respect to the Kadaster dataset, industrial real estate has the largest effect, followed by offices and retail stores, and residential real estate. Interestingly, whereas specialists in the commercial real estate market (Commercial real estate specialists, personal communication, December 2018) state differently, according to this research residential real estate has the smallest effect on the level of the LTV ratios. In accordance with the increasing demand for logistics properties, industrial real estate shows the largest effect on LTV ratios. With regard to the location factors in terms of the province, the G4 and the city, no significant effects have been found concerning **H3**, **H4** and **H5** respectively. Similarly, no conclusions can be drawn from the period of time with regard to **H2**.

With regard to the CBRE types of real estate (**H6**), no significant effect has been observed. In addition, no significant effect has been found for the different provinces (**H7**) and the G4 (**H8**). With respect to **H9a**, a negative significant effect has been observed for the nationality of the investor ($B = -0.061$, $p < 0.01$). Correspondingly, in accordance with **H9b**, Dutch investors ($B = 0.061$, $p < 0.01$) have a positive significant effect on the LTV ratios. So, it might be that foreign investors drive down the LTV ratio in contrast to Dutch investors. Concerning the types of investors, **H10a** and **H10b** show significant effects of both the different types of investors combined and divided on the LTV ratios. **H10a** ($B = 0.024$, $p < 0.01$) indicates a positive effect of the type of investor factor in general on the LTV ratios. However, the different types of investors all have a strongly significant negative effect on the LTV ratios. With the largest negative effect for institutional investors ($B = -0.124$, $p < 0.01$), followed by all other collective vehicles ($B = -0.121$, $p < 0.01$), private investors ($B = -0.107$, $p < 0.01$) and property companies ($B = -0.097$, $p < 0.01$) respectively. This is in line with the literature, as institutional investors are expected to take on less amount of debt due to the fact that such investors have more access to other financial resources.

Hypotheses **H1a**, **H1b** and **H1c** and **H6** on the one hand and hypotheses **H3**, **H5**, **H7** and **H8** on the other hand, concern the Kadaster and CBRE types of real estate and the location factors respectively. As the CBRE types of real estate show no significant effect and with regard to the location factors no significant effects have been observed with respect to both datasets, no direct conclusion can be drawn, concerning the evaluation of these explanatory variables, from the interrelated hypotheses as tested regarding the Kadaster dataset and Kadaster-CBRE dataset.
Further results assume a positive relation between the ECBs interest rate and the LTV ratios in both the Kadaster dataset ($B = 0.007$, $p < 0.01$) and the Kadaster-CBRE dataset ($B = 0.020$, $p < 0.05$). With regard to the adjusted LTV ratios in this study, an increase in the overnight interest rate seemingly drives the commercial real estate transaction prices down to a larger extent than the mortgage loans. Hence, the LTV ratios increase. A negative effect has been observed with respect to Basel II ($B = -0.010$, $p < 0.05$) and Basel 2.5 (-0.015, $p < 0.05$). As due to additional capital requirements the LTV ratios are expected to decrease, these results are in line with research from Lim et al. (2011) and Crowe, Dell'Ariccia, Igan and Rabanal (2011). In addition, a commercial real estate transaction taking place in Friesland ($B = 0.031$, $p < 0.05$) and Limburg ($B = 0.115$, $p < 0.005$) leads to a higher LTV ratio. As no evidence has been found for the other provinces, no conclusion can be drawn from these results.

For all the tested models of both datasets the F-statistics are strongly significant. However, with an adjusted R-squared of 0.010 for the models concerning the Kadaster dataset and an adjusted R-squared ranging from 0.095 to 0.103 for models with regard to the Kadaster-CBRE dataset, the variance of the LTV ratios is only to a minor extent explained by the observed explanatory variables in this study. As the R-squared is significantly larger for Models **7** to **11** of the Kadaster-CBRE dataset in comparison to Models **1** to **6** of the Kadaster-dataset, the explaining factor of the variables concerning the former dataset is notably higher.

9 Conclusion, Discussion and Limitations

This thesis evaluates the adjusted LTV ratios in the commercial real estate market in The Netherlands from 2005 until Q3 2018 by means of an assessment of the effects different commercial real estate characteristics have on the LTV ratios with regard to commercial real estate transactions.

9.1 Conclusion

In order to determine the aforementioned characteristics of commercial real estate, as well as providing for a robust dataset and generating a sound research, the following has been discussed in this research. In Section **2** the underlying theory of capital structure decision-making, as well as the determinants of interest with respect to the LTV ratio, have been introduced by evaluating the existing literature. With respect to Section **3**, in accordance with data from both the Kadaster and CBRE and with respect to the literature review, the variables of interest have been described. Followed by Section **4**, in which the methodology and the hypotheses have been introduced and formulated respectively. Then, in Section **5** multiple databases have been collected and edited in order to eventually generate the Kadaster dataset and Kadaster-CBRE dataset. In Section **6** the LTV ratios have been broken down into the different independent variables over the course of the sample period in order to provide for an overview of both datasets. In Section **7**, corresponding with the chosen methodology and formulated hypotheses, parametric assumptions have been tested to the data and the data has been further assessed by utilising tests of means in order to ascertain sound results with respect to the hypotheses testing. Finally, in Section **8** the hypotheses have been tested and further exploratory results have been analysed.

The above-mentioned steps have been taken in order to provide for an answer to the following research question: What factors have – and how have these factors – affected the development of LTV ratios in the Dutch commercial real estate market from 2005 until Q3 2018?

In order to test the determinants of interest for this study, GLM univariate analyses have been utilised. This procedure has enabled to test the effects of different factors on the means of several groupings of LTV ratios. Concerning these factors, the types of real estate residential real estate, industrial real estate, as well as offices and retail stores show a positive effect on the LTV ratios. This effect is the largest for industrial real estate, followed by offices and retail stores, and residential real estate respectively. In accordance with the literature, residential real estate is expected to have the largest effect on LTV ratios. However, concerning the increasing demand for logistics properties over recent years in The Netherlands, industrial real estate shows the largest effect on LTV ratios. With regard to the provinces, cities and period of time, no significant effects have been found. Nonetheless, the breakdown of the LTV ratios into the explanatory variables over time has shown a clear downward trend development of the LTV

ratios from the peak years 2005, 2006 and 2007 on until 2013 when after the levels of the LTV ratios have expanded until Q3 2018. Concerning the types of investors in general, a positive effect has been observed. However, with respect to the different types of investors, the most substantial negative effect has been detected for institutional investors, followed by other collective vehicles (e.g. investment funds), private investors and property companies (e.g. REITs). This is in line with the literature, as institutional investors are expected to take on less amount of debt due to the fact that such investors have more access to other financial resources. Whereas the nationality of the investors in general results in a negative effect, Dutch investors positively affect LTV ratios. So, it appears that foreign investors drive down the LTV ratio in contrast to Dutch investors. Additional results show a positive relation between the ECBs interest rate and the LTV ratios. With regard to the adjusted LTV ratios in this study, an increase in the overnight interest rate seemingly drives down the commercial real estate transaction prices to a larger extent than the mortgage loans. Hence, the LTV ratios increase. A negative effect has been observed with respect to Basel II and Basel 2.5. So, in line with the literature, increasing capital constraints leads to lower LTV ratios. Lastly, the fact that a commercial real estate transaction takes place in Friesland or Limburg drives up LTV ratios. As no evidence has been found for the other provinces, no conclusion can be drawn from these results. For all the tested models the F-statistics are strongly significant. However, as the R-squared is predominantly low, the variance of the LTV ratios is only to a minor extent explained by the observed explanatory variables in this study.

To conclude, this thesis provides for an introduction into the research concerning LTV ratios in the commercial real estate market. More specifically, it has quantified the effect multiple commercial real estate characteristics have on commercial real estate transactions in terms of mortgage debt flows. As the most challenging part has been to construct a comprehensive dataset comprising interrelated commercial real estate transactions and (registration values of) mortgage loans, it is recommended to establish a reliable method to generate the LTV ratios for further research.

9.2 Discussion and Limitations

This Section discusses both the limitations with regard to the lack of literature in the field of commercial real estate transactions and the data collection process.

In order to identify and determine the factors of effect with respect to LTV ratios, a literature review has been conducted. During this process, it appeared that little research has been conducted in the field of commercial real estate in relation to LTV ratios specifically and the extent to which mortgage loans or debt financing are addressed by commercial real estate investors. As data with regard to commercial real estate transactions and mortgage loans is not publicly available, only limited publications are available. In addition, mainly due to the fact that many real estate investors are not publicly listed and subsequently data concerning these investors is not available, there consists a lack of research in this area. As a result, most of the cited literature in this thesis involves (publicly listed) REITs and to a smaller extent other listed (private equity) real estate funds and institutional investors such as pension funds. Consequently, it is hard to evaluate the results with respect to the existing literature. Therefore, in accordance with data of both the Kadaster and CBRE, as many as factors have been gathered that are expected to affect the LTV ratios in order to generate a comprehensive study. As a result, Section **2** and **3** provide for both a literature review on the factors in play and an overview of the determinants of the LTV ratios. In addition, Section **6** displays a breakdown of the LTV ratios into the explanatory variables in order to clarify the selection of the determinants and provide for a transparent overview of different factors in the commercial real estate market.

As the Kadaster dataset and Kadaster-CBRE dataset have been manually generated from – to a certain extent – non-public databases from the Kadaster and CBRE, Section **5** thoroughly describes the data collection and editing process. However, although by applying the multiple criteria in addition to identifying the relevant information in order to comprise all the available information in one line per transaction, it remained difficult to match these transactions with a corresponding mortgage loan. As previously discussed, in commercial real estate transactions investors use mortgage loans, just like other types of loans, in order to free up capital for investments in general and thus not always specifically for the transaction it is linked to. In addition, if possible, in times when real estate prices are rising, investors postpone taking on a (mortgage) loan since the registration value of mortgage loans will be higher at a later period in time. Hence, the properties that are part of a transaction are not necessarily the same as the underlying of the mortgage loan. As such transactions and related mortgage loans are hard to identify, a limited amount of time between the registration of the mortgage loan and the deed of sale has been included in order to ascertain a direct relation between a mortgage loan and a transaction. However, as a consequence valuable data might have been excluded from this research. In addition, due to applying a limit to the LTV ratios, a vast number of transactions is

kept out of this research. This is a result of a mismatch between the transaction data and mortgage loan data, as the limited values of LTV ratios have been put in place in accordance with interviews conducted with professionals in the field of commercial real estate.

To conclude, this thesis provides for an introduction into the research concerning LTV ratios in the commercial real estate market. This study concerns manually generated datasets in which relatively little data has remained from the original databases, which illustrates the difficulty to acquire relevant data. Therefore, for future research in this field it would be recommended to begin with finding a way to match commercial real estate transactions with the corresponding mortgage loans in order to generate a sound database comprising relevant transactions and subsequent LTV ratios. However, with regard to the nature of such transactions, the question is whether this would be possible at all. In addition, in this thesis multiple determinants of the LTV ratios have been assessed. Future studies might first focus on only a few of the factors in order to conduct a more in-depth research of the LTV ratios. For example, with regard to the types of investors in this study, there could be a more detailed assessment on the subtypes of this factor in an effort to evaluate, among others, the different institutional investors on a more detailed level. Also, as this thesis concerns data on Dutch commercial real estate transactions only, it would be recommended to conduct a similar research in other (European) countries in order to assess the results of this thesis with respect to different commercial real estate markets.

With regard to relating research, it might be of interest to assess the debt levels in general in the commercial real estate market. In this thesis, decreasing LTV ratios over time have been shown. As this is especially the case since the global financial crisis and partially driven by regulatory involvement, it eventually leads to the question: knowing that a smaller amount of the financing operations of real estate investors can be covered by senior debt or mortgage loans, how do these investors structure both their debt and their investment? This might be subject to further research.

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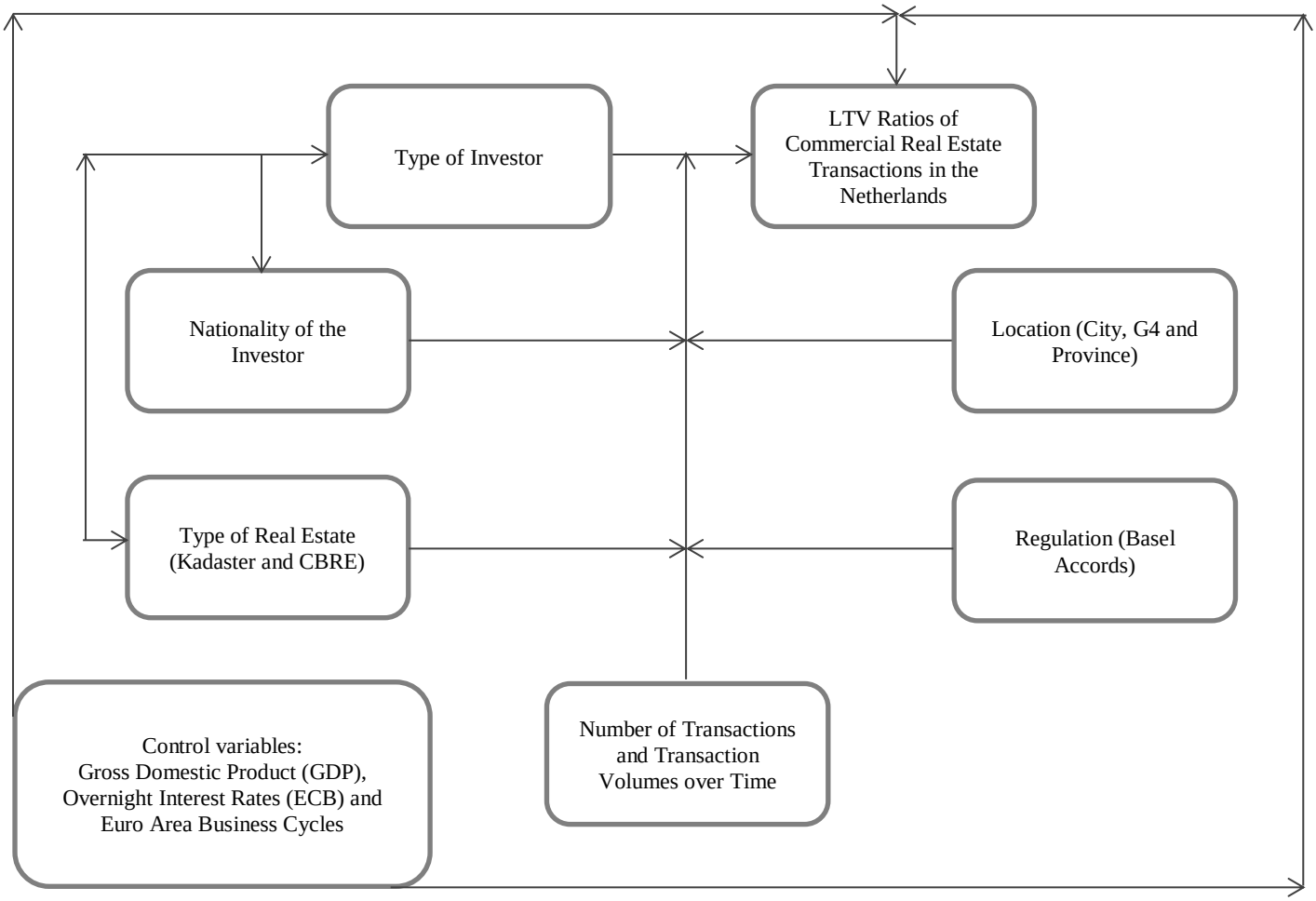
11 Appendices

11.1 Appendix A



Note: Appendix A shows the dependent variable, as well as the independent (control) variables of interest in this study.

11.2 Appendix B

Period of time (quarters)	Real GDP growth per quarter (%)
03-2018	2,50%
02-2018	1,60%
01-2018	2,40%
04-2017	1,40%
03-2017	1,40%
02-2017	1,10%
01-2017	0,80%
04-2016	0,10%
03-2016	-0,20%
02-2016	0,50%
01-2016	1,40%
04-2015	1,10%
03-2015	1,60%
02-2015	1,30%
01-2015	-0,90%
04-2014	0,70%
03-2014	-0,10%
02-2014	-0,60%
01-2014	1,00%
04-2013	0,00%
03-2013	1,60%
02-2013	2,00%
01-2013	1,60%
04-2012	2,00%
03-2012	1,00%
02-2012	1,40%
01-2012	1,30%
04-2011	0,90%
03-2011	-0,30%
02-2011	-0,40%
01-2011	0,40%
04-2010	1,20%
03-2010	1,60%
02-2010	1,70%
01-2010	-0,60%
04-2009	-1,40%
03-2009	-0,30%
02-2009	0,60%
01-2009	1,50%
04-2008	3,00%
03-2008	2,10%
02-2008	1,60%
01-2008	1,80%
04-2007	1,20%
03-2007	2,00%
02-2007	2,50%
01-2007	1,70%
04-2006	1,80%
03-2006	1,50%
02-2006	1,60%
01-2006	2,20%
04-2005	2,50%
03-2005	2,50%
02-2005	2,40%
01-2005	2,30%
04-2004	1,10%

Note: Appendix B shows the GDP growth rate per quarter and is derived from Eurostat (Eurostat, 2019).

11.3 Appendix C

Date		Main refinancing operation	
		Fixed rate tenders Fixed rate	Variable rate tenders Minimum bid rate
With effect from			
2016	16 Mar.	0.00	-
2015	9 Dec.	0.05	-
2014	10 Sep.	0.05	-
	11 Jun.	0.15	-
2013	13 Nov.	0.25	-
	8 May.	0.50	-
2012	11 Jul.	0.75	-
2011	14 Dec.	1.00	-
	9 Nov.	1.25	-
	13 Jul.	1.50	-
	13 Apr.	1.25	-
2009	13 May	1.00	-
	8 Apr.	1.25	-
	11 Mar.	1.50	-
	21 Jan.	2.00	-
2008	10 Dec.	2.50	-
	12 Nov.	3.25	-
	15 Oct.4	3.75	-
	9 Jul.	-	4.25
2007	13 Jun.	-	4.00
	14 Mar.	-	3.75
2006	13 Dec.	-	3.50
	11 Oct.	-	3.25
	9 Aug.	-	3.00
	15 Jun.	-	2.75
	8 Mar.	-	2.50
2005	6 Dec.	-	2.25
2003	6 Jun.	-	2.00

Note: Appendix C shows the interest rates of the ECB concerning the main refinancing operations (ECB, 2019).

11.4 Appendix D

Column	Description
OBJE_OVER_ID	Transaction (ID)
OBJE_ONTV_DATUM	Transaction date
OBJE_KOOP_SOM	Transaction price
OBJE_STUK	Deed of sale (ID)
OBJE_MUT_SRT_K	Kind of transaction
NNP_VV_K	Transferor type
VV_NAAM	Transferor name
NNP_VK_K	Acquirer type
VK_NAAM	Acquirer name
OBJE_OBJEKT	Plot of land (ID; matching key)
OBJE_GROOTTE	Plot of land size
OBJE_KULT_TEXT	Plot of land type
OBJA_KULT_GEB_K	Plot of land type specification 1
OBJE_KULT_ONGEB_K	Plot of land type specification 2
OBJA_PHT	Postal code, house number (addition)
OBJA_PTT_K	Postal code, house number
OBJA_STRAAT	Street name
OBJA_HUIS_NR	House number
OBJA_HUIS_LR	House number (addition)
OBJA_AANDUIDING	Plot of land specified 3
OBJE_BURG_GEM_K_NAAM	Municipality name
OBJE_IND_MEER_O_G	Indication more than one plots of land involved in a transaction (criterion 1)
AARDEIGENDOM	Nature of ownership
ACN_WT	Property type
IND_NP_VK	Indication transferor type verified
IND_NP_VV	Indication acquirer type verified
OBJE_BEB_K	Indication nature of property on plot of land
OVER_IND_BETROUWBAAR	Indication transaction and transaction price reliable (criterion 2)
BIJEENKOMSTFUNCTIE	Plot of land usage
CELFUNCTIE	Property usage: prison
GEZONDHEIDSZORGFUNCTIE	Property usage: health care
INDUSTRIEFUNCTIE	Property usage: industrial
KANTOORFUNCTIE	Property usage: offices
LOGIESFUNCTIE	Property usage: hotel
ONDERWIJSFUNCTIE	Property usage: education
OVERIGE_GEBRUIKSFUNCTIE	Property usage: other
SPORTFUNCTIE	Property usage: sport
WINKELFUNCTIE	Property usage: retail
WOONFUNCTIE	Property usage: residential
BAG_INDENTIFICATIE_1	Unique code on property level (matching key)
BAG_INDENTIFICATIE_2	Unique code on address level
BAG_PROVINCIE	Province name
BOUWJAAR	Year of construction
VBO_OPPERVLAK	Size of property on plot of land
STATUS_ADRES	Status of property on plot of land
BEGINDATUMTIJDVAKGELDIGHEID	Starting date registered BAG ID
EINDDATUMTIJDVAKGELDIGHEID	End date registered BAG ID
KWALITEIT	Data source
EPC_KLASSE	Energy label
EPC_EP_INDEX	Energy label (index)
TYPE_TRANSACTIE	Transaction type (OV20: commercial real estate)
HOBF_OBJEKT	Plot of land (ID; matching key)
HOBF_FEIT	Mortgage loan registration
HOBF_BEGIN_DATUM	Mortgage loan starting date (on underlying plot of land)
HOBF_EINDE_DATUM	Mortgage loan end date (on underlying plot of land)
HFEI_ID	Mortgage loan registration (ID)
HFEI_HSTU_ID	Mortgage deed (ID)
HFEI_BEGIN_DATUM	Mortgage loan starting date
HFEI_EINDE_DATUM	Mortgage loan end date
HFEI_AARD_FEIT_K	Mortgage type (HYP: mortgages)
HFEI_RANGORDE	Mortgage loan pick order
HSCH_ID	Mortgage loan registration 2 (ID)
HSCH_BEGIN_DATUM	Mortgage loan starting date 2
HSCH_EINDE_DATUM	Mortgage loan end date 2
HSCH_BEDRAG	Mortgage loan amount
HSCH_RENTE_PERCENTAGE	Mortgage loan interest rate
HSTU_STUK	Mortgage deed
HSTU_ONTV_DATUM	Mortgage deed registration date

Note: Appendix D shows the columns of information corresponding with the commercial real estate transactions database and mortgage loan database of the Kadaster.

11.5 Appendix E

	2005 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2006 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2007 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)
LTV ratios												
Average LTV ratio	6751%	7649%	11254%	1227%	1521%	1350%	1262%	1476%	2160%	2421%	2102%	2911%
Median LTV ratio	111%	113%	110%	120%	107%	108%	100%	116%	107%	107%	100%	118%
Average LTV ratio excl. 1% smallest and largest values	359%	370%	354%	408%	447%	430%	491%	397%	360%	387%	370%	444%
Average LTV ratio excl. 5% smallest and largest values	240%	252%	237%	223%	203%	207%	207%	217%	190%	200%	193%	210%
Average LTV ratio excl. values <50% and >150%	100%	100%	100%	101%	99%	99%	98%	101%	100%	99%	98%	102%
LTV ratios: criterion V												
Average LTV ratio	264%	268%	256%	281%	1067%	1102%	1102%	605%	264%	266%	315%	210%
Median LTV ratio	95%	98%	94%	102%	95%	96%	96%	84%	100%	100%	97%	100%
Average LTV ratio excl. 1% smallest and largest values	141%	140%	126%	156%	146%	148%	148%	111%	161%	160%	171%	149%
Average LTV ratio excl. 5% smallest and largest values	106%	108%	102%	114%	106%	107%	107%	89%	114%	113%	115%	113%
Average LTV ratio excl. values <50% and >150%	98%	98%	97%	99%	97%	98%	98%	93%	98%	97%	96%	99%
LTV ratios: criterion III												
Average LTV ratio	9699%	11760%	13110%	8785%	8152%	8545%	361%	24162%	5343%	6249%	226%	17143%
Median LTV ratio	98%	100%	98%	107%	100%	100%	96%	108%	100%	100%	100%	108%
Average LTV ratio excl. 1% smallest and largest values	214%	210%	223%	194%	199%	183%	169%	203%	152%	158%	143%	184%
Average LTV ratio excl. 5% smallest and largest values	150%	137%	163%	137%	124%	121%	111%	140%	119%	122%	114%	138%
Average LTV ratio excl. values <50% and >150%	98%	98%	96%	100%	97%	97%	95%	101%	99%	99%	97%	102%
LTV ratios: criteria III and V												
Average LTV ratio	1054%	1218%	245%	2841%	6771%	7430%	352%	19661%	5039%	5437%	253%	13681%
Median LTV ratio	89%	95%	92%	100%	93%	94%	88%	100%	100%	100%	98%	101%
Average LTV ratio excl. 1% smallest and largest values	118%	122%	126%	117%	115%	113%	103%	125%	146%	145%	147%	144%
Average LTV ratio excl. 5% smallest and largest values	99%	102%	100%	101%	96%	95%	89%	106%	111%	110%	109%	113%
Average LTV ratio excl. values <50% and >150%	97%	98%	97%	98%	95%	96%	94%	99%	99%	98%	96%	101%

	2008 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2009 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2010 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)
LTV ratios												
Average LTV ratio	1008057%	1111274%	1829223%	5803%	21034%	23792%	2924%	53983%	13128%	14755%	19648%	5691%
Median LTV ratio	115%	116%	113%	119%	111%	109%	105%	113%	104%	106%	100%	120%
Average LTV ratio excl. 1% smallest and largest values	770%	810%	1000%	517%	518%	508%	486%	600%	370%	364%	291%	641%
Average LTV ratio excl. 5% smallest and largest values	355%	390%	534%	260%	275%	244%	282%	207%	188%	191%	166%	211%
Average LTV ratio excl. values <50% and >150%	98%	98%	96%	101%	98%	98%	95%	100%	97%	99%	97%	101%
LTV ratios: criterion V												
Average LTV ratio	4300%	4558%	8482%	200%	243%	245%	282%	216%	560%	598%	815%	267%
Median LTV ratio	97%	98%	94%	101%	100%	100%	100%	103%	99%	100%	88%	108%
Average LTV ratio excl. 1% smallest and largest values	147%	146%	156%	126%	150%	148%	167%	162%	140%	210%	267%	127%
Average LTV ratio excl. 5% smallest and largest values	110%	110%	117%	105%	115%	113%	129%	141%	115%	115%	156%	114%
Average LTV ratio excl. values <50% and >150%	96%	96%	93%	100%	96%	96%	94%	99%	98%	98%	95%	101%
LTV ratios: criterion III												
Average LTV ratio	7905%	6734%	6062%	7830%	22736%	26524%	472%	74989%	1196%	622%	322%	1265%
Median LTV ratio	102%	105%	102%	108%	103%	100%	100%	105%	88%	91%	82%	106%
Average LTV ratio excl. 1% smallest and largest values	208%	220%	205%	247%	237%	221%	241%	171%	155%	152%	153%	149%
Average LTV ratio excl. 5% smallest and largest values	143%	149%	142%	155%	155%	139%	148%	130%	109%	110%	106%	121%
Average LTV ratio excl. values <50% and >150%	97%	98%	96%	101%	98%	97%	96%	98%	96%	96%	94%	100%
LTV ratios: criteria III and V												
Average LTV ratio	245%	249%	260%	233%	302%	312%	404%	185%	292%	315%	394%	153%
Median LTV ratio	95%	96%	91%	101%	97%	97%	95%	100%	85%	84%	75%	100%
Average LTV ratio excl. 1% smallest and largest values	135%	134%	125%	144%	153%	154%	165%	122%	121%	126%	119%	114%
Average LTV ratio excl. 5% smallest and largest values	104%	104%	99%	113%	105%	105%	108%	101%	88%	90%	84%	101%
Average LTV ratio excl. values <50% and >150%	95%	95%	92%	100%	96%	96%	95%	97%	96%	96%	94%	99%

	2011 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2012 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2013 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)
LTV ratios												
Average LTV ratio	2216%	2349%	1879%	3254%	14369%	15394%	7069%	32058%	187731%	223710%	232322%	202602%
Median LTV ratio	118%	120%	110%	137%	120%	118%	111%	128%	124%	125%	111%	147%
Average LTV ratio excl. 1% smallest and largest values	571%	564%	515%	626%	849%	878%	1106%	682%	629%	651%	556%	1022%
Average LTV ratio excl. 5% smallest and largest values	268%	279%	287%	266%	326%	331%	330%	311%	339%	333%	301%	434%
Average LTV ratio excl. values <50% and >150%	97%	98%	93%	105%	97%	96%	92%	105%	97%	100%	98%	104%
LTV ratios: criterion V												
Average LTV ratio	270%	277%	259%	300%	665%	737%	1099%	199%	38977%	45764%	48026%	42677%
Median LTV ratio	107%	109%	100%	118%	106%	111%	104%	119%	109%	112%	105%	118%
Average LTV ratio excl. 1% smallest and largest values	158%	160%	161%	162%	237%	300%	508%	155%	249%	251%	427%	155%
Average LTV ratio excl. 5% smallest and largest values	124%	127%	121%	134%	145%	154%	184%	134%	160%	155%	187%	135%
Average LTV ratio excl. values <50% and >150%	99%	100%	97%	105%	96%	98%	94%	104%	96%	98%	93%	104%
LTV ratios: criterion III												
Average LTV ratio	21181%	429%	376%	537%	5063%	6110%	530%	18884%	505157%	631504%	427201%	1139823%
Median LTV ratio	102%	108%	101%	117%	107%	107%	101%	119%	100%	100%	94%	121%
Average LTV ratio excl. 1% smallest and largest values	187%	188%	188%	186%	206%	226%	196%	240%	214%	187%	172%	243%
Average LTV ratio excl. 5% smallest and largest values	137%	146%	145%	148%	150%	151%	142%	169%	136%	124%	114%	150%
Average LTV ratio excl. values <50% and >150%	96%	98%	94%	104%	97%	96%	93%	102%	94%	95%	93%	101%
LTV ratios: criteria III and V												
Average LTV ratio	223%	240%	260%	202%	407%	451%	577%	207%	80637%	102949%	102379%	103831%
Median LTV ratio	100%	100%	98%	107%	100%	100%	96%	109%	100%	101%	100%	110%
Average LTV ratio excl. 1% smallest and largest values	129%	138%	148%	129%	147%	152%	193%	150%	127%	131%	126%	140%
Average LTV ratio excl. 5% smallest and largest values	109%	112%	110%	115%	115%	118%	114%	127%	119%	118%	110%	123%
Average LTV ratio excl. values <50% and >150%	97%	98%	96%	102%	95%	96%	93%	101%	93%	96%	94%	100%

	2014 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2015 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2016 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)
LTV ratios												
Average LTV ratio	3980%	4482%	1984%	11487%	2770%	3385%	852%	11887%	689%	698%	539%	1079%
Median LTV ratio	123%	128%	116%	160%	125%	125%	117%	136%	121%	120%	111%	141%
Average LTV ratio excl. 1% smallest and largest values	1025%	1156%	1028%	1471%	525%	578%	581%	552%	363%	351%	316%	440%
Average LTV ratio excl. 5% smallest and largest values	554%	622%	608%	661%	299%	312%	317%	295%	241%	229%	210%	280%
Average LTV ratio excl. values <50% and >150%	98%	99%	97%	103%	105%	102%	102%	103%	100%	99%	96%	104%
LTV ratios: criterion V												
Average LTV ratio	750%	784%	400%	1408%	750%	808%	970%	493%	15935%	18809%	31475%	320%
Median LTV ratio	111%	110%	103%	125%	118%	117%	114%	120%	121%	116%	108%	125%
Average LTV ratio excl. 1% smallest and largest values	247%	251%	264%	269%	432%	487%	617%	194%	237%	215%	211%	218%
Average LTV ratio excl. 5% smallest and largest values	164%	163%	177%	158%	239%	258%	370%	151%	180%	164%	160%	168%
Average LTV ratio excl. values <50% and >150%	98%	98%	96%	103%	102%	101%	99%	105%	99%	98%	94%	103%
LTV ratios: criterion III												
Average LTV ratio	119103%	139190%	188211%	904%	601%	670%	728%	471%	551%	546%	539%	569%
Median LTV ratio	108%	109%	106%	116%	108%	115%	115%	115%	119%	110%	106%	122%
Average LTV ratio excl. 1% smallest and largest values	393%	418%	438%	342%	412%	499%	554%	288%	353%	337%	363%	267%
Average LTV ratio excl. 5% smallest and largest values	261%	275%	299%	191%	245%	274%	321%	177%	204%	183%	169%	187%
Average LTV ratio excl. values <50% and >150%	97%	97%	97%	100%	98%	100%	99%	102%	98%	97%	95%	101%
LTV ratios: criteria III and V												
Average LTV ratio	396%	405%	250%	689%	652%	688%	851%	301%	383%	350%	379%	304%
Median LTV ratio	103%	100%	98%	106%	112%	111%	115%	108%	114%	106%	103%	112%
Average LTV ratio excl. 1% smallest and largest values	184%	174%	175%	182%	469%	497%	653%	166%	225%	187%	176%	210%
Average LTV ratio excl. 5% smallest and largest values	133%	128%	128%	129%	254%	283%	377%	133%	170%	142%	136%	155%
Average LTV ratio excl. values <50% and >150%	97%	96%	94%	100%	100%	100%	99%	102%	98%	96%	94%	100%

	2017 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2018 LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)	2005 - 2018 (Q3) LTV ratios	LTV ratios: criterion II (positive)	LTV ratios: criterion I (positive) and II (positive)	LTV ratios: criterion I (negative) and II (positive)
LTV ratios												
Average LTV ratio	51836%	27894%	1527%	102137%	269%	275%	249%	350%	94036%	102816%	150917%	31139%
Median LTV ratio	108%	106%	98%	132%	104%	105%	100%	123%	114%	115%	107%	129%
Average LTV ratio excl. 1% smallest and largest values	578%	622%	672%	348%	176%	185%	161%	258%	539%	561%	566%	600%
Average LTV ratio excl. 5% smallest and largest values	196%	190%	176%	229%	142%	145%	132%	188%	273%	280%	284%	285%
Average LTV ratio excl. values <50% and >150%	96%	96%	94%	102%	96%	95%	92%	102%	98%	98%	96%	102%
LTV ratios: criterion V												
Average LTV ratio	923%	1003%	1436%	247%	203%	182%	167%	210%	4655%	5386%	6792%	3402%
Median LTV ratio	107%	106%	100%	117%	111%	108%	106%	112%	105%	106%	101%	111%
Average LTV ratio excl. 1% smallest and largest values	216%	205%	184%	187%	160%	155%	142%	174%	202%	213%	254%	167%
Average LTV ratio excl. 5% smallest and largest values	151%	146%	141%	154%	141%	135%	129%	145%	141%	141%	157%	133%
Average LTV ratio excl. values <50% and >150%	94%	94%	90%	102%	96%	95%	92%	100%	97%	98%	95%	101%
LTV ratios: criterion III												
Average LTV ratio	22519%	28031%	1279%	97258%	229%	223%	199%	285%	52102%	61938%	45687%	99493%
Median LTV ratio	105%	102%	96%	120%	109%	109%	106%	119%	104%	104%	100%	114%
Average LTV ratio excl. 1% smallest and largest values	257%	237%	206%	240%	173%	176%	162%	214%	240%	244%	244%	226%
Average LTV ratio excl. 5% smallest and largest values	155%	143%	127%	183%	145%	150%	133%	168%	160%	159%	160%	157%
Average LTV ratio excl. values <50% and >150%	94%	95%	93%	101%	95%	94%	91%	101%	97%	97%	95%	101%
LTV ratios: criteria III and V												
Average LTV ratio	1198%	1344%	1914%	215%	201%	176%	163%	203%	6986%	8683%	7763%	10193%
Median LTV ratio	103%	103%	100%	111%	110%	107%	106%	108%	100%	100%	97%	105%
Average LTV ratio excl. 1% smallest and largest values	187%	178%	159%	177%	156%	148%	143%	173%	172%	171%	183%	150%
Average LTV ratio excl. 5% smallest and largest values	142%	136%	129%	147%	141%	134%	129%	144%	128%	127%	130%	122%
Average LTV ratio excl. values <50% and >150%	94%	95%	92%	100%	96%	94%	92%	99%	96%	96%	94%	100%

Note: Appendix E shows the effect the multiple selection criteria have on the LTV ratio as denoted in Section **5.4**.

11.6 Appendix F

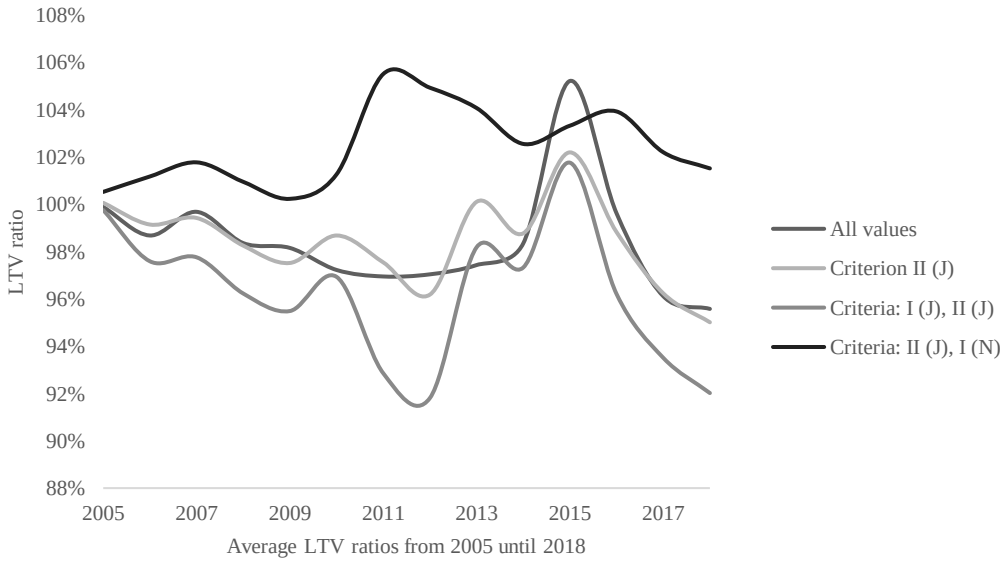


Figure **F**.**1**: Overview development trend over the years 2005 until Q3 2018 of LTV ratios with a minimum value of 50% and a maximum value 150%.

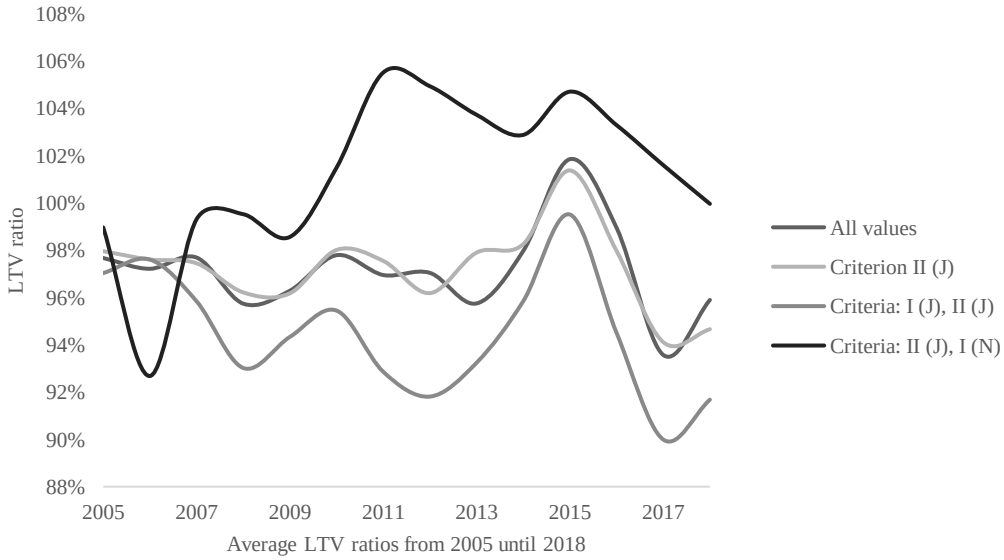


Figure **F**.**2**: Overview development trend over the years 2005 until Q3 2018 of LTV ratios with a minimum value of 50% and a maximum value 150%. In addition, only the LTV ratios of which in the underlying transaction the same number of plots of land are involved as in the associated registered mortgage loan (criterion V) have been selected.

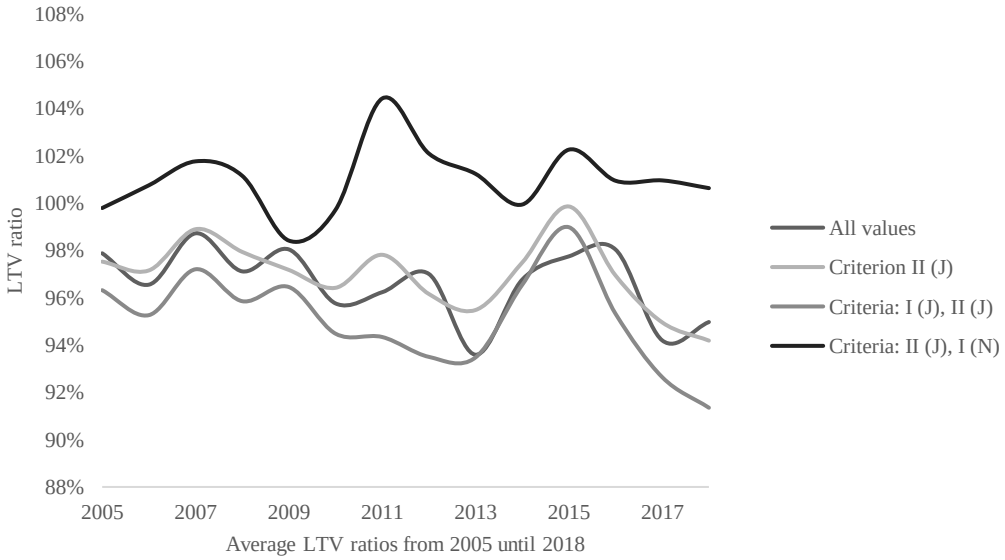


Figure **F**.**3**: Overview development trend over the years 2005 until Q3 2018 of LTV ratios with a minimum value of 50% and a maximum value 150%. In addition, only the LTV ratios of which the time period in days between the underlying transaction and registered mortgage loan is smaller than seven days (criterion III) have been selected.

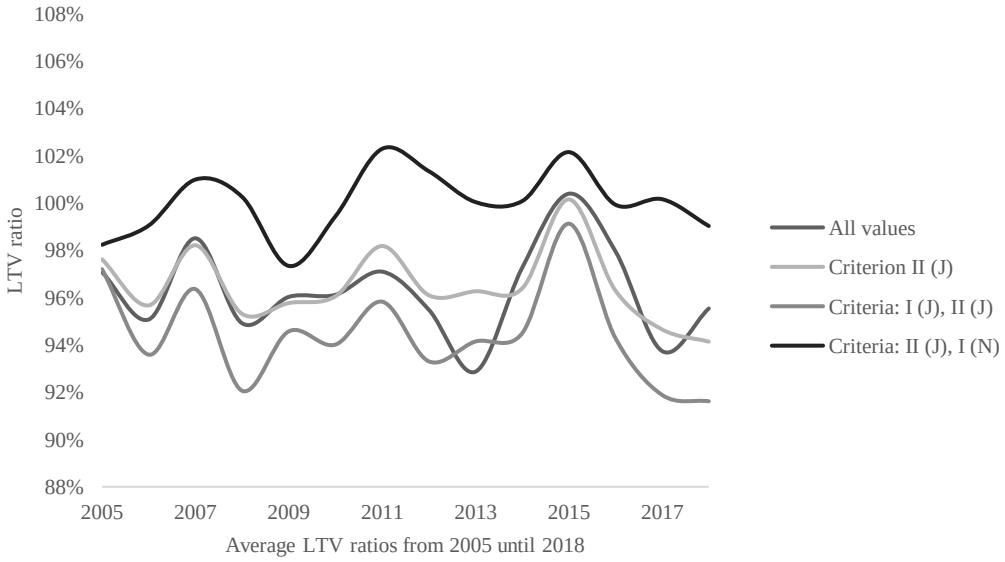


Figure **F**.**4**: Overview development trend over the years 2005 until Q3 2018 of LTV ratios with a minimum value of 50% and a maximum value 150%. In addition, only the LTV ratios of which the time period in days between the underlying transaction and registered mortgage loan is smaller than seven days (criterion III) and LTV ratios of which in the underlying transaction the same number of plots of land are involved as in the associated registered mortgage loan (criterion V) have been selected.

11.7 Appendix G

Column	Description
Transaction_Date	Transaction date
Other_City	Name of city
Property_Street_Address	Address and house number
BAG ID	Unique code on property level (matching key)
Main_Use	Main use of a property
Sub_Use	Sub use of a property
Property_Size	Size (in square meters) of a property
Price_Local	Transaction price
Vendor1	Vendor name
Vendor1_Nationality	Vendor nationality
Vendor1_Main_Type	Vendor type
Vendor1_Sub_Type	Vendor sub type
Purchaser1	Purchaser name
Purchaser1_Nationality	Purchaser nationality
Purchaser1_Main_Type	Purchaser type
Purchaser1_Sub_Type	Purchaser sub type
Property_Status	Property status

Note: Appendix G shows the columns of information corresponding with the commercial real estate investment database of CBRE.

11.8 Appendix H

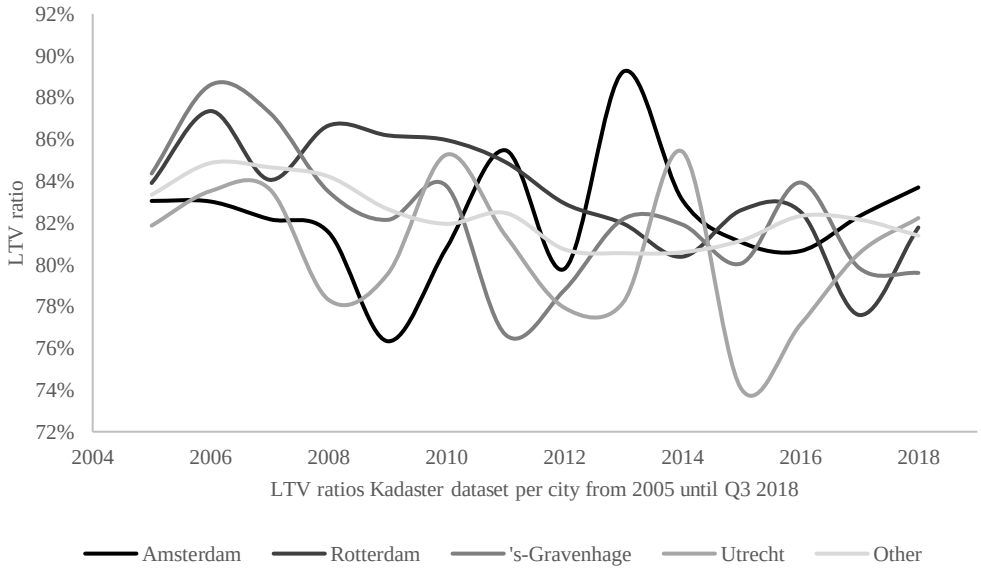


Figure **H.1**: LTV ratios of the Kadaster dataset from 2005 until Q3 2018 broken down into the cities Amsterdam, Rotterdam, ’s Gravenhage, Utrecht and the remaining cities combined as Other.

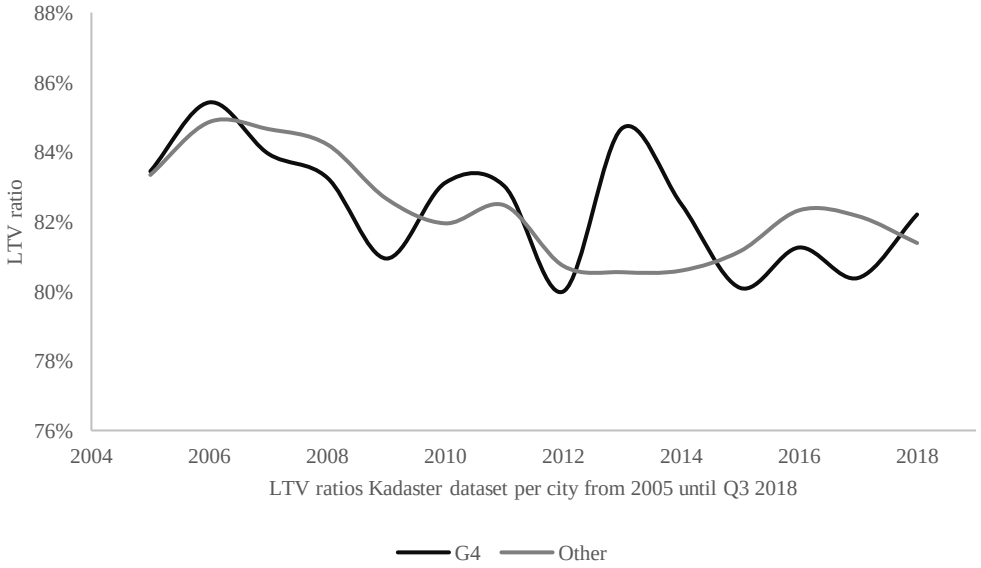


Figure **H.2**: LTV ratios of the Kadaster dataset from 2005 until Q3 2018 broken down into the G4, comprising the cities Amsterdam, Rotterdam, ’s Gravenhage, Utrecht, and the remaining cities combined as Other.

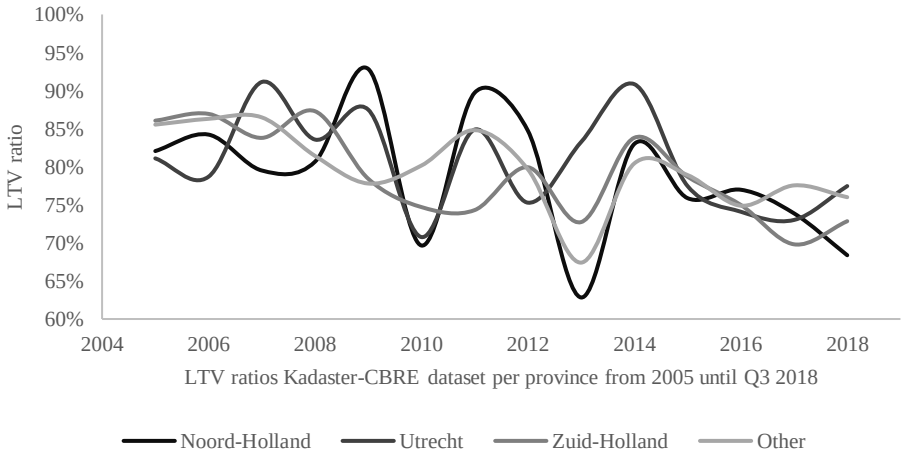


Figure **H**.**3**: LTV ratios of the Kadaster-CBRE dataset from 2005 until Q3 2018 broken down into the provinces Noord-Holland, Utrecht, Zuid-Holland and the remaining provinces combined as Other.

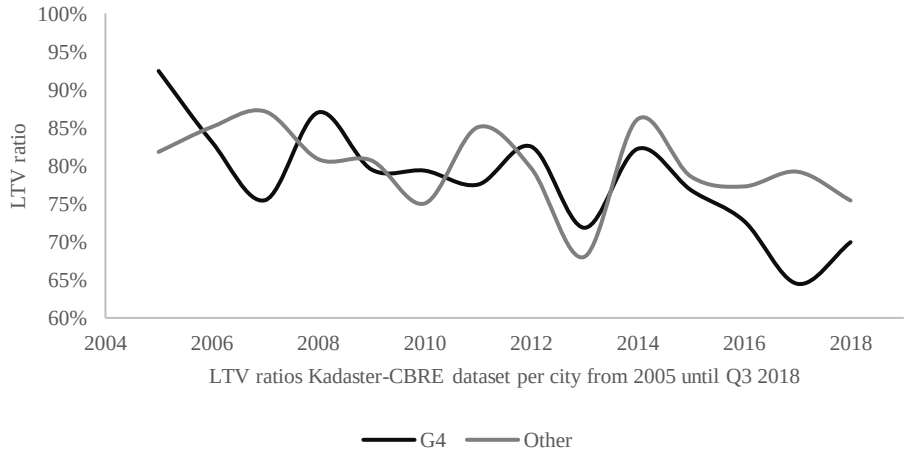


Figure **H**.**4**: LTV ratios of the Kadaster-CBRE dataset from 2005 until Q3 2018 broken down into the G4, comprising the cities Amsterdam, Rotterdam, 's Gravenhage, Utrecht, and the remaining cities combined as Other.

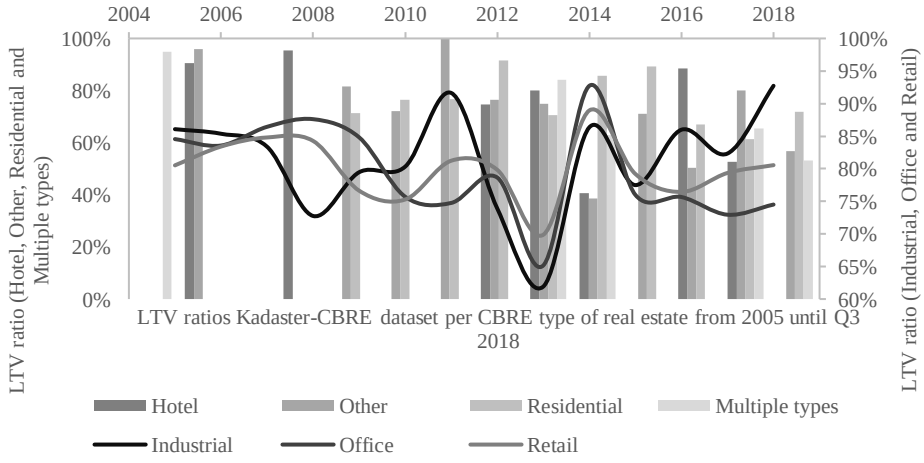


Figure **H**.**5**: LTV ratios of the Kadaster-CBRE dataset from 2005 until Q3 2018 broken down into the CBRE types of real estate Industrial, Office, Retail, Residential, multiple types of real estate and the remaining types of real estate combined as Other.

11.9 Appendix I

*Table **I.1**: Descriptive statistics Kadaster dataset*

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
LTV ratio		0.350	1.050	0.827	0.176	-0.765	-0.377
Period of time		2005	2018	2011	4.295	0.206	-1.378
CEPR business cycles		0.000	1.000	0.827	0.378	-1.733	1.004
ECBs interest rate		0.000%	4.250%	1.493%	1.515%	0.616	-1.128
Real GDP growth rate		-1.400%	3.000%	1.312%	0.964%	-0.782	0.188
Commercial real estate investment volume		6.06E+08	7.34E+09	2.61E+09	1.65E+09	1.131	0.517
Commercial real estate number of transactions		87.000	435.000	182.561	81.275	1.267	1.543
Basel II (dummy)		0	1	0.326	0.469	0.744	-1.447
Basel 2.5 (dummy)		0	1	0.105	0.306	2.582	4.665
Basel III (dummy)		0	1	0.386	0.487	0.469	-1.780
STOXX Europe 600 Real Estate Cap		-20.990%	34.351%	0.914%	10.916%	0.163	0.751
G4 (dummy)		0	1	0.810	0.392	-1.582	0.502
City		1	5	4.463	1.231	-2.114	2.834
Province		2	13	8.329	2.931	-0.220	-0.900
Kadaster type of real estate		1	4	2.395	1.076	0.096	-1.259
Valid N (listwise)	15512						

*Table **I.2**: Descriptive statistics Kadaster-CBRE dataset*

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
LTV ratio		0.355	1.048	0.799	0.176	-0.482	-0.746
Nationality of investor (dummy)		0	1	0.363	0.481	0.570	-1.680
Property status (dummy)		1	3	1.672	0.539	-0.043	-0.746
Type of investor		2	7	5.292	1.208	-0.483	-0.070
Province		2	14	8.418	2.812	-0.210	-0.546
CBRE type of real estate		1	7	3.840	1.637	0.335	-1.370
CEPR business cycles		0	1	0.864	0.343	-2.128	2.534
ECBs interest rate		0.000%	4.250%	1.458%	1.541%	0.627	-1.182
Real GDP growth rate		-1.400%	3.000%	1.304%	0.911%	-0.811	0.422
G4 (dummy)		0	1	0.717	0.451	-0.964	-1.074
STOXX Europe 600		-20.990%	34.350%	1.571%	10.509%	0.121	0.594
Real Estate Cap Commercial real estate investment volume		6.06E+08	7.34E+09	2.82E+09	1.76E+09	0.945	-0.165
Commercial real estate number of transactions		87	435	192.038	86.834	1.180	1.040
Basel II (dummy)		0	1	0.289	0.454	0.933	-1.132
Basel 2.5 (dummy)		0	1	0.095	0.294	2.761	5.639
Basel III (dummy)		0	1	0.419	0.494	0.328	-1.898
City		1	5	4.208	1.425	-1.521	0.649
Type of vendor		2	7	5.258	1.654	-0.694	-0.739
Valid N (listwise)	713						

*Table **I.3**: Test of means output Kadaster type of real estate of the Kadaster dataset.*

Kadaster type of real estate	Mean	N	Std. Deviation
Industrial real estate	0.840	4129	0.168
Offices and retail stores	0.834	4121	0.172
Residential real estate	0.820	4268	0.180
Other real estate	0.809	2994	0.186
Total	0.827	15512	0.176

			Sum of Squares	df	Mean Square	F	Sig.
LTV ratio * Kadaster type of real estate	Between Groups	(Combined)	2.105	3	0.702	22.675	1.214E-15
		Linearity	2.052	1	2.052	66.330	4.102E-16
		Deviation from Linearity	0.052	2	0.026	0.848	0.428
	Within Groups		479.848	15508	0.031		
	Total		481.953	15511			

	R	R Squared	Eta	Eta Squared
LTV ratio * Kadaster type of real estate	-0.065	0.004	0.066	0.004

*Table **I.4**: Test of means output Province of the Kadaster dataset.*

Province	Mean	N	Std. Deviation
Flevoland	0.828	288	0.172
Friesland	0.848	565	0.174
Gelderland	0.818	1567	0.178
Groningen	0.841	420	0.172
Limburg	0.833	720	0.175
Noord-Brabant	0.830	2248	0.175
Noord-Holland	0.823	3189	0.180
Overijssel	0.823	925	0.170
Utrecht	0.817	1184	0.181
Zeeland	0.830	368	0.173
Zuid-Holland	0.831	3714	0.174
Drenthe	0.818	324	0.179
Total	0.827	15512	0.176

			Sum of Squares	df	Mean Square	F	Sig.
LTV ratio * Province	Between Groups	(Combined)	0.759	11	0.069	2.223	0.011
		Linearity	0.002	1	0.002	0.050	0.823
		Deviation from Linearity	0.757	10	0.076	2.440	0.007
	Within Groups		481.194	15500	0.031		
	Total		481.953	15511			

	R	R Squared	Eta	Eta Squared
LTV ratio * Province	-0.002	3.214E-06	0.040	0,002

*Table **I.5**: Test of means output Period of time of the Kadaster dataset.*

Period of time	Mean	N	Std. Deviation
2005	0.834	1353	0.162
2006	0.850	1497	0.156
2007	0.845	1666	0.164
2008	0.840	1512	0.168
2009	0.824	940	0.174
2010	0.821	934	0.175
2011	0.826	912	0.174
2012	0.806	713	0.190
2013	0.814	665	0.183
2014	0.810	788	0.193
2015	0.810	949	0,193
2016	0.821	1155	0.188
2017	0.818	1416	0.184
2018	0.815	1012	0.184
Total	0.827	15512	0.176

			Sum of Squares	df	Mean Square	F	Sig.
LTV ratio * Period of time	Between Groups	(Combined)	2.917	13	0.224	7.260	2.256E-14
		Linearity	1.818	1	1.818	58.810	1.840E-14
		Deviation from Linearity	1.100	12	0.092	2.964	3.836E-4
	Within Groups		479.035	15498	0.031		
	Total		481.953	15511			

	R	R Squared	Eta	Eta Squared
LTV ratio * Period of time	-0.061	0.004	0.078	0.006

*Table **I.6**: Test of means output G4 of the Kadaster-CBRE dataset.*

G4	Mean	N	Std. Deviation
G4	0.774	202	0.190
Other	0.808	511	0.169
Total	0.799	713	0.176

			Sum of Squares	df	Mean Square	F	Sig.
LTV ratio * G4	Between Groups	(Combined)	0.167	1	0.167	5.460	0.020
	Within Groups		21.795	711	0.031		
	Total		21.962	712			

a. With fewer than three groups, linearity measures for LTV-ratio * dummy G4 cannot be computed.

	Eta	Eta Squared
LTV-ratio * G4	0.087	0.008

*Table **I.7**: Test of means output Nationality of investor of the Kadaster-CBRE dataset.*

Nationality of investor	Mean	N	Std. Deviation
Dutch nationality	0.813	454	0.167
Other	0.773	259	0.188
Total	0.799	713	0.176

			Sum of Squares	df	Mean Square	F	Sig.
LTV ratio * Nationality of investor	Between Groups	(Combined)	0.261	1	0.261	8.547	0.004
	Within Groups		21.702	711	0.031		
	Total		21.962	712			

a. With fewer than three groups, linearity measures for LTV-ratio * nationality cannot be computed.

	Eta	Eta Squared
LTV ratio * Nationality of investor	0.109	0.012

*Table **I.8**: Test of means output Type of investor of the Kadaster-CBRE dataset.*

Type of investor	Mean	N	Std. Deviation
Institutional investors	0.708	22	0.207
Other	0.725	12	0.192
All other collective vehicles	0.750	159	0.176
Private investors	0.809	182	0.167
Property company	0.805	219	0.178
Unlabeled	0.860	119	0.153
Total	0.799	713	0.176

			Sum of Squares	df	Mean Square	F	Sig.
LTV ratio * Type of investor	Between Groups	(Combined)	1.097	5	0.219	7.434	8.255E-07
		Linearity	0.955	1	0.955	32.361	1.875E-08
		Deviation from Linearity	0.142	4	0.035	1.203	0.308
	Within Groups		20.865	707	0.030		
	Total		21.962	712			

	R	R Squared	Eta	Eta Squared
LTV ratio * Type of investor	0.209	0.043	0.223	0.050

*Table **I.9**: Test of means output CBRE type of real estate of the Kadaster-CBRE dataset.*

CBRE types of real estate	Mean	N	Std. Deviation
Hotel	0.766	12	0.216
Industrial	0.825	157	0.166
Office	0.804	246	0.174
Other	0.754	33	0.182
Residential	0.755	62	0.169
Retail	0.806	189	0.174
>1 type of real estate	0.634	14	0.203
Total	0.799	713	0.176

			Sum of Squares	df	Mean Square	F	Sig.
LTV ratio * CBRE types of real estate	Between Groups	(Combined)	0.703	6	0.117	3.890	0.001
		Linearity	0.119	1	0.119	3.962	0.047
		Deviation from Linearity	0.583	5	0.117	3.875	0.002
	Within Groups		21.260	706	0.030		
	Total		21.962	712			

	R	R Squared	Eta	Eta Squared
LTV ratio * CBRE types of real estate	-0.074	0.005	0.179	0.032

*Figure **I.10**: Scatterplot Kadaster dataset*

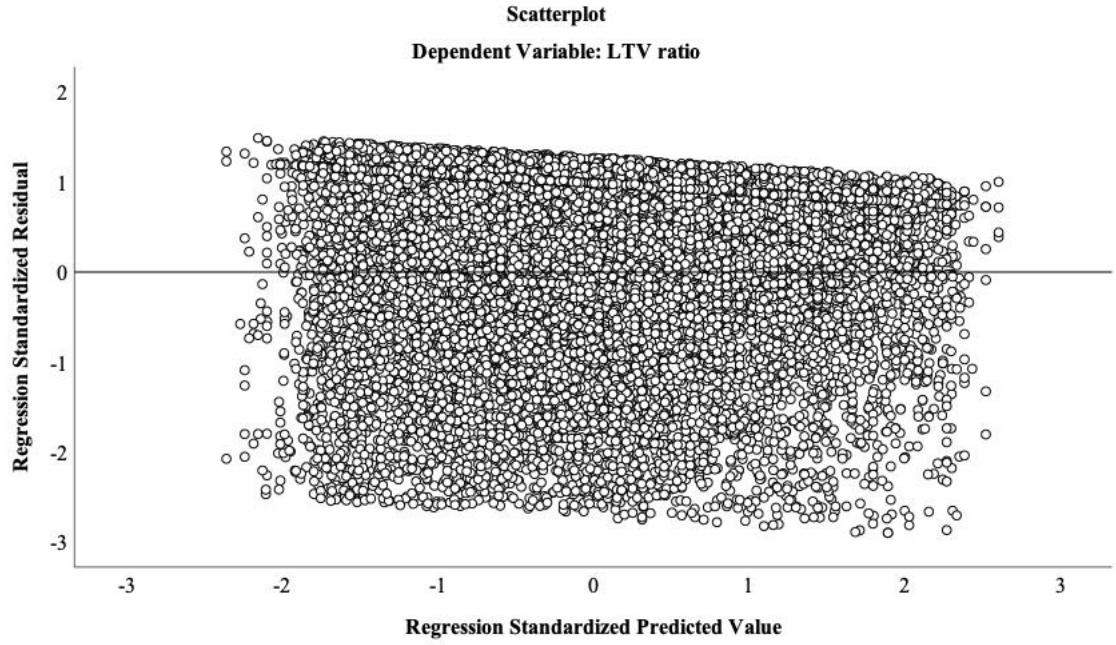


*Figure **I.11**: Scatterplot Kadaster-CBRE dataset*

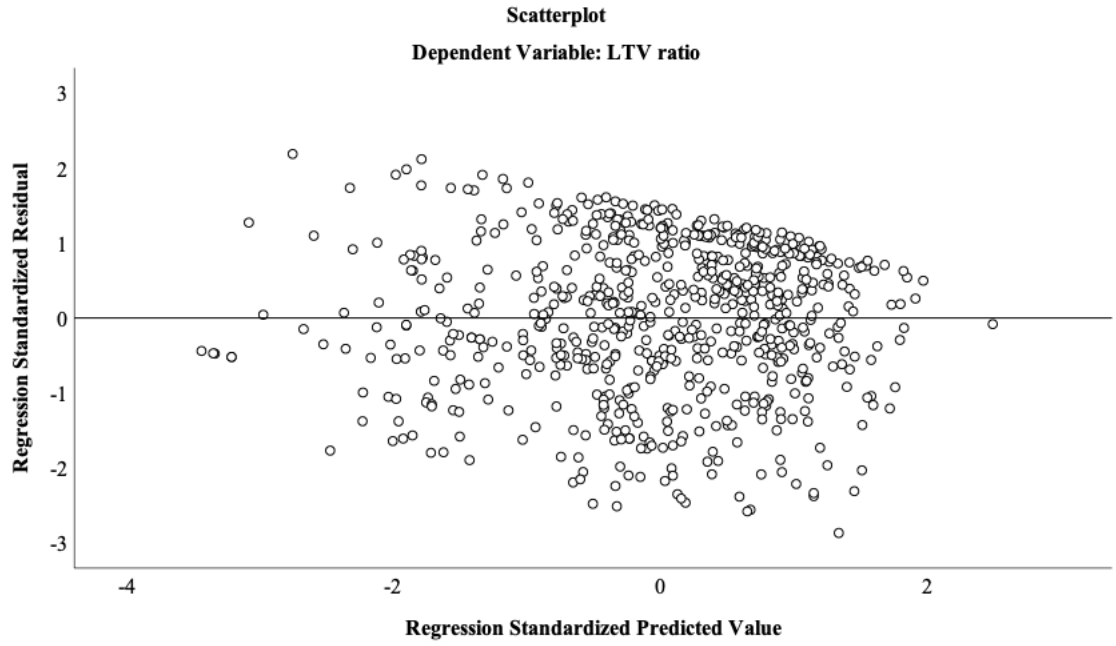


*Table **I.12**: VIF values Kadaster dataset*

	Unstandardized Coefficients		Standardized Coefficients			95,0% Confidence Interval for B		Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	0.978	3.742		0.261	0.794	-6.357	8.312		
Period of time	6.660E-05	0.002	-0.002	-0.036	0.972	-0.004	0.004	0.031	32.387
CEPR business cycles	-0.004	0.005	-0.008	-0.776	0.438	-0.014	0.006	0.554	1.805
ECBs interest rate	0.007	0.002	0.062	3.059	0.002	0.003	0.012	0.155	6.452
Real GDP growth rate	-0.001	0.002	-0.006	-0.532	0.595	-0.005	0.003	0.597	1.675
Commercial real estate investment volume	-2.054E-12	0	-0.019	-0.947	0.344	0	0	0.155	6.435
Commercial real estate number of transactions	7.140E-05	0	0.033	1.367	0.172	0	0	0.110	9.087
Basel II (dummy)	-0.010	0.008	-0.026	-1.301	0.193	-0.025	0.005	0.157	6.377
Basel 2.5 (dummy)	-0.015	0.012	-0.026	-1.212	0.225	-0.040	0.009	0.136	7.359
Basel III (dummy)	-0.011	0.016	-0.031	-0.687	0.492	-0.043	0.021	0.032	31.427
STOXX Europe 600 Real Estate Cap	0	0	-0.019	-2.009	0.045	-0.001	0	0.716	1.398
G4 (dummy)	-0.012	0.009	-0.027	-1.393	0.164	-0.030	0.005	0.166	6.007
City	0.004	0.003	0.029	1.515	0.130	-0.001	0.009	0.177	5.651
Province	-0.001	0.001	-0.009	-1.006	0.314	-0.002	0	0.864	1.157
Kadaster type of real estate	-0.011	0.001	-0.065	-8.127	0	-0.013	-0.008	0.997	1.003

a. Dependent Variable: LTV ratio

*Table **I.13**: VIF values Kadaster-CBRE dataset*

Model	Unstandardized Coefficients		Standardized Coefficients			95,0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	0.751	0.067		11.143	0	0.619	0.883		
Nationality of investor (dummy)	-0.060	0.014	-0.165	-4.400	0	-0.087	-0.033	0.901	1.110
Property status (dummy)	-0.023	0.016	-0.072	-1.477	0.140	-0.054	0.008	0.541	1.849
Type of investor	0.024	0.006	0.164	4.301	0	0.013	0.035	0.875	1.143
Province	0.002	0.002	0.030	0.753	0.452	-0.003	0.007	0.804	1.244
CBRE type of real estate	-0.004	0.004	-0.039	-1.038	0.300	-0.012	0.004	0.890	1.124
CEPR business cycles	-0.028	0.025	-0.055	-1.136	0.256	-0.076	0.020	0.549	1.821
ECBs interest rate	0.020	0.009	0.175	2.284	0.023	0.003	0.037	0.217	4.618
Real GDP growth rate	-0.010	0.009	-0.053	-1.178	0.239	-0.027	0.007	0.640	1.562
G4 (dummy)	0.028	0.033	0.072	0.843	0.399	-0.037	0.093	0.174	5.738
STOXX Europe 600 Real Estate Cap	0	0.001	-0.007	-0.172	0.864	-0.001	0.001	0.730	1.369
Commercial real estate investment volume	4.868E-12	0	0.049	0.542	0.588	0	0	0.157	6.369
Commercial real estate number of transactions	0	0	-0.085	-0.968	0.333	-0.001	0	0.164	6.109
Basel II (dummy)	-0.032	0.023	-0.082	-1.407	0.160	-0.076	0.013	0.374	2.676
Basel 2.5 (dummy)	-0.010	0.035	-0.016	-0.280	0.780	-0.079	0.059	0.368	2.717
Basel III (dummy)	-0.006	0.033	-0.017	-0.181	0.856	-0.072	0.059	0.145	6.909
City	-0.005	0.010	-0.037	-0.448	0.654	-0.024	0.015	0.192	5.215
Type of vendor	0.004	0.004	0.040	0.985	0.325	-0.004	0.013	0.778	1.286

a. Dependent Variable: LTV ratio

*Table **I.14**: Durbin-Watson value Kadaster dataset*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					
					R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	0.103[a]	0.011	0.010	0.175	0.011	11.870	14	15497	5.928E-28	1.974

a. Predictors: See Formula **(2)**.

b. Dependent Variable: LTV ratio

*Table **I.15**: Durbin-Watson value Kadaster-CBRE dataset*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					
					R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	0.340[a]	0.116	0.094	0.167	0.116	5.346	17	695	2.829E-11	1.897

a. Predictors: See Formula **(3)**.

b. Dependent Variable: LTV-ratio

*Table **I.16**: Correlation matrix Kadaster dataset*

Pearson Correlation	LTV ratio	Period of time	CEPR business cycles	ECBs interest rate	Real GDP growth rate	Commercial real estate investment volume	Commercial real estate number of transactions	Basel II (dummy)	Basel 2.5 (dummy)	Basel III (dummy)	STOXX Europe 600 Real Estate Cap	G4 (dummy)	City	Province	Kadaster type of real estate
LTV ratio	1														
Period of time	-0.061**	1													
CEPR business cycles	-0.004	0.130**	1												
ECBs interest rate	0.074**	-0.840**	-0.064**	1											
Real GDP growth rate	0.037**	-0.328**	-0.161**	0.392**	1**										
Commercial real estate investment volume	-0.004	0.442**	0.374**	-0.159**	0.002	1									
Commercial real estate number of transactions	0.002	0.472**	0.383**	-0.164**	0.034**	0.899**	1								
Basel II (dummy)	0.033**	-0.448**	-0.253**	0.520**	0.057**	-0.184**	-0.230**	1							
Basel 2.5 (dummy)	-0.019*	0.035**	-0.389**	-0.106**	-0.200**	-0.305**	-0.313**	-0.238**	1						
Basel III (dummy)	-0.052**	0.890**	0.316**	-0.753**	-0.233**	0.492**	0.487**	-0.551**	-0.271**	1					
STOXX Europe 600 Real Estate Cap	-0.017*	-0.041**	0.345**	-0.079**	-0.197**	-0.002	0.033**	-0.267**	-0.019*	0.016*	1				
G4 (dummy)	0.000	0.027**	-0.008	-0.027**	-0.023**	0.021*	0.020*	-0.008	0.014	0.014	0.015	1**			
City	0.005	0.017*	-0.008	-0.017*	-0.018*	0.020*	0.021**	-0.004	0.012	0.006	0.012	0.901**	1		
Province	-0.002	-0.023**	0.010	0.021*	0.023**	-0.009	-0.006	-0.001	-0.009	-0.015	0.003	-0.289**	-0.164**	1	
Kadaster type of real estate	-0.065**	-0.006	-0.018*	-0.004	-0.007	-0.019*	-0.025**	0.000	0.018*	-0.008	-0.007	-0.022**	-0.016	-0.030**	1**

*, ** indicate significance at the 95% and 99% level, respectively.

*Table **I.17**: Correlation matrix Kadaster-CBRE dataset*

Pearson Correlation	LTV ratio	Nationality of investor (dummy)	Property status (dummy)	Type of investor	Province	CBRE type of real estate	CEPR business cycles	ECBs interest rate	Real GDP growth rate	G4 (dummy)	STOXX Europe 600 Real Estate Cap	Commercial real estate investment volume	Commercial real estate number of transactions	Basel II (dummy)	Basel 2.5 (dummy)	Basel III (dummy)	City	Type of vendor
LTV ratio	1																	
Nationality of investor (dummy)	-0.109**	1																
Property status (dummy)	-0.177**	-0.254**	1															
Type of investor	0.209**	0.088*	-0.247**	1														
Province	-0.026	0.028	0.113**	-0.102**	1													
CBRE type of real estate	-0.074*	-0.122**	0.249**	-0.015	0.037	1												
CEPR business cycles	-0.068	0.087*	-0.029	0.001	0.008	0.076*	1											
ECBs interest rate	0.207**	0.133**	-0.541**	0.171**	-0.062	-0.205**	-0.042	1										
Real GDP growth rate	0.053	0.071	-0.317**	0.058	0.011	-0.055	-0.116**	0.371**	1									
G4 (dummy)	0.087*	-0.043	-0.169**	0.154**	-0.301**	0.074*	0.032	0.145**	0.114**	1								
STOXX Europe 600 Real Estate Cap	-0.007	-0.005	-0.033	0.015	0.021	0.024	0.301**	-0.091*	-0.150**	0.028	1							
Commercial real estate investment volume	-0.099**	0.002	0.104**	-0.088*	-0.039	0.034	0.348**	-0.173**	-0.006	0.015	-0.095*	1						
Commercial real estate number of transactions	-0.115**	0.021	0.090*	-0.080*	-0.026	0.066	0.356**	-0.194**	0.076*	0.039	-0.026	0.901**	1					
Basel II (dummy)	0.069	0.001	-0.123**	0.069	-0.069	-0.110**	-0.180**	0.522**	0.047	0.071	-0.219**	-0.122**	-0.202**	1				
Basel 2.5 (dummy)	0.036	-0.076*	0.153**	0.013	0.047	0.003	-0.470**	-0.100**	-0.193**	-0.029	-0.058	-0.306**	-0.317**	-0.207**	1			

Basel III (dummy)	-0.190**	-0.063	0.386**	-0.165**	0.036	0.193**	0.287**	-0.776**	-0.234**	-0.128**	-0.007	0.482**	0.479**	-0.542**	-0.276**	1		
City	0.066	0.005	-0.154**	0.124**	-0.132**	0.072	0.029	0.132**	0.077*	0.885**	0.016	0.002	0.028	0.074*	-0.010	-0.116**	1	
Type of vendor	0.140**	0.150**	-0.393**	0.277**	-0.028	-0.062	-0.005	0.298**	0.201**	0.083*	0.024	-0.147**	-0.140**	0.061	-0.080*	-0.236**	0.085*	1

*, ** indicate significance at the 95% and 99% level, respectively.

11.10 Appendix J

Table **J.1**: Parameter estimates Kadaster dataset

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.805***	0.798***	0.787***	0.862	0.910	0.860
	(0.010)	(0.014)	(0.019)	(3.742)	(3.742)	(3.742)
CEPR business cycles	-0.004	-0.004	-0.012*	-0.004	-0.004	-0.004
	(0.005)	(0.005)	(0.007)	(0.005)	(0.005)	(0.005)
ECBs interest rate	0.007***	0.007***	0.008*	0.007***	0.007***	0.007***
	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)
Real GDP growth rate	-0.001	-0.001	0.002	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
STOXX Europe 600 Real Estate Cap	0.000**	0.000**	0.000	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Commercial real estate investment volume	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Commercial real estate number of transactions	0.000*	0.000*	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
G4 (dummy)	0.001	-0.002	-0.002	-0.002	-0.011	
	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)	
G4 (dummy; non-G4)						0a
G4 (dummy; G4)						0.002
						(0.004)
Industrial real estate	0.031***	0.031***	0.031***	0.031***	0.031***	0.031***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Offices and retail stores	0.024***	0.023***	0.023***	0.023***	0.023***	0.023***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Residential real estate	0.011**	0.010**	0.010**	0.010**	0.010**	0.010**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Other real estate	0a	0a	0a	0a	0a	0a
Flevoland		0.007	0.007	0.007	0.007	0.007
		(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Friesland		0.031**	0.031**	0.031**	0.031**	0.031**
		(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Gelderland		0.003	0.003	0.003	0.003	0.003
		(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Groningen		0.023*	0.023*	0.023*	0.023*	0.023*
		(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Limburg		0.017	0.017	0.017	0.017	0.017
		(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Noord-Brabant		0.013	0.013	0.013	0.013	0.013
		(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Noord-Holland		0.003	0.003	0.003	0.003	0.003
		(0.010)	(0.010)	(0.010)	(0.011)	(0.010)
Overijssel		0.008	0.007	0.008	0.008	0.008
		(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Utrecht		0.000	0.000	0.000	0.005	0.000
		(0.011)	(0.011)	(0.011)	(0.011)	(0.011)

Zeeland		0.014 (0.013)	0.014 (0.013)	0.014 (0.013)	0.014 (0.013)	0.014 (0.013)
Zuid-Holland		0.011 (0.010)	0.011 (0.010)	0.011 (0.010)	0.009 (0.010)	0.011 (0.010)
Drenthe		0a	0a	0a	0a	0a
Period of time				0.000 (0.002)	0.000 (0.002)	0.000 (0.002)
Year: 2005			0.008 (0.015)			
Year: 2006			0.013 (0.017)			
Year: 2007			0.004 (0.020)			
Year: 2008			-0.005 (0.018)			
Year: 2009			0.005 (0.013)			
Year: 2010			0.009 (0.012)			
Year: 2011			0.007 (0.013)			
Year: 2012			-0.016 (0.014)			
Year: 2013			0.002 (0.011)			
Year: 2014			0.005 (0.012)			
Year: 2015			0.004 (0.010)			
Year: 2016			0.012 (0.009)			
Year: 2017			0.006 (0.008)			
Year: 2018			0a			
Amsterdam					-0.009 (0.010)	
's-Gravenhage					-0.006 (0.009)	
Utrecht					-0.026* (0.014)	
Rotterdam					0a	
Other (city)					0a	
Basel II	-0.010** (0.005)	-0.010* (0.005)	0a	-0.010 (0.008)	-0.010 (0.008)	-0.010 (0.008)
Basel 2.5	-0.015** (0.007)	-0.015** (0.007)	0a	-0.015 (0.012)	-0.015 (0.012)	-0.015 (0.012)
Basel III	-0.012 (0.007)	-0.012* (0.007)	0a	-0.012 (0.016)	-0.012 (0.016)	-0.012 (0.016)

F	12.627***	7.854***	5.768***	7.539***	6.856***	7.539***
R-squared	0.010	0.012	0.013	0.012	0.012	0.012
Adjusted R-Squared	0.010	0.010	0.010	0.010	0.010	0.010
No. Observations	15512					

Standard errors are reported in parentheses.
*, **, *** indicate significance at the 90%, 95%, and 99% level, respectively.

Table **J**.**2**: Parameter estimates Kadaster-CBRE dataset

	Model 7	Model 8	Model 9	Model 10	Model 11
Intercept	0.759*** (0.065)	0.698*** (0.077)	0.684*** (0.066)	0.965*** (0.064)	0.894*** (0.084)
Nationality of investor	-0.061*** (0.014)	-0.066*** (0.014)		-0.090*** (0.019)	-0.090*** (0.020)
Nationality (dummy; other)			0a		
Nationality (dummy; Dutch)			0.061*** (0.014)		
Property status	-0.023 (0.016)	-0.023 (0.016)	-0.023 (0.016)	-0.010 (0.017)	-0.008 (0.017)
Province	0.002 (0.002)		0.002 (0.002)	0.002 (0.002)	0.002 (0.002)
Flevoland		-0.019 (0.059)			
Friesland		0.102* (0.060)			
Gelderland		0.025 (0.049)			
Groningen		0.092 (0.057)			
Limburg		0.115** (0.054)			
Noord-Brabant		0.087* (0.046)			
Noord-Holland		0.056 (0.046)			
Overijssel		0.052 (0.050)			
Utrecht		0.064 (0.048)			
Zeeland		0.101 (0.070)			
Zuid-Holland		0.075 (0.046)			
Drenthe		0a			
Type of investor	0.024*** (0.006)	0.024*** (0.006)	0.024*** (0.006)		

Institutional investors				-0.124*** (0.043)	-0.115** (0.044)
Other (type of investor)				-0.143*** (0.053)	-0.146*** (0.053)
All other collective vehicles				-0.121*** (0.025)	-0.121*** (0.025)
Private investors				-0.107*** (0.030)	-0.107*** (0.030)
Property company				-0.097*** (0.029)	-0.097*** (0.029)
Unlabelled (type of investor)				0a	0a
Type of vendor	0.004 (0.004)	0.004 (0.004)	0.004 (0.004)	0.002 (0.004)	0.002 (0.004)
CBRE type of real estate	-0.004 (0.004)	-0.004 (0.004)	-0.004 (0.004)	-0.005 (0.004)	
Hotel					0.059 (0.070)
Industrial					0.060 (0.052)
Office					0.069 (0.050)
Other					0.017 (0.058)
Residential					0.037 (0.053)
Retail					0.050 (0.051)
>1 type of real estate					0a
CEPR business cycles	-0.028 (0.025)	-0.027 (0.025)	-0.028 (0.025)	-0.032 (0.025)	-0.035 (0.025)
ECBs interest rate	0.020** (0.009)	0.020** (0.009)	0.020** (0.009)	0.022** (0.009)	0.021** (0.009)
Real GDP growth rate	-0.010 (0.009)	-0.011 (0.009)	-0.010 (0.009)	-0.011 (0.009)	-0.013 (0.009)
G4		0.009 (0.018)	0.015 (0.015)	0.012 (0.015)	0.013 (0.016)
G4 (dummy; non-G4)	0a				
G4 (dummy; G4)	-0.015 (0.015)				
STOXX Europe 600 Real Estate Cap	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)
Commercial real estate investment volume	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Commercial real estate number of transactions	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Basel II	-0.032 (0.023)	-0.035 (0.023)	-0.032 (0.023)	-0.033 (0.023)	-0.035 (0.023)
Basel 2.5	-0.011 (0.035)	-0.018 (0.035)	-0.011 (0.035)	-0.007 (0.035)	-0.010 (0.035)

Basel III	-0.007 (0.033)	-0.015 (0.033)	-0.007 (0.033)	0.000 (0.033)	-0.002 (0.034)
F	5.674***	4.156***	5.674***	4.964***	4.112***
R-squared	0.115	0.136	0.115	0.125	0.130
Adjusted R-Squared	0.095	0.103	0.095	0.100	0.098
No. Observations	713				

Standard errors are reported in parentheses.

*, **, *** indicate significance at the 90%, 95%, and 99% level, respectively.