The Interest Rate Sensitivity of Institutional Real Estate Investments

ABSTRACT

Real estate is known for high risk-adjusted returns and its diversification qualities. However, apart from traditional volatility-based risk measures, institutional investors also have to manage the interest rate risk of their portfolios. In practice, the interest rate sensitivity of the assets must be matched with the interest rate sensitivity of the companies' liabilities. Regulation standards like Solvency II incentivize life insurance companies to minimize their interest rate risk exposure by requiring large amounts of economic capital to cover remaining interest rate risk. Furthermore, the current low interest environment raises the question of how sensitively real estate assets react to positive interest rate shocks. We estimate the interest rate sensitivity of real estate empirically, using a panel regression model. We find a strong link between the level and the term structure of market interest rates and the valuation of real estate. By dividing our sample into different subsamples, we identify both interest shock sensitive and interest shock robust submarkets. To the best of our knowledge, this is the first study analyzing the influence of interest rate shocks on real estate valuations based on actual portfolio data of a major life insurance company.

Keywords: Duration, Interest rate sensitivity, risk management, pension funds, life insurance

1 INTRODUCTION

According to the European Central Bank, half of the investments of insurance companies and pension schemes in Europe are in fixed-interest securities.[1] Since market interest rates and the yields on top-rated bonds are both at their historical low, this poses a major challenge to the institutional investors which often have to deliver a high guaranteed return rate to their policyholders.[2] The need for action, especially for life endowment insurance companies, is even increasing given that high-yielding bonds from the pre-low interest phase which insurers still hold in their portfolios mature sooner than the "high rate" insurance policies do. Insurers are therefore forced to shift their investments from bonds into higher-yielding asset classes such as equities or real estate. According to practitioner studies, European insurers have already started to expand their quotas for real estate.[3]

Real estate is known for its high risk-adjusted returns and its excellent diversification properties (i.e., the returns of real estate show low correlations to those of bonds and equities). However, apart from traditional volatility-based risk measures, institutional investors also have to manage the interest rate risk of their portfolios. In practice, the interest rate sensitivity of the assets should be matched with the interest rate sensitivity of the companies' liabilities. This hedges the companies' equity (i.e., the residual of assets and liabilities) against interest rate shocks and thus protects policyholders and shareholders from the risk of insolvency due to interest rate volatility. Modern regulation standards like Solvency II and Omnibus II therefore strongly incentivize life insurance companies and pension schemes to minimize their interest rate risk exposure by requiring large amounts of economic capital to cover the remaining interest rate risk (the so-called duration gap).

The interest rate sensitivity of an asset is usually measured by the "modified duration". The duration is a formula that measures the change in the value of a bond in response to a change in market interest rates of 100-basis-points (1%). It follows the concept that interest rates and bond prices move in opposite directions. Even though it is general knowledge that the valuation and pricing of real estate depends on the opportunity costs and the market interest rates, an exact mathematical relationship (like the duration in the case of bonds) cannot be established. This is also the reason why regulatory frameworks (like Solvency II) and rating

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[1] See ECB (2017).

[2] According to an analysis by Assekurata (2016), the average guaranteed interest rate on existing policies among German life insurance companies amounted to 2.97% in 2016.

[3] See, e.g. EY (2016) or EY (2017).

frameworks (like the S&P insurer financial strength rating) do consider real estate as not interest rate sensitive at all. Real estate therefore requires large amounts of economic capital and loses its attractiveness in comparison to bonds – despite favourable risk-return characteristics.

This paper aims to bridge the gap between the knowledge that real estate is certainly sensitive to changes in market interest rates and the fact that there is no exact bond-like relationship. In chapter 2, we describe the modified duration in theory and discuss to what extent the concept can be applied to real estate. Chapter 3 provides a review of the existing literature about the interest rate sensitivity of real estate. In chapter 4, we empirically measure the duration of the real estate portfolio of a major European life endowment insurer. Chapter 5 summarizes the findings of our study.

2 DURATION

The concept of duration initially goes back to Macaulay (1938). The Macaulay duration calculates the term of an investment needed for the counteracting effects of a change in market value due to a rate change and a change of the reinvestment yield to exactly offset each other. Using this point in time as the planning horizon, the investor is immune to any interest rate changes. The duration is calculated using the following formula:

$$D_{Mac} = \sum_{t=1}^{T} t * \frac{CF_t * q^{-t}}{PV_0}$$

Hicks (1939) introduced the so-called modified duration. The modified duration indicates the percentage change in the value of a bond when the market interest level changes by one percentage point. Hence it describes the interest rate sensitivity. The modified duration is calculated using the following formula:

$$D_{Mod} = D_{Mac} * \frac{1}{1+r} \approx -1 * \; interest\ rate\ elasticity$$

The duration (D_{Mac}) is determined by four factors:

1. The amount of the coupon payments CF_t,
2. the market value of the bond PV_0,
3. the term of the investment t,
4. the return rate of the bond ($q = 1 + r$).

The determining factors are all given and deterministic for the respective bond. During a given lease term, real estate exhibits a similarly deterministic structure and payout profile:

1. For a given lease term, the rents are determined by a lease contract and do not fluctuate widely (CF_t),
2. as a non-listed assets class, real estate has a rather determinable market value (PV_0),
3. the lease term can be considered as the term structure of the investment (t),
4. for a given lease term, the rental return is determinable ($q = 1 + r$).

However, after a given lease term, the payout profile is subject to unknown, rather stochastic reletting conditions. This makes real estate look more like an equity investment and makes the direct application of the duration formula impossible.

Nevertheless, there are reasons to assume a strong relationship between the market interest rate and real estate prices. First, from a capital market perspective, real estate competes with bonds as an investment, which decreases (increases) the yield expectation on real estate whenever the yields on bonds decrease (increase). Second, real estate investments are often highly leveraged. Whenever credit costs decrease, investing in real estate therefore becomes more profitable and prices rise for any given yield expectation. Lastly, rents are often linked to inflation, which in turn is empirically correlated to the market interest level.

Given these preliminary considerations, we aim to derive the interest rate sensitivity of real estate empirically. The next chapter provides an overview of existing literature before we start with the econometric analysis in chapter 3.

3 LITERATURE

The existing literature can be classified into two categories. The first category models the cash flow of real estate based on a set of assumptions and then analyzes the theoretical sensitivity of the value of the respective property to certain input factors . The second category empirically analyzes the relationship between interest rates and real estate values and prices in practice.

Ward (1988) is the first to engage in the duration of real estate. He uses a Dividend Discount Model to compute the duration of stocks and inflation pass-through rates between 0% and 100%. When assuming a lifetime of 100 years for a property, the duration ranges between 9.33 and 36.05 years.

Hartzell et al. (1988) apply a more sophisticated evaluation approach for the duration of commercial real estate. They identify a significantly lower duration ranging between 0 and 6 years, which results from assuming an inflation rate pass-through of 51% to 100%.

Adams et al. (1999) deal with the advantages of the Discounted Cash Flow Model for the appraisement of properties. They show that the modified duration amounts to 20.32% when the discount rate is 5% and real rental growth is 0%.

Brown (2000) is the first one to deal exclusively with the duration of real estate and pointed out its links to asset volatility. He uses a Term and Reversion Equivalent Yield Approach. Unlike the other approaches, Brown assumes that a change in the equivalent yield implies the inflation rate pass-through. He bases this assumption on the fact that the market participants' behavior is primarily return-oriented. Brown finds a Macaulay duration of 12.8 years for commercial real estate. Furthermore, he attempts to compute the inflation rate pass-through for the results of his approach as well as the models by Ward (1988) and Hamelink (1989).

There are also studies analyzing the empirical interest rate elasticity of real estate. The vast majority of these studies examine the determinants for house prices and make references to the influence of interest rates as side notes. The research by Iossifov, Čihák and Shanghavi (2008), Constantinescu (2010) as well as Chaney and Hoesli (2010) specifically deal with the interest rate elasticity of real estate.

Iossifov, Čihák and Shanghavi (2008) investigate the interest rate elasticity of real estate on the basis of 20 countries and quarterly data for a long period and determine an interest rate sensitivity of -3.6%.

Constantinescu (2010) examines the interest rate sensitivity of Swiss residential properties by using an autoregressive distributed lag model. He determines an interest rate elasticity of about -4.5% for the time period 1988 to 2008 with a confidence interval of [-6.5%; -2.5%].

Chaney and Hoesli (2010) engage in the interest rate sensitivity of office properties. In a sophisticated DCF model, they present the entire life cycle of a typical Swiss office property and perform a Monte Carlo simulation. Inter alia, they include the properties of the yield curve, market rent development, vacancy rates as well as various other contract features. For a typical office property, they determine an interest rate elasticity of -13.1% with a standard deviation of 7.9%. The risk premium, the macroeconomic environment, the properties of the yield curve and the remaining life span turn out to be the most influential parameters.

As shown in table 1, previous studies mainly conclude that real estate presents the expected negative interest rate elasticity. The results range between 0% and -100%, with the vast majority of results being situated between -3% and -25%, which is also the common range for corporate bonds duration.

Table 1: Literature Review – Key Findings

Authors	Approach	Theoretical Duration	ID
Ward (1988)	Dividend Discount Model (DDM)	2.8 to 36	0% to 100%
Hartzell et al. (1988)	DCF formula; Simulation of the formula parameters	0 to 6	51% to 100%
Adams et al. (1999)	DCF formula	11.4% to > 100%	
Brown (2000)	Equivalent Yield Model (DCF) Use of IPD statistics for the formula parameters (rent, income and equivalent yield)	12.8 years	
Hamelink et al.	Use of Ward's formula; estimation of the formula parameters (discount rate, rental growth and inflation rate pass-through)	1.82% to 23.05% -3.15% (interest rate elasticity)	0% to 100%
		Empirical Duration	
Iossifov et al. (2008)	Linear regression model and 3SLS-estimation	-3.6%	
Constantinescu (2010)	Autoregressive distributed lag model using a residential rental index and government bond yields	-2.5% to -6.5%	
Chaney, Hoesli (2010)	Simulation of the entire life cycle of a common office property	-13.1% with a standard deviation of 7.8%	

4 DATA

In this section, we introduce the dataset used within the empirical analysis. We use the actual portfolio data of a major European life insurance company. Specifically, the dataset comprises the valuations of 550 properties for the December 2008 to June 2016 time period (91 months). The total portfolio valuation amounts to approximately EUR 11 billion. The analyzed properties are located in Germany (mostly office and retail), France (mostly office) and Switzerland (mostly residential assets). Asset types comprise office, retail and residential. Furthermore, the assets are categorized by risk profile (core, opportunistic and value added) and lot size (by investment volume, as depicted in the result tables). As the dependent variable for our analysis, we use the relative change in the valuations of the properties over time (percentage changes). We aim to analyze the effects of the parallel shifts of the yield curve (i.e., shocks on the interest rate level), but also the effects of a rotation of the yield curve (i.e., changes in the time preference and the risk perception of market participants). We therefore include both the 10-Year Germany Bond Yield and also the 1-Year Germany Bond Yield (both approximate the risk free rate inside the Eurozone for the respective maturity). Both variables serve as our main explanatory variables. In order to interpret the results similar to the duration in case of a bond portfolio, we include the government bond yields as absolute changes of current yield level (percentage point changes, first differences of the yields). As control variables, we consider macroeconomic uncertainty and the returns of competing asset classes other than bonds (i.e., stocks). The macroeconomic development of the national economy, especially during downturns, has a significant impact on investments and the pricing of real estate. We integrate two popular uncertainty indices to control for macroeconomic influence. First, we use the Policy Uncertainty Index Europe from Baker et al. (2017) for macroeconomic uncertainty. Second, an implied volatility index (VIX), which is widely used to account for stock market uncertainty. In detail, we use the VIX Europe volatility index based on the Eurostoxx 50. It is important to note that all variables that do not vary over time (such as the properties' location and size) are implicitly included, since the panel regression model uses fixed effects for the individual observations.

5 EMPIRICAL ANALYSIS

We use a panel regression model to examine the effect of long-term and short-term interest rates on the valuation of the properties in our dataset. Our unbalanced panel consists of 3,850 property-month observations (we included only months in which a property changes its value by more than one percent). The key variable of interest is the valuation of property *i* at the end of month *t*. For the purpose of our empirical analysis, we estimate the following panel regression model:

$$\Delta\, Value_{it} = ß_0 + ß_1 \cdot VIX\_Europe_t + ß_2 \cdot Policy\_Uncertainty\_Index\_Europe_t + ß_3 \cdot \Delta\, 10\_Y\_GermanBond_t + ß_4 \cdot \Delta\, 1\_Y\_GermanBond_t + ß_5 \cdot \Delta\, Euro\_Stoxx\_50_{\,t} + u_{it}$$

To increase the significance and practical relevance of our analysis, we divide our sample into four different subsamples using country, asset type, risk profile and lot size as the relevant categories. The results are shown in table 2 to table 5. We judge the results by their tendency (positive or negative sign), by their amplitude and most importantly also by their statistical significance, which is determined by a regular t-test on the regression coefficients. And indicated by the legend below our regression output tables (* p<0.01; ** p<0.05; * p<0.1).**

Table 2: Interest Rate Sensitivity by Country

	All		Switzerland		Germany		France	
VIX Stock Market Uncertainty	-0.122		-0.362		4.039	***	-1.966	***
Economic Policy Uncertainty	0.852	***	0.751	**	-1.870	**	2.962	***
10-Year Germany Bond Yield	-1.841	***	-0.154		-6.916	***	-0.349	
1-Year Germany Bond Yield	0.602		-3.486	*	3.624		2.010	
Combined Yield Shift	-1.239	*	-3.640	***	-3.292	**	1.661	
STOXX Europe Total Return	-0.059		0.050		0.005		-0.211	**
Constant	5.726	***	3.210		17.760	***	-0.087	
Observations	3850		1749		991		1110	
R-squared	0.035		0.04		0.088		0.082	
Number of individual Properties	550		258		170		122	

*** p<0.01; ** p<0.05; * p<0.1

The overall R-squared for the complete dataset and for all subsamples show that the interest rate (along with the macroeconomics control variables) is not the major determining factor for the valuation of the analyzed properties. Valuations change primarily due to supply and demand on the local real estate market and due to the characteristics of the individual properties.

However, changes in the interest rate level and term structure do have a statistically significant and economically relevant effect on the valuations. The overall portfolio exhibits an interest rate sensitivity of -1.24, where the effect mainly stems from changes in the long-term interest rate. Changes in the short-term interest rate have no significant effect. Properties in Germany and Switzerland are more sensitive to shifts of the interest rate curve, both show an interest rate sensitivity of -3.23 and -3.64 respectively. While the properties in Switzerland are only sensitive to changes in short-term interest rates, the German properties react extremely sensitively to the long end of the yield curve. Following the market expectations hypothesis, the Swiss property market appreciates when the long-term risk premiums on the bond market rise, whereas the German property market seems to depreciate. However, it is worth noting that Germany is the only analyzed submarket with a positive effect of uncertainty on the valuations, hereby confirming the role of Germany as a “safe haven”.[4] Properties in France show a positive correlation to the level interest rates, which is however not statistically significant.[5]

As an overall result, the German sub-portfolio shows the highest empirical interest rate sensitivity and proves to be a suitable hedge against negative interest rate shocks. However, in an environment with very low interest rates, this sub-portfolio will also devalue most when interest rates normalize. In contrast, the French sub-portfolio shows the least desirable characteristics for hedging liabilities against negative interest rate shocks. On the other hand, France is expected to be the most robust submarket in times of increasing interest rates.

In addition to economic differences between Germany, Switzerland and France, differences in the rental law, in financing conditions and in real estate valuation methods may also explain different interest rate sensitivities.

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[4] The net sum of both uncertainty coefficients remains positive and significant only for Germany. Since both uncertainty indices are normalized to a mean of zero and a variance of one, it is possible to compare their effects and create a total.

[5] All three regional sub-portfolios consist of all three major asset types (office, residential, retail). Office is the main asset type in Germany and France, residential in Switzerland.

Table 3: Interest Rate Sensitivity by Asset Type

	All		Office		Residential		Retail	
VIX Stock Market Uncertainty	-0.122		-0.050		-0.446		3.379	*
Economic Policy Uncertainty	0.852	***	0.969	**	0.836	**	0.291	
10-Year Germany Bond Yield	-1.841	***	-1.597	*	-1.574	**	-5.793	**
1-Year Germany Bond Yield	0.602		0.425		0.310		2.603	
Combined Yield Shift	-1.239	*	-1.172		-1.264		-3.190	
STOXX Europe Total Return	-0.059		-0.067		-0.090		0.490	
Constant	5.726	***	4.285	***	5.855	***	11.790	***
Observations	3850		1275		2355		220	
R-squared	0.035		0.037		0.031		0.1	
Number of individual Properties	550		179		335		36	

*** p<0.01; ** p<0.05; * p<0.1

None of the subsamples split by asset type show a significant sensitivity to parallel shifts of the yield curve. It is, however, striking that all subsamples are sensitive to changes in the long-term interest rate (i.e., a steeper yield curve). This result is congruent with the results from our analysis of the regional subsamples (table 2).

Retail exhibits the strongest sensitivity to changes in the long-term interest rate, whereas office seems to remain robust. Both asset types differ mainly by the structure of their rental contracts. The rent for retail properties often includes a large revenue-based component, whereas the rental contracts for office and residential are less flexible and only contain a moderate inflation indexation or a stepwise rent increase. This is not only reflected in the interest rate sensitivity itself, but also in the high coefficient of determination for the analysis of the retail subsample.

It should be noted that the asset type is correlated to the country in our dataset. Most of the retail properties are located in Germany, whereas the majority of the office properties is located in France.

Table 4: Interest Rate Sensitivity by Risk Profile

	All		Core		Opportunistic		Value Added
VIX Stock Market Uncertainty	-0.122		-0.219		-1.260		2.962
Economic Policy Uncertainty	0.852	***	0.933	***	3.030		-2.126
10-Year Germany Bond Yield	-1.841	***	-1.887	***	5.213		-3.844
1-Year Germany Bond Yield	0.602		0.626		-2.844		1.825
Combined Yield Shift	-1.239	*	-1.261	*	2.369		-2.019
STOXX Europe Total Return	-0.059		-0.047		0.476		-0.679
Constant	5.726	***	6.155	***	-19.740	*	5.551
Observations	3850		3640		58		152
R-squared	0.035		0.038		0.062		0.058
Number of individual Properties	550		523		8		19

*** p<0.01; ** p<0.05; * p<0.1

Table 4 shows that assets in the risk categories opportunistic and value-added do not react sensitively to interest rate changes at all. However, this result is not statistically robust, since the sample sizes of these subsamples are very small.

Table 5: Interest Rate Sensitivity by Lot Size

	All		Small Cap		Mid Cap		Large Cap	
VIX Stock Market Uncertainty	-0,122		0,289		-1,137	***	0,485	
Economic Policy Uncertainty	0,852	***	1,218	**	0,644	**	0,577	
10-Year Germany Bond Yield	-1,841	***	-1,652		0,378		-4,036	***
1-Year Germany Bond Yield	0,602		0,811		-2,831	*	3,360	**
Combined Yield Shift	-1,239	*	-0,841		-2,453	***	-0,676	
STOXX Europe Total Return	-0,059		0,005		-0,148	*	-0,063	
Constant	5,726	***	5,144	***	2,315	**	9,492	***
Observations	3850		1223		1300		1327	
R-squared	0,035		0,02		0,038		0,082	
Number of individual Properties	550		183		183		184	

*** p<0.01; ** p<0.05; * p<0.1

Assets in the small cap category range from EUR 1 to 6 million (EUR 750 million in total). The mid cap category comprises assets from EUR 6 to 14 million (EUR 1700 million in total) and the large cap category comprises assets from EUR 14 to 500 million (EUR 8700 million in total). Whereas the small cap assets show no interest rate sensitivity at all, the mid cap cluster proves to be sensitive to parallel shifts of the yield curve. This effect mainly results from the statistically significant negative interest rate sensitivity to changes in the long-term interest rate. The large cap cluster comprises retail assets in Germany as well as office buildings in France. Therefore, this segment is mixed, which does not allow for sensible interpretations.

6 CONCLUSION

Our results show that real estate is indeed sensitive to changes in the interest rate level and term structure. Even though the low coefficients of determination of our regression models show that the interest rate is not the main determining factor, we find a systematic (i.e., statistically significant) link between market interest rates of different terms and the valuation of real estate assets.

Furthermore, we find that different market segments react predictably differently to interest rate shocks. The valuation of a German retail portfolio reacts systematically negatively to interest rate shocks. Investors with interest rate sensitive liabilities can use this result to minimize their duration gap. A French office portfolio, on the other hand, shows a slight and non-significant positive correlation to interest rate shocks. This type of properties can be considered to be robust against positive interest shocks.

As a valuable side result, we show that the German property market is robust against the level of overall economic uncertainty, which supports the image of Germany as a “safe haven”. We also show that almost all of the analyzed market segments are very sensitive to a steepening yield curve. This confirms the common notion of real estate as a substitute for bonds. Finally, regulatory frameworks, such as Solvency II, should take into account that real estate is indeed an interest rate sensitive asset and can therefore contribute to portfolio diversification in a similar way than bonds do.

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