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Commercial Real Estate at the ZLB: Investment Demand and CAPM-WACC Invariance

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Abstract. *This paper analyzes the implications of a low interest rate environment (the zero lower bound – ZLB) for the demand for commercial real estate. Investment demand is conventionally assessed by return and risk adjusted return, as given by net present value (NPV) and the Sharpe-ratio. The main question of the paper is whether there is any asymmetry between different evaluation models for the discount rate across different levels of the interest rate. First, we apply a conventional net-present value (NPV) approach, where the weighted average cost of capital (WACC) and the capital asset pricing model (CAPM) are used for evaluation. Considering the invariance level of systemic risk, we find WACC to be an alternative to CAPM for offensive and defensive investments when interest rates are close to historical averages. However, at the ZLB, WACC is only an alternative for investments if they carry the same risk as the market such that beta values are close to one. Second, we simulate our models using US data to see how the WACC shortcut performs across time, and especially at the ZLB, in this economy. We see differences between the period preceding the financial crisis and the period after 2010, even though the Federal Funds rate is close to zero in both periods. We relate this to the difference in systemic risk between the two periods, and show how results in the latter period is quite similar across evaluation models.*

Keywords: *commercial real estate, net-present value (NPV), capital asset pricing model (CAPM), model invariance, weighted average cost of capital (WACC), zero lower bound (ZLB)*

1 Introduction

In the aftermath of the financial crisis of 2007–2008, the US Federal Reserve lowered interest rates to 0.25%, as shown in Figure 1, a policy commonly known as the zero lower bound (ZLB) policy (see for instance, Gilchrist et al, 2015). Since then, many countries have been flirting with ZLB.

As an economy approaches the ZLB, a number of uncertainties arise. The concern for financial instability (Fischer 2016) and the efficiency of monetary

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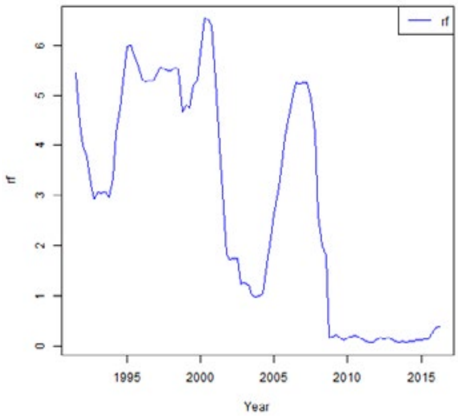

Figure 1. *Federal funds rate, effective (US Federal Reserve).*

policy (Adam and Billi 2007; Wright 2012) is by far the most debated. Both are related to how the ZLB influences the monetary transmission mechanism and the way monetary policy impacts the real side of the economy. At ZLB the economy might be exposed to a liquidity trap (Eggertson and Woodford 2003), search-for-yield behavior (Goodmart and Hoffman 2010) or stronger output-multipliers (Woodford 2010; Eggertson 2011).

This paper analyses investment demand at the ZLB using a standard net-present value (NPV) criteria and a conventional Sharpe-ratio (e.g Ball et al. 1998; Geltner 2007). For investments in commercial real estate, the ZLB is, due to the discount effect, a potentially very powerful situation. A lower discount rate impacts positively on the present value of future cash flow components and stimulates investment demand. However, if the ZLB also is characterized by higher risk, the effect on investment demand might be the opposite. The US case, which we use for illustrative purposes, covers both a period where the ZLB regime was characterized by high risk and a period where risk was presumed to be lower. Still, leaving risk aside, an interesting first question is whether the discount effect is symmetric across discount rate models irrespective of the interest rate level.

The purpose of this paper is therefore twofold. First, we look for asymmetries in investment demand across the interest rate cycle when using a NPV framework, and allow for different models when deriving the alternative rate of return. This will enable the possibility of assessing whether the choice of model may influence investment demand for different interest rate values. The second purpose of the paper regards whether risk influences the asymmetry or symmetry between models, and whether this may differ across the interest rate cycle too.

In terms of discount rate models, the capital asset pricing model (CAPM) is the preferred method. However, finding the alternative rate of return it is not always accessible from CAPM. This is due to the market portfolio being a theoretical concept (Roll 1977) or that one is unable to derive the beta value from market fundamentals (see Damodaran (2012) for the fundamental approach to beta values).

The weighted average cost of capital (WACC) is an acceptable alternative to CAPM when the investment at hand does not alter the business, nor the financial, risk of the investing firm (e.g. Berk and DeMarco 2007; Keown, et al. 2014).

The first part of the paper considers for which type of real estate investments it is acceptable to use WACC at different interest rate levels. We compare the ZLB to a situation where interest rates are closer to historical averages, which we refer to as a situation with "normal" interest rates. The paper highlights systemic risk, an important part of a real estate investment's financial risk, where model invariance across CAPM and WACC is at the heart of the reasoning. Focusing on systemic risk in private real estate is as a natural extension to the focus on systemic risk in public real estate investments, either through stocks or REITS (Real Estate Investment Trusts). For financial real estate investments, beta values are far from stable over time, and they behave asymmetrically in bear and bull markets (Chatrah et al. 2000; Liang et al. 2004; Chiang et al. 2013; Stoyu 2016). According to Cotter and Roll (2011), beta values differ across types of real estate, where beta values related to office and industrial REITs fall short of retail REITs' beta values. The invariance level between models and variations in invariance across the interest rate cycle is thus important for doing proper assessments.

The invariance condition specifies when WACC is an alternative to CAPM. We consider the invariance level of systemic risk to find the type of investments for which WACC is an alternative to CAPM across the interest rate cycle. While WACC is shown to be an alternative to CAPM for investments that carry the same risk as the market at the ZLB, WACC is an alternative for more offensive or more defensive investments at higher interest rates.

The second part of the paper is related to risk, where we focus on how risk impacts the difference in the alternative rate of return derived from WACC and CAPM respectively. This is relevant both for understanding individual firms' investment demand and for understanding the monetary policy transmission at ZLB.

The relative approach, where investment demand at ZLB is analyzed relative to demand at more normal interest rates, relates our paper to amongst others Boukez et al. (2017) analyzing the efficiency of public investments across different interest rate levels, arguing for shorter time to build and stronger multipliers at ZLB. A comparative approach across the interest rate cycle is also relevant when considering the asymmetric beta values of different types of real estate and real estate as a source for diversification and hedging in a portfolio framework (see e.g. Gyorko and Nelling (1996)). Finding evaluation methods for real estate that abstract away from asymmetries across cycles is also the focus of the Long-term value Working Group of the property Industry Alliance Debt group (2017). Acknowledging that risk management has not been effective enough and that procyclic behavior tends to be encouraged, the working group discusses the performance of different evaluation methods across boom-bust periods.

The rest of the paper is organized as follows: The next section gives the theoretical framework. Subsection 2.1 presents the NPV-framework and the Sharpe-ratio, while section 2.2 highlights the two models for the discount rate: CAPM and WACC. For CAPM, the focus is on the asymmetric effect on the

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required rate of return from changes in the risk free rate across the level of systemic risk. For WACC, we highlight how the relation between the mortgage rate and the return to equity matters for the effect from increased leverage on the required rate of return. Section 3 derives the invariance condition for systemic risk across CAPM and WACC, and discusses for which type of investments WACC is an alternative to CAPM. Section 4, endogenizes the rates of return and highlight the relation between our risk components. Finally, Section 5 presents the simulations using US data, and the last part concludes the paper.

2 Theoretical framework

This section introduces the model framework for analyzing investment demand and the risk-return profile of commercial real estate. Section 2.1 presents the NPV approach and the Sharpe ratio.

2.1 Net present value and the Sharpe ratio

Net present value is calculated by the value of discounted future cash flows for an investment. This may be expressed as

$$NPV = -C_0 + \sum_{t=1}^{T} \frac{C_t}{(1+r)^t}, \tag{1}$$

where NPV is net present value, C_0 the cash flow in period 0 (most importantly the investment cost) and C_t is the cash flow in period t. The cash flows for period $t = 1$ through T are discounted by the discount factor $(1 + r)$ where r is the opportunity cost of capital. If $NPV > 0$, the project is profitable and the investment should be made, and if $NPV < 0$, it is not profitable such that the investment should not be made.

Furthermore, the opportunity cost of capital associated with the discount factor that provides $NPV = 0$ is known as the internal rate of return (irr). Hence, the internal rate of return shows the project's rate of return. The internal rate of return is an alternative approach for evaluating the profitability of a project. Conventionally, an investment is profitable when $irr > r$ while the opposite inequality, $irr < r$, implies that an investment is non-profitable.

By manipulating (1), we can find irr from the following:

$$-C_0 + \sum_{t=1}^{T} \frac{C_t}{(1+irr)^t} = 0. \tag{2}$$

Both the risk and the return of an investment is important for investors. Sharpe (1966) introduced a ratio between an investments risk and return by scaling the difference between the investment return and the risk free rate with the standard deviation σ_i of the investment return. Using the internal rate of return as the investment return, the Sharpe-ratio equals

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$$SHP_i = \frac{r_i - r_f}{\sigma_i} = \frac{irr - r_f}{\sigma_i}. \tag{3}$$

The Sharpe-ratio gives the risk-adjusted rate of return in excess of the risk free rate. When assessing investment demand in the forthcoming sections, we frame our reasoning in terms of both NPV and Sharpe-ratio considerations.

2.2 Calculating the alternative rate of return

In order to find the alternative rate of return, or the opportunity cost of capital, to use as the discount rate in the NPV model (r in (1)), the shareholder should set a rate that is in line with the expected return on alternatives to investing in the project in question. This alternative rate of return may be derived from the risk profile of the project or the combination of debt and equity. The former is calculated using the capital asset pricing model (CAPM) and the latter by using the weighted average cost of capital (WACC).

2.2.1 CAPM

The CAPM expresses the shareholder's required rate of return

$$r_{CAPM} = r_f + \beta\left(r_m - r_f\right), \tag{4}$$

where r_{CAPM} is expected return, r_f the risk free rate (e.g. long-term government bonds or the federal funds rate), r_m the expected market return and β the systemic risk (measured by the how the return of the company varies relative to the market return). Hence, $r_m - r_f$ measures the risk premium for the systemic risk.

This can be written as

$$r_{CAPM} = \left(1-\beta\right) r_f + \beta r_m, \tag{5}$$

which implies that

$$\frac{\partial r_{CAPM}}{\partial r_f} \begin{cases} > 0 \text{ if } \beta < 1 \\ < 0 \text{ if } \beta > 1 \end{cases}. \tag{6}$$

An increase in the risk free rate leads to a higher rate of return if $\beta < 1$ and a lower rate of return if $\beta > 1$. Hence, if the project/company is more volatile than the market, a reduction in the risk free rate increases the rate of the return, while a less volatile project will imply a reduction in the rate of return when the risk free rate falls. A lower risk free rate will have a direct negative effect on the expected rate of return and, in addition, a positive indirect effect from the increased risk premium. A lower risk free rate increases the risk premium since the difference between the risk free rate and the expected market return increases. The indirect effect dominates the direct effect of a lower risk free rate if $\beta > 1$ while the opposite is the case when $\beta < 1$.

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The calculated r_{CAPM} may be used as the discount factor when calculating the net present value for a project, i.e.

$$NPV = -C_0 + \sum_{t=1}^{T} \frac{C_t}{(1 + r_{CAPM})^t} \cdot \tag{7}$$

Hence, the risk free rate and the level of systemic risk may influence whether the investment is considered profitable or not.

2.2.2 WACC

The WACC expresses the expected return demanded by investors as

$$r_{WACC} = \frac{D}{V} r_d + \frac{E}{V} r_e, \tag{8}$$

where D is the amount of debt, E the amount of equity and V the total value, such that D/V expresses the debt share, E/V the equity share, and $V = D + E$. The return on equity is r_e, and the interest rate on the debt is r_d.

Since real estate is mainly financed by debt, the interest rate on the debt is important for evaluating the profitability of the asset (i.e. the real estate). Furthermore, a low interest rate on debt decreases r_{WACC} *(ceteris paribus),* such that expected return will decrease.

Furthermore, this may be written as

$$r_{WACC} = d\left(r_d - r_e\right) + r_e \text{, where } d \equiv \frac{D}{V}. \tag{9}$$

This yields

$$\frac{\partial r_{WACC}}{\partial d} = r_d - r_e \tag{10}$$

such that

$$\frac{\partial r_{WACC}}{\partial d} \begin{cases} > 0 & if\ r_d > r_e \\ < 0 & if\ r_d < r_e \end{cases}. \tag{11}$$

Hence, a higher debt-to-value ratio leads to a reduced r_{WACC} and subsequently a higher NPV if the interest rate on debt is lower than the return on equity. When the return on real estate is higher than the interest rate on debt, more projects may be considered profitable if they are debt-financed. Financing a project to a large extent by equity may not be profitable in such a case, leading investors to favor debt over equity.

The calculated r_{WACC} may be used as the discount factor when calculating the net present value for a project, i.e.

$$NPV = -C_0 + \sum_{t=1}^{T} \frac{C_t}{(1 + r_{WACC})^t} \cdot \tag{12}$$

More projects will therefore be considered profitable if r_{WACC} is lower, since this increases NPV.

3 Invariance and exogenous rates of return

This section considers the situation where the rate of return obtained from WACC and CAPM are equal ($r_{WACC} = r_{CAPM}$). Solving for the risk free rate of return under this assumption, we find

$$r_f^* = \frac{dr_d + (1-d)r_e - \beta r_m}{1-\beta}, \tag{13}$$

where r_f^* is the risk free rate of return that produces the same discount factor from CAPM and WACC. When the discount rates are the same, the NPV and the Sharpe ratio are equal across models. Rearranging gives

$$\beta^* = \frac{dr_d + (1-d)r_e - r_f}{r_m - r_f}, \tag{14}$$

where β^* is the invariance level of systemic risk, i.e. the level of systemic risk that provides the same discount rate from both WACC and CAPM. Hence, if $\beta = \beta^*$, where β^* is the specific non-linear combination of returns and interest rates given in (14), we find $r_{WACC} = r_{CAPM}$.

Assuming $r_m > r_f$,we see how $\frac{\partial \beta^*}{\partial r_d} > 0$, $\frac{\partial \beta^*}{\partial r_e} > 0$ (given $0 < d < 1$), $\frac{\partial \beta^*}{\partial r_m} < 0$, and $\frac{\partial \beta^*}{\partial d} > 0$ (given $r_d > r_e$). Hence, under these assumptions, the invariance level is positively related to the interest rate on debt, the return on equity and the debt-to-value ratio, while it is negatively related to the expected market return.

Figure 2a illustrates the invariance condition between WACC and CAPM, expressed in terms of systemic risk. For real estate investments where the level of systemic risk is equal to β_0^*, it is irrelevant whether CAPM or WACC are used to derive the discount factor.

For investments where $\beta < \beta_0^*$, WACC will reject projects that would have been accepted using CAPM while WACC will accept investments that CAPM rejects for $\beta > \beta^*$. Stated differently, it is only when $\beta = \beta^*$ that WACC is an alternative to CAPM.

WACC will be too restrictive when $\beta < \beta^*$ and too expansive when $\beta > \beta^*$. This implies that fewer projects will be considered profitable when using WACC rather than CAPM when systemic risk is too low, while more projects will be considered profitable when using WACC rather than CAPM when the systemic risk is too high.

The invariance level of systemic risk is determined by the interaction between the components of the two models. Figure 2b illustrates the comparative statics of our exogenous model components. WACC components (increased r_d, r_e, or d) impact β^* positively while CAPM components (increased r_m) impact β^* negatively.

Turning back to the risk free rate of return we find the effect on the invariance level of systemic risk as

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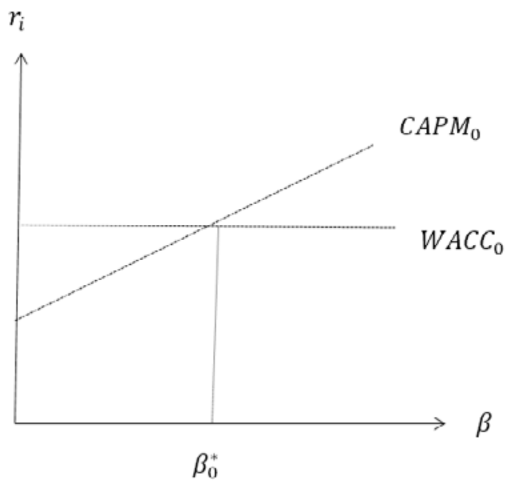

Figure 2a. *The invariance level of systemic risk between CAPM and WACC.*

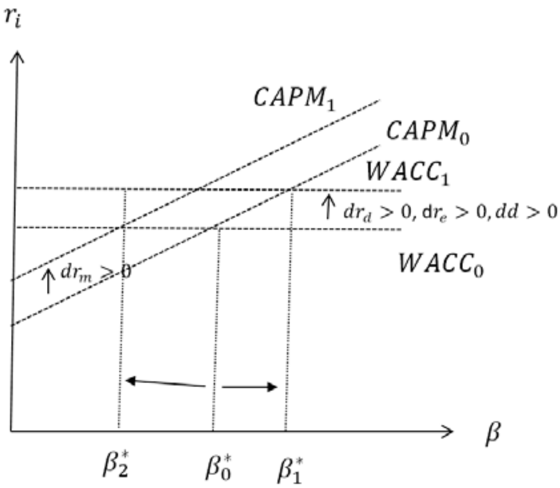

Figure 2b. *Comparative statics. While WACC components impact positively on the invariance level $\beta_0^* \rightarrow \beta_1^*$, is the impact from CAPM negative $\beta_0^* \rightarrow \beta_2^*$.*

$$\frac{\partial \beta^*}{\partial r_f} = \frac{-1}{r_m - r_f} - \frac{-\left(dr_d + (1-d) r_e - r_f\right)}{\left(r_m - r_f\right)^2} = \frac{-1}{r_m - r_f} + \frac{\beta^*}{r_m - r_f} = \frac{1}{r_m - r_f}\left(\beta^* - 1\right). \quad (15)$$

.

From (15) we see that the effect of a higher risk free rate of return on the invariance level of systemic risk (in general) is ambiguous. When $\beta^* > 1$, the effect on the invariance level is positive, while it is negative when $\beta^* < 1$ (we assume $r_m > r_f$). When $\beta^* = 1$, there is no effect on the invariance level.

This ambiguity is due to that a higher risk free rate of return has two effects on the invariance level of systemic risk. First, there is *a level-effect* as the risk free rate of return determines the "floor" for pricing of all risky assets. A higher risk free rate of return lifts the return on all risky investments, shifting the CAPM-curve up. This has a negative impact on the invariance level of systemic risk. Second, a higher risk free rate of return reduces (*ceteris paribus*) the risk premium from systemic risk exposures, introducing a positive *risk-pricing effect* on the invariance level of systemic risk. The risk pricing effect changes the slope of the CAPM-curve in our (β, r_f)-diagram.

For the invariance level, the *level-effect* is negative while the *risk-pricing effect* is positive when considering a positive shock to the risk free rate of return. The strength of the risk pricing effect is, as indicated by β^* in (16), related to the prevailing systemic risk exposure. When $\beta^* > 1$ (an offensive investment with high systemic risk) the *risk-pricing effect* dominates the *level-effect* and the total effect is positive. When $\beta^* < 1$ (a defensive investment with low systemic risk) the *level-effect* dominates, making the total effect negative and reducing the invariance level of systemic risk.

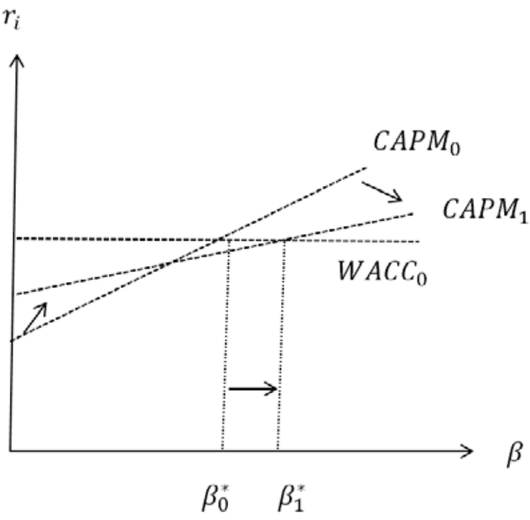

***Figure 3a.** The invariance level of systemic risk and a shock to the risk free rate of return. A risk pricing effect that dominates the level effect shifts the CAPM curve ($CAPM_0 \rightarrow CAPM_1$) and impacts positively on the invariance level of systemic risk.*

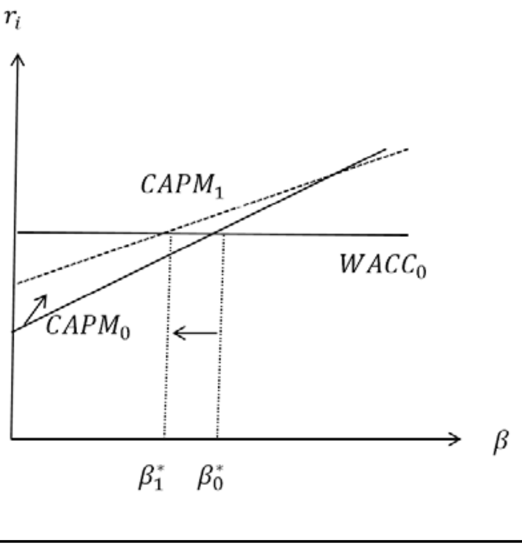

***Figure 3b.** The invariance level of systemic risk and a shock to the risk free rate of return. A level effect that dominates the risk pricing effect shifts the CAPM curve ($CAPM_0 \rightarrow CAPM_1$) producing a negative total impact on the invariance level of systemic risk.*

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Figure 3 illustrates the effect of a higher risk free rate of return (increased r_f). Figure 3a presents the case where the *risk-pricing effect* dominates *the level-effect* (β_0^*> 1) such that a higher risk free rate of return impacts positively on the invariance level of systemic risk. Figure 3b shows the opposite case (β_0^* < 1).

When combined, Figures 3a and 3b allows us to elaborate on the effect of a higher risk free rate of return on the invariance level of systemic risk, and discuss the relation between CAPM and WACC for different type of investments across the interest rate cycle.

From Figures 3a and 3b, we see how a higher risk free rate of return pushes the condition for when WACC is an acceptable alternative for deriving the discount rate away from β^*= 1. When β_0^*> 1, we see in Figure 3a a *level-effect* that dominates the *risk-pricing effect* and impact positively ($\Delta\beta^*$ > 0) on the invariance

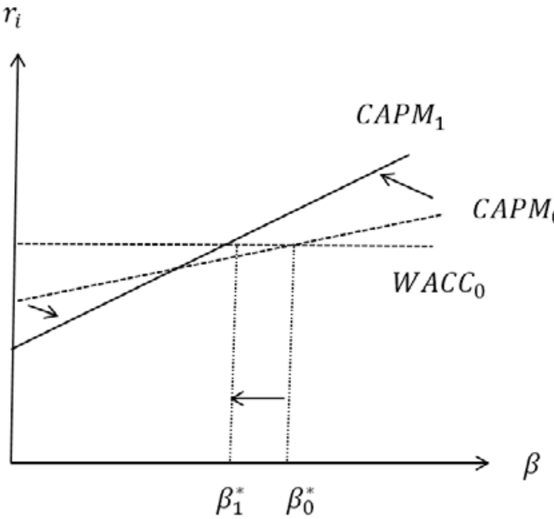

Figure 4a. *The invariance level of systemic risk and a negative shock to the risk free rate of return. A risk pricing effect that dominates the level effect shifts the CAPM curve ($CAPM_0$ → $CAPM_1$) and impacts negatively on the invariance level of systemic risk.*

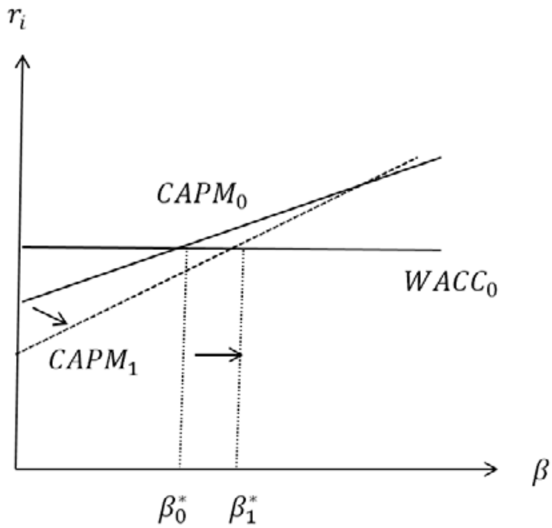

Figure 4b. *The invariance level of systemic risk and a negative shock to the risk free rate of return. A level effect that dominates the risk pricing effect shifts the CAPM- curve ($CAPM_0$ → $CAPM_1$) producing a positive total impact on the invariance level of systemic risk.*

level of systemic risk. This pushes the condition for when WACC is an acceptable alternative to CAPM further away from $\beta^* = 1$. For investments characterised by $\beta_0^* < 1$, we see from Figure 3b how a *risk-pricing effect* that dominates the *level-effect* impacts negatively on the invariance level of systemic risk, $\Delta\beta^* < 0$, pushing the invariance level further below $\beta^* = 1$.

Figure 4 illustrates the effect of a *lower* risk free rate of return. Figure 4a shows a *risk-pricing effect* that dominates *the level-effect* and a reduction in the risk free rate of return that impacts negatively on the invariance level of systemic risk ($\beta_0^* > 1$). Figure 4b shows (again) the opposite case ($\beta_0^* < 1$).

Figure 4a shows the negative *level-effect* dominating the positive *risk-pricing effect* and a negative total effect on the invariance level of systemic risk. Starting from $\beta_0^* > 1$ this pushes the invariance level of systemic risk towards $\beta^* = 1$. Figure 4b shows the *risk-pricing effect* dominating the *level-effect* and a lower risk free rate of return that lifts the invariance level of systemic risk towards $\beta^* = 1$ (as β_0^* < 1 initially).

Figures 3a and 3b show how the invariance level of systemic risk is pushed away from $\beta^* = 1$ as the risk free rate of return increases, while Figures 4a and 4b show that the invariance level is pushed towards $\beta^* = 1$ as the risk free rate of return falls. Stated differently, when the economy moves towards the ZLB, we find WACC to be an acceptable alternative to CAPM for investments that carry the same systemic risk as the market. At higher rates of risk free return on the other hand, WACC is an acceptable alternative for investments where the systemic risk exceeds, or falls short of, the market risk.

In addition, using WACC for deriving the discount rate when approaching the ZLB and when $\beta_0^* > 1$ imply that the investment criterion becomes too restrictive, and that the economy at the aggregate level will invest too little. When using WACC as we approach the ZLB and $\beta_0^* < 1$, there is welfare loss in terms of overinvestments. Depending on the relevant systemic risk exposure, the WACC approach might either exacerbate or dampen the discount effect arising at the ZLB.

When $r_f = 0$, the invariance condition reduces to

$$\beta^* = \frac{dr_d + (1-d)r_e}{r_m}. \tag{16}$$

Again, invariance is related to conditions in the debt and the equity market, to the market return and the funding structure. These issues are discussed more in depth in the next section, when endogenizing the model components.

4 Invariance and endogenous rates of return

So far, all rates of return have been treated as exogenous. However, in reality they are all closely related. To illustrate the endogeneity across the relevant WACC and CAPM components, this section relates the borrowing rate to the risk free rate by defining $r_d \equiv r_f + \rho$, where ρ is a risk premium on the risk free rate for borrowing.

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Assuming $r_{WACC} = r_{CAPM}$, and solving for the risk free rate of return, we find the invariance level as

$$r_f^* = \frac{\beta r_m - d\rho - (1-d)r_e}{d + \beta - 1}. \tag{17}$$

Again, rearranging in terms of systemic risk gives

$$\beta^* = \frac{(1-d)(r_e - r_f) + d\rho}{r_m - r_f}, \tag{18}$$

where we see the proximity to (13) and (14). The comparative statics are

$$\begin{aligned}
&\frac{\partial \beta^*}{\partial r_e} = \frac{(1-d)}{r_m - r_f} > 0, \quad \frac{\partial \beta^*}{\partial r_m} = \frac{-\beta^*}{r_m - r_f} < 0, \quad \frac{\partial \beta^*}{\partial d} = -\frac{\left(r_e - r_f\right) + \rho}{r_m - r_f} < 0 \\
&\frac{\partial \beta^*}{\partial r_f} = \frac{-1}{r_m - r_f}\left(\left(1-d\right) + \beta^*\right) < 0 \text{ and } \frac{\partial \beta^*}{\partial \rho} = \frac{d}{r_m - r_f} > 0,
\end{aligned} \tag{19}$$

when we assume $r_m > r_f, r_e > r_f$ and $d \in \langle 0,1 \rangle$.

The partial derivatives show how the invariance condition is affected by partial shocks to the different model components. We illustrate the negative correlation between the invariance level of systemic risk and the risk premium on external funding numerically in the next subsection.

The comparative statics show the complex interrelation between markets and funding that is necessary in order to obtain invariance between WACC and CAPM. The effect of a change in the risk free rate of return is for instance contingent both on the funding structure, the excess return to the market portfolio and the prevailing invariance level. The effect of the market portfolio itself is both contingent on the prevailing invariance level of systemic risk and the market portfolios excess return. Incomplete pass-through, for instance due to inefficient markets or funding constraints, is an important reason for lack of invariance across our two models.

4.1 A numerical ZLB case highlighting the risk components

If we assume that we are at the ZLB, we can for simplifying reasons set the risk free interest rate to zero $r_f = 0$. This yields

$$r_{WACC} = d\rho + (1-d)r_e \tag{20}$$

and

$$r_{CAPM} = \beta r_m. \tag{21}$$

We further simplify by assuming that financing is done exclusively by debt ($d = 1$) since commercial real estate often is financed using a large degree of debt.

We then get

$$r_{WACC} = \rho \,. \tag{22}$$

From the equations above, we see that increased risk in the form of a higher risk premium, ρ, or higher systemic risk, β, will increase the alternative rate of return derived from both WACC and CAPM, for any given level of r_m. If $\beta r_m > \rho$, we have $r_{CAPM} > r_{WACC}$.

A simple numerical example might help understand the implications of the risk components. If we set $r_m = 15$, $\beta = 1.5$ and $\rho = 1$, we have $r_{CAPM} = 1.5 \times 15 = 22.5$ and $r_{WACC} = 1$ such that r_{CAPM} is over twenty times larger than r_{WACC}, yielding a lower NPV when using CAPM than when using WACC. For these parameter values, the WACC-shortcut increases the expected profits of an investment, compared to using CAPM. The difference in profitability is smaller when the risk free rate is higher and we are not at the ZLB. This implies that WACC to a lesser extent seems to evaluate risk than CAPM at the ZLB. This is due to imposing risk by the risk premium in WACC and by the systemic risk component β in CAPM.

Changes in the value of the two risk parameters impact results directly. A low(er) β, or a high(er) ρ, impact NPV. For $r_m = 15$ and $\rho = 1$, we need $\beta = 0.067$ for $r_{CAPM} = r_{WACC}$. When $r_m = 15$ and $\beta = 1.5$, we need $\rho = 22.5$ for $r_{CAPM} = r_{WACC}$. How different risk components evolve and how markets are pricing risk matters for which model one may use for assessing commercial real estate.

5 Simulations using US data

By using time series data for the right hand side variables in (4) and (9) (the equations for CAPM and WACC, respectively), we can simulate WACC and CAPM for each period. The resulting simulated time series for WACC and CAPM will then be a result of the risk free interest rate, market return, return on equity, debt interest rate, risk, and loan-to-value ratio at the pertaining periods. We use quarterly data or monthly data collapsed into quarterly data for the analysis below. The sample is from the third quarter of 1991 until the second quarter of 2016.

For the risk free rate, r_f, we use data on the federal funds rate from the US Federal Reserve Data Releases. Data on expected market return, r_m, is also taken from the US Federal Reserve Data Releases, where we calculate the yearly growth rate for the commercial real estate price. Hence, we assume adaptive expectations when calculating market return. The return on equity, r_e, is found by dividing the expected rate of appreciation in house prices (here we use for this) by the equity-to-value ratio (see e.g. Brueggeman and Fisher (2011, p.193) for the relationship between expected rate of appreciation in house prices (EAHP) and expected appreciation on home equity (EAHE)). The loan-to-value ratio is set to 80% ($d = 0.8$, c.f. (9)) for the entire sample since this is the highest loan-to-value ratio that you can get on an apartment loan from a conventional lender as well as Government-Sponsored Enterprises (C-loans, 2018a). For the debt interest rate, r_d, we use the 30-year conventional mortgage rate provided by Freddie Mac and

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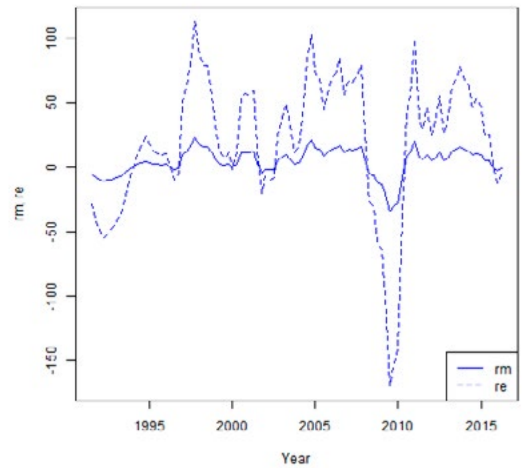

Figure 5a. *Expected market return and expected equity return. (Source: US Federal Reserve Data Releases and authors' calculations)*

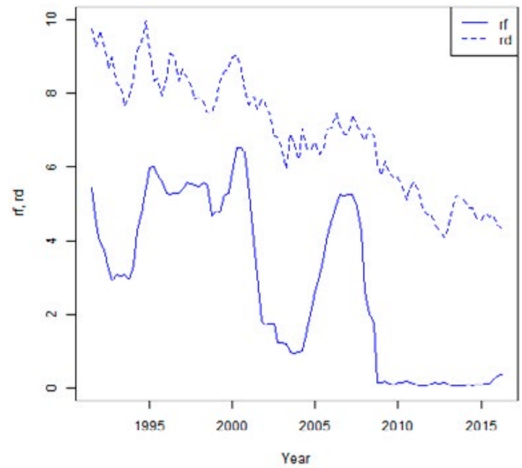

Figure 5b. *Federal funds rate and debt interest rate (30 year fixed rate plus a premium of 100 basis points). (Source: US Federal Reserve Data Releases, Freddie Mac, and authors' calculations)*

add a premium of 75 basis points (as suggested by C-loans (2018b)). A detailed description of the data sources can be found in the appendix.

Risk is measured by β, and we use the "Contributions to the Cleveland Financial Stress Index: Commercial Real Estate Spread" from Federal Reserve Bank of Cleveland which captures the risk associated with investing in commercial real estate relative to a risk free instrument. Figure 5a pictures the expected market return and the expected return to equity, while the borrowing rate and the Federal Funds rate is given in Figure 5b.

As shown in Figures 6a and 6b, r_{WACC} is somewhat larger than r_{CAPM} from the beginning of the sample until shortly before the financial crisis. The gap between alternative rates of return increased prior to the crisis, and for investors

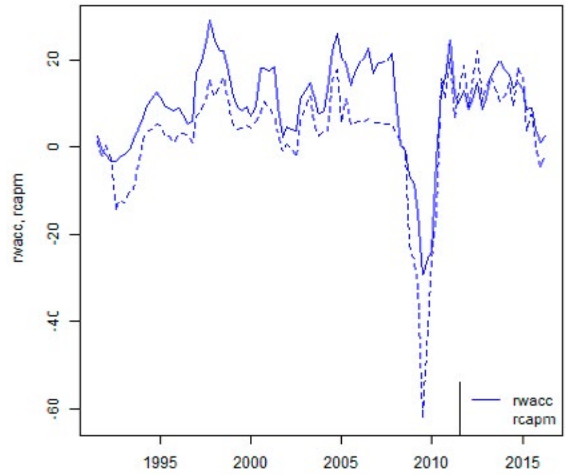

Figure 6a. *Simulated WACC and CAPM from US data. Source: Authors' calculations*

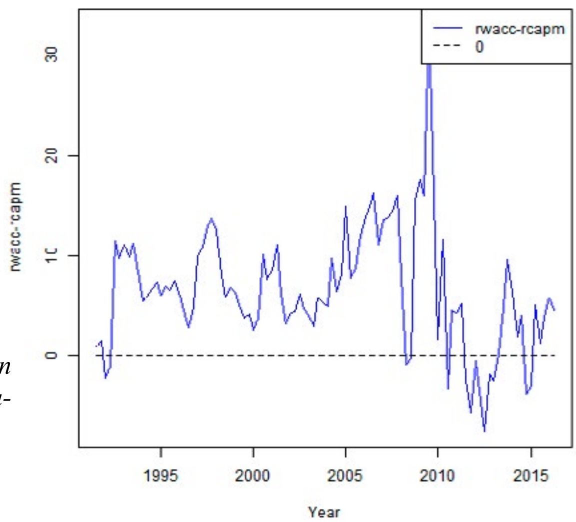

Figure 6b. *Difference between WACC and CAPM. Source: Authors' calculations.*

using CAPM rather than WACC, the lower alternative rate of return might have stimulated investments. While the Federal Funds Rate declined, the expected equity return increased. This may have resulted in that the search-for-yield behavior among investors created some inverse pass-through from the Federal Funds Rate. In that case, the higher equity return would have dominated the lower borrowing cost, even for funding structures with high leverage, and, as risk was assessed to be low and moderate, WACC predictions would have risen far higher than those of CAPM. In the 2010s, the gap between WACC and CAPM as predictors for alternative rates of return was smaller, making the choice between models less important. Overall, during the time span, we consider the gap between the WACC and CAPM return requirement positive, favoring WACC. Generally, the WACC is thereby a shortcut that will produce underinvestment through the NPV assessment.

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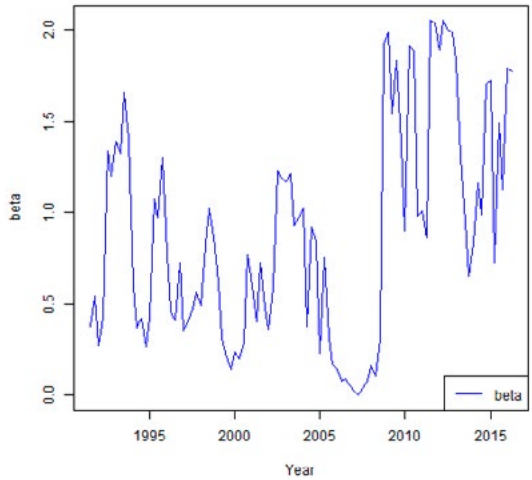

Figure 7. *Risk, measured by beta. (Source: Federal Reserve Bank of Cleveland)*

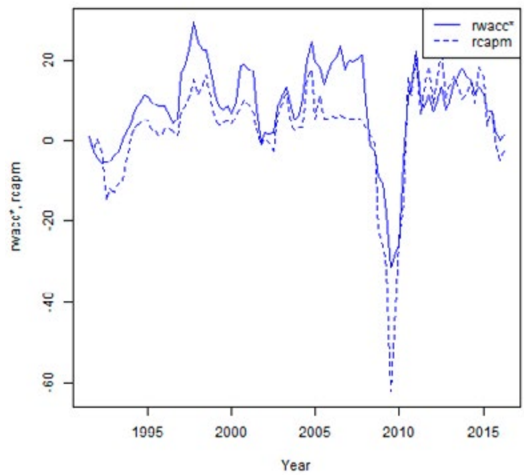

Figure 8. *WACC and CAPM when the debt interest is a 278 basis point markup on the risk free rate.*[1] *(Source: Authors' calculations)*

We may also look at the relationship between our two models for the required rate of return in light of how risk evolved over the sample. Risk was relatively low in the early 2000s (see Figure 7) compared to the period after the financial crisis. The average beta value was 0.71 in the 90s, 0.64 in the 2000s, and 1.44 from 2010 until the end of the sample. A combination of a low risk free rate and high risk has brought CAPM requirements close to WACC requirements after the financial crisis (the ZLB). For a combination of a low risk free rate and low risk, features not passed through to equity return requirements may have created a large gap between the two required rates of return, calculated CAPM and WACC, before the crisis. This is a result that can be motivated theoretically by the partial effect of the risk free interest rate on WACC for different beta values in (6).

Using a 30-year fixed mortgage rate may be an unrealistically long time frame for investments in commercial real estate. At the other extreme, we may

1 This only affects r_{WACC}, the altered r_{WACC} marked by an asterisk in the figure legend.

consider an adjustable mortgage rate that is set as a mark-up over the federal funds rate. By setting $r_m = r_f + 2.78$, i.e. a mark-up of 278 basis points ($\rho = 2.78$, c.f. section 4), the simulated WACC is as shown by Figure 8 compared with the simulated CAPM. 270 basis points correspond to the average difference between the 5/1-Year Adjustable Rate Mortgage Average in the United States from Freddie Mac, and the effective federal funds rate, from the middle of 2005 (which is the first observation of the adjustable rate) until the end of the sample. Using this adjustable mortgage rate would have shortened the sample considerably, so the average value of the difference for the available sample was used as a markup. This shows a similar pattern as in Figure 6a, implying that using this approach for the debt interest rate does not alter the main conclusions.

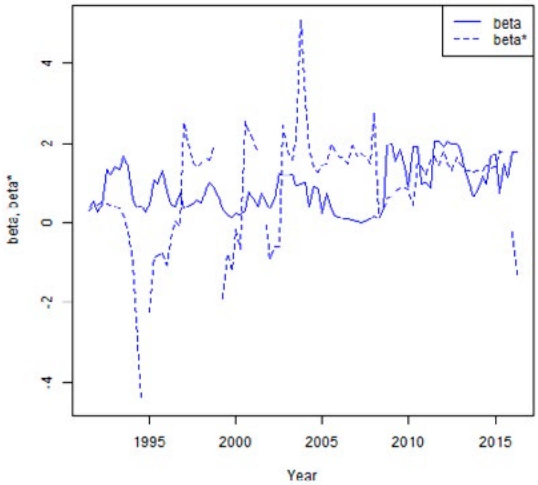

Figure 9. *Beta and invariance beta (beta*). (Source: Federal Reserve Bank of Cleveland and Authors' calculations)*

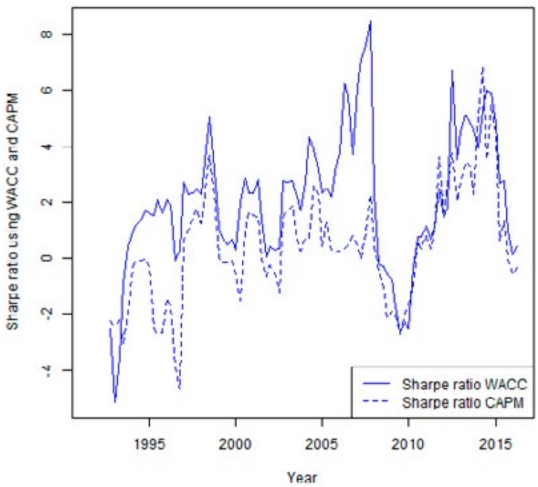

Figure 10. *Sharpe ratios for WACC and CAPM. (Source: Authors' calculations)*

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Our theoretical discussion is framed in terms of model invariance, expressed as an invariance level of systemic risk. When comparing our theoretical invariance level of systemic risk (β^* from (14)) to the observed value of systemic risk (as shown in Figure 7), we may link the US estimates to the theoretical discussion of using different models for deriving the alternative rate of return.

The invariance level of systemic risk is shown together with the observed systemic risk (β) in Figure 9 (after exempting from some extreme values due to a near zero denominator in (14) – by removing all observations that are over and under four times the interquartile ranges of the observations – to improve the readability of the figure). We see that the largest deviation between the observed systemic risk and the invariance level of systemic risk is in the years prior to the financial crisis. Since 2010, the gap between two beta values are smaller.

In the period prior to the financial crisis, the simulated invariance level of systemic risk is relatively high ($\beta^* > 1$). At the same time, the Federal Funds rate approach the ZLB. From Section 3 we know this makes WACC too restrictive and that welfare losses – as argued above – will come about in the form of underinvestment. However, the time varying beta values for commercial real estate is affecting the conditions for model invariance. When moving towards the ZLB, WACC is considered an acceptable alternative to CAPM for investments that carry the same risk as the market, while it might be an alternative for either offensive or defensive investments at higher interest rates. Hence, approaching the ZLB, WACC becomes less of an option for real estate investments than it is at more normal interest rate levels. We can investigate this further by considering how the Sharpe ratio varies across the two models.

By considering the Sharpe ratio – see (3) – for our WACC and CAPM models ($SHP_{WACC} = \frac{r_{WACC} - r_f}{\sigma_{WACC}}$ and $SHP_{CAPM} = \frac{r_{CAPM} - r_f}{\sigma_{CAPM}}$, where the standard deviation is calculated as a rolling standard deviation using a history of six quarters), we are able to measure risk-adjusted excess return over the risk free rate.

When selecting the window size used for calculating the historical standard deviation, there is a tradeoff between having a large or a small window size. A large window size will capture a lot of history from the returns time series. However, with a large window size, distant history is just as important for the historical standard deviation as more recent history. With a small windows size, more recent history becomes more important, e.g. reducing the impact on past crises on the Sharpe ratio today. Additionally, a disadvantage when using a large window size is that the sample size is decreased since more observations are used as initial values. A very small window size, on the other hand, will make the standard deviation fluctuate a lot since the average is based only on a few observations that can change a lot between periods. We choose a window of six quarters, such that history from one and a half year is of relevance to indicate the volatility of the returns. The qualitative results related to the differences between the Sharpe ratios for WACC and CAPM are robust to changing the window size – we have simulated the Sharpe ratios using a window size up to 20 quarters, which provides the same qualitative results. Hence, we chose the smallest possible window in order to increase the sample size. A shorter window than six (and to some extent five) quarters would have caused very large fluctuations in the historical volatility since large deviations contributes to the historical volatility to a high degree, making the graphs harder to interpret.

In order to highlight the difference between our two methods for the alternative rate of return, we use the internal rate of return as the relevant rate of return. As shown in Figure 10, the difference between the risk adjusted excess return for the two models is much higher in the period prior to the financial crisis than for the rest of the sample. This coincides with the large difference between the invariance beta and the observed beta, which we also observe prior to the financial crisis. Hence, the higher Sharpe-ratio derived from our WACC approach in the period preceding the financial crisis may be related to the lower standard deviation inherent in the WACC return, but also to the higher internal rate of return the WACC approach produce. Looking exclusively at Sharpe ratios when assessing commercial real estate investments – without recognizing that observed beta values fell below the invariance level risk during this period – might have falsely lured investors into commercial real estate investments if using the WACC shortcut when assessing profitability.

6 Discussion and conclusions

A number of uncertainties may arise when entering new territory. Thinking in terms of the functioning of an economy, the ZLB is definitely new territory. At the ZLB, the monetary transmission mechanism is by far the most substantial uncertainty.

This paper contributes to the understanding of the monetary policy transmission at the ZLB by analyzing investment demand, an important channel for the transmission mechanism. The paper assesses different evaluation models for commercial real estate at the ZLB, relative to how the models perform at interest rate levels closer to historical averages. Using a NPV approach, combined with a Sharpe ratio, to assess investment profitability and demand, we track asymmetries across the interest rate cycle between evaluation models for commercial real estate investments.

We start by comparing the core models for calculating the alternative rate of return, CAPM and WACC, keeping all model components exogenous. While CAPM is the preferred method for finding the required rate of return, it is not always accessible, and WACC is an acceptable alternative when an investment does not alter the business risk nor the financial risk of the investing firm. Knowing how systemic risk is an important part of financial risk, we place our reasoning in terms of the two models' invariance level of systemic risk.

Comparative statics show how the risk free rate of return affects the invariance level of systemic risk that equates the discount rate from CAPM and WACC both through a *level effect* and a *risk pricing effect*. The effect of a higher risk free rate of return on the invariance level of systemic risk is in general ambiguous, and depends on the initial level of systemic risk.

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When deriving the discount rate using WACC, a move towards the ZLB may result in welfare losses due to underinvestment, while higher interest rates may produce welfare losses in terms of overinvestments. From our benchmark model, we may also distinguish between investments with different systemic risk in order to assess when WACC can used as an alternative to CAPM. At normal interest rates, WACC is an alternative to CAPM for either defensive ($\beta < 1$) or offensive ($\beta > 1$) investments. However, close to the ZLB, WACC is an alternative to CAPM for investments where ($\beta \approx 1$). Hence, a move towards the ZLB introduces a new regime for model relevance when assessing commercial real estate.

When simulating the models using US data, we find deviations between the invariance level of systemic risk and the actual level of systemic risk. The difference between CAPM and WACC is especially large in the period preceding the financial crisis, a period with a low risk free interest rate where also systemic risk was very low. In general, the WACC approach is more conservative than CAPM, in the sense that the required rate of return is higher when using WACC, creating a welfare loss in terms of underinvestment in commercial real estate when using a WACC shortcut. The time series variation in beta makes us able to distinguish between periods where WACC *could* be an alternative to CAPM. As US commercial real estate during the 90s was a rather defensive investment and during the 2010s a rather offensive investment, the ZLB is not an optimal situation for using WACC. This is evident even though the higher systemic risk in the 2010s to some extent compensate for the ZLB effect, and makes the WACC procedure produce rather similar results as the CAPM procedure.

References

Adam, K. and Billi, R. M. (2007). Discretionary Monetary Policy and the Zero Lower Bound on Nominal Interest Rates, Journal of Monetary Economics 54 (3), 728–752. https://doi.org/10.1016/j.jmoneco.2005.11.003

Ball, M., C. Lizieri and MacGregor, B. (1998). The Economics of Commercial Property Markets, Routledge, London and New York.

Berk, J. and DeMarco, P. (2007). Corporate Finance. Pearson.

Bouakez, H., Guillard, M. and Roulleau-Pasdeloup, J. (2017). Public investments, time to build and the zero lower bound, Review of Economic Dynamics 23, 60–79. https://doi.org/10.1016/j.red.2016.09.001

Brueggeman, W. B. and Fisher, J. D. (2011). Real Estate Finance and Investments. McGraw-Hill Irwin. 14th edition.

C-loans (2018a). Loan-To-Value Ratio for Commercial Loans. [online] Commercial Loans – Commercial Mortgages – C-Loans.com. Available at: http://www.c-loans.com/knowledge-base/loan-to-value-ratio-for-commercial-loans [Accessed 8 Jan. 2018].

C-loans (2018b). Commercial Mortgage Rates Compared to Home Loan Rates. [online] Commercial Loans – Commercial Mortgages - C-Loans.com. Available at: http://www.c-loans.com/borrowers-investors/commercial-mortgage-rates-compared-to-home-loan-rates [Accessed 8 Jan. 2018].

Chatrah, A., Liang, Y., and McIntosh, W. (2000). The asymmetric REIT-beta puzzle, Journal of Real Estate Portfolio Management, 101–111.

Chiang, K. C., Lee, M. L., and Wiesen, C. H. (2004). Another look at the asymmetric REIT-beta puzzle, Journal of Real Estate Research, 25–42.

Chiang, M. C., Tsai, I. C. and Sing, T. F. (2013). Are REITs a good shelter from financial crisis? Evidence from Asian markets. Journal of Property Investments and Finance, 237–253. https://doi.org/10.1108/14635781311322210

Cotter, J. and Roll, R. (2011). A comparative anatomy of REITS and residential real estate indexes: Returns, risks and distributional characteristics. Working paper, University College of Dublin, Dublin, Ireland.

Damodaran, A. (2012). Investment valuation, Tools and Techniques for Determining the Value of any Asset. (3 ed.) Hobroken, Nj: John Wiley and Sons.

Eggertsson, G. B. and Woodford, M. (2003). Optimal Monetary Policy in a Liquidity Trap, NBER Working Paper No. 9968.

Eggertson, G. B. (2011). What fiscal policy is effective at zero interest rates? NBER Macroeconomics Annual 25, 59–112. https://doi.org/10.1086/657529

Fischer, S. (2016). Monetary Policy, Financial Stability, and the Zero Lower Bound. American Economic Review, vol. 106, no. 5, May 2016, 39–42. https://doi.org/10.1257/aer.p20161005

Geltner, D. (2007). Commercial real estate: Analysis and Investments. Cengage learning.

Gilchrist, S., Lopez-Salido, D. and Zakraajsek, E. (2015). Monetary Policy and real borrowing costs at the Zero Lower Bound, American Economic Journal: Macroeconomics, 7(1), 77–109. https://doi.org/10.1257/mac.20130324

Goodhart, C. and Hoffman, B. (2008). House Prices, Money, Credit, and the Macroeconomy, Oxford Review of Economic Policy 24 (1), 180–205. https://doi.org/10.1093/oxrep/grn009

Gyourko, J. and Nelling, E. (1996). Systemic risk and diversification in the equity REIT market, Real Estate Economics, 493–515. https://doi.org/10.1111/1540-6229.00701

Keown, A.J., Martin, J. D. and Petty, J. W. (2014). Foundations of Finance. The logic and practice of financial management. Eight edition. Global edition. Pearson.

Property Industry Alliance Debt Group (2017). "Methodologies and Real Estate Lending: A report by the Long-term Value Working Group of the Property Industry Alliance Debt Group." http://www.bpf.org.uk/sites/default/files/resources/Long-term-Value-Methodologies-and-Real-EstateLending.pdf

Roll, R. (1977). A critique of the asset pricing theory's test: Part I, Journal of Financial Economics, 4, 129–176. https://doi.org/10.1016/0304-405X(77)90009-5

Stoyu, I. I. (2016). Study of REIT ETF beta, The Journal of Risk Finance, 17 (3), 347–369. https://doi.org/10.1108/JRF-12-2015-0120

Sing, T. F., Chen, M. C. and Ma, T. (2012). The structure of REIT-beta. Applied Financial Economics, 827–836.

Woodford, M. (2010). Simple analytics of the government expenditure multiplier, American Economic Journal: Macroeconomics 3 (January), 1–35. https://doi.org/10.3386/w15714

Wright, J. H. (2012). What does monetary policy do to long-term interest rates at the zero lower bound? Economic Journal 122 (564), 447–466. https://doi.org/10.1111/j.1468-0297.2012.02556.x

Appendix

Table 1. *Variables used in the analysis. The sample used is 1991Q3–2016Q2.*

Variable	Source	Code
Effective federal funds rate (used as the risk free interest rate r_f)	Quandl	FED/RIFSPFF_N_M https://www.quandl.com/data/FRED/FEDFUNDS
Commercial real estate price index (used to calculate r_m)	Quandl	FED/FL075035503_Q https://www.quandl.com/data/FED/FL075035503_Q
30-Year Conventional Mortgage Rate (used to calculate r_d)	Quandl	FMAC/MORTG https://www.quandl.com/data/FMAC/MORTG
Contributions to the Cleveland Financial Stress Index: Commercial Real Estate Spread (β)	Quandl	FRED/CRESD678FRBCLE https://www.quandl.com/data/FRED/CRESD678FRBCLE
5/1-Year Adjustable Rate Mortgage Average in the United States (used to calculate the average markup on the risk free rate)	Quandl	FMAC/5US https://www.quandl.com/data/FMAC/5US