Money Distilled: Traditional versus Quantitative Hedging for Real Estate Private Equity SLOCs

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Master Thesis Quantitative Finance

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Synopsis

In this paper I conduct a comparative study of traditional hedging techniques versus advanced quantitative methods in the setting of a specific real estate financing. I examine whether either of the two hedging methods, when applied to a subscription line of credit (SLOC) for a specific real estate investment can capture higher IRR returns and thus elevate the promote for the real estate private equity investor. I estimate multiple interest rate paths of the floating rate (3M EURIBOR) by modeling a Vasicek model (discretized by the Euler model) in conjunction with a Monte Carlo simulation. Subsequently, I draw a comparison between the two hedging methods, qualitative reasoning included. While traditional hedging dominates in the real estate investment industry, aadvanced quantitative 'exotic' derivatives are rarely adopted. Real estate private equity investors often use SLOC for a short duration (1 to 3 years). It is a frequently used financial tool by real estate private equity sponsors to enhance their promote.

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Management summary

Direct real estate investments predominantly rely on a mix of equity and debt, primarily sourced from banks (Geltner et al., 2013). The debt component often comprises variable rate commercial loans, where the interest rate is a sum of a variable reference rate and a credit risk margin. Fluctuations in the reference rate, influenced by macroeconomic factors, can significantly impact loan costs. The past decade's low and stable interest rates reduced the importance of hedging for real estate borrowers. However, the recent surge in interest rate, has brought hedging back into focus (Bowie & Chatham Financial, 2023). This shift is due to increased debt servicing costs and the impact on cash flows, making cost-effective hedging strategies crucial (Harkins et al., 2015).

Real estate investors commonly use Over-The-Counter (OTC) derivatives for hedging interest rate risks (Jönköping University et al., 2017). The two principal hedging instruments are interest rate swaps and caps (Jones Lang LaSalle, 2019). Interest rate swaps allow borrowers to exchange a variable rate for fixed payments, while caps set an upper limit on the variable rate, offering protection against rising rates (Jönköping University et al., 2017). The choice between these instruments depends on individual borrower preferences and market conditions. More advanced (quantitative) derivatives, often called as 'exotic' derivatives, are rarely adopted by real estate borrowers. While traditional methods like swaps and caps remain relevant, exploring advanced solutions can be compelling to navigate current market complexities and optimize returns.

In real estate private equity, IRR is a crucial performance metric, accounting for the time value of money. Waterfall distributions, which allocate profits between joint venture partners, are structured around IRR benchmarks. The sponsor's promote, or additional share of profits, is contingent on surpassing these hurdle rates. A SLOC is a short term loan and provides instant liquidity as it is backed by equity. The debt instrument is commonly used by (real estate) private equity investors to elevate the IRR for the purpose of generating a superior promote by delaying (equity) capital calls from investors (Case & Nareit, 2018).

Within real estate private equity, employing a credit line significantly boosts the IRR, outperforming scenarios where a credit line is not used. This leads to a higher promote for the investment firm. When comparing hedging strategies, traditional methods offer predictability and stability, especially in extreme interest rate environments, while advanced strategies provide flexibility and customization in intricate rate scenarios. Across various interest rate forecasts—downward, flat, and upward—traditional interest rate swaps consistently deliver superior IRR and promote. However, in scenarios requiring early prepayment flexibility, geared interest rate collars are preferred due to their adaptability. While further research could explore refinancing options and alternative debt instruments for potentially higher returns, the key recommendation for real estate private equity firms is to judiciously select their hedging strategies based on the anticipated interest rate environment and their need for flexibility (e.g. early prepayment), ensuring optimal financial performance.

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1 Introduction

The structure of the introduction chapter focuses first on 'why', then on 'what', and finally on 'how'. First, starting with the underlying reasons and background of the topic. Next, the problem discussion is described followed by the objective, main question and sub questions, integrating the delimitation of this study's scope. Following this, the methodology or simply put; the approach employed to analyze the topic is further narrowed down. The chapter concludes with a reader's guide.

1.1 Background

Direct real estate investments are often financed by a mix of equity and debt, with the vast majority of loans is still granted by banks (Geltner et al., 2013). It is important to know that commercial real estate debt is granted in variable rate (or also referred to as floating-rate) commercial loans. The all-in interest rate (or effective interest rate) charged usually comprises of two components: the reference rate (the variable part) and a margin (that reflects the credit risk associated with the borrower and asset). As the reference rate changes due to various (macroeconomic) factors, the interest rate on the loan will adjust accordingly. This paper primarily focuses on the use of interest rate derivatives to hedge the reference rate (specifically, the 3M EURIBOR) by real estate investors that utilize external debt from banks to finance direct real estate. Moreover, in this paper, interest rate hedging serves as cash flow hedge that safeguards against fluctuations in the cash flows of a specific asset, which arise from alterations in a particular factor, in this case the variability in interest payments of floating rate debt (Harkins et al., 2015).

Real estate investors that employ external debt financing use Over-The-Counter (OTC) interest rate derivatives rather than publicly exchange-traded derivatives (Jönköping University et al., 2017). Twice a year, the Bank for International Settlements (BIS) gathers data on the market size of OTC derivatives (Jönköping University et al., 2017). Based on data from the latter half of 2022, interest rate swaps account for 91% of the total gross value of all OTC interest rate derivatives (Bank for International Settlements, 2023). According to Jones Lang LasSalle, the two most common interest rate hedging instruments, used by real estate investors that employ external debt financing, are interest swaps and interest rate caps (Jones Lang LaSalle, 2019). The interest rate swap allows the borrower to exchange the variable reference rate for fixed interest payments ensuring the interest expenses. On the other hand, an interest rate cap, accounts for 9% of the total gross value of all OTC derivatives, provides a borrower with a ceiling on the reference rate, thereby capping their

interest expenses. The key distinction between the two instruments lies in their response to fluctuations in the reference rate. If the reference rate goes below the strike are of the cap, then the reference rate applies, but it will never exceed the predetermined strike rate during the term of the interest cap agreement. Moreover, with an interest rate cap the borrower gains the difference between the cap level and the actual reference rate. In contrast, with an interest rate swap, the borrower's payments are predetermined based on the agreed-upon fixed rate, meaning they don't gain any financial advantage if the reference rate drops below the swap rate due to its fixed nature (Hull, 2017). Some borrowers lean towards swaps as the premium is embedded into the all-in interest rate, whereas others (for example due to past experiences with breakage costs) prefer to an interest rate cap and pay an upfront premium (Harkins et al., 2015). The working of these two traditional derivatives is further outlined in the appendix about hedging products.

The last 12 years, the traditional hedging strategies were most popular among real estate borrowers. Or, if the lending party permits, borrowers maintained their debts with the variable reference rate. Given that the margins were equal (or sometimes lower) than the all-in interest rate given the fixed swap rate was zero or even negative. With interest rate caps, the upfront premium was relatively palatable and (unlike swaps) enabled real estate borrowers to prepay the loan without breakage costs.

1.2 Problem discussion

Interest rate hedging has become a prevalent matter of discussion since reference rates turned positive again in 2022 and continued their ascent in 2023. The prolonged period of low interest rates of the past decade, coupled with low interest rate volatility and a relatively flat interest rate term structure made interest rate hedging become subordinately important for real estate borrowers. Given the common hedging instruments employed by real estate borrowers were relatively inexpensive with limited impact on the cash flow. However, this landscape has changed since 2022 with the steep rise in interest rates in a short time period. Moreover, the 3M EURIBOR rose from zero percent in in mid-2022 to almost 400 bps by 2023. The sharp rise in interest rates, coupled with an inverted yield curve and increased volatility led to significantly higher debt service thus substantial influence on the cash flow. Consequently, the cost of traditional hedging instruments increased substantially, making interest rate hedging become a very relevant topic for many real estate investors that use significant amounts of debt to finance their assets.

The derivatives market provides many hedging strategies than just the common traditional methods used by real estate investors. Yet, the financial crisis that began in 2007 led to significant criticism of derivatives, with Warren Buffett notably labeling them as 'weapons of mass destruction'[1] (Harkins et al., 2015). However, when employed appropriately, these financial instruments can offer value, enabling borrowers to adeptly navigate and mitigate their financial risks (Harkins et al., 2015). More important, it can enable real estate investors to execute new deals even in complex market conditions characterized by higher debt service. To compete successfully in today's market, real estate investment managers are under great pressure to make new deals keep on going in innovative ways to best satisfy investors' and fundraisers' needs. Looking beyond traditional interest rate hedging strategies might be one of these innovative approaches. However, there is no one-size fits it all, hedging solutions must be tailored to specific needs. Hence, I consider a very specific case study to analyze returns comparing traditional and more advanced hedging solutions.

This case study focuses on hedging the interest rate risk on a Subscription Line Of Credit (SLOC) deployed for direct real estate investments by a real estate private equity firm. A SLOC is often used within (real estate) private equity to boost the Internal Rate of Return (IRR) of a fund, in this case with real estate as the underlying asset. In (real estate) private equity, the IRR is one of the most common performance measures. Utilizing a credit line can postpone the need to draw on investor capital, effectively shortening the investment period. Because the IRR accounts for the time value of money, this strategic (equity) delay through a credit line may consequently elevate the IRR. In this case, the IRR directly influences the "promote" structure. The promote, or "carried interest", is a tiered performance fee rewarding the general partner (GP or so-called 'sponsor' and in this case the investment firm) for surpassing specific return benchmarks. As the project's IRR crosses predefined thresholds, the GP's share of profits increases. This incentivizes the GP to maximize returns, by utilizing a SLOC. The purpose of the investment firm in question is to elevate the investment firm's performance fee – which is linked to the IRR – by utilizing a SLOC.

[1] Warren Buffett, "Berkshire Hathaway Inc. Annual Report," 2002, p. 15.

1.3 Purpose and research questions

The objective of my research is to identify if exotic derivatives (e.g., geared interest rate collar) on a SLOC can capture a higher IRR in comparison to plain vanilla derivatives in a high interest rate environment. Simply put, I develop a framework to assess if more advanced interest rate hedging methods in comparison to the (common) traditional hedging solutions (swaps & caps) can be more beneficial in the use of hedging the reference rate on a specific subscription line of credit for a specific real estate private equity investor. The purpose of this paper is not to dive into the working of interest rate derivatives, but on which derivatives do best in favor of the real estate private equity investor in the current and expected interest rate environment when hedging a short-term facility as the SLOC. The readers target audience should include basic knowledge in real estate financings and moreover interest rate derivatives.

To delve deeper into this topic, three sub questions will be explored:

1. Which hedging strategies are commonly used among real estate borrowers?;
2. How does the use of a SLOC influence the IRR of a (real estate private equity) fund?; and
3. How can an advanced interest rate hedging strategy when applied to a SLOC for real estate investments look like?

1.4 Methodology

The quantitative analysis, I approach by simulating the reference rate (3M EURIBOR) with a Vasicek model in conjunction with the Monte Carlo simulation. The reference rate is used to evaluate the hedging performance of various financial derivatives in order to determine the cost of debt associated with each derivative under different interest rate scenarios. Based on the cost of debt of each derivative and the project cash flow from the investment firm in question, the IRR of the real estate fund is estimated. By comparing the IRR outcome under each derivative in different interest rate paths, the value of certain exotic options versus more traditional hedging instruments are assessed. Subsequently, the IRR and associated projected cash flows are used in a specific cash flow waterfall distribution to assess under which derivative and interest rate scenario the investment firm achieves the highest promote in favor of the real estate private equity investor. The approach and model can be applicable in several cases to hedge interest rate risk, not only in the real estate industry.

1.5 Dispositon

The outline of this thesis is as follows. The **Theory and Data** section encompasses the exploration of interest rate dynamics, specifically the 3M EURIBOR and its influence on real estate. It also touches upon the use of interest rate derivatives by commercial real estate borrowers. The section concludes with a detailed look at the SLOC and its role within the (real estate) private equity industry. Following this, the **Instrument Comparison** section delves into both traditional and advanced hedging instruments that have been examined. This section also exhibits the pricing of the derivatives examined. Next, the **Methodology** section offers a deep dive into the mathematical approach employed to forecast the 3M EURIBOR floating rate. This forecasting is pivotal for estimating the cost of debt for each derivative, which is integrated into projected cash flows to calculate the IRRs. The subsequent section, **Empirical Findings**, first focuses on the simulation of the 3M EURIBOR. Next, the main results (i.e., IRR under three interest rate scenarios using various derivatives) are discussed in detail. In the **Conclusion** section, the core insights derived from the empirical findings are presented, offering a summary and interpretation of the research. Lastly, the thesis concludes with a more in-depth description of the examined interest rate derivatives. This final section aids in interpreting the results by providing clarity on the working of each derivative.

2 Theory and data

Chapter two of my thesis delves into the three key pillars. Beginning by understanding the bigger picture; the interest rate environment, with a particular emphasis on the 3M EURIBOR. Next, shifting to the use of derivatives in commercial real estate financing offering insights into why certain hedging strategies are employed specifically by real estate private equity investors. Finally, the chapter delves deeper into the debt instrument (SLOC) on which hedging strategies are examined. The role and (strategic) utilization of the SLOC in the real estate private equity sector provides further context and understanding.

2.1 The interest rate environment

Interest rates play a pivotal role in the macro-economic environment, serving as a 'barometer' for the cost of borrowing and therefore vital for interest rate hedging strategies. Interest rates also serve as an indicator of a nation's economic health. In essence, interest rates are set by central banks as part of their monetary policy, which is influenced by various factors such as inflation, unemployment, and overall economic growth. A change in interest rates spreads through the economy, affecting sectors differently.

For the real estate sector, interest rates have a dual impact: directly, by influencing the cost of funds and indirectly, by shaping the broader economic climate in which real estate transactions occur. When interest rates drop, it often signals a monetary policy aimed at stimulating economic activity. This leads to business expansion, driving demand for commercial spaces and potentially indicating an uptick in consumer confidence and purchasing power. Consequently, the allure of real estate as an investment avenue heightens due to its potential for lucrative risk-adjusted returns.

On the other hand, a rise in interest rates typically signifies a contractionary monetary policy. This can constrict economic growth, leading to challenges like diminishing rental growth, rising vacancy rates, and elevated financing costs. Such conditions can challenge the feasibility of new real estate deals or strain existing ones. Moreover, in a downturn, if the risk-free rate (often associated with government bonds) escalates and the expected return on real estate does not match up, the Sharpe ratio of real estate investments diminishes. This can lead to potential shifts in capital allocation, contingent on the performance of alternative asset classes.

The performance of the underlying economy, therefore, directly impacts property values, rental rates, and occupancy levels. It's a reflection of the economic situation and prospects of a region or country (Geltner et al., 2013). In the scope of this thesis, while the direct impact of interest rates on the cost of funds is explored, the indirect channel concerning the broader economic implications is also acknowledged, though not delved into in depth.

The cost of hedging instruments is influenced by a myriad of factors, including the current interest rate and the yield curve. For the purposes of this study, our primary emphasis will be on the yield curve, which serves as a graphical representation of interest rates across various maturities, reflecting both the general level of the interest rates and their implied market volatility (Harkins et al., 2015).

Yield curve

The yield curve is a graphical depiction that illustrates the correlation between the interest rates earned by debt securities and the time left until their maturity (European Central Bank, 2023). The below graph shows a five-year yield curve. The shape and slope of the yield curve, representing the relationship between short-term and long-term interest rates, can indicate economic outlooks and influence hedging decisions (Harkins et al., 2015).

As Figure 1 illustrates the Euro Yield Curve underwent significant changes throughout the last 15 years. In 2008, the yield curve shows a normal yield curve with long-term interest rates slightly higher than short-term interest rates. On the first of July 2022, approximately 5 months after the start of the Russian invasion of Ukraine, an upward sloping curve is shown in Figure 1, with long-term interest rates much higher than short-term interest rates. Whilst one year prior, the yield curve was normal and merely showed a small shift in rates, from negative to positive rates. At present, an inverted yield curve is suspected with short-term rates higher than long-term rates.

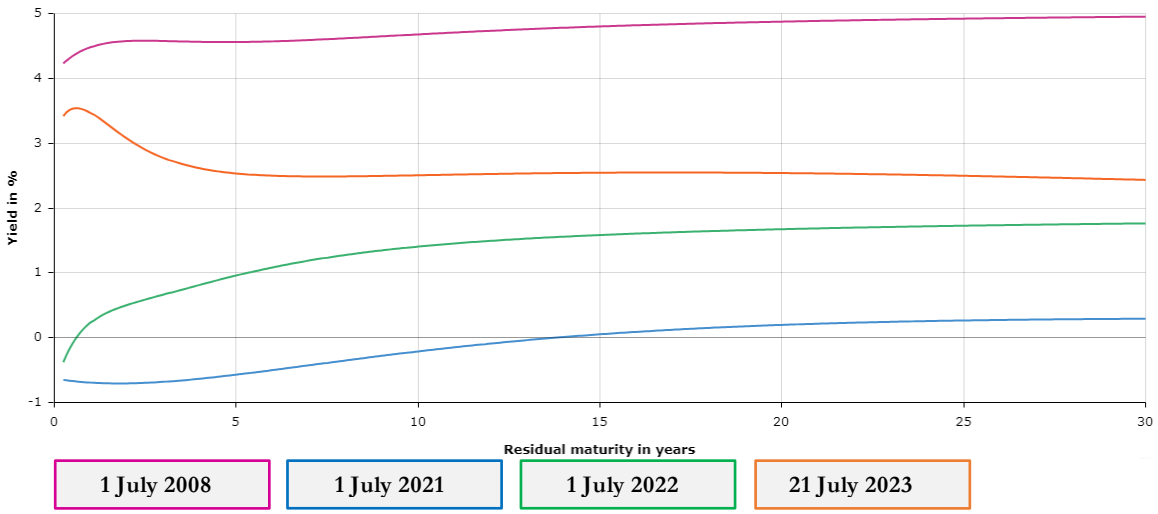


Figure 1: Euro area yield curves (spot rates AAA rated bonds). Source: European Central Bank, 2023.

General level of interest rate

Diving deeper into the present interest rate environment, moreover into the 3M EURIBOR. The price of hedging instruments is shaped by various determinants, notably the prevailing interest rate and the structure of the yield curve. The current interest rate, set by central banks, serves as a benchmark for short-term lending and borrowing in the economy. As mentioned earlier, it's a reflection of the monetary policy stance and is influenced by macroeconomic factors such as inflation, unemployment, and economic growth prospects. On the other hand, the yield curve represents a graphical depiction of the interest rates on debt for a range of maturities, illustrating the relationship between short-term and long-term bond yields. An upward-sloping yield curve usually signals positive future economic growth, while a downward-sloping or inverted curve can indicate economic downturns or recessions. For the purpose of this paper, special emphasis is placed on the yield curve, which represents the overall level of interest rates and also captures their implied market volatility. Figure 2 displays the 3M EURIBOR Quarter-over Quarter of the past 10 years from the moment of writing this paper. Between 2015 and 2022, the 3M EURIBOR was negative and became positive in the second quarter of 2022. During the period from 2022 to 2023, there was sustained high volatility in the reference rate. For instance, in March 2023, the 5-year EURIBOR SWAP reached 304 bps, showing a YoY increase of 238 bps and a MoM increase of 21 bps.

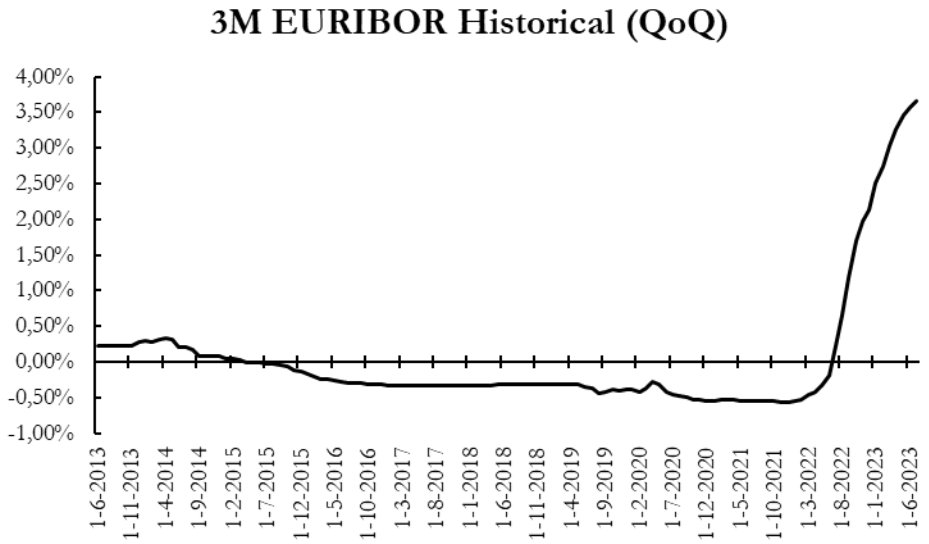


Figure 2: 3M EURIBOR historical (quarterly frequency). Source: Bloomberg, 2023.

It is worth noting that when writing this paper, the European environment finds itself in a high inflationary market thus intervening by the ECB was inevitable, resulting in a steep rise of the 3M EURIBOR as displayed in figure 2 above and created the inversion of the yield curve by lifting up the front end of the yield curve as displayed in figure 1. The European Central Bank (ECB) raised the three key ECB interest rates (refinancing operations, marginal lending facility and deposit facility) by 25 points to 3.50% on June 15 '23, the highest in 22 years (European Central Bank [ECB], 2023). This move aims to curb inflation, which they expect to be 5.40% in 2023, 3.00% in 2024, and 2.20% in 2025. The ECB's delayed response to inflation led to these upward revisions. President Christine Lagarde said the ECB wants to bring inflation back to a 2.00% target supported by increased borrowing costs and tighter financing conditions. Despite no clear indication of future rate hikes, the prevailing 6.10% inflation and a strong labor market suggest a continuation of the current monetary policy. Market experts anticipate at least one more rate increase, with potential hikes in July and September as displayed in Figure 3. The ECB's future decisions will depend on upcoming data and the impact of their recent actions on market dynamics (Bowie & Chatham Financial, 2023). Examining the forward curve of Chatham Financial reveals that the rate climbs to 378 bps by May 2024 as its peak. Subsequently, it averages at 303 bps through to August 2033.

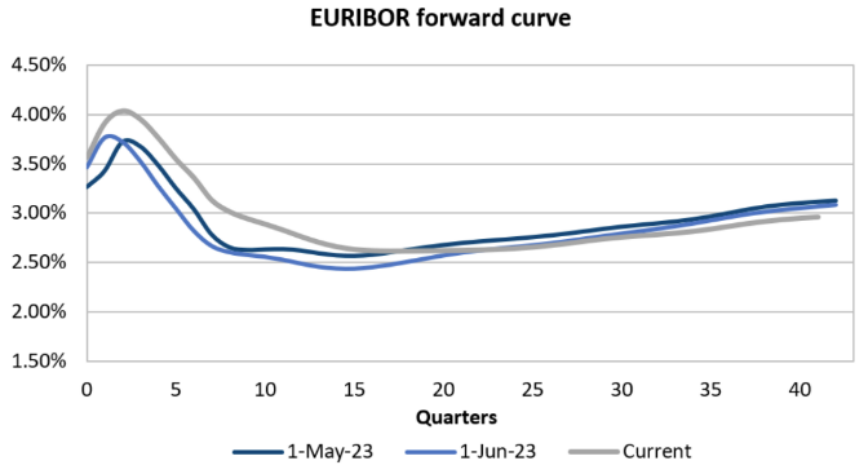


Figure 3: EURIBOR forward curve. Source: Chatham Financial, 2023.

Hence, the costs of borrowing became much higher than real estate investors were used to in comparison to the last 10 years. However, it is worth keeping in mind that the forward curve has often been a poor predictor of interest rate movements as the below hairy chart displays.

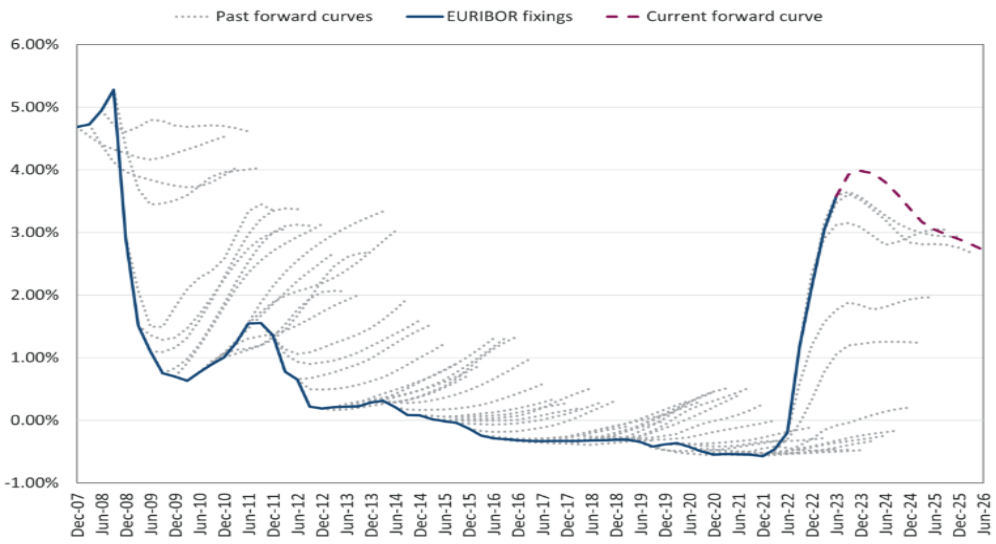


Figure 4: 3M EURIBOR vs historical forward curves. Source: Chatham Financial, 2023.

2.2 The use of derivatives in hedging commercial real estate financings

The intricate relationship between real estate and debt financing highlights the significance of interest rate risk within the real estate transactions domain. The primary objective when confronting interest rate risk is to strategically diminish its influence, ensuring that the deal's outcome is predominantly dictated by the property's performance rather than volatile interest rate shifts (De Rossi, 2022).

Historical

In the late 20th century, as global financial markets became more integrated and sophisticated, interest rate volatility began to pose significant risks to borrowers, including those in the commercial real estate sector. This led to the search for tools to mitigate such risks. The 1980s and 1990s saw a significant rise in the use of interest rate swaps. Commercial real estate borrowers started using swaps to convert their floating rate liabilities to fixed rates, providing them with payment certainty. With the unpredictable nature of interest rates, especially during periods of economic uncertainty, caps became a popular tool for borrowers to protect themselves against upward interest rate movements. By the late 1990s and early 2000s, zero-cost collars gained traction as they provided a balanced protection against both rising and falling interest rates without an upfront cost (Harkins et al., 2015).

Outlook

Over the past 12 years, ultra-loose monetary policy has meant that few real estate borrowers have worried about interest rate risk. However, with central banks raising rates to combat rising inflation, floating-rate debt costs have increased. This has caught many borrowers unawareness and has led to an increase in interest in hedging strategies. The premiums for interest rate caps, which many borrowers in the market use, have increased significantly between January 2022 and July 2022 (Cunningham & Cunningham, 2022). However, since February 2022 the 3M EURIBOR increased Month-over-Month (MoM) which led to a positive rate in July 2022 for the first time since 2015. Given the 3M EURIBOR continued a steady upward trend, this has led to a shift in the proportion of transactions now deploying swaps. Borrowers are being forced to give much more thought to their hedging strategies. Some are exploring other creative ways to hedge their debt, i.e. through more advanced derivatives. Across the European real estate market, banks have traditionally insisted borrowers hedge at least a large proportion of their debt. Now, lenders of all types are reported to be working with sponsors to help manage the increased cost of hedging. There is a strong possibility that real estate borrowers will need to get used to higher debt costs, including the greater financial burden of hedging, in years to come (Cunningham & Cunningham, 2022).

2.3 Subscription Line of Credit (SLOC)

Subscription lines of credit (SLOCs) are short-term loan facilities provided to private equity funds. These facilities allow funds to access capital quickly for investments, rather than waiting to call capital from their investors. SLOCs are typically secured by the uncalled capital commitments of the limited partners in the fund. Thus, a SLOC provides a fund with immediate liquidity by allowing it to borrow against the undrawn capital commitments of its limited partners (LPs). Rather than calling capital from the LPs every time a new investment is made, or expenses are incurred, the fund can draw down on its line of credit. Eventually, when certain conditions are met or a period has elapsed, the fund will call capital from its investors to repay the line of credit (Hillier et al., c. 2016).

In the context of real estate private equity, SLOCs are particularly relevant due to the nature of the real estate market. Real estate private equity funds often deal with time-sensitive investment opportunities. Therefore, real estate transactions often require quick access to capital to secure deals in a competitive market. SLOCs provide this liquidity, enabling funds to act swiftly on investment opportunities without needing to immediately call capital from investors (Hillier et al., c. 2016).

The use of SLOCs offers several benefits. Firstly, they can enhance liquidity and enable funds to act quickly on investment opportunities. Secondly, they can potentially increase the IRR as the delay in calling investor capital reduces the investment period, thereby boosting the IRR – as illustrated by Brad Case in a Nareit article[2]. For example, if a manager closes a forward commitment real estate development deal it can jack up the IRR by delaying initial cash flow while using the SLOC till delivery of the building. However, SLOCs also come with risks. The cost of interest and fees can be significant, and funds become dependent on the lender's willingness to extend credit. Additionally, there's a risk of increased exposure if the credit line is called at an unfavorable time, which could negatively impact the fund's performance. For instance, take forward funding real estate development deals, when a development goes bad and the investors want to abandon the deal and thus reject a capital call while the sponsor already made payments through the SLOC (Case & Nareit, 2018).
A study conducted by BlackRock in collaboration with Technical University of Munich (TUM) further delved into how subscription lines influence private equity fund performance (Cornel et al., 2019). This research examined the implications of various borrowing conditions on IRRs and multiples under multiple performance scenarios, spanning a wide array of vintage years. The findings indicate that subscription lines are more beneficial as an operational simplification tool (as managers can alleviate administrative loads) for both the fund manager and its investors than as a mechanism to enhance performance (Cornel et al., 2019).

[2] Brad Case, "IRR is an Easily Manipulated "Performance" Metric", Nareit, 2018.

In the commercial real estate industry, and especially within real estate private equity, the IRR is one of the most prevalent performance metrics (Phalippou, 2008).. Although there is debate regarding the relevance of this metrics which will become more apparent following the example below. The primary strength of the IRR lies in its capacity to equitably compare returns across different asset classes with the same holding periods. What's even more important, the IRR incorporates the concept of the time value of money, emphasizing that a euro received today holds more value than one received in the future, given its potential to be reinvested and generate interest. Hence, the IRR is dependent on the timing and magnitude of the free cash flow derived from a property. To illustrate, I calculate the IRR of a cash flow without employing a SLOC, and one where a SLOC is utilized:

Date	No Sloc	Slocked
01/01/2024	-10.000.000	-0
01/01/2025	1.000.000	-0
01/01/2026	1.000.000	-10.000.000
01/01/2027	1.000.000	1.000.000
01/01/2028	12.500.000	12.500.000
IRR	13,08%	16,92%

Figure 5: Influence of SLOC on IRR. Source: Author's own compilation.

As observed, the IRR performance metric is sensitive to the timing of cash flows. The Slocked cash flow exhibits a higher IRR with approx. 4 bps over the same holding period by merely tweaking the timing of the cash flow. The Slocked cash flow uses the SLOC in year 1 to purchase the asset, while calling the capital just two years after acquisition to repay SLOC. In the above-mentioned example, it is assumed that the income generated in the first two years is sufficient to cover the interest expenses incurred from the SLOC.

Within the realm of real estate private equity, the "waterfall" distribution framework is a prevalent method for allocating profits between joint venture (JV) partners and an integral component dictating the hierarchy of cash distributions to both investors and the sponsor. When structured correctly, ensuring aligned incentives, waterfalls can pave the way for the investment to realize exceptional success (Jiwa, 2019). Within this framework, both the sponsor, often termed the "general partner", and the investor group, known as the "limited partners", contribute initial equity capital. The subsequent property cash flows are then apportioned based on predetermined return benchmarks, primarily gauged using the IRR. These predetermined return benchmarks are an inherent incentive for the sponsor to optimize the IRR, as it can amplify their portion of the revenue stream. This unequal profit distribution mechanism enables the to grant the sponsor (or the active manager), a share of profits that may exceed their proportional equity contribution. This additional share or incentive payment is termed a "promote" (First National Realty Partners, 2022). To qualify for this promote, the investment's return must surpass certain established hurdle rates. JVs commonly set multiple hurdle rates, allowing the Sponsor to earn an increasingly larger promote as the investment's return escalates. The initial benchmark in this tiered system is known as the preferred return ("pref"). Until this rate is achieved, the profits from the investment are distributed in line with each partner's equity contribution (pari passu) (First National Realty Partners, 2022).

The waterfall distributions and hurdle rates of the case study are further outlined in the methodology section.

3 Instrument comparison

This section covers the selected derivatives, their pricing, and the underlying assumptions for these valuations. It also differentiates between traditional and advanced hedging strategies.

3.1 Hedging methods & pricings

To compare how different interest rate derivatives under a variety of (future) interest rate environments perform, I first determine which traditional and advanced derivatives to examine and what the ancillary prices of these derivatives are. As mentioned in the introduction section, there is no one-size fits all hedging strategy, thus hedging solutions are tailored made to specifics needs. Therefore, I make use of case study to make the comparison under specific conditions and requirements. These specific conditions of the investment firm as well as the key terms of the credit line are set out in the next section under sub-section Case study. Hence, the determination of the interest rate derivatives in this paper are based upon the case study. Additionally, the derivatives are priced (all derived on the same date from a Dutch commercial bank) based on the underlying loan notional and term structure. It is worth stating, this paper does not aim to elucidate the workings of interest rate derivatives. For a thorough explanation of the derivatives mentioned below, please refer to the appendix.

Traditional hedging strategies

The two traditional hedging in this paper compromise two plain vanilla derivates:

- A Mark-to-Market (MtM) Interest Rate Swap;
- Out-of-the-money (OtM) Interest Rate Cap.

Both hedging instruments are based upon a EUR 100m loan notional and a two year term from 1-1-2024 till 1-1-2026. As identified in the second section of this paper, these instruments have been selected as they are the commonly used by real estate borrowers. The investment firm decided to select a MtM interest rate swap and OtM interest rate cap as it reflects their typical approach to hedge interest rate risk. Some borrowers lean towards swaps where the premium is embedded into the all-in interest rate, whereas others prefer an interest rate cap and pay an upfront premium. Or, if the lending party permits, they maintain their debts with a variable rate (Harkins et al., 2015).

Below the contract rate of the two-year vanilla swap and the upfront premium of the interest rate cap with a € 100m loan notional:

- 3.4790% fixing rate for a 2-year interest rate swap; and an
- upfront premium of EUR 374,800.00 for a 2-year interest rate cap.

Advanced hedging strategies

After taken the (i) key assumptions of the investment firm into account, (ii) the simulation of the 3M EURIBOR (both described in the next section) and (iii) afterwards consolidating a financial consultancy, the following three more advanced hedging solutions are chosen by the investment firm:

- Interest Rate Swaption (European style, embedded receiver's swaption);
- Cancellable Swap (European style, embedded receiver's swaption);
- Geared Interest Rate Collar;

Also here, the hedging instruments are based upon a EUR 100m loan notional and two-year term from 1-1-2024. These interest rate derivatives occasionally occur within the real estate industry to hedge interest risk, mostly by sophisticated borrowers given their complex structure. The selection of these instruments is motivated to evaluate the effectiveness of different hedging instruments under different interest rate paths (as further outlined in the fifth section).

Below the pricing details of the different hedging strategies based on a two-year term and a loan notional of € 100m:

- Interest Rate Swaption: EUR 140,250.00 upfront premium with an option to swap on January 1, 2025 against a forward rate swap at 3.45%;
- Cancellable Swap: 3.8125% fixing rate with the option to terminate the swap on January 1, 2025;
- Geared Interest Rate Collar: net premium of EUR 79,800.00.

Note that the interest rate swaption and cancellable swap are both exercised on the exercise date (1-1-2025). Further explained in the findings section.

Pricings	IR Swap	IR Cap	IR Swaption	Cancel. Swap	Geared IR Collar
Fixed Swap Rate	3,4790%	-	3,450%	3,8125%	-
Upfront (Net) Premium	-	EUR 374.800	EUR 140.250	-	EUR 79.800

Figure 6: Derivative pricings. Source: Author's own compilation.

4 Methodology

This chapter provides a brief overview of the research methodology and delves deeper into the methods employed. Given the numerical characteristics of this study, quantitative methods – the Vasicek model, Monte Carlo simulation, and case study – are utilized for conducting the research.

4.1 Research approach and methods

This study employs an inductive research methodology, often referred to as a "bottom-up" approach. Unlike the deductive method, which starts with a theory and tests it through a hypothesis, the inductive method begins with observations and uses these to formulate a hypothesis (Jönköping University et al., 2017). This hypothesis is then explored, and general conclusions are drawn. The aim of this thesis is to draw broad conclusions on the effectiveness of different hedging strategies, particularly when using subscription lines of credit by real estate private equity investors (Jönköping University et al., 2017). Given this objective, the inductive approach is the most suitable as it allows for the examination of real-world observations and the development of conclusions based on these observations (Jönköping University et al., 2017).

Since the performance of the derivatives on the credit line depends on the evolution of the future reference rate, future interest rate paths are forecasted. By simulating the future reference rate (forward curve), I use the Monte Carlo simulation to simulate 10,000 interest rate paths. To ensure the reference rate simulation embodies real world characteristics, an interest rate model must integrate statistical characteristics. Therefore, I use the Vasicek model which incorporates these characteristics. The Vasicek model is then discretized by the Euler model to convert the model into discrete-time versions to practically facilitate the Monte Carlo simulation in Excel. Under various forward curve scenarios, the reference rate is used to measure the performance of a variety of interest rate hedging strategies. Subsequent sub-sections offer more in-depth insights about the use of the Vasicek model and Monte Carlo simulation in this study. Last, the case study is further narrowed down including key terms and conditions which are necessary to take into this analysis. The forward curve, simulated at a quarterly frequency, is utilized in Excel to calculate the cost of debt for each derivative. The cost of debt is integrated in the projected cash flow and then aids in determining the free cash flow and its corresponding performance indicators.

4.2 Vasicek model

Interest rate models must integrate the statistical characteristics inherent in the movements of interest rates. These characteristics include (1) drift (the tendency to drift or trend in a particular direction), (2) volatility (degree of variation in the rate changes), and (3) mean-reversion (which is the propensity of the rates to return to their long-term average). These key elements accurately reflect real-world interest rate dynamics (Jönköping University et al., 2017). Mean reversion describes the tendency of interest rates to revert to a long-term average, with low rates increasing due to stimulated capital demand, and high rates decreasing as they slow economic activity and reduce capital demand. The drift in these models signifies the speed of this reversion, with a larger drift indicating a faster return to the mean. Given the inherent randomness in real-world interest rate movements, a volatility component is also included, typically through a normal or chi-square distribution (Hull, 2017).

The common practice in interest-rate modeling is to assume that short-term rates follow a certain statistical process, with other rates in the term structure tied to these short-term rates. This is called a one-factor model, where the short-term interest rate is the only factor driving rates across all other maturities. Once the short rate is determined, I can establish the rates for all other maturities using arbitrage arguments. There are multi-factor models, like two-factor models that include a long-term rate as the second factor, but they're not as widely used because they're more complex. The high correlation between rate changes for different maturities gives some weight to the use of a one-factor model. There's also empirical evidence showing that a shift in interest rates accounts for most changes in the yield curve (Harkins et al., 2015). Given all this, and considering that the goal of this thesis is not to model the 3M EURIBOR as accurately as possible but to study the effectiveness of hedging strategies, I've decided to focus on one-factor models, specifically the short-term interest rate model. This way, I can avoid the difficulties of determining which "lags" are important, which would be necessary with more complex models like generalized autoregressive conditional heteroskedasticity (GARCH) model and autoregressive integrated moving average (ARIMA) model.

The Vasicek model is a mathematical framework that outlines the evolution of interest rates. As a one-factor short-rate model, it represents interest rate movements as being influenced by a single source of market risk. The Vasicek model, introduced in 1977, incorporates mean reversion, a feature that pulls future rates back towards their long-term average. This is particularly important in an inflationary environment where interest rates may be high, as it influences the interest rates on subscription lines of credit. The mean-reverting nature of the Vasicek model will pull future rates back towards the long-term average (Hull, 2017).

The Vasicek model is chosen for this thesis over other traditional interest rate models such as the Cox-Ingersoll-Ross (CIR) and Hull-White models for several reasons. Unlike the Hull-White model, the Vasicek model does not dismiss the occurrence of negative interest rates, a market phenomenon observed between 2015-2017 and 2019-2022. Excluding them could bias the results. Furthermore, the Vasicek model avoids the use of a time-dependent deterministic function, which is unnecessary for interest rate simulation and is a feature of the Hull-White model. Therefore, due to its mean reversion characteristic, allowance for negative interest rates, and avoidance of the time-dependent deterministic function, the Vasicek model provides a more streamlined and efficient approach for this analysis.

The Vasicek model is defined by the stochastic differential equation:

$$dr_t = a(b - r_t)\,dt + \sigma\,dW_t \qquad (1)$$

Where: *a: speed of reversion*

b: long term mean level

r: short-rate

σ: volatility

W_t: Wiener process, representing random market risk (continuous-time stochastic process)

where r is the short rate, and a, b, and σ are constants that define the model (Hull, 2017). These are determined by calibrating to market data, i.e. historical 3M EURIBOR. The model's capacity to incorporate mean reversion is particularly pertinent. Mean reversion signifies a process where interest rates gravitate towards a long-term average. This is significant when considering the use of subscription lines of credit, as the interest rates on these lines of credit will be influenced by these future interest rate movements. The model's allowance for negative interest rates is also relevant, providing a more robust evaluation of the hedging strategies under consideration (Jönköping University et al., 2017).

First, I calculate the change between successive interest rates (delta);

$$[r(t+1) - r(t)] \quad (2)$$

Next, I calculate the delta mean reversion which represent the tendency of the interest rate to revert to its long-term mean;

$$[k(\theta - r(t))] \quad (3)$$

Subsequently I predict the change in rates by subtracting the mean reversion term from the difference in rates computed in step 1;

$$[r(t+1) - r(t) - k(\theta - r(t))] \quad (4)$$

As the Vasicek model assumes that rate changes are normally distributed with a mean given by the mean reversion term and a variance, I calculate the Probability Density Function (pdf) for changes in rates. Afterwards I compute the natural logarithm of each pdf value. By aggregating all the logarithmic values, I obtain my log-likelihood, which I aim to maximize. Using Excel's Solver add-in, I adjust the parameters k, θ and σ to maximize this sum.

Euler model

To perform Monte Carlo simulations, the continuous-time stochastic Vasicek model needs to be converted into discrete-time versions. This conversion is known as "discretization." To discretize the model, one commonly used method is the Euler model.

$$r_{t+1} = r_t + a(b - r_t) + \sigma Z \quad (5)$$

Where: r_{t+1}*: forecasted rate for the next month*

r_t*: rate of the current month*

a: speed of mean reversion

b: long-term mean level

σ*: volatility*

Z: standard normal random variable (generated in Excel using the formula NORM.INV(RAND(), 0, 1)

First, I calculate the mean conversion component which captures the tendency of the interest rate to revert towards its long-term mean ($a(b - r_t)$) with the long term mean and mean reversion speed derived from the Vasicek model. Second, I compute the stochastic component of the Euler model by introducing randomness into the model (σZ), reflecting the inherent uncertainty in interest rate movements (van Haastrecht & Pelsser, 2008).

4.3 Monte Carlo simulation

The Monte Carlo, named after the famous casino in Monaco, simulation can be thought of as a computational method that depends on continuous random sampling to obtain numerical data. It involves simulating a physical process (in this case, the evolution of interest rates and investment values) many times over. The result is a probability distribution of possible outcomes, which can be studied and used to inform decision-making processes (Naber & de Kroon, z.d.). The fundamental idea is to employ random elements to tackle issues that are, in essence, deterministic. It's like conducting a series of "what-if" scenarios to understand what could happen in the future, given the randomness and uncertainties of the present (Naber & de Kroon, z.d.).

In the context of this paper, the Monte Carlo simulation is the tool used to model the behavior of interest rates over time, which is crucial for assessing the effectiveness of different hedging strategies. It allows to generate a wide range of possible future interest rate scenarios based on the Vasicek model, which incorporates key features of interest rate behavior such as mean reversion and volatility. By simulating 10,000 of potential future interest rates paths, a broad spectrum of possible outcomes and their associated probabilities are captured (Jönköping University et al., 2017). This is particularly useful when evaluating the performance of different hedging strategies.

4.4 Case study

A globally recognized investment management firm, who like to remain anonymous, is launching a new European real estate fund. The investment strategy of the new fund entails direct value-add real estate transactions among different asset classes and jurisdictions within Europe. Fundraising phase has been successfully completed, capital commitments from a selective group of LPs are secured. The European transaction management team has already built up a pipeline with EUR 100m real estate deals that fits the investment profile of the fund. One of the final steps is securing a SLOC for the fund, for the purpose of having instant access to liquidity and boosting the IRR of the target. The investment firm is seeking to obtain EUR 100m debt for a term of 2-years. Currently, they have obtained some term sheets from investment banks to facilitate this credit line. The competing banks are Goldman Sachs, Wells Fargo, Deutsche Bank and RBC. The archetype real estate finance transaction entails a (bankruptcy remote) special purpose vehicle (SPV), which in this case will also be the borrower. The LPs provide 90% of the equity and the investment firm acting as General Partner of the JV provides 10% of the equity. The investment firm has provided Net Operating Income (NOI) projections, along with key target performance metrics and financial terms and conditions from the term sheets they have received (e.g. margin, duration) from commercial and investment banks.

The key terms and conditions of the credit line are set out below:

- Start date and immediate drawdown in full is set at 1/1/2024;
- Loan amount of EUR 100 million;
- Maturity date is set at 1/1/2026 (i.e., 2-year term);
- Margin of 210 bps + 3M EURIBOR;
- Hedging not required;
- Bullet structure (no amortization);
- Commitment fee of 50 bps on the undraw amount;
- No prepayment penalties applicable on the margin.

Key conditions of the investment firm are:

- During the credit line's tenure, the underlying real estate will not be sold;
- Preferably keeping the window open for early prepayment;
- After drawdown of the credit line, no active hedging management needs to be required till maturity.

As discussed in the SLOC section, sponsors are often entitled to a promote. In this specific JV, a four-tier model promote structure is embedded in the Limited Partnership Agreement to incentive the sponsor for the purpose of optimizing returns:

1. Hurdle 1: Pari Passu until a 12% IRR, following a 10% GP split;
2. Hurdle 2: 15% Promote up to 15% IRR, following a 23,5% GP split;
3. Hurdle 3: 20% Promote up to 18% IRR, following a 28,0% GP split;
4. Hurdle 4: 25% Promote up to 20% IRR, following a 32,5% GP split;

I prepared a cash flow waterfall distribution based on the above-mentioned promote framework for assessing the hedging strategy's influence on the promote structure (if any). It is crucial to understand the promote structure of the sponsor in this case, as a specific hedging strategy may not equally serve the interests of both the sponsor and the LPs. The sponsor might lean towards a hedging strategy with a more left-skewed IRR distribution, even if it results in higher borrowing costs. This preference arises because a left-skewed distribution, despite its associated risks, can lead to scenarios where the IRR exceeds certain thresholds in the promote structure more quickly. Perhaps it can trigger the sponsor's promote tiers earlier, maximizing their returns even if it's not the optimal strategy for the overall partnership. The assessment and evaluation of the hedging influence on the IRR is further described in the next section.

5 Empirical findings

This chapter presents the outcome of the Vasicek model and Monte Carlo simulations. Based on this outcome, the approach on the data analysis by shaping scenario's to describe the results of both traditional and more advanced derivatives based on the case study are covered in detail.

5.1 3M EURIBOR simulation

Through the implementation of the Vasicek model, the following unconditional parameters are found based on the historical 3M Euribor (MoM) timeframe from 1974 till mid-2023:

- Long-term mean (b): 1.0784%;
- Mean-reverting speed (a): 0.8702%; and
- Volatility (σ): 0.1623%.

In summary, the historical 3M EURIBOR, as described by the Vasicek model, tends to revert to a level of 1.0784% relatively quickly when it deviates from this mean, and it does so with a modest level of volatility. As the current rate is higher than the long-term mean, it is expected that the reference rate will fall over the long run.

Incorporating the parameters of the Vasicek model and then discretizing it through the Euler model, I conduct 10,000 simulations via the Monte Carlo approach. The average, 95th percentile potential, 25% VaR and 5% VaR of the simulated interest rate on each Interest Payment Date (IPD) of the credit line are displayed in the figure below.

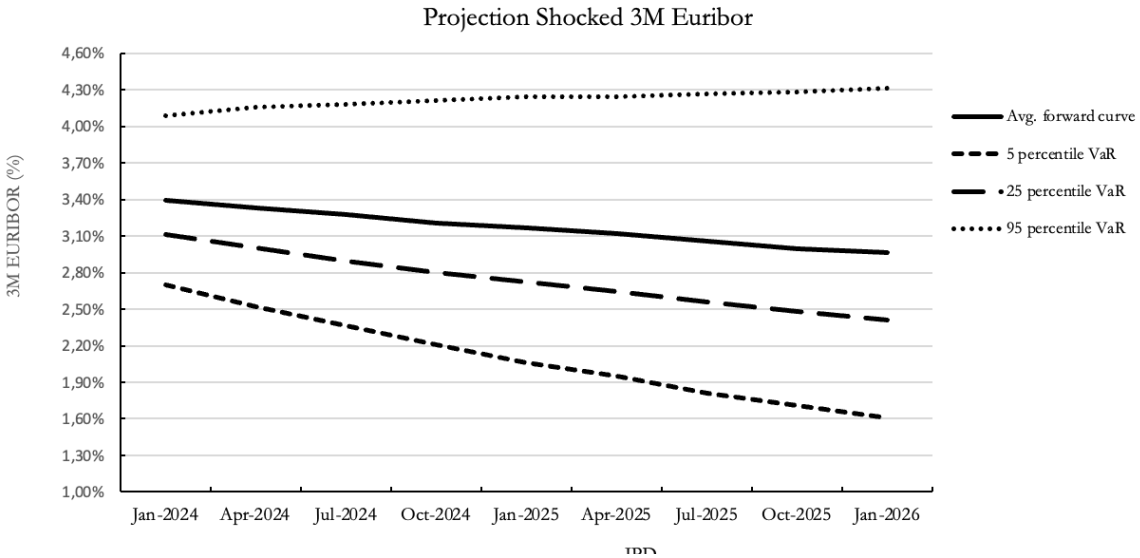


Figure 7: Projection 3M Euribor on each IPD. Source: Author's own compilation.

Turbulent rate dynamics

I choose to refine the Vasicek-Monte Carlo model by specifically focusing on the turbulent period that we are in when writing this paper. After a decade, since year 2022 the reference rate became positive again, marked by significant volatility and unpredictability in global interest rates. Rather than employing the historical 3M Euribor data from the 1994-2023 timeframe, I revise the model using solely the data from the period when the reference first became positive again. Respectively, I choose to use the historical 3M Euribor (MoM) from July 2022 till September 2023. This choice is deliberate. By focusing solely on this core period, I aim to understand how the Vasicek-Monte Carlo simulations, performs under 'extreme' market conditions. This approach offers insights that might be overlooked in a more comprehensive, long-term data set. The rationale behind this, I want to capture the buildup and the peak to understand the interest rate dynamics during this period.

In this regard, I made a second Vasicek model – based upon the historical 3M EURIBOR (MoM) from period July 2022 till September 2023 – which resulted in the following unconditional parameters:

- Long-term mean (b): 5.018213437%;
- Mean-reverting speed (a): 10.09316392%; and
- Volatility (σ): 0.061774534%.

Compared to the first Vasicek model, the second Vasicek model predicts a higher long-term mean interest rate. Despite this higher mean, it reverts to its long-term mean very rapidly and has a lower volatility than the first model.

The Euler model and subsequently Monte-Carlo approach is used to determine the average forward curve on each IPD of the credit line. This forward curve is displayed in the below figure.

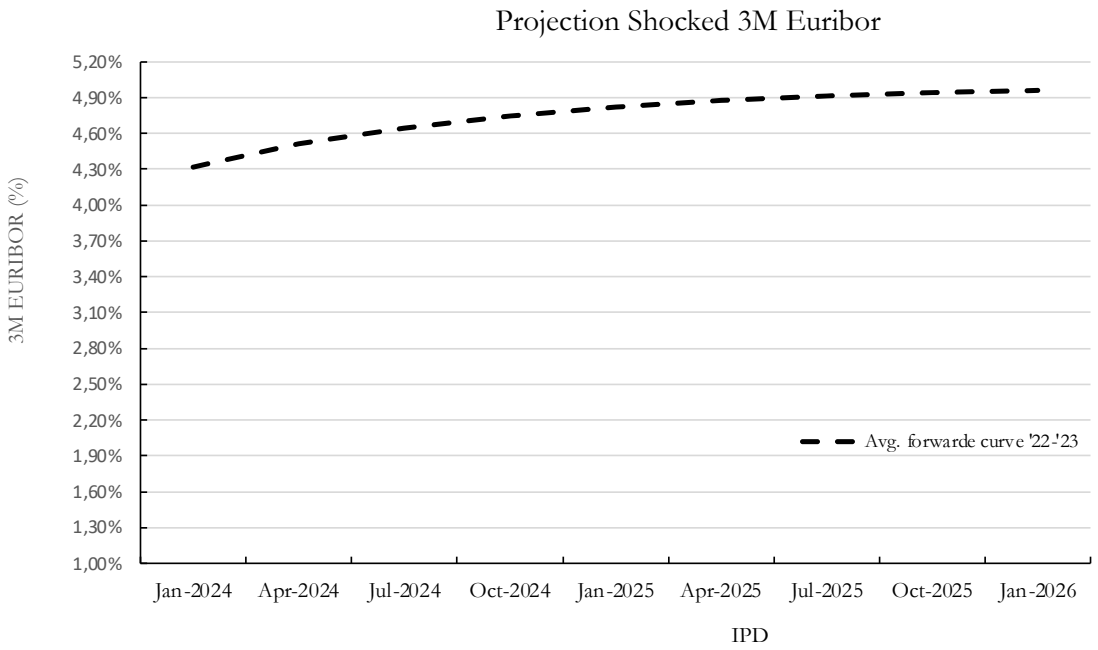


Figure 8: Projection 3M Euribor on each IPD. Source: Author's own compilation.

5.2 Interest rate scenarios

Based on the above forward curves, I group these into three distinct categories based on the interest rate environments they represent. Specifically:

- Scenario A – downward interest rate curve

  The average forward curve, 5% VaR, and 25% VaR based on the historical data from 1997 to mid-2023 exhibit a declining interest rate environment.

- Scenario B – flat interest rate curve

  The 95th percentile based on the historical data from 1997 to mid-2023, is indicative of a flat interest rate environment.

- Scenario C – upward interest rate curve

  The average forward curve based on the turbulent period from 2022 to mid-2023 is associated with a rising interest rate environment.

These three interest rate categories should be keep in mind when reviewing the next results and conclusion section. In his book "Options, Futures and Derivatives," John Hull highlights the advantages of 'exotic' interest rate derivatives, especially in volatile or uncertain market scenarios. These strategies can be customized according to unique market conditions, providing considerable flexibility. The different interest rate scenario's presents a valuable chance to examine and employ specific recommended 'exotic' derivatives as the choice between the different hedging strategies is based on the risk appetite and market forecasts of the investment firm (sponsor).

5.3 Void of credit line

To justify the use of a credit line, the projected IRR – with a credit line embedded in the projected cash flow – should consistently outperform across all scenarios as mentioned in the previous sub-section, regardless of the chosen derivative. And in addition, preferably the projected IRR should trigger a higher tier within the four-tier promote model for the sponsor to earn a higher promote. As mentioned in the previous section, cash flow is distributed pari passu until a preferred return of 12% IRR is achieved. After which the second tier at 15% IRR hurdle triggers the first promote.

In case of no credit line in place (i.e., no debt service incurred in the projected cash flow), the projected IRR (5-yr term) pre-promote of the fund amounts to 12,2%. In such case, the sponsor is entitled to a promote of EUR 450k which boosts the GP's IRR with merely 4 bps towards 12,8%.

5.4 Traditional hedging strategies

The traditional hedging methods evaluated are the interest rate swap and interest rate cap. Besides these, keeping the rate floating is also considered a traditional strategy used among real estate investors (if allowed by the lender, such as it is in this case) and thus shown here. The figure below exhibits first the IRR and second the cost of debt (5-yr avg.) of each derivative in the three defined interest rate scenarios.

	Scenario A			Scenario B	Scenario C
	Avg. forward curve	5 percentile VaR	25 percentile VaR	95 percentile VaR	Avg. forwarde curve '22-'23
Floating	18,74%, 5,32%	20,00%, 4,19%	19,24%, 4,86%	17,56%, 6,43%	16,97%, 7,01%
Cap	18,52%, 5,51%	19,76%, 4,38%	19,01%, 5,05%	17,56%, 6,43%	17,59%, 6,38%
Swap	18,37%, 5,66%	18,37%, 5,66%	18,37%, 5,66%	18,37%, 5,66%	18,37%, 5,66%

Figure 9: IRR (5-yr) & avg. Cost of Debt (5-yr). Source: Author's own compilation.

1. The **average forward curve** shows the IRR based on the cost of debt, which is derived from the average forward curve generated by the Vasicek-Monte Carlo model using historical 3M EURIBOR data from 1994 to mid-2023.
2. The **5% VaR forward curve** provides a perspective from the riskier end of the spectrum. The IRR is calculated based on the cost of debt tied to the 5% VaR and also relies on the Vasicek-Monte Carlo model and the historical 3M EURIBOR data;

3. In the **25% VaR forward curve**, the focus shifts to the implications of the 25% Value at Risk (VaR). The IRR here is derived from the associated cost of debt, as determined by the Vasicek-Monte Carlo model using the aforementioned 3M EURIBOR data.
4. The **95% VaR forward curve** delves deeper into potential outcomes by computing the IRR using the cost of debt based on the 95th percentile (95% confidence interval) generated by the Vasicek-Monte Carlo model using historical 3M EURIBOR data from 1994 to mid-2023. This ensures that the results are not unduly influenced by outlier predictions/extreme values, providing a more stable and reliable measure of the performance.

Scenario A – downward interest rate scenario

In this downward interest rate scenario, keeping the reference rate floating (unhedged) generally offer the highest IRR and the lowest average cost of debt. The cap remains Out-of-the-Money as well as the plain vanilla swap due to fact that the fixed swap rate and cap strike rate is above the projected forward rates for the duration of the derivative and credit line. Should the forward rates never exceed one of the two thresholds, both strategies incur a loss.

As a consequence, leaving the rate floating delivers the best GP IRR and thus the best promote in favor of the sponsor. Both hedging instruments as well as keeping the rate floating hits in every scenario at least the third tier promote. Yet, the difference in promote is significant (at least EUR 100k and up to ~ EUR 1m). If the interest rate plunges (as in the 5% VaR & 25% VaR), an unhedged rate even hits the fourth tier within the four-tier promote structure.

Scenario B – flat interest rate scenario

In a flat interest rate curve, the interest rate swap offers the highest IRR. The swap is from start In-the-Money since the swap strike rate is above the shocked 3M EUIRBOR at each IPD. The fund's performance when utilizing an interest rate cap or keeping the reference rate floating exhibits minimal variance. The interest rate cap holds positive value as the cap's strike rate is below the shocked Euribor on each IPD. Nevertheless, the deviation between the shocked Euribor and cap strike rate is limited. And since an interest rate cap comes with an upfront premium, in this case it delivers a similar result when keeping the rate floating.

In this scenario, the difference in promote is significant; in comparison to an unhedged rate or opting for an interest rate cap, the interest rate swap delivers over EUR 450k more in promote for the GP – resulting in a 2% higher GP IRR.

Scenario C – upward interest rate scenario

In the upward interest rate scenario, both hedging instruments hold positive values as the cap strike rate and fixed swap rate from start is well below the shocked Euribor on each IPD. The interest rate swap offers the best IRR, given the fixed swap strike rate is 60 bps lower than the cap's strike rate. Additionally, the cap comes with an upfront premium, and given both derivatives stay ItM during the life of the credit line, the cap undertakes a higher debt service. However, the interest cap still performs better than keeping the rate floating, and leaves the window open for prepaying the credit line without breakage costs (unlike the interest rate swap).

Keeping the reference rate floating underperforms and has significant negative effect on the GP's promote by over EUR 800k in comparison to the swap. If an interest rate cap is chosen over a swap, the sponsor loses over EUR 400k in promote.

The below figure shows first the GP promote and second the GP's IRR (5-yr avg.).

	Scenario A			Scenario B	Scenario C
	Avg. forward curve	5 percentile VaR	25 percentile VaR	95 percentile VaR	Avg. forwarde curve '22-'23
Floating	€ 3,700M, 28%	€ 4,515M, 31%	€ 3,984M, 29%	€ 3,021M, 25%	€ 2,673M, 24%
Cap	€ 3,578M, 27%	€ 4,355M, 31%	€ 3,856M, 29%	€ 3,046M, 25%	€ 3,046M, 25%
Swap	€ 3,492M, 27%	€ 3,492M, 27%	€ 3,492M, 27%	€ 3,492M, 27%	€ 3,492M, 27%

Figure 10: GP Promote & GP IRR (5-yr). Source: Author's own compilation.

5.5 Advanced hedging strategies

The advanced hedging methods evaluated are the interest rate swaption, cancellable interest rate swap and a geared interest rate collar. Given the fact that the sponsor prefers no active hedging management, it is worth stating that, both the swaption and cancellable swap are exercised on the exercise date (i.e., 1-1-2025).

	Scenario A			Scenario B	Scenario C
	Avg. forward curve	5 percentile VaR	25 percentile VaR	95 percentile VaR	Avg. forwarde curve '22-'23
Swaption	18,45%, 5,60%	19,03%, 5,11%	18,68%, 5,40%	17,88%, 6,09%	17,60%, 6,33%
Cancel. Swap	18,40%, 5,61%	19,04%, 4,97%	18,66%, 5,35%	17,78%, 6,24%	17,46%, 6,57%
Geared Collar	18,69%, 5,36%	19,70%, 4,47%	19,19%, 4,90%	17,76%, 6,23%	17,76%, 6,23%

Figure 11: IRR (5-yr) & avg. Cost of Debt (5-yr). Source: Author's own compilation.

Scenario A – downward interest rate scenario

As the above figure shows, the geared interest rate collar performs best in a downward interest rate scenario. It is worth stating that during the second year of the credit line in the 5% VaR forward curve, the geared interest collar transitions into a liability as the shocked Euribor drops beneath the intermediate floor of 2%. However, the shocked Euribor reaches its lowest of 1,61% at maturity of the credit line and thus limits the impact of the geared collar as the relatively low net upfront premium compensates for this deviation. The cancellable swap is not effective in this scenario as in the first year the fixed swap rate surpasses the shocked Euribor and the subsequent cancellation of the swap rate can't compensate for the losses incurred in year 1. Conversely, the interest rate swaption mirrors the opposite behavior of the cancellable swap. However, in this case, both hedging strategies exhibit comparable performances.

As figure 12 illustrates, there are no major deviations in the promote between the derivatives.

Scenario B – flat interest rate scenario

The interest rate swaption delivers best in a relatively flat interest rate environment. It is worth stating that in this scenario the interest rate swaption is already in-the-money at start (3.45% fixed swap rate versus 4.09% first IPD shocked Euribor). This also the case with cancellable swap. However, as it expires during midway of credit line's tenure, the shocked Euribor surpasses the fixed swap rate, resulting in a higher cost of debt followed by a reduced IRR. Additionally, the geared collar is at start also in-the-money and performs similar to the cancellable swap. In this scenario, there are no major deviations in the promote across these three derivatives.

Scenario C – upward interest rate scenario

The geared interest rate collar does best in the rising interest rate climate. Meaning that the derivative is well structured, the high cap strike rate at 4% becomes effective immediately in this scenario. Thanks to the diminished net upfront premium, the hedging costs and consequently the cost of debt is more favorable than with other derivatives. Given the cancellable interest rate swap is cancelled midway through the term of the credit line (i.e., 1-1-2025) and the subsequent shocked 3M Euribor on each IPD post cancellation surpasses the fixed swap rate, the cost of debt increases during the second year of the credit line. On the other hand, the interest rate swaption recovers its performance during the second year of the credit line as it incurs significant losses in the first year by keeping the reference rate unhedged.

	Scenario A			Scenario B	Scenario C
	Avg. forward curve	5 percentile VaR	25 percentile VaR	95 percentile VaR	Avg. forwarde curve '22-'23
Swaption	€ 3,533M, 27%	€ 3,849M, 29%	€ 3,661M, 28%	€ 3,217M, 26%	€ 3,217M, 26%
Cancel. Swap	€ 3,512M, 27%	€ 3,882M, 29%	€ 3,662M, 28%	€ 3,149M, 26%	€ 2,960M, 25%
Geared Collar	€ 3,573M, 27%	€ 4,111M, 30%	€ 3,775M, 28%	€ 3,158M, 26%	€ 3,158M, 26%

Figure 12: GP Promote & GP IRR (5-yr). Source: Author's own compilation.

6 Conclusion

The last section presents the response to the primary question posed. Including recommendations to the company in question, derived from the empirical findings and their subsequent analysis. To wrap up this master thesis, potential further research and a brief reflection are covered shortly.

6.1 Opening statements

Referring back to the Theory and data section, it was already implied that real estate private equity investors utilize a credit line to boost IRR. In case of no credit line, the IRR of the projected cash flow amounts to 12.8%. Meaning that, across all interest rate scenarios, irrespective of the derivative employed, the performance of the IRR is superior when utilizing a credit line as opposed to the scenario where a credit line is not employed. Consequently, the use of the credit line results in a significant higher promote in favor of the investment firm. It is evident that, in this case, a credit line is a strategic compelling financial tool for the sponsor.

When comparing the two categories of hedging strategies directly. Traditional strategies are characterized by their straightforward and intuitive approach, providing consistent performance across various forward curve scenarios. They offer stability and are often preferred for their predictability, especially in extreme interest rate environments (Hull, 2017). Advanced strategies, while more complex, provide a broader range of tools to navigate intricate rate scenarios. They can be tailored to specific market conditions and offer flexibility, particularly beneficial in uncertain or volatile rate contexts (Hull, 2017). For sponsors, the choice between these strategies should hinge on a combination of their risk appetite and market forecasts. The key lies in balancing predictability and adaptability to navigate the complexities of the interest rate landscape (Hull, 2017). One of the mean reasons to include different interest rate scenarios.

6.2 Recommendation

Across the three distinct interest rate forward curve scenarios examined – downward, flat and upward – both traditional and advanced strategies give the following conclusion.

When the investment firm is convinced of a downward interest rate scenario, the geared interest rate collar offers superior IRR and promote. The geared collar's structure could yet be honed to reduce upfront costs, enhancing its appeal. Notably, a floating rate, while advantageous for its prepayment flexibility, demands active management—a proviso for the investment firm in question aiming to minimize hands-on involvement.

When the investment firm is convinced of a flat interest rate scenario, the traditional interest rate swap does best, providing the highest IRR and promote in favor of the investment firm. The geared interest rate collar should be considered when still including early prepayment options. If the investment firm prioritizes the ability to prepay the credit line without incurring breakage costs, the geared interest rate collar does best and allows full flexibility for early prepayment without active hedge management.

When the investment firm is convinced of an upward interest rate scenario, the traditional interest rate swap again delivers premier results, providing the highest IRR and promote in favor of the investment firm. Given the investment firm prioritizes the ability to prepay the credit line without incurring breakage costs, the geared interest rate collar is the preferred derivative in this scenario as it allows full flexibility for early prepayment (i.e., no breakage costs and no active hedge management applicable).

As indicated in the above recommendation, the qualitative reasoning (such as early prepayment or no proactive hedge management) determines the preferred derivative. This means that the chosen derivative may not necessarily be the most profitable option. Unless the qualitative reasoning demonstrates a contradiction, although this aspect is not covered.

6.3 Further research

As discussed in this thesis, interest rate hedging does not follow a uniform approach; therefore, this study focuses on a specific case, for which tailored assumptions are made to suit the unique aspects of the scenario. Due to the bespoke nature of each case in interest rate hedging, the conclusions drawn from this study regarding the hedging of a SLOC cannot be universally applied to all scenarios. Nevertheless, the methodological approach used could potentially be amended and used in the analysis of interest rate hedging strategies. Secondly, given the current market volatility in derivative rates, this research must be conducted swiftly. Recommendations derived from the analysis may become outdated quickly, necessitating a re-evaluation of the hedge on the actual day it is intended to be executed. Thirdly, especially for the company in question, it is assumed that there will be no refinancing options at maturity, and the remaining hold period (of three years) will be entirely funded through equity. The refinancing at maturity of the credit line could potentially yield higher returns and is worth investigating. Lastly, to challenge my intellectual, further research into the debt instrument that is hedged can offer higher returns. The finance sector offers a variety of loan optimalization on the SLOC, like PIK payments or a balloon structure, that could potentially yield higher returns, along with the many more available exotic derivatives for examination.

References

Bank for International Settlements. (2023, 24 augustus). *OTC, interest rate derivatives: Interest rate derivatives*. BIS. Geraadpleegd op 29 augustus 2023, van https://stats.bis.org/statx/srs/table/d7?f=pdf

Bowie, J., [Jackie Bowie] & Chatham Financial. (2023, 22 juni). *ECB holds course but BOE in trouble*. Chatham Financial. Geraadpleegd op 7 oktober 2023, van https://www.chathamfinancial.com/insights/boe-ecb-recap-june-2023

Case, B. & Nareit. (2018, 9 mei). *IRR is an easily manipulated "Performance" metric*. Nareit. Geraadpleegd op 19 augustus 2023, van https://www.reit.com/news/blog/market-commentary/irr-is-an-easily-manipulated-performance-metric

Cornel, J., Modell, J. F., Schillinger, P., & Braun, R. (2019, augustus). *Subscription lines and private equity- institutional | BlackRock*. BlackRock. https://www.blackrock.com/institutions/en-us/insights/investment-actions/impact-of-subscription-lines

Cunningham, D., & Cunningham, D. (2022). We need to talk about hedging. *Real Estate Capital Europe*. https://www.recapitalnews.com/we-need-to-talk-about-hedging/#blaize-register-form

De Rossi, G. (2022). Interest rate hedging in commercial real estate. *Leveraged Breakdowns*. https://www.leveragedbreakdowns.com/2022/04/11/interest-rate-hedging-in-commercial-real-estate/

European Central Bank. (2023, 26 juni). *Euro Area yield curves*. https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html

European Central Bank [ECB]. (2023, 15 juni). *Monetary policy decisions*. European Central Bank. Geraadpleegd op 7 oktober 2023, van https://www.ecb.europa.eu/press/pr/date/2023/html/ecb.mp230615~d34cddb4c6.en.html#:~:text=Key%20ECB%20interest%20rates,-The%20Governing%20Council&text=Accordingly%2C%20the%20interest%20rate%20on,effect%20from%2021%20June%202023.

Financial, C. (2023, 13 juli). *The Hairy Chart: Historical accuracy of LIBOR forward curves*. Chatham Financial. https://www.chathamfinancial.com/insights/libor-forward-curves-historical-accuracy

First National Realty Partners. (2022). How an investment’s internal Rate of Return (IRR) can be manipulated. *First National Realty Partners*. https://fnrpusa.com/blog/how-an-investments-internal-rate-of-return-irr-can-be-manipulated/

Geltner, D., Miller, N., Clayton, J., & Eichholtz, P. (2013). *Commercial Real Estate: Analysis and Investments* (Third Edition). Mbition.

Harkins, I., Rathbone, J., & Phelan, B. (2015, januari). *A Review of Interest Rate Hedging in Real Estate*. Geraadpleegd op 25 juli 2023, van https://www.ipf.org.uk/static/uploaded/bfb61d45-98ed-42b6-8e7a333d502fb282.pdf

Hillier, D., Ross, S., Westerfield, R., Jaffe, J., & Jordan, B. (c. 2016). *Corporate Finance: Vol. 3rd European Edition*. McGraw-Hill Education.

Hull, J. C. (2017). *Options, Futures, and Other Derivatives: Vol. Global Edition* (9de editie). Pearson.

Jiwa, A. (2019). Complex but integral: An overview of real estate waterfalls. *Toptal Finance Blog*. https://www.toptal.com/finance/real-estate/real-estate-waterfalls

Jones Lang LaSalle. (2019). *Real Estate Hedging Strategies*. JLL. Geraadpleegd op 28 augustus 2023, van https://www.jll.co.uk/content/dam/jll-com/documents/pdf/research/real-estate-finance-hedging-strategies-report.pdf

Jönköping University, Bock, F. K., [Felix Kristopher Bock], & van de Wiel, W. M. G., [Wimjan Maria Gerard van de Wiel]. (2017, mei). *Real Estate Financing and Interest Rate Hedging: A quantitative real estate investment case study*. Jönköping University. Geraadpleegd op 19 augustus 2023, van http://www.diva-portal.org/smash/get/diva2:1111379/FULLTEXT01.pdf

Kazemi, H. (2020, 29 september). *Subscription Line of Credit: Benefits, risks, and distortions*. Portfolio for the Future | CAIA. https://caia.org/blog/2020/09/29/subscription-line-of-credit-benefits-risks-and-distortions

Naber, R. M. A. M., & de Kroon, J. J. C. (z.d.). *Risico en onzekerheid - ALM studies en verder*. Amsterdam School of Real Estate. https://asrestudenten.nl/pluginfile.php/101961/mod_label/intro/Syllabus_Naber_De_Kroon_Risico%20%20onzekerheid_ALM_studies_en_verder.pdf

Özgürel, B. (2014). Monte Carlo Simulation for Vasicek interest rate model parameters. *ResearchGate*. https://www.researchgate.net/publication/275823417_Monte_Carlo_Simulation_for_Vasicek_Interest_Rate_Model_Parameters

Phalippou, L. & University of Oxford - Said Business School. (2008). The hazards of using IRR to measure performance: the case of private equity. *Social Science Research Network*. https://doi.org/10.2139/ssrn.1111796

Real Estate Finance Hedging Strategies. (z.d.). JLL. https://www.jll.co.uk/content/dam/jll-com/documents/pdf/research/real-estate-finance-hedging-strategies-report.pdf

Ritchie, G., & McCormick, L. C. (2023, 25 juli). Is the Yield Curve Inverted? What It Means for Recession Forecasts. *Bloomberg.com*. https://www.bloomberg.com/news/articles/2023-07-25/is-the-yield-curve-inverted-what-it-means-for-recession-forecasts

Robson, C., & McCartan, K. (z.d.). *Real World Research* (Fourth Edition). Wiley.

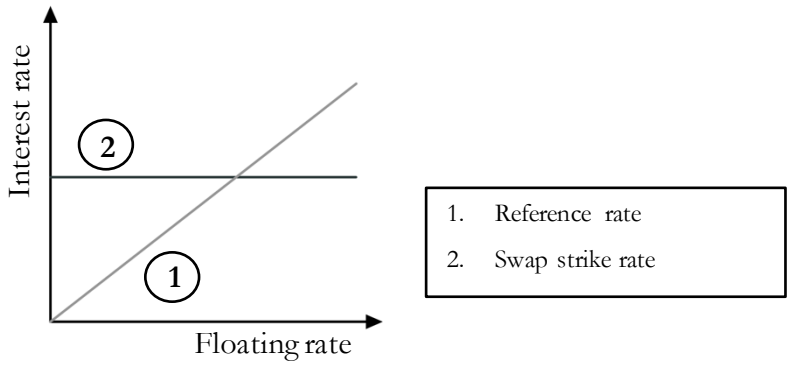
van Haastrecht, A., & Pelsser, A. (2008). *Efficient, almost exact simulation of the Heston stochastic volatility model*. University of Amsterdam. https://pure.uva.nl/ws/files/4291187/64392_302222.pdf

7 Appendix: hedging products

7.1 Traditional methods

Interest rate swap

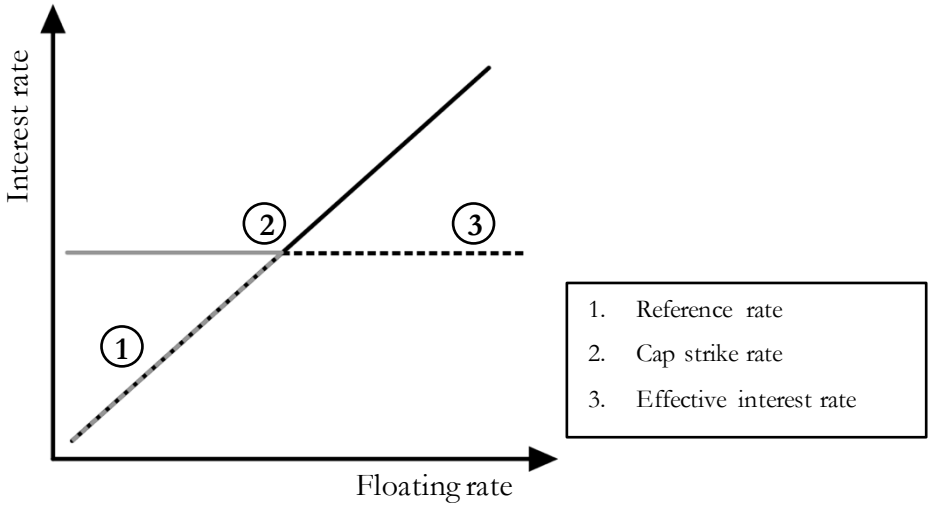
An interest rate swap is a financial agreement made between two entities, often a borrower and a financial institution. Within the real estate sphere, this instrument is primarily utilized by participants to mitigate potential volatility associated with fluctuating interest rates. Essentially, the borrower commits to remitting a predetermined fixed interest rate to the bank. In return, the bank provides the borrower with a variable rate, often pegged to the three-month Libor. It's worth noting that typically, the bank involved in the swap is also the primary lender. This means the variable rate offered through the swap usually matches the rate (excluding any margin) specified in the loan. The core intent of this arrangement is to stabilize the borrower's financial expenses by safeguarding them against unexpected surges in short-term rates. If at the outset of a given three-month term the variable rate surpasses the fixed rate, the bank transfers the difference to the borrower. Conversely, if the variable rate is less than the fixed rate, the borrower pays the bank the difference. This ensures that the borrower's financial obligations align with the previously agreed fixed rate, irrespective of prevailing market conditions (Harkins et al., 2015).



One salient benefit of an interest rate swap is the fiscal predictability it offers borrowers. The predetermined fixed rate ensures a consistent cash flow trajectory, eliminating concerns of unexpected rate hikes. Additionally, the absence of any initial upfront premiums adds to its appeal, especially among real estate investment managers. However, there is no such thing as a free lunch. The primary limitation is that borrowers are locked into a fixed rate and miss out on potential savings if market rates fall below this level during the contract's duration. Post the credit debacle, with the market witnessing an unforeseen plunge in short-term rates, stakeholders are now more wary. They're tuned in to the possibility of stinging early termination fees, which might leave a sour taste if the interest landscape is bleak when pulling the plug (Harkins et al., 2015).

Interest rate cap

An interest rate cap functions as a protective mechanism against the rise of the variable interest rates, operating much like an insurance policy. While it shares similarities with an interest rate swap, its distinct feature is the absence of payments until the floating rate breaches the cap strike rate. To initiate this agreement, borrowers must submit a premium payment to the bank, generally in advance. The cap's central purpose is to define a ceiling on the finance costs for those holding variable rate debts. This design allows borrowers to exploit the advantages of diminished short-term interest rates, only capping their benefit when rates climb beyond the agreed-upon limit. Payments are made only if the prevailing floating rate overtakes the cap strike rate, with the bank compensating the borrower for the difference over the quarter (Harkins et al., 2015).

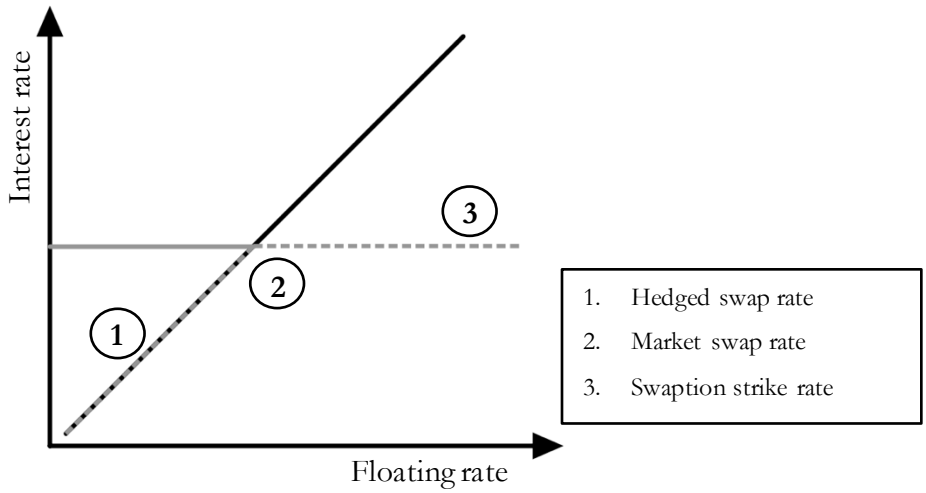


Engaging with an interest rate cap comes with its pros and cons. Conceptually, it mirrors an insurance policy, shielding borrowers from potential spikes in interest rates. A prominent perk is the borrower's ability to establish an upper limit on their interest rate exposure while still retaining the opportunity to gain from lower variable rates if they're beneath the cap strike. Its popularity among borrowing parties and lenders can also be attributed to the absence of fees for premature termination. Any remaining value linked to the cap still accrues to the borrower, without any liabilities. On the downside, the need to shell out a premium (often upfront) can increase the total borrowing cost. Should the variable rate remain below the cap strike throughout the contract's life, the borrower may end up incurring higher expenses than if they had chosen not to hedge, leading to perceptions of diminished utility from the arrangement (Harkins et al., 2015).

7.2 Advanced methods

Interest rate swaption

An interest rate swaption is a type of option contract granting the borrower the choice to initiate an interest rate swap at a predetermined future date, locked at a specific rate termed the strike rate, and for a set duration. On the execution date, if the prevailing market swap rate for the hedged duration exceeds the established strike rate, activating the option becomes the best course of action. Conversely, if the market rate dips below the strike rate, the borrower would typically forgo the swaption. From the borrower's standpoint, the allure of a swaption lies in its guarantee of a capped interest rate starting from a future date for a designated time span. During the swaption's validity, borrowers can enjoy the leeway of capitalizing on potentially more favorable variable rates up until the swaption's activation date. It gifts the holder the luxury of postponing decisions related to hedging their interest rate exposure until clearer insights emerge regarding their upcoming lending needs. Such a mechanism lets the borrower navigate what they hope will be a landscape of diminished ambiguities. Swaptions equip borrowers with tools to shield against unfavorable shifts in impending borrowing expenses without binding them to any commitment. Should there be no need for the hedge on the intended date, the borrower remains insulated from any costs tied to hedge termination. Mirroring the cap, early termination of a swaption doesn't impose extra charges. However, implied is the opportunity cost in case the market rates never surge above the strike rate then perhaps other hedging strategies could be more lucrative. Furthermore, borrowers maintain their rights to any residual value linked to the swaption. Notably, the absence of obligation ensures borrowers aren't forced into the swap, especially if market interest rates plummet instead of surging (Harkins et al., 2015).

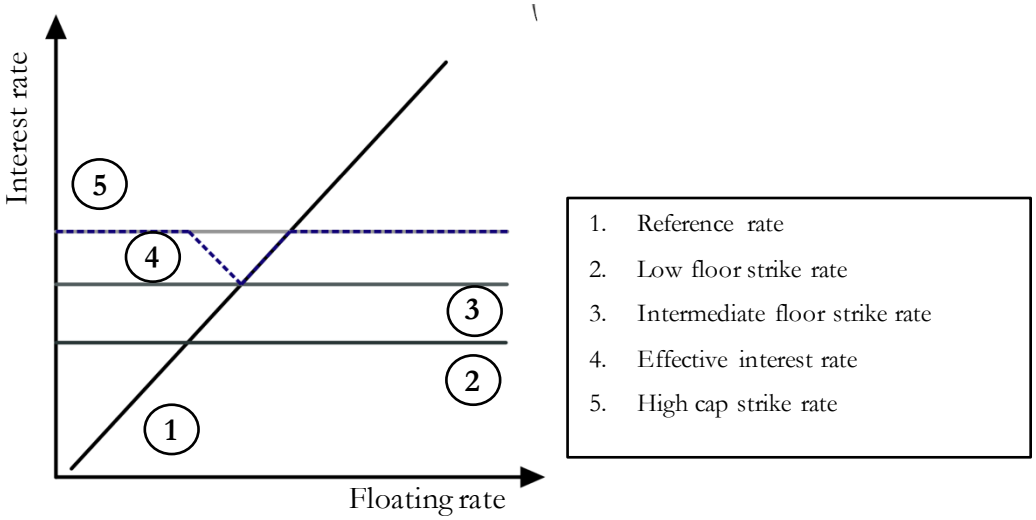


Cancellable swap

Swaps can be customized, offering an intriguing feature – the ability to terminate them at a predefined date without any added charges. This creates what's termed a "cancellable interest rate swap". These contracts result from fusing a swap with a receiver's swaption, ensuring the embedded swap rate (1) aligns with the swaption's strike rate and (2) accommodates the swaption's procurement cost. This setup shields the borrower's borrowing rates for a set span, giving them the leverage to terminate the contract on specified future dates without the risk of incurring penalties. A borrower cancellable swap, akin to a regular interest rate swap, promises a fixed interest rate and typically doesn't demand any initial cash outlay. What sets it apart is its added flexibility, enabling borrowers to nullify the agreement at future dates without incurring charges. Or simply put, the cancellable interest rate swap is like the upgraded version of the classic interest rate swap, with the addition of a no-cost cancellation clause. The evident shortcoming is its contract rate, which usually exceeds what a standard interest rate swap would have stipulated initially, implying potential opportunity costs if market rates rise during the instrument's duration (Harkins et al., 2015).

Geared Interest Rate Collar

Geared interest rate collars offer a dynamic twist to the more conventional vanilla collars often embraced in interest rate hedging strategies. These derivatives come in various forms, but one particular model often encounters real estate investment managers. At its core, this model mirrors a conventional collar with a fixed maximum rate. The twist in geared versions is a clause that, upon reference rate dropping beneath the floor strike, sees the effective rate gradually climb, often up to the cap strike rate. This instrument essentially melds an interest rate cap at an elevated strike rate, the sale of dual interest rate floors at a mid-tier strike rate, and the purchase of a singular interest rate floor at a lower tier. If rates plummet below the lower limit, the effective borrower's rate typically matches the higher strike rate. Borrowers wielding a geared collar lock in a maximum rate, but also stand to benefit from potentially lowered rates if they stay within certain parameters. This product's lowest rate typically materializes when rates equal the mid-tier strike. Contrasting it with a standard zero-cost interest rate collar, the zero-cost geared version often presents a lowered max rate, offset by the geared floors (Harkins et al., 2015).



On every adjustment date, the cap and floor strike rates are weighed against the contracted floating rate:

1. Above the cap strike rate: if floating rates surpass the cap strike the bank steps in, covering the gap for that duration, which translates to the borrower's rate being locked at the cap.
2. Between cap and intermediate floor strikes: it's a draw. The borrower rides along with the floating rate.
3. Between intermediate and low floor strikes: the borrower chip in twice the difference for that period, placing their effective rate somewhere between the intermediate and cap, depending on the ongoing floating rate.
4. Below the low floor strike: n this scenario, the borrower pay the bank twice the gap between the lower and intermediate strikes, plus the variance between the low strike and the floating rate. For the borrower, it circles back to the cap strike rate as the effective rate (Harkins et al., 2015).