Abstract

In this dissertation, I examine how interest rate volatility influences the pricing wedge between LIBOR- and SONIA-based swaptions following the transition away from LIBOR. The aim is to determine whether pricing discrepancies vary systematically across different volatility regimes and what this implies for market participants managing benchmark-linked instruments under varying volatility regimes. I price at-the-money GBP swaptions using the Black model for LIBOR and the Bachelier model for SONIA, holding all contract terms constant. Volatility regimes are defined using realised SONIA volatility, and relative pricing wedges are compared across low-, moderate-, and high-volatility periods. I apply ANOVA, Kruskal-Wallis, and regression analysis to test for statistical significance and identify key drivers. The results show that pricing wedges are regime-dependent rather than linear. The largest median wedge occurs in moderate-volatility conditions, while extreme volatility narrows the wedge but increases dispersion. Statistical tests confirm significant regime differences, with volatility and forward rate emerging as primary predictors.. These findings have practical relevance for market participants managing both legacy and new exposures. Understanding how the pricing wedge behaves under different volatility conditions helps inform hedging strategies, model selection, and stress testing. I conclude that volatility-aware pricing approaches are essential to anticipate regime-dependent valuation differences and to manage model risk and hedge effectiveness in the post-LIBOR landscape.

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1 Introduction

Over the past decade, global financial markets have undergone a significant transformation following the discontinuation of the LIBOR and the subsequent adoption of alternative risk-free rates (ARRs), notably SONIA in the UK. This reform, primarily driven by concerns over manipulation of LIBOR and its reliance on subjective bank estimates, has fundamentally changed the landscape of interest rate derivatives. As of November 2018, the notional value of GBP-denominated financial contracts referencing LIBOR was $30tn, highlighting the scale and importance of this transition (Bank of England, 2018b).

Following this transition, swaptions, which are options on interest rate swaps, have become a focal point in understanding the practical implications of benchmark reform. These instruments grant the holder the right, but not the obligation, to enter into a swap at a specified future date and are widely used by financial institutions to hedge interest rate risk (Hull, 2012). The pricing of such derivatives depends heavily on the characteristics of the reference benchmark interest rates. Under the LIBOR framework, swaptions were typically valued using the Black model, however, SONIA's characteristics have led to greater reliance on the Bachelier model. This shift reflects the broader structural changes in benchmark rates and introduces new valuation complexities. As a result, differences in model assumptions and benchmark structures can lead to valuation discrepancies for otherwise identical swaptions. This divergence in prices is referred to as the pricing wedge, and its behaviour under different market conditions forms the core focus of this dissertation.

This dissertation investigates whether the swaption pricing wedge between LIBOR-based (including synthetic LIBOR post-2021) and SONIA-based benchmarks is systematically influenced by changes in market volatility. The analysis uses fixed contract inputs and consistent volatility assumptions to isolate the effect of benchmark structure across defined volatility conditions.

The central research question is:

Does the magnitude of the pricing wedge between LIBOR and SONIA swaptions vary systematically across different interest rate volatility regimes?

The results show that the pricing wedge is regime-dependent rather than linearly related to volatility. Surprisingly, the greatest median wedge occurs in moderate-volatility periods rather than under extreme stress. During high-volatility episodes such as the COVID-19 crisis or the 2022 gilt market shock, the median wedge narrows, although pricing variability increases significantly. This suggests that extreme conditions may temporarily compress LIBOR's credit and liquidity premia, narrowing its divergence from SONIA, potentially due to central bank intervention. This highlights a risk management blind spot. Moderate volatility, often overlooked, may present the greatest risk of valuation mismatch between LIBOR- and SONIA-linked instruments.

From a practical perspective, these results are highly relevant for institutions managing both legacy LIBOR-based contracts and new SONIA-based instruments. While pricing differences between the instruments is expected, the study shows that the extent of that divergence varies by volatility regime. When volatility rises, pricing models and benchmark dynamics interact in nonlinear ways, affecting hedge effectiveness, valuation accuracy, and model risk. Understanding how the wedge behaves across regimes enables better model calibration, scenario analysis, and pricing decisions, especially as markets continue to adapt to a post-LIBOR environment. To capture this evolution, the study includes both historical LIBOR and synthetic LIBOR data across the transition period.

These considerations have become particularly salient in light of recent market events. During the COVID-19 crisis or the UK gilt crisis in October 2022, short term interest rate volatility surged, challenging the standard pricing models. The Black model tends to become less reliable in such conditions while the Bachelier model may underestimate risks associated with extreme rate movements. This makes it important to systematically evaluate pricing differences between LIBOR and SONIA swaptions across varying levels of volatility.

Although existing studies have examined swaption pricing under both LIBOR and SONIA, they often focus on model calibration or implied volatility surfaces (Calame and Mouaddib, 2021; Yueh and Wu, 2024). However, these studies typically do not segment results by realized volatility regimes or use a controlled setup that isolates model behaviour. This dissertation contributes to the literature by applying a consistent methodology across low, moderate, and high volatility conditions, defined using realised short-term interest rate volatility. It also considers key stress events, such as the COVID-19 shock and the gilt crisis, to assess whether pricing discrepancies intensify during turbulent periods.

The structure of this dissertation is as follows: Chapter 2 reviews existing literature on benchmark reform, swaption pricing, and volatility modelling to establish the study's context and identify the research gap. Chapter 3 outlines the data sources and methodology, explaining how volatility regimes are defined and applied across pricing models. Chapter 4 presents the results of the comparative pricing analysis, interprets these findings in relation to the research question, and discusses their practical implications and limitations. and Chapter 5 summarises the conclusions and implications.

2 Literature Review

The replacement of LIBOR with ARRs such as the SONIA in the UK has represented one of the most significant structural changes in modern financial markets. LIBOR, once the dominant benchmark, was deeply embedded within the financial system's infrastructure and operational processes (Bank of England, 2018b). However, its credibility deteriorated due to its dependence on panel bank submissions rather than actual market transactions, making it susceptible to manipulation (Tuckman, 2023). The deterioration of LIBOR's integrity, along with the loss of interbank liquidity accelerated the move towards transaction-based reference rates such as

SONIA (Martin & Sagan, 2020; Fuller, Russell & Connor, 2018).

In response, regulatory bodies such as the FCA and BOE advocated for a transition to more robust alternatives. SONIA, based on actual overnight unsecured lending transactions and administered by the Bank of England, emerged as the UK's preferred risk-free rate (Bank of England, 2018b). Click (2018) argues that this reform offered an opportunity to rebuild trust in financial markets. At the same time, Duffie and Stein (2015) highlight the inherent trade-off between eliminating manipulation and preserving liquidity.

While SONIA improves transparency and reliability, its compounded-in-arrears methodology introduces operational uncertainty (Bank of England, 2020). To address these challenges and promote standardisation, the BOE began publishing a daily SONIA Compounded Index in August 2020. This encourages the adoption of the shift method rather than the lag method, mitigating contractual complexity and reconciliation discrepancies among market participants (Richards, 2020). Despite this, Klingler and Syrstad (2021) find that SONIA is more sensitive to central bank reserves and less reactive to credit risk, suggesting it and LIBOR are not economically interchangeable.

To understand the implications of this transition, it is important to contrast the structural features of LIBOR and SONIA. LIBOR is a forward-looking rate that includes credit and liquidity risk premia, varying across maturities and market conditions (Michaud & Upper, 2008; Gefang et al., 2011). In contrast, SONIA is backward-looking and nearly risk-free as it contains minimal credit or liquidity premia. While SONIA enhances transparency and reliability, it also introduces limitations. Particularly, its lack of risk premia means it cannot convey expectations about future funding conditions as LIBOR did, especially the refinancing and rollover risks (Backwell et al., 2025). These limitations become especially evident during market stress. For instance, the spike in the LIBOR-OIS spread at the onset of the COVID-19 crisis was largely due to credit risk (Skov & Skovmand, 2023). In the absence of such signals, banks have had to adjust by increasing lending rates and tightening collateral requirements (Kim et al., 2024).

LIBOR's integral role in market infrastructure meant its discontinuation caused considerable disruption. Its removal impacted marketmaking, pricing and risk transfer across numerous asset classes (Ashton & Christophers, 2015). The coexistence of LIBOR and SONIA during the transition required firms to operate dual systems, align valuation methodologies and implement fallback provisions to ensure contractual continuity (Schrimpf & Sushko, 2019). This presented significant operational and legal challenges, particularly for cross currency products and legacy derivatives.

A critical area impacted by the transition is swaption pricing, Under the LIBOR regime, the Black model, a framework assuming lognormal forward rates and strictly positive interest rates, was widely used (Black, 1976). This aligned with LIBOR's rate dynamics and term structure. However, with the adoption of SONIA and the prevalence of low or occasionally negative interest rate environment, the Black model has become less suitable. Instead, the Bachelier model, which assumes normally distributed rates and accommodates negative values, has become more appropriate (Bachelier, 1900).

In addition to pricing models, the transition has also reshaped how volatility is modeled. SONIA-based options, especially in short-term maturities, often display time-inhomogeneous volatility due to anticipated policy events (Backwell & Hayes, 2022). Consequently, traditional constant volatility assumptions have become less viable. As a result, more sophisticated tools, such as multi-curve frameworks and Taylor series approximations, are increasingly employed to better capture rate dynamics and ensure accurate calibration (Calame & Mouaddib, 2021; Mercurio, 2010).

Recent literature has explored the implications of these modeling shifts. Yueh and Wu (2024) examined implied volatilities under the Black model and found persistent pricing distortions between LIBOR and SOFR swaptions, particularly in short-dated instruments. Calame and Mouaddib (2021) demonstrated that fallback-adjusted LIBOR swaptions can be priced as SONIA swaptions using modified strikes, but this method loses accuracy for long maturities or in volatile conditions. These findings show that models must be adjusted specifically for SONIA, rather than reusing those built for LIBOR.

Volatility during periods of market stress presents an additional challenge. Lameir (2023) finds that swaption pricing errors increase significantly during periods of elevated volatility. This can amplify when traditional models are applied outside their calibrated conditions. This emphasises the sensitivity of swaption pricing to volatility and the need for adapting models accordingly.

Although SONIA is now the standard benchmark for new contracts, the transition away from LIBOR required temporary fallback arrangements to manage legacy exposures. To address this, synthetic LIBOR was introduced by regulators as an interim solution, allowing firms time to convert legacy contracts in an orderly fashion (FCA, 2024). Synthetic LIBOR is calculated using compounded SONIA plus a fixed spread derived from historical LIBOR-SONIA differences, consistent with ISDA fallback conventions. It is primarily applied to cash market instruments such as bonds and loans. In practice, lenders such as HSBC amended loan agreements to adopt alternative risk-free rates as part of the broader fallback process (HSBC, 2023). For cleared derivatives, central counterparties such as LCH implemented the ISDA fallback protocol, converting GBP LIBOR swaps into SONIA equivalents with adjusted terms (LCH, 2021). However, during periods of market volatility, pricing under fallback mechanisms may diverge from that of standard SONIA instruments, raising concerns about hedge effectiveness and transition robustness. Although synthetic LIBOR is linked to legacy contracts and will be discontinued as those contracts mature, it remains a relevant reference point for understanding the complexities of the transition process.

The shift from LIBOR to alternative risk-free rates has also reshaped institutional practices in trading, hedging, and risk management. For example, forward rate agreements have become largely obsolete, and new instruments are emerging to manage basis risks (Todorov, 2022). Institutions like insurers and pension funds have had to revise internal systems and risk frameworks to accommodate changes in benchmark behaviour (White, 2021). These operational shifts highlight the importance of understanding pricing discrepancies between old and new benchmarks under different market conditions, particularly as volatility stresses the assumptions embedded in traditional valuation models.

While existing research has examined the transition from LIBOR to SONIA, limited attention has been paid to how pricing discrepancies between the two benchmarks evolve under different volatility conditions. This gap is particularly relevant given the increased reliance on alternative models and fallback mechanisms. The next chapter outlines the methodology used to investigate this relationship systematically.

3 Methodology

In this dissertation, I adopt a quantitative empirical methodology to examine the pricing wedge between LIBOR- and SONIA-based swaptions across different volatility regimes. I implement the analysis in MATLAB and carry out historical data collection, volatility classification, pricing model construction, and statistical testing.

3.1 Data Collection and Preparation

The dataset spans from April 2018 to December 2023 and includes SONIA and LIBOR interest rate data. I select April 2018 to mark the introduction of the reformed SONIA benchmark by the Bank of England, which provides a consistent, transaction-based overnight rate (Bank of England, 2018a). The end date of December 2023 captures the most recent complete calendar year prior to the scheduled cessation of 3-month synthetic GBP LIBOR in March 2024 (FCA, 2022).

I obtain SONIA daily rates and the SONIA Compounded Index from the Bank of England. I source historical 3-month GBP LIBOR data from the European Central Bank, based on Refinitiv submissions.

Since LIBOR data is only available monthly, I forward-fill it to construct a daily series. From January 2022 onward, following the cessation of panel-based GBP LIBOR, I use synthetic LIBOR (Kelly, 2024). I calculate this by compounding daily SONIA over a three-month period and adding the ISDA-defined fallback spread of 11.93 basis points.

I derive SONIA discount factors from the SONIA Compounded Index, while I compute LIBOR discount factors using a simple daily accrual method based on a 365-day year.

3.2 Volatility Estimation and Regime Classification

I measure market volatility using realised SONIA volatility, calculated as the rolling 21-day standard deviation of daily rate changes (Rustamov, 2024):

$$\sigma_t = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(r_{t-i}-\bar{r})^2}$$

where r_t is the daily rate change and $\bar{r}$ is the rolling mean.

To facilitate a regime-based analysis, I segment the realised volatility series into three categories using empirical percentiles. Observations falling below the 30th percentile are classified as "Low" volatility, those above the 70th percentile as "High," and those in the middle range as "Moderate." Where the valuation date coincides with an observed volatility value, I use the value directly. Otherwise, I estimate it using linear interpolation between adjacent observations.

This segmentation allows me to to group pricing wedge observations by market conditions, allowing the analysis of pricing wedge behaviour across stable and turbulent periods, including events such as the COVID-19 crisis and the 2022 gilt shock.

I do not use implied volatility in this study due to its model-dependence (Rustamov, 2024). Instead, I rely on realised volatility, calculated from observed rate changes, which provides a consistent, data-driven measure of market stress. This approach allows the analysis to capture actual historical conditions without introducing model-specific biases that could distort the pricing wedge.

3.3 Swaption Pricing Models

I price swaptions using two benchmark models. For LIBOR-based pricing, I apply the Black model:

$$P_{Black} = A[F.N(d_1) - K.N(d_2)]$$

$$d_1 = \frac{\ln(F/K) + 0.5\sigma^2 T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

For SONIA-based pricing, I use the Bachelier model:

$$P_{\text{Bachelier}} = A\left[(F-K)\cdot N(d) + \sigma\sqrt{T}\cdot n(d)\right]$$

$$d = \frac{F-K}{\sigma\sqrt{T}}$$

In both models, A denotes the present value of the fixed leg (annuity), F is the forward swap rate, K is the strike (equal to F), is the annualised volatility and T is time to expiry. $N()$

and $n()$ refer to the standard normal cumulative distribution and probability density functions, respectively.

I calculate the annuity A as:

$$A = \sum_{i=1}^{n} \alpha_i \cdot D(0, t_i)$$

where α_i is the accrual fraction for payment i and $D(0, t_i)$ is the discount factor for the fixed leg cash flow at time t_i.

Forward swap rates are computed using the par rate formula:

$$F = \frac{D(0, t_1) - D(0, t_n)}{\sum_{i=1}^{n} \alpha_i \cdot D(0, t_i)}$$

where $D(0, t_1)$ and $D(0, t_n)$ are the discount factors at the start and end of the swap's fixed leg, respectively.

All swaptions are priced at-the- money, with the strike K equal to the forward rate F. This assumption eliminates the need to model moneyness and focuses the analysis on differences arising from the benchmark structure and model assumptions. ATM pricing is commonly used in derivative pricing analysis and reflects typical quoting conventions in the swaption market.

Each swaption uses a notional value of one for scaling simplicity. Fixed leg payments are assumed to occur semi-annually, and tenors of one, three, and five years are evaluated. When exact discount factors, forward rates, or volatility values are available on a pricing date, those values are used directly. In cases where data do not align precisely, linear interpolation is applied between adjacent observations.

3.4 Measuring the Pricing Wedge

I quantify the pricing wedge as the difference between LIBOR- and SONIA-based swaption values. Two wedge metrics are calculated.

I define the absolute pricing wedge as:

$$\text{Wedge}_{\text{abs}} = |P_{\text{LIBOR}} - P_{\text{SONIA}}|$$

Next, I compute the relative pricing wedge, which normalises the absolute difference by the average of the two prices:

$$\text{Wedge}_{\text{rel}} = \frac{|P_{\text{LIBOR}} - P_{\text{SONIA}}|}{\frac{1}{2}\left(P_{\text{LIBOR}} + P_{\text{SONIA}}\right)}$$

3.5 Statistical Testing and Model Estimation

I use a one-way analysis of variance (ANOVA) to compare the average relative pricing wedge across the three volatility regimes. ANOVA is employed because it is appropriate for testing mean differences across multiple groups (Field, 2013).

To validate ANOVA assumptions, I apply the Lilliefors test to assess whether the distribution of residuals was approximately normal and Levene's test was used to determine whether the variance of the relative wedge was consistent across the volatility regimes (Field, 2013). These steps are necessary to ensure that the conditions required for reliable statistical inference are satisfied.

If either of these assumptions is violated, I use the Kruskal-Wallis test instead (Field, 2013). This test compares group medians and does not rely on normality or equal variances. If the test finds significant differences, I conduct additional pairwise comparisons to identify which volatility regimes differ from each other.

In addition to the categorical regime analysis, I estimate two linear regression models to examine how pricing differences vary continuously with market conditions.

In the first model, I regress the relative wedge on realised volatility, swap tenor, and forward rate:

$$Wedge_{Relative} = \beta_0 + \beta_1 \cdot Volatility + \beta_2 \cdot Tenor + \beta_3 \cdot ForwardRate + \varepsilon$$

The second specification introduces an interaction term between volatility and tenor. I use this to test whether the effect of volatility changes depending on swap length, helping capture any variation in pricing sensitivity across maturities (Field, 2013).

$$Wedge_{Relative} = \beta_0 + \beta_1 \cdot Volatility + \beta_2 \cdot Tenor + \beta_3 \cdot ForwardRate + \beta_4 \cdot (Volatility \cdot Tenor) + \varepsilon$$

I assess model performance using adjusted R-squared. I also examine the statistical significance of coefficients to identify variables that have a measurable effect on pricing differences. Residual plots are reviewed to confirm that the models are appropriately specified.

4 Results & Discussion

4.1 Benchmark Transition and Rate Dynamics

Figure 1 illustrates the evolution of SONIA, LIBOR, and synthetic LIBOR from April 2018 to December 2023, a period characterised by significant benchmark reform and episodes of market stress. SONIA and LIBOR both remained below 1% prior to 2022, reflecting a prolonged low-rate environment. During the onset of the COVID-19 pandemic in early 2020, both rates fell further in response to emergency monetary easing. However, from early 2022, all three benchmarks (SONIA, LIBOR, and synthetic LIBOR) began rising steadily as central banks tightened policy to combat inflation.

Throughout the period, LIBOR consistently priced above SONIA, reflecting structural differences between the two benchmarks (Michaud & Upper, 2008). Synthetic LIBOR, introduced in 2022, closely tracked SONIA with a fixed spread, following ISDA fallback conventions.

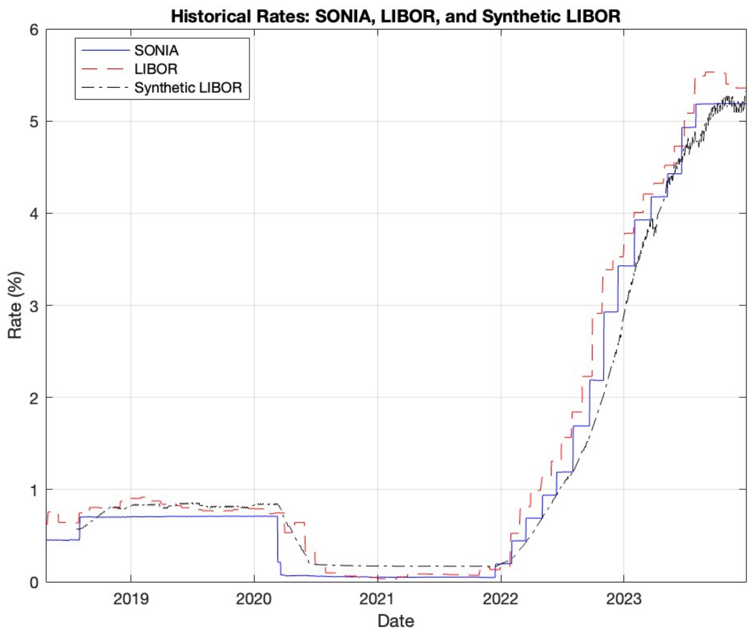

Figure 1.
This figure shows the movement of SONIA, LIBOR, and synthetic LIBOR during the LIBOR transition. All rates dropped sharply in early 2020 due to emergency rate cuts during the COVID-19 crisis. LIBOR remained above SONIA throughout, reflecting credit and liquidity risk. From 2022, all three rates rose as central banks tightened policy. Synthetic LIBOR, introduced in 2022, closely followed SONIA with a fixed spread.

These trends support the view that LIBOR and SONIA are not economically interchangeable. As Klingler and Syrstad (2021) note, SONIA is less responsive to credit risk and more influenced by central bank reserves, indicating that the two rates behave differently under stress. This distinction is visible in Figure 1, where the persistent gap between LIBOR and SONIA highlights the presence of risk premia in LIBOR that SONIA, as a near risk-free rate, does not capture. As further noted by Backwell et al. (2025), the absence of forward-looking credit premia in SONIA limits its ability to reflect refinancing and funding risks during periods of market stress. This is supported by Figure 1, where SONIA dropped more sharply than LIBOR at the onset of the COVID-19 crisis in early 2020, suggesting that LIBOR incorporated heightened credit risk while SONIA did not.

4.2 Volatility Regimes and Pricing Wedge behavior

Volatility, measured as the 21-day rolling standard deviation of daily SONIA rate changes, varied considerably over the sample period. As shown in Figure 2, major spikes occurred during key stress events, most notably during the COVID-19 shock in early 2020 and the UK gilt crisis in October 2022. The highest realised volatility was 16.26% on 26 October 2022, while the lowest recorded was just 0.02% in February 2023. These fluctuations confirm that the dataset spans both calm and turbulent market conditions, justifying the segmentation of observations into low-, moderate-, and high-volatility regimes for subsequent analysis.

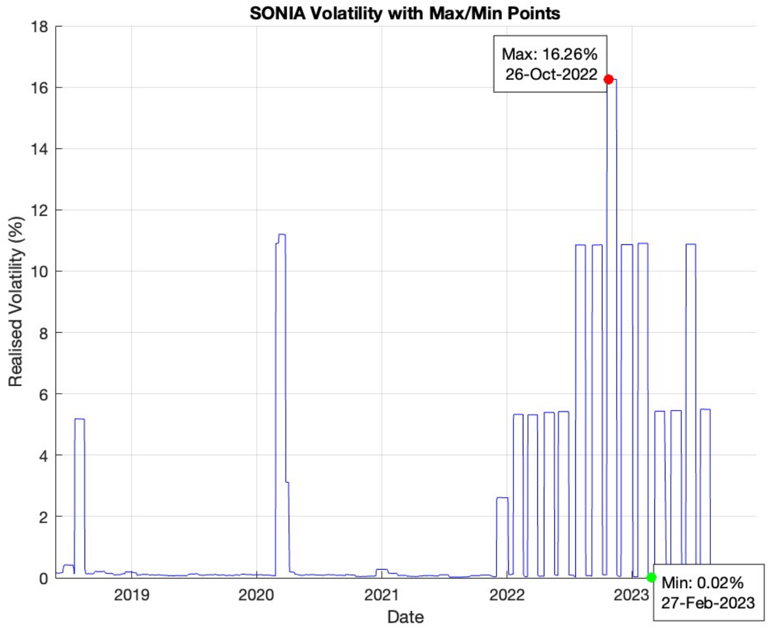

Figure 2.
This figure shows daily realised volatility of the SONIA rate over the observation period. Volatility spiked sharply during March 2020 (COVID-19 onset) and again in late 2022, reaching a maximum of 16.26% on 26 October 2022. The minimum recorded volatility was 0.02% on 27 February 2023. These fluctuations highlight the impact of market stress and policy shifts on short-term rate stability.

Figure 3 presents the behaviour of the relative pricing wedge across these volatility regimes. The highest median wedge occurs in the moderate-volatility regime at 0.99562, followed closely by the low-volatility regime at 0.99503. In contrast, the high-volatility regime exhibits a substantially lower median of 0.98806. Furthermore, wedge variability increases with volatility. The high-volatility regime has the widest spread (0.96662 to 0.9997), suggesting greater inconsistency in swaption pricing under stress. These results indicate that pricing divergence between LIBOR- and SONIA-based swaptions not only becomes more variable in volatile environments, but also that the median difference narrows in extreme conditions.

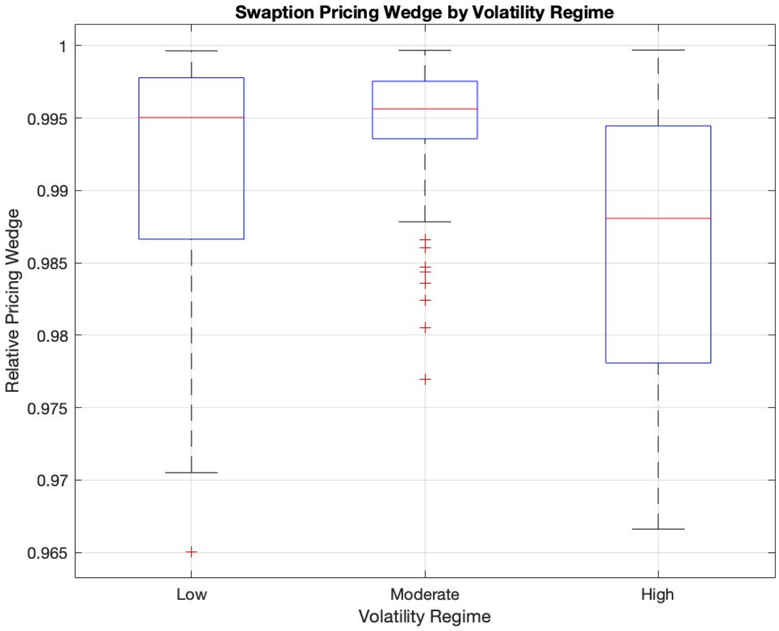

Figure 3.
This boxplot shows the distribution of relative pricing wedges between LIBOR- and SONIA-based swaptions across low, moderate, and high volatility regimes. The largest median wedge appears in the moderate-volatility regime, while the high-volatility regime shows greater pricing dispersion but a smaller median difference. These results suggest that pricing discrepancies are not linear and may peak under intermediate market conditions.

This pattern both supports and complicates earlier findings. Calame and Mouaddib (2021) noted that fallback-adjusted LIBOR swaptions tend to track SONIA-based pricing in stable markets but can diverge in more volatile periods. While this study confirms volatility's role in driving pricing differences, it nuances that view by showing that the greatest divergence appears not in high volatility but in moderate regimes. One possible explanation is that in extreme conditions, central bank intervention compresses risk premia, temporarily aligning the structural behaviour of LIBOR and SONIA. In contrast, moderate volatility may represent periods of partial convergence, where SONIA remains near risk-free, while LIBOR continues to incorporate meaningful credit and liquidity premia, resulting in larger pricing wedges.

Overall, these findings suggest that pricing wedge behaviour is not linearly related to volatility. The greatest average divergence occurs under moderate stress, whereas extreme market conditions reduce median differences but increase pricing dispersion. This has practical implications for risk management, as it indicates that valuation mismatches between LIBOR- and SONIA-linked contracts are most significant when markets are unstable but not yet in crisis.

4.3 Statistical Analysis

To formally evaluate whether the relative pricing wedge between LIBOR- and SONIA-based swaptions differed across volatility regimes, both parametric and non-parametric tests were conducted. The one-way ANOVA (Table 1) yielded a statistically significant result, $F(2, 93) = 7.81$, $p = 0.0007$, indicating that mean wedge values varied across low-, moderate-, and high-volatility periods. However, diagnostic tests in Table 2 revealed that key assumptions of the ANOVA were violated. The Lilliefors test for normality returned a p-value of 0.0010, and Levene's test for homogeneity of variance produced a p-value of 0.0002. These results indicated that the residuals were not normally distributed and variances were unequal across groups.

Table 1.
ANOVA Summary of Swaption Pricing Wedges Across Volatility Regimes.
This table reports the results of a one-way ANOVA test evaluating whether the mean pricing wedge differs significantly across low, moderate, and high volatility regimes. The F-statistic of 7.81 and corresponding p-value of 0.0007 indicate a statistically significant difference in mean pricing wedges across groups at the 1% significance level.

Source	**SS**	**df**	**MS**	**F**	**Prob ¿ F**
Groups	0.00099	2	0.00049	7.81	0.0007
Error	0.00589	93	0.00006		
Total	0.00688	95			

Table 2.
Kruskal–Wallis Test and Assumption Diagnostics.
This table presents diagnostics for the ANOVA assumptions and results of a non-parametric Kruskal–Wallis test. The Lilliefors and Levene's tests reject normality and homogeneity of variances, respectively, justifying the use of a non-parametric approach. The Kruskal–Wallis test yields a statistically significant result (^{2}(2) = 12.77, p = 0.0017), indicating that pricing wedges differ significantly across volatility regimes.

Test	**Statistic (df)**	**p-value / Interpretation**
Lilliefors Test (Normality)	—	$p = 0.0010$, residuals not normally distributed
Levene's Test (Equal Variance)	—	$p = 0.0002$, variances not equal across groups
Kruskal–Wallis Test	$\chi^2(2) = 12.77$	$p = 0.0017$

To account for these violations, the Kruskal-Wallis test was used as a more robust non-parametric alternative. As shown in Table 2, the Kruskal-Wallis test confirmed significant differences across volatility regimes, $\chi^2(2) = 12.77$, p = 0.0017. Post-hoc comparisons revealed that the difference between the moderate- and high-volatility groups was statistically significant, while differences involving the low-volatility group were not. These results are consistent with the descriptive analysis in Section 4.2, where the highest median wedge occurred in moderate-volatility regimes, while wedge dispersion widened under high volatility. This suggests that pricing wedge behaviour is regime-dependent rather than linear.

Table 3.
Linear Regression Results: Basic and Interaction Models.
This table presents two linear regression models estimating the swaption pricing wedge using volatility, tenor, and forward rate. In the basic model, volatility (p = 0.0274) and forward rate (p ¡ 0.0001) are statistically significant predictors, while tenor is not. The interaction model adds a volatility–tenor interaction term, but it is not significant, and volatility also loses significance. Forward rate remains highly significant in both models. Additionally, both the $\mathbf{R^2}$ and adjusted $\mathbf{R^2}$ are slightly lower in the interaction model (0.9895 and 0.9893, respectively), suggesting that including the interaction term does not improve the model's explanatory power.

Model	**Variable**	**Estimate**	**t-Stat**	**p-Value**
Basic	Intercept	0.99950	5553.00	¡ 0.0001
	Volatility	0.00001	2.24	0.0274
	Tenor	-0.00012	-1.63	0.1071
	Forward Rate	-0.01237	-81.65	¡ 0.0001
	R^2	0.9896		
	Adjusted R^2	0.9894		
Interaction	Intercept	0.99950	5395.00	¡ 0.0001
	Volatility	0.00001	1.25	0.2142
	Tenor	-0.00012	-1.45	0.1494
	Forward Rate	-0.01237	-78.18	¡ 0.0001
	Volatility × Tenor	0.00000[1]	-0.03	0.9752
	R^2	0.9895		
	Adjusted R^2	0.9893		

To examine which market variables most influenced pricing divergence, two linear regression models were estimated using the relative pricing wedge as the dependent variable. The first model included realised volatility, forward rate, and swap tenor. As shown in Table 3, both volatility and forward rate were statistically significant, with p-values of 0.0274 and < 0.0001, respectively. Volatility had a positive coefficient, indicating that higher market uncertainty was generally associated with larger pricing wedges. This supports findings by Lameir (2023), who reported increasing pricing errors during periods of elevated volatility when traditional models are stressed.

The forward rate had a significant negative coefficient, suggesting that pricing discrepancies narrowed as interest rates increased. Although this relationship is not explicitly covered in prior literature, it may be due to a declining marginal effect of credit and liquidity premia at higher rate levels, reducing differences between benchmark-based pricing models.

Swap tenor, by contrast, was not a statistically significant predictor (p = 0.1071). This contrasts with findings by Calame and Mouaddib (2021), who observed that fallback-adjusted LIBOR pricing methods tend to lose accuracy over longer maturities, particularly under volatile conditions. The lack of significance here may be explained by the consistent pricing setup applied in this study, with all swaptions priced at-the-money and under controlled conditions, limiting the role of maturity related effects.

[1] Rounded from -6.5003×10^{-8} for readability.

A second regression model tested for an interaction between volatility and tenor, but the interaction term was not significant ($p = 0.9752$), and model performance remained unchanged. In both models, the adjusted R-squared was approximately 0.989, as shown in Table 3, indicating strong overall explanatory power.

Taken together, these results confirm that volatility and rate environment are the dominant drivers of swaption pricing divergence between LIBOR and SONIA. The findings align with Calame and Mouaddib (2021), who showed that fallback-adjusted swaptions perform reliably under stable conditions but can diverge during market stress. At the same time, the narrowing of the wedge during extreme volatility may reflect temporary structural convergence, potentially driven by central bank interventions that compress credit and liquidity risk premia. These findings highlight the importance of adapting pricing frameworks not only to benchmark structure but also to prevailing volatility and rate regimes.

These results demonstrate that the swaption pricing wedge is sensitive to volatility conditions in ways that have direct consequences for risk management. Institutions holding both SONIA- and LIBOR-linked instruments may face increased valuation mismatches under moderate volatility, where the wedge is largest, and heightened pricing uncertainty under extreme stress. By understanding these regime-dependent behaviours, firms can better anticipate breakdowns in model alignment and adapt their hedging strategies accordingly.

4.4 Implications, Open Questions, and Recommendations

From a risk management perspective, these findings highlight the importance of recognising the structural divergence between benchmarks and adjusting models to account for volatility-driven pricing variation.

The results of this study show that the pricing difference between LIBOR- and SONIA-based swaptions is not constant. It changes depending on market volatility, with the largest differences occurring during periods of moderate volatility. This means that financial institutions using fixed pricing models may be exposed to unexpected risks if they do not adjust for changing market conditions. To manage this, firms should use models that can adapt to different levels of volatility.

These results highlight that even when both instruments are priced fairly within their respective models, differences in benchmark structure naturally lead to diverging valuations. These pricing differences do not indicate mispricing but reflect the economic nonequivalence of the benchmarks. Ignoring this structural divergence may lead to hedging mismatches or unintended exposures. To mitigate such risks, firms should adopt pricing frameworks that dynamically adjust to market regimes and recognise that fallback mechanisms, while useful under stress, do not make LIBOR and SONIA interchangeable.

The findings also show that synthetic LIBOR behaves similarly to SONIA during periods of high volatility.This suggests that fallback mechanisms may perform reliably under short-term stress, helping maintain valuation consistency in crisis scenarios. However, this reliability is temporary. Since synthetic LIBOR is a transitional tool and was discontinued in 2024 (FCA, 2024), it should not be viewed as a long-term substitute. Its construction does not capture evolving credit conditions, and its use is restricted to legacy contracts. Therefore, firms should proactively convert such exposures to SONIA to ensure long-term pricing accuracy and compliance.

There are still some open questions. This study only analysed at-the-money swaptions, where the strike rate equals the forward rate. Future research could test how pricing differences behave for in-the-money or out-of-the-money swaptions. It would also be useful to examine the role of implied volatility, which reflects market expectations rather than past rate movements.

Based on these findings, financial institutions should use pricing models that take volatility into account and clearly separate SONIA and synthetic LIBOR exposures when assessing risk. They should stress-test pricing assumptions under different volatility regimes, especially moderate ones, where differences are widest. Finally, firms should not rely on synthetic LIBOR as a long-term solution and should complete the transition to alternative risk-free rates to ensure accuracy, consistency, and regulatory compliance.

4.5 Limitations

This analysis has four limitations that may affect how the results should be interpreted.

First, forward rates were calculated using daily LIBOR values created by forward-filling monthly data. While this method preserves the structure of the original series, it may smooth over short-term fluctuations and introduce some inaccuracy.

Second, the models used in this study treat volatility as a fixed input. While realised volatility reflects past rate changes, it does not incorporate market expectations or allow volatility to vary over time, which may limit pricing accuracy in stressed conditions.

Third, swaptions were priced only at-the-money and with a notional of one. These simplifications were used to ensure consistency across cases, but they may reduce the applicability of the results to contracts with different strikes or sizes.

Fourth, external validity is limited. The focus on GBP swaptions and the LIBOR–SONIA transition means the findings may not directly apply to other currencies or benchmark reforms, such as those involving SOFR or €STR.

5 Conclusion

This dissertation examines how interest rate volatility influences the pricing wedge between LIBOR- and SONIA-based swaptions during the post-LIBOR transition period. Using a controlled pricing framework and a regime-based classification of realised volatility, the study aims to determine whether pricing discrepancies vary systematically with across volatility regimes and what this means for market participants managing benchmark-linked instruments.

The results reveal that pricing wedges are regime-dependent rather than linear. The largest median divergence occurs in moderate-volatility periods, while high-volatility regimes exhibit smaller median differences but higher dispersion in pricing outcomes. This non-linear pattern suggests that during extreme market stress, the gap between LIBOR and SONIA may temporarily narrow, possibly due to central bank actions. However, this effect is inconsistent, and pricing models become less reliable under these conditions, leading to more variation in results.

Regression analysis supports these findings, with realised volatility and the forward rate as statistically significant drivers of the pricing wedge. Volatility is positively associated with wedge magnitude, consistent with evidence that pricing errors increase in periods of elevated market stress (Lameir, 2023) while higher forward rates tend to reduce pricing differences. One possible explanation is that credit and liquidity risk premia embedded in LIBOR have a reduced marginal effect at higher interest rate levels. In contrast, swap tenor and interaction effects were not statistically significant, possibly due to the standardisation of the pricing inputs.

These findings highlight the need for volatility-aware pricing models. Institutions managing portfolios with exposure to both SONIA and legacy LIBOR contracts should be aware that valuation mismatches are most likely to arise in moderate-volatility regimes. While these conditions may not trigger conventional stress-testing thresholds they still pose risks to hedge effectiveness, capital allocation, and pricing accuracy.

This study also extends the insights of previous literature by showing that pricing discrepancies are not confined to periods of extreme volatility or long maturities but can peak under intermediate market conditions (Calame and Mouaddib, 2021). This has implications for how firms calibrate their models and monitor benchmark transition risk, particularly during times of relative market stability.

While the research offers important insights, it is subject to certain limitations. The analysis focuses on GBP-denominated, at-the-money swaptions, using realised rather than implied volatility. Future research could extend the scope to include instruments with varying strikes, tenors, or alternative benchmarks such as SOFR or €STR. It may also be valuable to incorporate forward-looking measures of volatility to better capture market expectations.

In conclusion, this dissertation provides robust empirical evidence that swaption pricing wedges between LIBOR and SONIA vary across volatility regimes. Recognising and responding to this regime dependence is essential for effective valuation and risk management in the post-LIBOR era.

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