EXAMINING THE IMPACT OF CENTRAL CLEARING AND SWAP EXECUTION FACILITIES ON INTEREST RATE SWAP SPREADS AND THEIR DETERMINANTS

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Abstract

This study explores how the determinants of interest rate swap spreads have changed since the implementation of Title VII of the Dodd-Frank Act of 2010. Utilizing ordinary least squares (OLS) regression, we analyze key variable effects at different stages of the regulation. Through this approach, we offer valuable insights into the impact of central clearing and trading on swap execution facilities (SEFs) and swap spreads. First, contrary to previous empirical evidence, increases in swap volatility correspond to a tightening, rather than a widening, of swap spreads after the implementation of SEF trading. This result suggests the SEF framework may enhance the appeal of swaps as a safe-haven and hedging instrument. Second, we observe that the Treasury liquidity premium (TLP) no longer significantly influences swap spreads after the implementation of SEF trading. Third, after SEF trading occurs, the curve slope and swap volatility remain the only significant drivers of swap spreads. Last, a difference-in-difference analysis reveals that the regulation did not materially impact changes in swap spreads; instead, they align with the observed trend of spread tightening in the overall markets. These results signify significant departures from previous research findings (Grinblatt, 2001; Fehle, 2003; Tah, 2022), holding importance for academic scholars and practitioners in swap pricing and risk management.

Keywords: Swap Spreads, Interest Rate Swap, Treasury Liquidity Premium, Hedging, Dodd-Frank, Title VII

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1. INTRODUCTION

Title VII of the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act[1], commonly known as "Dodd-Frank", was introduced to reform the over-the-counter (OTC) derivatives markets in response to the 2008–2009 financial crisis. This legislation played a pivotal role in shaping the interest rate swaps (IRS) and swap spread markets. Key changes brought about by Title VII include mandatory central clearing, standardized swap terms, collateralization, the establishment of a trade reporting depository, and the regulation of swap execution facility (SEF) trading platforms. While our primary focus in this study centers on central clearing and SEF trading, it is essential to note that all these factors contribute significantly to the essence of Title VII.

Swap spreads are defined as the risk premium between fixed for floating interest rate swap rates and U.S Treasury bonds of the same tenor. They

[1] https://www.govinfo.gov/content/pkg/COMPS-9515/uslm/COMPS-9515.xml

serve as valuable proxies for a wide array of financial and economic measures, encompassing general economic risk, banking sector health, market liquidity risk, and uncertainty. As such, there is a body of research dedicated to testing and understanding the determinants of swap spreads. Many of these studies use the same key explanatory variables which include the TLP, counterparty risk, yield curve slope, volatility, and mortgage duration. This study fills an important gap in the literature because it explores changes to these relationships during key periods before and after the adoption of the regulation. Several studies have explored the impacts of the financial crisis on the crucial determinants of swap spreads (Henshall-Howard, 2011; Toyoshima, 2012; Ito, 2014). However, there exists a gap in the literature, as none have specifically examined these determinants during the period surrounding the implementation of Dodd-Frank Title VII. Given the extensive restructuring of the IRS market through the act, we posit that various determinants will undergo modifications through different implementation stages. Consequently, this study seeks to address two crucial questions within the existing literature:

RQ1: How did the relationships of swap spread determinants change after the regulation was enacted?

RQ2: What impact did the regulation have on the magnitude of the swap spread risk premium?

In contrast to longitudinal studies, we adopt a temporal segmentation approach. We concentrate on three crucial periods corresponding to key implementation phases of the Dodd-Frank regulation: pre-clearing, mandated clearing, and SEF trading. In our approach, we analyze changes in the coefficients during each period, aiming to identify fluctuations that align with the changing regulatory requirements. We contribute to the existing literature by investigating the impacts of these variables through the stages of central clearing and the SEF trading regulation. Our focus encompasses 2-, 5-, and 10-year swap spreads to provide a comprehensive viewpoint across the most liquid part of the term structure. Although this study is unique, the ordinary least squares (OLS) approach is similar to previous research conducted by Fehle (2003) and Ito (2014). The implications of this work are important to both academics and practitioners. It will reveal new relationships between crucial explanatory variables and swap spreads, offering insights into their impact on swap premiums, trading liquidity, hedging, and duration management. It holds relevance to those actively using the IRS in this context, as well as to those who must operationally adapt to Dodd-Frank regulations. Notably, Dodd-Frank has been shown to adversely impact a firm's excess stock returns (Kwon, 2019).

In the following sections, we delve into existing research, starting with the benefits of Dodd-Frank and a survey of literature on swap spread determinants. The subsequent sections will address specific aspects, including data, methodology, results, and conclusions.

The structure of this paper is as follows. Section 2 provides a review of relevant literature. In Section 3, we detail the dataset employed and outline the chosen research methodology. Section 4 offers empirical results, presenting the core findings of the study. Section 5 provides a more detailed discussion of these results. Section 6 provides a concluding summary of the key takeaways in addition to suggestions for future research.

2. THEORETICAL BACKGROUND, LITERATURE REVIEW, AND HYPOTHESIS DEVELOPMENT

2.1. Dodd-Frank Title VII

Title VII of Dodd-Frank implemented various enhancements to the trading, clearing, and reporting framework of the IRS. Among its primary goals are to improve risk management practices through central clearing and enhance trading liquidity and transparency. To understand more specifics of the risk management practices, please refer to Appendix A.

Prior studies show that central clearing can materially reduce counterparty risk exposure and the risk of contagion. Acharya et al. (2009) argue that a central counterparty clearing house (CCP) reduces direct CP failure risk if the CCP itself is adequately protected. A major finding in their study suggests that central clearing reduces a counterparty risk externality, which is the lack of visibility into a counterparty's other transactions and exposures. Clearing significantly reduces asymmetric information risk as it adds visibility into each member's broker activity, its risk exposures and has the ability to directly manage this risk (Acharya & Bisin, 2014). This increased visibility and enhanced risk management procedures have contributed to a decline in direct counterparty risks. Such risk reductions are significant as the default of a counterparty has been a factor incorporated into the pricing of IRS markets (Biais et al., 2012).

In addition to enhancing the risk framework, empirical evidence suggests that increased price transparency among traders is associated with reduced bid/ask spreads and improved trading flow (Loon & Zhong, 2014; Slive et al., 2012; Benos et al., 2020). Disclosure of post-trade information improves market liquidity as traders are more informed when making execution decisions (Garratt et al., 2019). The introduction of SEFs allows participants in the IRS market to seek swap quotes from multiple executing brokers, thereby enhancing transparency and fostering competitiveness among dealers. SEFs provide investors with continuous access to quoted swap rates, marking a departure from the traditional voice-based, bilateral trading prevalent in OTC derivatives markets. This shift has substantially altered market dynamics, leading to increased price competition, which aligns with augmented trading liquidity (Benos et al., 2020).

Moreover, this requirement enhances the simplicity of trading compared to legacy bilateral methods, facilitating quicker and more straightforward swap transactions. The updated SEF trading process resembles the trading mechanisms of exchange-traded Treasury futures and highly liquid OTC bonds, including Treasury and corporate bonds. Previously, these instruments were traded on electronic systems like Bloomberg, Tradeweb, and MarketAxess before the implementation of Dodd-Frank. These other instruments were previously traded on electronic systems like Bloomberg, Tradeweb, and MarketAxess before the introduction of Dodd-Frank. Thus, the updated swap trading process enhances user-friendliness, transparency, and overall liquidity, bringing the IRS more in line with these other liquid markets.

2.2. Determinants of swap spreads

Previous studies have identified key factors influencing the dynamics of swap spreads. These include the TLP, also known as the convenience yield (Grinblatt, 2001), counterparty default risk (Duffie & Singleton, 1997), the slope of the yield curve (Sorensen & Bollier, 1994), volatility in swap rates (Lekkos & Milas, 2001), and mortgage duration (Asgharian & Karlsson, 2008). This research builds upon current literature by integrating the credit default swap spread of U.S. Treasuries (USCDS) as a proxy for the default risk of U.S. Government Debt. Default risk premiums of USCDS have played a significant role in the tightening of swap spreads (Nippani & Smith, 2010).

The Treasury liquidity premium is calculated through the TED spread, representing the liquidity difference between the 3-month Libor and 3-month T-Bill rates. Early research conducted by Grinblatt (2001) and Duffie and Singleton (1997) investigated the influence of TLP and credit risk on swap spreads, highlighting the significant role played by TLP, particularly in shorter-maturity swaps. TLP has an immaterial impact on swap spreads beyond 2-years. Grinblatt (2001) posits that swap rates and Treasury yields are considered default-free rates. The key disparity between these rates is attributed to the liquidity premium or convenience yield inherent in Treasury securities compared to swaps. Duffie and Singleton (1997) developed a model for the term structure of swap rates and specifically discounted the curve by a risk-adjusted short rate that included a credit risk as well as a Treasury liquidity component. Ultimately, they found that liquidity was a more important determinant of swap spreads relative to credit. Since then, numerous studies have utilized the TED spread as the proxy for TLP, consistently demonstrating a robust positive relationship with swap spreads (Lekkos & Milas, 2001; Fehle, 2003; Liu et al., 2006; Tah, 2022). Recent trends indicate a reduced Treasury convenience premium after the financial crisis Klingler and Sundaresan (2023). Furthermore, the enactment of the Dodd-Frank Act has led to notable enhancements in trading liquidity for the IRS. This improvement stems from heightened trading competitiveness and transparency facilitated by the SEF platform (Benos et al., 2020).

The empirical evidence on how direct counterparty default risk affects swap spreads is mixed. Early studies consistently showed a positive and significant coefficient between counterparty risk and swap spreads (Duffie & Singleton, 1997; Fehle, 2003; Liu et al., 2006). Sun et al. (1993) provide one of the earliest studies comparing the rates offered by two counterparties with differing credit ratings and found evidence that lower-rated firms offer higher swap rates. In contrast, Duffie and Singleton (1997) and Liu et al. (2006) show that the credit risk premium is broken into a default risk component, and a Treasury liquidity component and, consistent with Grinblatt (2001), their findings also suggest that swap spread premiums are overwhelmingly related to liquidity premia of Treasuries and suggest that credit risk is not materially priced in swaps. Collin-Dufresne and Solnik (2001) found that the IRS have negligible counterparty risk since IRS payments only consist of two-sided, net interest payments, rather than the much larger notional values. Additionally, counterparty risk priced into IRS has significantly diminished due to market enhancements such as increased collateral usage and improvements in contract language. These changes were partially in response to the collapses of several financial firms with substantial OTC exposures in the late 1980s and early 1990s (Culp, 2010). Consequently, we anticipate observing minimal to no influence from counterparty risk on swap spreads. The corporate quality spread has served as a reliable proxy for counterparty risk (Minton, 1997; In et al., 2003; Chung & Chan, 2010). The contemporary regulatory framework introduces additional risk mitigation enhancements, further diminishing the influence of counterparty risk on swap spreads (Markit, 2009; Culp, 2010; Cont & Kokholm, 2014).

The yield curve slope has had a consistent, negative relationship with swap spreads. Steeper yield curves suggest more counterparty default risk since there is a larger net pay gap between counterparties relative to flatter yield curves. Additionally, a steeper slope of the yield curve may be indicative of anticipated economic growth and improved business conditions typically leading to tighter swap spreads (Estrella & Hardouvelis, 1991; Lekkos & Milas, 2001). The slope of the yield curve encompasses several drivers of swap spreads, such as counterparty risk (Sorensen & Bollier, 1994), economic conditions (Estrella & Hardouvelis, 1991), and forward rate inefficiencies (Fama, 1984). Consequently, the yield curve is expected to retain its significance as an explanatory variable. Swaption implied volatility holds significant importance in this context. Historically, U.S. Treasuries have been a favored asset in times of heightened volatility and uncertainty (Longstaff, 2002). As implied volatility increases, it amplifies the expected variability of future cash flows tied to floating rates, thereby intensifying uncertainty. When demand for Treasuries increases (decreases) relative to IRS it results in wider (tighter) swap spreads. Prior research suggests there is a positive relationship between volatility and swap spreads (Minton, 1997; In et al., 2003; Ito, 2014; Tah, 2022).

Government-sponsored entities (GSEs) and other large institutions hold a significant amount of mortgage-backed securities (MBS). The duration of MBS securities fluctuates in response to changes in interest rates. This variability is influenced by shifts in cash flows tied to borrower behaviors — refinancing during rate declines and extending mortgages when rates surpass the borrower's mortgage rate. Option-adjusted durations of MBS are frequently rebalanced and hedged with the IRS. Consistent findings from prior research establish a clear and positive correlation between the duration of MBS indices and swap spreads. Studies by Asgharian and Karlsson (2008), Cortes (2003), Feldhütter and Lando (2008), and Hanson (2014) support this connection and highlight the positive association.

U.S. Treasuries have traditionally been viewed as a "flight to quality" asset during periods of economic distress and market volatility. Prior research indicates that factors such as rising aggregate debt levels, default risk concerns, safe-haven status, and increasing U.S. debt risk premiums relative to other countries contributed to the tightening of swap spreads following the 2008–2009 financial crisis (Krishnamurthy & Vissing-Jorgensen, 2012; Du et al., 2018; Augustin et al., 2021). Given this evidence, we incorporate the U.S. credit default swap (CDS) spread as a suitable proxy for assessing the concerns over the diminishing preeminence of U.S. debt markets. Although not directly relevant to this study, it is worth noting that demand factors also impact swap spreads in the 30-year part of the yield curve. Klingler and Sundaresan (2019) show that demand for long-duration swaps for pension plans can lower swap spreads. Additionally, Jermann (2020) finds that dealer balance sheet constraints drive increased demand for IRS and can significantly drive spreads downward and even negative. Our focus will be on the shorter tenors which are the most liquid for both the Treasury and swap markets.

3. DATA AND RESEARCH METHODOLOGY

3.1. Data

We utilize a comprehensive dataset comprising interest rates, yield curves, corporate bonds, credit default swaps, mortgage durations, and implied volatilities. The data sources include Bloomberg, IHS-Markit, the Federal Reserve Bank of St. Louis dataset (FRED), and Bank of America/Merrill Lynch (BAML) Indices. The primary analyses cover the period from 3/21/2011 to 2/27/2015 to capture a pre-clearing period up until after the implementation of the SEF trading period. Additionally, we ran a baseline regression analysis that spans from 7/1/2009 to 3/18/2013.

Daily swap rates and Treasury yields across the 2-year, 5-year, and 10-year tenors come from the FRED database using the Constant Maturity Swap (CMS) and Constant Maturity Treasury (CMT) mid rates. These rates represent on-the-run market rates for each tenor. To calculate the swap spread for each maturity, we subtract the daily Treasury rate from the daily swap rate.

The TED spread represents the TLP and is the difference between the daily 3-month Libor and 3-month Treasury Bill rates (Grinblatt, 2001). To assess counterparty default risk, we utilize the corporate quality spread, derived by subtracting the yields of AAA-rated corporate bonds from those of single-A-rated corporate bonds. This spread measures the additional compensation investors require to account for increased corporate default risk (Minton, 1997; Fehle, 2003). The corporate bond yield spreads used in our analysis were sourced from BAML indices.

The yield curve slope (SLOPE) is determined by subtracting the one-year government yield from the n-year government yield, following the methodology introduced by Eom et al. (2000) and utilized by Fehle (2003). For example, to compute the 5-year swap term spread, we subtracted the 1-year Treasury yields from the 5-year Treasury yields. The FRED database was the source of LIBOR and Treasury bond rates. Swap rate volatility is measured using the implied rate volatility derived from the Credit Suisse interest rate volatility index. Mortgage option-adjusted duration (MTGEDUR) for the Bloomberg-Barclays Mortgage-Backed Index was pulled from Bloomberg. The proxy for credit risk of the United States Treasury is the 5-year U.S. CDS spread retrieved from IHS-Markit. Growing debt to gross domestic product (GDP) levels in the U.S. have investors more concerned over the probability of default on U.S. debt (Du et al., 2018; Krishnamurthy & Vissing-Jorgensen, 2012). The relative credit risk priced into swaps vs U.S. Treasuries will directly impact the level of swap spreads and is an important factor to add to this analysis.

Summary statistics and correlation coefficients of key data are presented in Tables 1 and 2, respectively.

Table 1. Descriptive information for key variables

Variable	*Mean*	*Median*	*Std. Dev.*	*Min*	*Max*
SSPR2	0.199	0.170	0.091	0.000	0.540
SSPR5	0.183	0.160	0.091	-0.090	0.480
SSPR10	0.110	0.110	0.053	-0.070	0.350
TLP	0.263	0.220	0.094	0.100	0.570
CP_RISK	0.647	0.410	0.493	0.010	1.690
SLOPE2	0.221	0.196	0.120	0.050	0.588
SLOPE5	1.089	1.197	0.430	0.390	2.048
SLOPE10	2.147	2.077	0.483	1.260	3.328
MTGEDUR	4.211	4.310	1.000	2.200	5.860
SWAPVOL	0.718	0.677	0.160	0.456	1.171
USCDS	0.334	0.325	0.124	0.153	0.644

Note: Data includes the pre-clearing, clearing, and SEF trading periods: 986 observations from 3/21/2011 to 2/27/2015. Slope names correspond to each tenor. E.g., SLOPE2 is the slope between 2y and 1y tenors, and SLOPE5 is the slope between the 5y and 1y tenors.

Table 2. Correlation matrix of key variables

	SSPR2	*SSPR5*	*SSPR10*	*TLP*	*CP_RISK*	*SLOPE2*	*SLOPE5*	*SLOPE10*	*MTGEDUR*	*SWAPVOL*	*USCDS*
SSPR2	1.0000	0.8903	0.4429	0.8264	0.7086	-0.1692	-0.2690	-0.2858	-0.5001	0.5661	0.4557
SSPR5	0.8903	1.0000	0.4846	0.7835	0.8161	-0.3622	-0.3904	-0.2533	-0.5439	0.5872	0.6882
SSPR10	0.4429	0.4846	1.0000	0.1922	0.0462	0.0733	0.0993	0.0336	0.1565	0.4264	0.0026
TLP	0.8264	0.7835	0.1922	1.0000	0.8070	-0.4308	-0.5250	-0.4620	-0.6798	0.3923	0.5276
CP_RISK	0.7086	0.8161	0.0462	0.8070	1.0000	-0.4957	-0.5684	-0.4041	-0.8012	0.4913	0.8001
SLOPE2	-0.1692	-0.3622	0.0733	-0.4308	-0.4957	1.0000	0.8928	0.6382	0.6043	0.0658	-0.5784
SLOPE5	-0.2690	-0.3904	0.0993	-0.5250	-0.5684	0.8928	1.0000	0.8925	0.8310	0.1099	-0.5063
SLOPE10	-0.2858	-0.2533	0.0336	-0.4620	-0.4041	0.6382	0.8925	1.0000	0.8044	0.1897	-0.2006
MTGEDUR	-0.5001	-0.5439	0.1565	-0.6798	-0.8012	0.6043	0.8310	0.8044	1.0000	-0.1126	-0.5729
SWAPVOL	0.5661	0.5872	0.4264	0.3923	0.4913	0.0658	0.1099	0.1897	-0.1126	1.0000	0.3769
USCDS	0.4557	0.6882	0.0026	0.5276	0.8001	-0.5784	-0.5063	-0.2006	-0.5729	0.3769	1.0000

3.2. Research methodology

3.2.1. Ordinary least squares regression

We investigate differences in factors affecting swap spreads across three significant periods: the "pre-clearing" phase, phase 1 of central clearing ("mandatory clearing"), and phase 2 of central clearing ("SEF trading"), as illustrated in Figure 1. To accomplish this, we employed three OLS regression models, each focused on a specific swap spread tenor. The first model, presented below, incorporates key drivers of swap spreads found in prior literature.

$$\Delta SSPR = \alpha + \beta_1[\Delta TLP] + \beta_2[\Delta CP\_RISK] + \beta_3[\Delta SLOPE] + \beta_4[\Delta SWAPVOL] + \beta_5[\Delta MTGEDUR] + \beta_6[\Delta USCDS] \quad (1)$$

SSPR refers to the swap spread associated with either the 2-year, 5-year, or 10-year tenor. *TLP* is the Treasury liquidity premium. *CP_RISK* signifies the swap counterparty default risk determined by the corporate quality spread. *SLOPE* represents the term spread for U.S. Treasury bonds across the maturity spectrum. *SWAPVOL* is the implied swap volatility. *MTGEDUR* corresponds to the option-adjusted duration of the Barclays U.S. MBS index, and *USCDS* refers to the 5-year credit default swap spread of the U.S. Treasury.

We utilized Eq. (1) in a baseline regression for the period following the financial crisis until just before the mandatory central clearing enforcement (7/1/2009 to 3/18/2013), with results presented in Table B.1 in Appendix B. These findings are purely informational, aiming to establish a foundational reference point for regression relationships before the central clearing implementation. However, our primary focus in this study centers on the more detailed partitioned analysis outlined below.

$$\Delta SSPR = \alpha + \beta_1[\Delta TLP * PRECLR] + \beta_2[\Delta TLP * MAND] + \beta_3[\Delta TLP * SEF] + \beta_4[\Delta CP\_RISK * PRECLR] + \beta_5[\Delta CP\_RISK * MAND] + \beta_6[\Delta CP\_RISK * SEF] + \beta_7[\Delta SLOPE * PRECLR] + \beta_8[\Delta SLOPE * MAND] + \beta_9[\Delta SLOPE * SEF] + \beta_{10}[\Delta SWAPVOL * PRECLR] + \beta_{11}[\Delta SWAPVOL * MAND] + \beta_{12}[\Delta SWAPVOL * SEF] + \beta_{13}[\Delta MTGEDUR * PRECLR] + \beta_{14}[\Delta MTGEDUR * MAND] + \beta_{15}[\Delta MTGEDUR * SEF] + \beta_{16}[\Delta USCDS * PRECLR] + \beta_{17}[\Delta USCDS * MAND] + \beta_{18}[\Delta USCDS * SEF] \quad (2)$$

Equation (2) integrates the explanatory variables from Eq. (1) alongside interaction variables. These interaction variables are formed by multiplying the value of each variable by a dummy, which takes the value of 1 during one of the three tested sub-periods and 0 otherwise. *PRECLR* is the period before the CFTC's requirement for central clearing. *MAND* represents the period right after central clearing implementation, which is separate and distinct from the required SEF trading period that followed. The coefficient for each interaction represents the impact the variable has on the swap spread in that given period.

1) *Pre-clearing:* Period prior to the clearing mandate (3/21/2011–3/10/2013).

2) *Mandated clearing:* Beginning of the mandatory clearing period up to the start of the SEF trading requirement (3/11/2013–2/14/2014).

3) *SEF trading:* Beginning of SEF trading requirement (2/18/2014–2/27/2015).

These periods are structured symmetrically, with 493 days before the CFTC's first required clearing date and 493 days after. The second 493-day period is split between the mandated clearing and SEF trading periods. The sub-periods are also displayed graphically in Figure 1. The results of this regression analysis are presented in Table 3.

Figure 1. Testing periods

Pre-clearing March 2011–March 2013 (493 days)	**Mandated clearing** March 2013–February 2014 (235 days)	**SEF trading** February 2014–February 2015 (258 days)
Period before CFTC mandated clearing for IRS (493 days)	Period just after CFTC mandated clearing for IRS and just before the SEF trading requirement began (493 days)	Period just after the SEF trading requirement began

We opted for a fully partitioned approach, reporting each interaction variable individually, instead of the more common model with the variable capturing the main effect and interaction variables representing offsets to the main effect. Although both methodologies produce the same results, the fully partitioned approach offers several advantages, including ease of interpretation and clearer understanding, especially when there are multiple coefficients to be interpreted (Yip & Tsang, 2007).

We conducted all regressions using the first differences for each variable, incorporating Newey and West's (1987) standard errors. This approach effectively addressed challenges posed by non-stationarity, autocorrelation, and heteroscedasticity inherent in the time series data.

3.2.2. Stepwise regression

The partitioned regression in Table 3 provides a comprehensive view of the relevant factor relationships. To enhance methodological precision, we incorporate a forward stepwise regression, offering a more nuanced and statistically robust perspective by addressing multicollinearity and potential misspecification. In this estimation, we utilize the same variables as in Eq. (2) but allow the stepwise process to refine the outcomes. This supplementary analysis not only validates the overarching findings of the partitioned regression but also contributes to the interpretability and resilience of the model. The iterative variable selection process provides a heightened level of confidence in the results.

3.2.3. T-tests for changes in swap spreads

T-tests were conducted to assess Title VII's material impact on swap spread levels across three sub-periods. Specifically, we analyzed the average spread changes between all of the tested periods for all 3 tenors. Please refer to Table 5 to see the structure of the comparisons and the results. We established symmetry by using identical pre- and post-regulation intervals, each spanning 235 days, as this duration represents the shortest of the three timeframes. For robustness, we conducted similar tests on Finance AA-rated spreads to discern whether the observed swap spread changes were attributable to central clearing effects or reflective of broader market trends. A difference-in-difference (DID) test was employed to highlight the net effect between swap spreads and Finance AA spreads. These tests are similar to those used to evaluate the regulatory effects of Title VII on Corporate Bond Spreads and the CDS-Bond Basis (McAlley, 2022).

4. RESULTS

4.1. Ordinary least squares regression results

We ran a partitioned regression analysis on key variables that span across the three phases of our sample. Three significant findings emerge from this analysis. First, the impact of volatility on swap spreads experienced substantial changes. Examining Table 3 reveals shifts in the coefficients for two-year swap spreads, changing from 0.051 in the pre-clearing period to 0.069 during mandated clearing, and further to -0.128 in the SEF trading period. This pattern is also observed in the 5-year and 10-year tenors. In the pre-clearing phase, volatility lacks statistical significance. However, with the onset of central clearing and SEF trading, volatility becomes a notable and significant explanatory variable. Importantly, during SEF trading, the observed impact indicates a tightening of spreads in response to increased volatility.

Second, the influence of the Treasury liquidity premium factor weakens with the introduction of central clearing and becomes statistically insignificant during the SEF period across all tenors. The TLP displays varying strength and significance throughout the pre-clearing, mandatory clearing, and SEF periods for both the 2-year and 5-year tenors. The coefficient linked to 2-year swap spreads decreases from a statistically significant +0.354 to +0.176 between the pre-clearing and clearing periods. Following the initiation of SEF trading, the TLP experienced a further decline to +0.149 and loses statistical significance. Comparable patterns are observed in the results for 5-year tenors, where TLP exerts significant impacts on swap spreads during the pre-clearing period but fails to maintain significance once swaps begin clearing and are required to trade via SEFs. Additionally, TLP does not exhibit a significant impact on 10-year swap spreads throughout any period, but this result is consistent with prior findings suggesting that TLP has no impact on longer tenors (Hamano, 1997; Ito, 2014; Tah, 2022).

Additionally, we ran a baseline regression to show the impact empirically tested determinants had on swap spreads after the financial crisis but before the Dodd-Frank regulation. Results are presented in Table B.1 in Appendix B and are consistent with extant literature. The purpose of this baseline regression was to highlight relationships from before the regulation was enacted following the financial crisis. They can be used for comparison purposes and to corroborate the results from prior literature.

Table 3. Estimates of OLS regression coefficients stratified by stages of the regulation (Part 1)

Variable	*2y SSPR*	*5y SSPR*	*10y SSPR*
TLP_PRECLEAR	0.354***	0.262**	0.047
	(0.104)	(0.130)	(0.147)
TLP_MANDATED	0.176**	0.154	0.114
	(0.077)	(0.169)	(0.188)
TLP_SEF	0.149	0.256	0.185
	(0.116)	(0.211)	(0.232)
CP_RISK_PRECLEAR	-0.001	-0.002	-0.002
	(0.001)	(0.001)	(0.001)
CP_RISK_MANDATED	-0.023	0.052	0.101
	(0.056)	(0.156)	(0.170)
CP_RISK_SEF	0.013	0.022	0.027
	(0.081)	(0.147)	(0.140)
SLOPE_PRECLEAR	-0.759***	-0.676***	-0.505***
	(0.083)	(0.142)	(0.102)
SLOPE_MANDATED	-0.638***	-0.568***	-0.575***
	(0.068)	(0.162)	(0.159)
SLOPE_SEF	-0.712***	-0.514***	-0.441***
	(0.087)	(0.096)	(0.087)
SWAPVOL_PRECLEAR	0.051	0.027	-0.008
	(0.037)	(0.043)	(0.049)
SWAPVOL_MANDATED	0.069*	0.192**	0.163*
	(0.036)	(0.094)	(0.085)

Table 3. Estimates of OLS regression coefficients stratified by stages of the regulation (Part 2)

Variable	*2y SSPR*	*5y SSPR*	*10y SSPR*
SWAPVOL_SEF	-0.128***	-0.239**	-0.211**
	(0.046)	(0.094)	(0.082)
MTGEDUR_PRECLEAR	0.017	0.0808*	0.051
	(0.017)	(0.048)	(0.041)
MTGEDUR_MANDATED	0.017	0.077	0.127
	(0.018)	(0.076)	(0.095)
MTGEDUR_SEF	0.0499**	0.053	0.047
	(0.023)	(0.048)	(0.049)
USCDS_PRECLEAR	0.067	-0.228	-0.358**
	(0.092)	(0.146)	(0.157)
USCDS_MANDATED	0.0940	0.086	0.084
	(0.054)	(0.139)	(0.143)
USCDS_SEF	0.056	0.330	0.425
	(0.220)	(0.331)	(0.316)
N	986	986	986
Adj. R-square	0.245	0.246	0.216

Note: This table reports OLS regression results for each key determinant of swap spreads. Each independent variable is partitioned using interaction variables to represent the impact the variable has on swap spreads during three distinct periods. The first period is the "Preclear" period which is the period before interest rate swaps were mandated for clearing by the (CFTC). The post-clearing period is split into two. First, the "Mandated" period is the period after central clearing was implemented, but before the requirement of SEF trading. Second, the "SEF" period is the period after SEF trading was required as part of the regulation. Results are partitioned to show each period's unique impact on swap spreads for all three tenors. For example, the coefficient for TSY_LIQ_PREM_PRECLEAR is the impact changes in this variable had on Swap spreads during the pre-clearing period.
****, **, and * represent significance levels at the 1%, 5%, and 10% levels. Standard errors are in parentheses.*

Table 4. Estimates of forward stepwise regression

Variable	*2y SSPR*	*5y SSPR*	*10y SSPR*
TLP_PRECLEAR	0.352***		
	(0.106)		
TLP_MANDATED	0.164**		
	(0.083)		
SLOPE_PRECLEAR	-0.728***	-0.663***	-0.422***
	(0.064)	(0.116)	(0.044)
SLOPE_MANDATED	-0.712***	-0.453***	-0.378***
	(0.077)	(0.065)	(0.053)
SLOPE_SEF	-0.616***	-0.487***	-0.435***
	(0.071)	(0.122)	(0.100)
MTGEDUR_PRECLEAR		0.0803*	
		(0.048)	
MTGEDUR_SEF	0.0490**		
	(0.023)		
SWAPVOL_PRECLEAR	0.0617*		
	(0.036)		
SWAPVOL_MANDATED	0.0849**	0.212*	0.194*
	(0.034)	(0.112)	(0.109)
SWAPVOL_SEF	-0.129***	-0.252***	-0.219***
	(0.043)	(0.086)	(0.076)
USCDS_PRECLEAR			-0.338**
			(0.149)
N	986	986	986
Adj. R-square	0.246	0.242	0.213

Note: This table reports forward stepwise regression results for the key determinants of swap spreads outlined in Table 3 and from Eq. (2). The key variables are partitioned using interaction variables to represent the impact the variable has on swap spreads during three distinct periods. The first period is the "Preclear" period which is the period before interest rate swaps were mandated for clearing by the (CFTC). The post-clearing period is split into two. First, the "Mandated" period is the period after central clearing was implemented, but before the requirement of SEF trading. Second, the "SEF" period is the period after SEF trading was required as part of the regulation. Results are partitioned to show each period's unique impact on swap spreads for all three tenors. For example, the coefficient for TSY_LIQ_PREM_PRECLEAR is the impact changes in this variable had on swap spreads during the pre-clearing period.
****, **, and * represent significance levels at the 1%, 5%, and 10% levels. Standard errors are in parentheses.*

4.2. Stepwise regression results

To reinforce the reliability of our results and mitigate issues of overfitting and multicollinearity, we conducted forward stepwise regression alongside the partitioned OLS. The outcomes, detailed in Table 4, corroborate the key findings presented in Table 3. Following the introduction of SEF trading, curve slope, and swap volatility emerge as key drivers of swap spreads across various tenors. Notable exceptions include the significant impact of mortgage duration on 2-year swap spreads and USCDS on 10-year swap spreads.

For the 2-year tenor, numerous explanatory variables served as drivers of swap spreads. Only a few were excluded from the model compared to the partitioned analysis. These exclusions include TLP in the SEF period, mortgage duration before SEF trading, and USCDS, which was not a factor in any period. For 5-year swaps, there was a reduction in the number of explanatory variables incorporated into the model. These comprised of curve slope in all periods, swap volatility in all periods except for pre-clearing, and mortgage duration only in the pre-clearing period. For 10-year swaps, the model produced the same significant variables with two exceptions. Mortgage duration ceased to contribute to the model, and USCDS emerged as a significant determinant of swap spreads with a -0.338 coefficient. Importantly, the stepwise model was consistent in showing the altered impact of swap volatility on swap spreads post-SEF trading, emphasizing the shift from a positive to a negative association.

4.3. T-tests: Changes in swap spread levels during the regulatory transition

Due to the substantial impact of Title VII on the IRS market, we examined whether discernible changes occurred in swap spread levels during the transition from the pre-regulation period to the post-regulation period. Our analysis revealed a statistically significant decrease in swap spread levels following the implementation of Title VII. Specifically, 2-year swap spreads witnessed an 8.8 basis point reduction after the initiation of central clearing, followed by a subsequent 1.5 basis point widening after the commencement of SEF trading. These results were derived by comparing the average spread within each period, contrasting the pre-clearing period with each of the mandated phases. Similar trends were observed for the 5 and 10-year tenors, where swap spreads contracted by 3.3 and 0.7 basis points, respectively. Notably, there was an insignificant spread change between the mandated clearing and SEF trading periods for the 5 and 10-year tenors.

4.4. Robustness of t-tests

Given that the changes in spreads during clearing periods may stem from factors other than central clearing or SEF trading, we conducted a comparable t-test employing Finance AA credit spreads across all tenors. Bond spreads of financial companies exhibit a relatively strong correlation with swap spreads (Chung & Chan, 2010; Toyoshima, 2012). The aim was to examine whether the tightening of swap spreads was primarily related to the new regulation or if there was a broader spread tightening trend in the overall markets during the same time frame.

To show the net impact, we performed a DID test to estimate the impact Title VII had on swap spreads considering the general spread tightening in the markets over the same period. The DID analysis shows that relative to FIN AA spreads, swap spreads were effectively wider during the regulatory transition. For example, between the pre-clearing and mandated periods, 2-year swap spreads decreased by 8.8 basis points, while 2-year Finance spreads declined by 28.3 basis points over the same duration. The comparison shows that swap spreads were effectively wider by 19.5 basis points when you consider them relative to the movement in Finance spreads. In the context of 5-year spreads, the DID spread indicates that 5-year swap spreads were effectively wider by 32.1 basis points, and 10-year swap spreads were effectively 46 basis points wider relative to Finance AA spreads.

Table 5. Difference-in-difference analysis: T-tests of spread changes between periods

Comparison periods	*Δ in 2y SSPR*	*Δ in 2y FINAA*	*DID*
PreClr - Mandated	-8.8***	-28.3***	19.5***
PreClr - SEF	-7.3***	-28.7***	21.4***
Mandated - SEF	1.5***	-0.4***	1.9***
	Δ in 5y SSPR	*Δ in 5y FINAA*	*DID*
PreClr - Mandated	-3.3***	-35.4***	32.1***
PreClr - SEF	-3.4***	-40.3***	36.9***
Mandated - SEF	-0.1	-4.9***	4.8***
	Δ in 10y SSPR	*Δ in 10y FINAA*	*DID*
PreClr - Mandated	-0.7***	-46.7***	46.0***
PreClr - SEF	-0.7***	-48.5***	47.8***
Mandated - SEF	0.0	-1.8	1.8

Note: Each value represents the change in the spread between the two periods indicated. For example, the values for "Pre-Clr – Mandated" are the changes in spreads from before the clearing requirement was imposed to after it was imposed. The DID column is the difference in the spread changes between SSPR and FIN AA. Period windows are 235 days to match the lowest of the three periods for consistency (see Figure 1).
****, **, and * represent significant levels at the 1%, 5%, and 10% levels.*

5. DISCUSSION

5.1. Swap volatility

The results show that swap volatility has historically had a positive association with swap spreads. This suggests that as volatility rises, swap spreads widen as a result and this volatility is priced into IRS in the form of higher rates relative to Treasuries. However, one of the key takeaways from these results is that after SEF trading began, this association turned negative. This marks a shift compared to the patterns found in existing literature. The shift in direction suggests that IRS may have become a more reliable hedging tool or a safe-haven asset after SEF trading began. This result is a departure from prior studies and holds important implications for swaps in their role in risk mitigation and portfolio management relative to U.S. Treasuries. The advantages of SEF trading offer increased transparency and liquidity in transactions, potentially altering trader preferences when hedging or seeking flight to safety. This could enhance the instrument's usability compared to other liquid assets like U.S. Treasury bonds and Treasury Bond futures.

5.2. Treasury liquidity premium

The results show that TLP is no longer a significant determinant of swap spreads post-clearing. This represents a major departure from the existing literature dating back to Grinblatt (2001), who was the first to find that the TLP or convenience yield of U.S. Treasuries had significant explanatory power on swap spreads. These new findings post-clearing and

SEF trading align with Klingler and Sundaresan (2023), who provide additional insights into the diminishing effect of TLP. Their study did not specifically analyze the impact of TLP over the central clearing and SEF trading implementation periods, which our research helps to illuminate.

5.3. Yield curve slope

The yield curve slope is the sole significant and consistent determinant across all models and periods. Changes in *SLOPE* exhibit a stronger negative association with swap spreads in shorter tenors when compared to longer tenors. Once SEF trading began, only two significant explanatory variables significantly impacted swap spreads for all three tenors: curve slope and swap volatility. Both variables are directly related to the economics of the swap as the curve slope aids in the determination of the break-even swap rate and implied volatility can impact the variability of the floating rate in a standard, fixed-for-floating, interest rate swap.

5.4. Spread changes

Post clearing, swap spreads narrowed suggesting that the regulation had a positive impact on swap spreads. As a result of the DID robustness test, we find that Finance AA spreads also exhibited a spread tightening during both the mandated and SEF periods across all tenors. Although there may be variation in magnitude, the overall trend of spread movements remains consistent. Consequently, it becomes more challenging to definitively attribute the primary cause of the spread tightening in swap spreads solely to the implementation of the regulation for interest rate swaps. This is because the broader credit markets also witnessed a concurrent tightening of spreads during these periods. Therefore, this narrowing of swap spreads was likely associated with the broader trend of spread tightening observed in the fixed-income markets, rather than being directly impacted by the implementation of the regulation itself.

5.5. Other observations

The counterparty risk factor does not represent a significant driver of swap spreads. This finding aligns with improved risk management practices and enhanced collateralization prior to the financial crisis and the risk mitigating measures implemented by the Dodd-Frank Title VII Act.

Implied default risk for U.S. Treasuries has a significant impact on 10-year swap spreads pre-clearing. This result suggests that as implied Treasury default premiums increase there is a tightening of swap spreads. This is rational, given that longer tenor instruments have more sensitivity to credit spread changes. As Treasury credit concerns increase, Treasury yields will increase relative to swap spreads and lead to tighter swap spreads. Therefore, longer tenor swap spreads are impacted by the perceived deterioration of the U.S. Government's credit quality.

6. CONCLUSION

We observe a negative association between implied swap volatility and swap spreads following the implementation of SEF trading. This finding represents a departure from previous literature, where this relationship conventionally exhibited a positive association before the advent of SEF trading. This may suggest that there is an increased preference for the IRS as a hedging instrument or flight to safety asset relative to U.S. Treasuries in the SEF trading environment. This outcome aligns logically with the various enhancements facilitated by trading on SEFs. Namely, mandatory electronic trading, greater price transparency, and liquidity. Second, we highlight the diminished impact of the TLP factor on swap spreads during the central clearing and SEF periods. The results were most notable in the SEF trading period where TLP had no impact across all tenors. This finding is significant relative to the extensive research conducted over the past 20 years. It represents a notable change in the relationship between this factor and swap spreads, which was initially tested by Duffie and Singleton (1997) and Grinblatt (2001). Treasury liquidity premium has consistently been recognized as a significant determinant of swap spreads in numerous studies and carries little to no significance in the environment of post-central clearing and SEF trading. Third, our analysis reveals that yield curve slope remains the sole significant and consistent determinant of swap spreads throughout all models and periods. Last, we find a tightening of swap spreads after central clearing and SEF trading. However, robustness tests reveal that the tightening in swap spreads was likely due to the broader trend of spread tightening observed in the fixed-income markets rather than being tied to the regulation.

In addition to the main findings, there were other observations worth mentioning. Counterparty default risk had no significant impact on swap spreads during the sample period. We also find a positive and significant effect of implied default risk for U.S. Treasuries on 10-year swap spreads. As credit default swap premiums rise on U.S. debt, swap spreads tighten. This outcome suggests that the increase in the perceived default risk of Treasuries has a meaningful impact on swap spreads.

These results indicate that Title VII of Dodd-Frank has significantly influenced the historically observed relationships between swap spreads and their key determinants. However, show a less material impact on the tightening of swap spreads.

This study has limitations and implications for future research. First, it underscores the need to explore new and significant drivers of swap spreads within this transformed regulatory landscape. Second, future work could test if IRS trading in the new SEF framework has become more efficient relative to Treasury bonds or Treasury futures as a hedging instrument or haven asset during times of high volatility. Last, future studies could benefit from embracing a stochastic approach, incorporating a Markov switching model to better capture the nuanced and endogenous shifts within the system.

REFERENCES

1. Acharya, V. V., Engle, R., Figlewski, S., Lynch, A., & Subrahmanyam, M. (2009). Centralized clearing for credit derivatives. *Financial Markets, Institutions & Instruments, 18*(2), 168–170. https://doi.org/10.1111/j.1468-0416.2009.00147_17.x
2. Acharya, V., & Bisin, A. (2014). Counterparty risk externality: Centralized versus over-the-counter markets. *Journal of Economic Theory, 149,* 153–182. https://doi.org/10.1016/j.jet.2013.07.001
3. Asgharian, H., & Karlsson, S. (2008). An empirical analysis of factors driving the swap spread. *The Journal of Fixed Income, 18*(2), 41–56. https://doi.org/10.3905/jfi.2008.712349
4. Augustin, P., Chernov, M., Schmid, L., & Song, D. (2021). Benchmark interest rates when the government is risky. *Journal of Financial Economics, 140*(1), 74–100. https://doi.org/10.1016/j.jfineco.2020.10.009
5. Benos, E., Payne, R., & Vasios, M. (2020). Centralized trading, transparency, and interest rate swap market liquidity: Evidence from the implementation of the Dodd–Frank Act. *Journal of Financial and Quantitative Analysis, 55*(1), 159–192. https://doi.org/10.1017/S0022109018001527
6. Biais, B., Heider, F., & Hoerova, M. (2012). *Clearing, counterparty risk and aggregate risk* (ECB Working Paper No. 1481). https://doi.org/10.2139/ssrn.2150295
7. Chung, H.-L., & Chan, W.-S. (2010). Impact of credit spreads, monetary policy and convergence trading on swap spreads. *International Review of Financial Analysis, 19*(2), 118–126. https://doi.org/10.1016/j.irfa.2010.01.004
8. CME Group. (2020). *CME clearing risk management and financial safeguards*. https://www.cmegroup.com /clearing/files/financialsafeguards.pdf
9. Collin-Dufresne, P., & Solnik, B. (2001). On the term structure of default premia in the swap and LIBOR markets. *The Journal of Finance, 56*(3), 1095–1115. https://doi.org/10.1111/0022-1082.00357
10. Cont, R., & Kokholm, T. (2014). Central clearing of OTC derivatives: Bilateral vs multilateral netting. *Statistics & Risk Modeling, 31*(1), 3–22. https://doi.org/10.1515/strm-2013-1161
11. Cortes, F. (2003). *Understanding and modelling swap spreads* (Quarterly Bulletin 2003 Q4). Bank of England. https://www.bankofengland.co.uk/quarterly-bulletin/2003/q4/understanding-and-modelling-swap-spreads
12. Culp, C. L. (2010). OTC-cleared derivatives: Benefits, costs, and implications of the "Dodd-Frank Wall Street Reform and Consumer Protection Act". *Journal of Applied Finance, 20*(2). https://ssrn.com/abstract=2693059
13. Du, W., Im, J., & Schreger, J. (2018). U.S. treasury premium. *Journal of International Economics, 112,* 167–181. https://doi.org/10.1016/j.jinteco.2018.01.001
14. Duffie, D., & Singleton, K. J. (1997). An econometric model of the term structure of interest-rate swap yields. *The Journal of Finance, 52*(4), 1287–1321. https://doi.org/10.1111/j.1540-6261.1997.tb01111.x
15. Eom, Y. H., Subrahmanyam, M. G., & Uno, J. (2000). *Credit risk and the yen interest rate swap market* (NYU Working Paper No. S-DRP-01-08). https://doi.org/10.2139/ssrn.218410
16. Estrella, A., & Hardouvelis, G. A. (1991). The term structure as a predictor of real economic activity. *The Journal of Finance, 46*(2), 555–576. https://doi.org/10.1111/j.1540-6261.1991.tb02674.x
17. Fama, E. F. (1984). Forward and spot exchange rates. *Journal of Monetary Economics, 14*(3), 319–338. https://doi.org/10.1016/0304-3932(84)90046-1
18. Fehle, F. (2003). The components of interest rate swap spreads: Theory and international evidence. *Journal of Futures Markets, 23*(4), 347–387. https://doi.org/10.1002/fut.10065
19. Feldhütter, P., & Lando, D. (2008). Decomposing swap spreads. *Journal of Financial Economics, 88*(2), 375–405. https://doi.org/10.1016/j.jfineco.2007.07.004
20. Garratt, R., Lee, M. J., Martin, A., & Townsend, R. M. (2019). *Who sees the trades? The effect of information on liquidity in inter-dealer markets* (Staff Report No. 892). Federal Reserve Bank of New York. https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr892.pdf
21. Grinblatt, M. (2001). An analytic solution for interest rate swap spreads. *International Review of Finance, 2*(3), 113–149. https://doi.org/10.1111/1468-2443.00022
22. Hamano, M. (1997). Empirical study of the yen interest rate swap spread. *Gendai Finance (Modern Finance), 1,* 55–67.
23. Hanson, S. G. (2014). Mortgage convexity. *Journal of Financial Economics, 113*(2), 270–299. https://doi.org/10 .1016/j.jfineco.2014.05.002
24. Henshall-Howard, J. (2011). *Driving swap spreads in South Africa: An investigation into the dominant factors influencing swap spreads in the South African market* [Master's thesis, University of Cape Town]. Open UCT. https://open.uct.ac.za/items/47070d18-5d54-4610-b857-8834eb188dc8
25. In, F., Brown, R., & Fang, V. (2003). Modeling volatility and changes in the swap spread. *International Review of Financial Analysis, 12*(5), 545–561. https://doi.org/10.1016/S1057-5219(03)00067-X
26. Ito, T. (2014). Global financial crisis and US interest rate swap spreads. *Applied Financial Economics, 20*(1–2: The Global Financial Crisis), 37–43. https://doi.org/10.1080/09603100903262921
27. Jermann, U. J. (2020). Negative swap spreads and limited arbitrage. *The Review of Financial Studies, 33*(1), 212–238. https://doi.org/10.1093/rfs/hhz030
28. Klingler, S., & Sundaresan, S. (2019). An explanation of negative swap spreads: Demand for duration from underfunded pension plans. *The Journal of Finance, 74*(2), 675–710. https://doi.org/10.1111/jofi.12750
29. Klingler, S., & Sundaresan, S. (2023). Diminishing treasury convenience premiums: Effects of dealers' excess demand and balance sheet constraints. *Journal of Monetary Economics, 135,* 55–69. https://doi.org/10.1016/j.jmoneco.2023.01.002
30. Krishnamurthy, A., & Vissing-Jorgensen, A. (2012). The aggregate demand for treasury debt. *Journal of Political Economy, 120*(2), 233–267. https://doi.org/10.1086/666526
31. Kwon, S. S. (2019). The value-relevance of fundamental signals and the impact of financial regulations on security valuation and earnings management. *Corporate Ownership & Control, 16*(3), 73–88. https://doi.org/10.22495 /cocv16i3art7
32. Lekkos, I., & Milas, C. (2001). Identifying the factors that affect interest-rate swap spreads: Some evidence from the United States and the United Kingdom. *Journal of Futures Markets: Futures, Options, and Other Derivative Products, 21*(8), 737–768. https://doi.org/10.1002/fut.1803
33. Liu, J., Longstaff, F. A., & Mandell, R. E. (2006). The market price of risk in interest rate swaps: The roles of default and liquidity risks. *The Journal of Business, 79*(5), 2337–2359. https://doi.org/10.1086/505237

34. Longstaff, F. A. (2002). *The flight-to-liquidity premium in US Treasury bond prices* (NBER Working Paper No. 9312). National Bureau of Economic Research. https://doi.org/10.3386/w9312
35. Loon, Y. C., & Zhong, Z. K. (2014). The impact of central clearing on counterparty risk, liquidity, and trading: Evidence from the credit default swap market. *Journal of Financial Economics, 112*(1), 91–115. https://doi.org/10.1016/j.jfineco.2013.12.001
36. Markit. (2009). *The CDS big bang: Understanding the changes to the global CDS contract and North American Conventions.*
37. McAlley, E. (2022). Bond spreads and CDS-bond basis: Impact of Dodd-Frank Title VII. *The Journal of Alternative Investments, 25*(2), 99–111. https://doi.org/10.3905/jai.2022.1.170
38. Minton, B. A. (1997). An empirical examination of basic valuation models for plain vanilla US interest rate swaps. *The Journal of Financial Economics, 44*(2), Article 251. https://doi.org/10.1016/S0304-405X(97)00005-6
39. Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica, 55*(3), 703–708. https://doi.org/10.2307/1913610
40. Nippani, S., & Smith, S. D. (2010). The increasing default risk of US Treasury securities due to the financial crisis. *Journal of Banking & Finance, 34*(10), 2472–2480. https://doi.org/10.1016/j.jbankfin.2010.04.005
41. Slive, J., Witmer, J., & Woodman, E. (2012). Liquidity and central clearing: Evidence from the credit default swap market. *Journal of Financial Market Infrastructures, 2*(1), 3–35. https://doi.org/10.21314/JFMI.2013.021
42. Sorensen, E. H., & Bollier, T. F. (1994). Pricing swap default risk. *Financial Analysts Journal, 50*(3), 23–33. https://doi.org/10.2469/faj.v50.n3.23
43. Sun, T.-S., Sundaresan, S., & Wang, C. (1993). Interest rate swaps: An empirical investigation. *Journal of Financial Economics, 34*(1), 77–99. https://doi.org/10.1016/0304-405X(93)90041-9
44. Tah, K. A. (2022). Determinants of Interest rate swap spreads: A quantile regression approach. *Journal of Economics and Finance, 46*(3), 522–534. https://doi.org/10.1007/s12197-022-09574-y
45. Toyoshima, Y. (2012). Determinants of interest rate swap spreads in the US: Bounds testing approach to cointegration. *Applied Financial Economics, 22*(4), 331–338. https://doi.org/10.1080/09603107.2011.613757
46. Yip, P. S. L., & Tsang, E. W. K. (2007). Interpreting dummy variables and their interaction effects in strategy research. *Strategic Organization, 5*(1), 13–30. https://doi.org/10.1177/1476127006073512

APPENDIX A. SUMMARY OF CLEARINGHOUSE RISK MANAGEMENT WATERFALL

An example from the Chicago Mercantile Exchange (CME Group, 2020):

The risk management waterfall typical of a clearinghouse following a clearing member default or inability to otherwise fulfill their obligations follows a well-designed process. First, all parties to a cleared transaction must post what is referred to as a "performance bond" or initial margin (IM). The initial margin is considered a safety deposit for any potential future performance or default issues and generally represents an expected worst-case loss amount based upon the size and risk of the open position. IM is set upon the initiation of the trade and can be altered at the clearing house's discretion in reaction to material changes in market dynamics. Second, as derivative positions change value each day, the counterparty who is out of the money must post a "mark to market" margin or variation margin (VM) to the party which is in the money or has a gain on their position. This protects the party with the market gain from the replacement cost of the swap. Third, the clearing house will use the defaulting clearing member's contributions to the guaranty fund. Each clearing member or clearing broker (CB) is required to contribute to a guaranty fund. The guaranty fund is meant to cover tail risk losses which may arise from extreme conditions. At the CME, the guaranty fund is sized to cover the simultaneous default of the two largest clearing members. Fourth, the clearing house's own first loss contribution will be utilized. Clearing houses are required to contribute their own capital; holding them more accountable for their decision-making and risk management practices. Fifth, the non-defaulting clearing brokers' guaranty fund contributions will be utilized. The mutualization of risk is considered a key benefit of CCPs vs. bilateral (Culp, 2010). Last, the clearing house will use its assessment powers to have non-defaulting members replenish the guaranty fund.

APPENDIX B. BASELINE REGRESSION

Table B.1. Baseline estimates of OLS regression coefficients (post-crisis through pre-clearing)

Variable	*2y SSPR*	*5y SSPR*	*10y SSPR*
TLP	0.256***	0.139	0.040
	(0.079)	(0.123)	(0.137)
CP_RISK	0.008	0.023	0.030
	(0.029)	(0.041)	(0.043)
SLOPE	-0.641***	-0.543***	-0.464***
	(0.061)	(0.083)	(0.070)
SWAPVOL	0.126***	0.142***	0.123***
	(0.030)	(0.035)	(0.038)
MTGEDUR	0.007	0.018*	0.003
	(0.012)	(0.033)	(0.029)
USCDS	-0.016	-0.243**	-0.343***
	(0.062)	(0.097)	(0.107)
N	924	924	924
Adj. R-square	0.213	0.240	0.226

Note: This table reports OLS baseline regression results for key determinants of swap spreads from after the financial crisis of 2008–2009 ending before mandated clearing. The time frame for this analysis is prior to the time frame of the primary analysis and is used for comparative purposes (period: 7/1/2009–3/8/2013).
****, **, and * represent significance levels at the 1%, 5%, and 10% levels. Standard errors are in parentheses.*