Enhancing Bank Robustness through Dynamic Control of Leverage (DCL) in Contingent Convertible Bonds (CoCos): A Case Study Analysis

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List of Symbols

Symbol	Description
$PV(.)$	Present Value
$D(.)$	Discount Factor
$\mathbb{E}_t[.]$	Expected Value
$e^{(.)}$	Exponential Function
$N(.)$	Standard Normal Cumulative Distribution Function
$N'(.)$	Probability Density Function of the Normal Distribution
$N_2(.)$	Bivariate Standard Normal Cumulative Distribution Function
$\mathbb{P}(.)$	Probability
$\mathbb{1}(.)$	Indicator function

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Abstract

Contingent Convertible (CoCo) bonds were introduced to strengthen bank stability by automatically converting debt into equity during financial distress. However, recent and historical bank failures, such as the collapse of Credit Suisse, have highlighted critical weaknesses in their design, including vulnerability to regulatory discretion and market panic. This study analyses a novel framework—Dynamic Control of Leverage (DCL) CoCo bonds—that addresses these limitations through gradual and predictable conversions triggered by continuous leverage monitoring. Using historical market data from Refinitiv Eikon, this study simulates DCL performance in three case studies—Credit Suisse, Deutsche Bank, and Lehman Brothers—to evaluate its effectiveness across varied crisis scenarios.

Results indicate that in the Credit Suisse simulation, DCL significantly mitigated risk and delayed the bank's collapse. In the Deutsche Bank case, the framework provided proactive stabilization of capital levels, mitigating a potential failure. However, during Lehman Brothers' swift systemic collapse, DCL had limited impact, underscoring its constraints under extreme conditions. These comparative results highlight DCL's strengths in bolstering bank resilience and its limitations in the face of rapid systemic failures. By providing empirical insights through real-data simulations, this research underscores DCL's potential as a more effective and transparent mechanism for enhancing bank robustness compared to conventional CoCo instruments.

Keywords: Contingent Convertible Bonds, Dynamic Control of Leverage, Banking stability

List of Abbreviations

Abbreviation	Description
AT1	Additional Tier 1
C	Conversion (to equity)
CET1	Core Equity Tier 1
CoCo	Contingent Convertible
DCL	Dynamic Control of Leverage
ERN	Equity Recourse Note
PONV	Point of non viability

Chapter 1

Introduction

The global financial crises of 2008 and the collapse of Credit Suisse in 2023 have underscored critical vulnerabilities in bank capital structures. In response to the 2008 crisis, regulators introduced contingent convertible bonds (CoCos) as a mechanism to bolster bank resilience by automatically converting debt into equity during distress, thereby aiming to avoid taxpayer-funded bailouts [1]. However, traditional CoCo bonds with fixed capital ratio triggers have shown significant limitations. They can fail to trigger conversions in time or create market uncertainty - as seen in Credit Suisse's 2023 failure, where $17 billion in CoCo (AT1) bonds were abruptly written down, highlighting a breakdown in the intended loss-absorbing mechanism. These events point to the need for more effective tools to enhance bank robustness and prevent such destabilizing outcomes [2] [3].

This thesis project analyses the novel Dynamic Control of Leverage (DCL) framework as an alternative approach to conventional CoCos designed to mitigate these shortcomings. DCL-based CoCo instruments monitor a bank's leverage and trigger debt-to-equity conversions dynamically, rather than relying on a single static threshold. By allowing proactive and gradual recapitalization to sensible leverage ratios, the DCL framework is expected to keep a bank's leverage within safe bounds and minimize the likelihood of default. In essence, DCL CoCos aim to provide the flexibility to shore up capital before a crisis point is reached, addressing problems of delay or inflexibility in traditional CoCo triggers [4].

The aims of this research are twofold. First, it seeks to evaluate whether DCL-driven CoCo bonds can more effectively maintain bank stability compared to traditional CoCos. Secondly, it investigates how applying DCL might alter outcomes in real-world scenarios. Specifically, the following research questions will be addressed:

- *How effective is the Dynamic Control of Leverage (DCL) framework in stabilizing banks during periods of financial distress compared to traditional CoCo* *bonds?*

- *To what extent can the implementation of DCL-based CoCo bonds mitigate financial distress and influence outcomes across different types of banking crises?*
- *What are the key parameters influencing the performance of DCL CoCo bonds, and how can they be optimized?*

To address these questions comprehensively, this thesis employs empirical simulations using historical financial data from three distinct banking crises—Credit Suisse, Deutsche Bank, and Lehman Brothers. These institutions represent varying degrees and types of financial distress, offering a robust testbed for assessing the Dynamic Control of Leverage (DCL) CoCo bonds under diverse crisis conditions.

The empirical simulations conducted in this research aim to verify the hypothesis that DCL-equipped CoCos can significantly improve a bank's ability to withstand financial shocks by enabling timely and controlled leverage adjustments. Specifically, the study explores whether such an approach would have mitigated the catastrophic outcomes observed in the Credit Suisse collapse in 2023, provided proactive stabilization under moderate distress scenarios, exemplified by Deutsche Bank, and how it would perform in the face of rapid systemic failures as exemplified by Lehman Brothers during the 2008 financial crisis.

This study offers several contributions. First, it advances the financial stability literature by exploring an innovative loss-absorbing instrument that could prevent bank failures more effectively than current tools. Second, it contributes to the CoCo bond literature by rigorously analyzing a dynamic trigger mechanism (DCL) through simulation and case study evidence. Third, it has strong policy implications and practical relevance: the findings can inform regulators and bank risk managers about improving capital regulation. If DCL CoCos prove effective, they could guide reforms in Additional Tier-1 capital requirements, helping policymakers strengthen the resilience of banks and reduce systemic risk.

Overall, by demonstrating the potential benefits of dynamically controlled leverage in CoCo bonds, this research is expected to show that DCL can enhance bank robustness and stability. Under the DCL framework, it is anticipated that a bank like Credit Suisse would experience a more timely, gradual and controlled capitalization process during distress, potentially averting the abrupt collapse witnessed in 2023. Such expected results would underscore DCL's value as a tool for financial stability, bridging a critical gap in current risk management practices.

Chapter 2

Literature Review

2.1 Overview of CoCo Bonds

Contingent Convertible (CoCo) bonds have gained prominence as financial instruments designed to stabilize banks during periods of financial distress. These bonds automatically convert into equity or are written down when a bank's capital falls below a predetermined threshold. CoCo bonds were introduced after the 2008 financial crisis to provide banks with an automatic mechanism for strengthening their capital base during distress [1]. These instruments aim to reduce reliance on government bailouts by ensuring that bondholders absorb losses before a bank's failure. Regulatory frameworks, including Basel III, have played a crucial role in shaping the issuance and structure of CoCo bonds by specifying minimum capital thresholds and loss-absorption mechanisms [5]. However, despite their intended function, CoCo bonds have faced criticism regarding their trigger mechanisms and market perception.

Notably, the design characteristics of CoCos, such as trigger level and loss-absorption method, influence their risk and pricing. For example, CoCos with higher trigger levels or principal write-down (PWD) features tend to offer higher yields at issuance than those with lower triggers or equity conversion features [5]. This reflects the greater risk to investors when conversion is more likely or more severe. Various pricing models have been proposed to value these hybrid instruments. De Spiegeleer and Schoutens, for instance, develop a derivatives-based framework to price CoCo bonds, applying it to early issues by Lloyds (2009) and Credit Suisse (2011). Their analysis quantifies the risks embedded in different CoCo structures and underscores how trigger conditions and conversion terms affect a CoCo's valuation [6].

The purpose of this literature review is to examine the development of CoCo bonds and their limitations, leading to the emergence of the DCL model. We explore how DCL improves upon existing CoCo frameworks by addressing issues related to dilution, regulatory uncertainty, and market volatility. This review is organized into key themes, including traditional CoCo bond structures, their regulatory challenges and criticisms, and the proposed advantages of the DCL approach. While the focus is primarily on the financial engineering literature, broader discussions on capital adequacy and financial stability are referenced where relevant.

2.2 Traditional Trigger Mechanisms

The 2023 Credit Suisse AT1 CoCo bond wipeout exemplified several inherent weaknesses in traditional CoCo designs. In that incident, AT1 bondholders were completely written off while shareholders still retained some value, an inversion of the usual loss hierarchy that shocked many market participants [2]. Note that although controversial, FINMA's decision to wipe out these bonds created a "healthy precedent" by reinforcing investor awareness of the high risks in such instruments. The global reaction – including divergent views from regulators outside Switzerland – underscores how design flaws and misperceptions about CoCos can erode market confidence. This controversy highlights the need to address longstanding criticisms of CoCo bonds in both regulatory and academic discussions.

Beyond these considerations, scholars have identified several structural weaknesses in conventional CoCo bond design. One major concern is that many CoCos carry low capital-ratio triggers (e.g. a Common Equity Tier 1 ratio around 5.125% to qualify as AT1), meaning conversion or write-down occurs only when the bank is already near failure. If the trigger threshold is set too low, the bank could slide into default before the CoCo ever converts, a scenario described as a *debt-induced collapse* where the instrument fails to recapitalize the firm in time [7], [8]. Compounding this issue, most AT1 CoCos include a discretionary point of non-viability (PONV) trigger that allows regulators to force conversion in extremis, adding further uncertainty for investors.

Additionally, the common use of accounting-based triggers (like regulatory CET1 ratios) has been widely criticized for its lack of transparency and responsiveness. The CET1 ratio is updated infrequently and can be influenced by accounting decisions, so relying on it makes the conversion decision backward-looking. This opacity and delay complicate investors' ability to assess conversion risk, potentially leading to mispricing or complacency in good times and then abrupt loss of confidence when conditions deteriorate [2].

To address such problems, researchers have proposed using market-based triggers (e.g. a threshold based on the bank's stock price), since market prices are forward-looking, objective, and continuously observable. A share-price trigger could in theory provide a timelier signal of distress, as it "encompasses all information known about the company" in real time [4]. However, pure market triggers carry their own challenges (such as the risk of self-fulfilling price spirals), so the optimal trigger design for CoCos remains an area of ongoing debate. Overall, the literature suggests that traditional CoCo bonds, as currently designed, may not always perform their intended role of smooth loss absorption and bank stabilization – a concern vividly illustrated by the Credit Suisse case and related studies.

2.2.1 Credit Suisse CoCo Wipeout and Market Reactions

The collapse of Credit Suisse in 2023 and the subsequent write-down of $17 billion worth of Additional Tier 1 (AT1) CoCo bonds by the Swiss Financial Market Supervisory Authority (FINMA) sent shockwaves through financial markets. Unlike traditional cases where equity holders bear losses first, the Credit Suisse case saw bondholders wiped out while shareholders retained some value. This inversion of the creditor hierarchy led to significant backlash and uncertainty surrounding CoCo bonds as a bail-in tool [2].

Regulators such as the European Central Bank (ECB) and the Bank of England responded by reaffirming their commitment to the conventional priority order in financial resolutions. The incident underscored the inherent risks and ambiguities in CoCo bond contracts, particularly those with discretionary triggers allowing regulators to make case-by-case determinations. Market reactions were immediate, with a sharp decline in AT1 bond prices globally and increased scrutiny of regulatory decision-making.

2.3 Introduction to DCL (Dynamic Control of Leverage) CoCo Bonds

In a recently published paper by Segal and Ólafsson, the authors present a novel framework for a contingent convertible bond called *Dynamic Control of Leverage* (DCL) *CoCo bond* [4]. The primary motivation behind this work is to address fundamental weaknesses in traditional CoCo bonds by introducing a mechanism that adapts dynamically to a firm's leverage levels, building on the work of Bulow and Klemperer (2015). The DCL model regulates a company's leverage by converting the traditional coupon payments of the bond to equity while a critical leverage threshold is breached. This process aims to enhance stability, prevent sudden large capital dilution (which has proven to be an issue for traditional CoCo bonds [2], and mitigate market panic compared to conventional CoCo bonds. The methodology integrates the leverage ratio as a transparent control variable, making the conversion process more predictable and reducing reliance on external regulatory intervention.

The contribution of the paper is significant as it presents an innovative alternative to existing CoCo bond structures, which have been criticized for their reliance on regulators. The DCL model provides an automated, self-regulating approach to leverage control, reducing risks associated with conventional CoCo conversions. This research is particularly relevant given recent financial crises (see Credit Suisse, SVN and FRB) and regulatory concerns over capital adequacy in financial institutions.

The authors define a stochastic model, assuming that equity follows geometric Brownian motion (GBM). Then they simulate several theoretical scenarios to demonstrate the model's effectiveness. The study also compares DCL with traditional CoCo bonds and other leverage-based financial instruments, establishing a clear advantage in terms of risk mitigation and predictability.

The technical standards align with established frameworks like the Basel III accords. The conversion mechanism, which limits dilution to interest payments rather than full principal amounts, is a logical improvement. The use of leverage as a trigger metric is a well-reasoned choice, as opposed to conventional models relying on accounting-based, or static triggers that are often subject to delays and discretion.

However, one potential limitation of the model is its reliance on simplified capital structure assumptions. While these assumptions help isolate the effects of DCL, real-world financial structures may introduce complexities not accounted for in the study. Furthermore, while the simulations suggest a reduction in default probability, additional empirical validation using real market data would strengthen the findings. That is particularly regarding potential risks associated with DCL implementation in different market environments.

This thesis aims to address these concerns by expanding the model to incorporate more complex capital structures and external economic factors, Conducting empirical testing with real-world data to validate simulation findings, and addressing potential risks related to investor perception and regulatory acceptance of the DCL model. It also aims to clarify the reduction in likelyhood of market panic and dilution risk, and how predictable their behaviour is affected compared to traditional CoCos.

In summary, the thesis by Segal and Ólafsson represents a valuable advancement in financial instruments for managing leverage and risk. With further empirical validation and refinements, the DCL framework has strong potential for practical application in financial markets in the current regulatory environment.

2.4 Empirical Gaps

Despite the substantial contributions of existing research, several empirical gaps persist in the literature surrounding CoCo bonds and specifically the DCL framework. First, while previous theoretical models and limited simulations exist, comprehensive empirical validations using historical datasets from real-world financial institutions are non-existent. Second, studies examining responses of market participants, including that of investors and regulators, to the introduction and use of DCL CoCos are lacking. Addressing these empirical gaps could significantly enhance understanding of- and aid in the practical implementation of DCL mechanisms.

2.5 Summary of Key Insights

The literature on CoCo bonds has highlighted both their benefits and limitations, particularly their unpredictable conversion mechanisms and regulatory uncertainty. The Credit Suisse CoCo wipeout underscored the risks associated with discretionary regulatory decisions, revealing weaknesses in traditional CoCo frameworks. Given this, alternative approaches like the Dynamic Control of Leverage (DCL) model have gained traction for their structured and self-regulating approach.

The DCL framework offers a promising improvement by dynamically managing leverage through interest payment conversions, mitigating sudden capital dilution and reducing market panic. Its leverage-based trigger mechanism enhances predictability compared to traditional CoCo structures. However, while theoretical models and simulations demonstrate its advantages, further empirical validation using real-world data is necessary to confirm its effectiveness in different market conditions.

Future research should focus on integrating DCL into existing regulatory frameworks and exploring its viability across diverse financial institutions. Additionally, addressing potential challenges such as investor perception and regulatory acceptance will be crucial in assessing its practical implementation. As financial markets evolve, the DCL approach represents a significant step toward enhancing financial stability and risk management in banking institutions.

Chapter 3

Methodology

3.1 Research Design

This study employs a quantitative and empirical research design, combining historical data analysis with simulation modeling to assess the performance of the DCL framework in CoCo bonds. The research replicates and expands upon the theoretical framework established by Segal and Ólafsson [4], applying it specifically to the real-world scenario of Credit Suisse between 2018 and 2023. Historical financial data including share values, total debt, AT1 debt, and outstanding shares were sourced from Refinitiv Eikon and Credit Suisse's publicly available annual reports. A comparative analysis is later applied to contrast outcomes from the simulated DCL bonds against traditional CoCo bonds, analysing the resulting indicators such as the leverage, dilution rates, and the frequency of conversions.

3.2 Data Collection and Sources

In this study, we aimed to examine whether a Dynamic Control of Leverage (DCL) CoCo bond framework would stabilize a bank's capital structure more effectively than a conventional CoCo bond. Specifically, we focused on Credit Suisse's data from 2018 to 2023 to investigate how often leverage ratio thresholds were breached under DCL simulations versus a traditional structure. The research question that will be tackled first is *whether implementing a DCL CoCo bond reduces the severity of threshold breaches compared to a standard CoCo mechanism* We hypothesized that banks using DCL CoCo bonds would experience significantly less severe trigger events, thereby mitigating sudden dilution and market disruptions.

To address the hypothesis, daily and yearly time-series data was collected from Refinitiv Eikon on Credit Suisse, encompassing daily closing stock prices, and yearly shares outstanding and total debt. Data on Additional Tier 1 (AT1) debt was not available on Reuters so it was manually compiled from the bank's yearly 20-F reports. These data points were then used to compute key parameters such as the equity value, total leverage, and the proportion of DCL bonds to total debt (α_k). Simulations at three different trigger-check frequencies (yearly, monthly, and daily) were made to analyse the effect of frequency and lag on the DCL mechanism to convert interest payments into equity. This allowed us to compare both the incidence of trigger events and the resulting leverage ratios over the five-year observation period for Credit Suisse.

3.3 Model Specification: DCL CoCo Bonds

The analysis utilizes comprehensive historical financial data sourced from Refinitiv Eikon and Credit Suisse's financial reports. The focus is placed on examining how varying key parameters—such as leverage thresholds, conversion frequencies, and coupon-to-equity conversion ratios—influence the bank's financial stability, market volatility, and equity dilution under distress conditions. Additionally, a sensitivity analysis is conducted to assess the robustness and reliability of the DCL approach across diverse market stress scenarios.

3.4 Implementation Steps

The implementation process involves several steps: acquiring and preparing financial data, specifying the DCL CoCo bond model parameters, running simulations, and conducting sensitivity analyses. Financial data from 2018–2023, including share prices, shares outstanding, and total debt, were obtained from Refinitiv Eikon and cross-checked against Credit Suisse's 20-F reports. (As noted, AT1 CoCo data were manually compiled from reports due to lack of a direct dataset.) The model parameters defined for the simulations included the bond's nominal amount, one or more leverage trigger thresholds (L_c levels), conversion prices, and conversion frequency. We then simulated the DCL conversion process over the historical period, tracking whenever the simulated leverage exceeded L_c and thus triggered an interest-to-equity conversion.

Finally, we performed sensitivity analyses to explore how varying the key parameters – such as the trigger level (e.g., 88%, 90%, 92%, 94% debt-to-assets), the interest conversion frequency (annual vs. quarterly vs. monthly), and the conversion price – would impact outcomes like the bank's leverage trajectory, the total equity dilution, and the number of conversion events. The results of the DCL simulations are compared against the actual historical outcomes for Credit Suisse's AT1 (which had a static trigger and was ultimately written down) to quantify relative benefits and trade-offs.

3.5 Limitations of the Methodology

Several limitations of this methodology should be noted. First, the model makes simplified assumptions that do not fully capture the complexity of a real bank's capital structure (for example, we assume a single class of CoCo debt and do not model other contingent liabilities or interactions with other capital instruments). This simplification was necessary to isolate the effect of the DCL mechanism, but it means that certain secondary effects are not considered. Second, the analysis relies on historical data and a back-testing approach, which may limit the generalizability of the findings – future crises or market conditions could deviate from historical patterns. Third, the simulations do not explicitly incorporate potential dynamic responses from investors or changes in regulatory behavior. In a real-world setting, the introduction of DCL CoCo bonds could itself influence investor confidence or regulatory actions in ways that are not captured here.

Chapter 4

Empirical Analysis and Results

4.1 Introduction

This chapter conducts an empirical evaluation of the Dynamic Control of Leverage (DCL) contingent convertible (CoCo) framework across three representative bank crisis scenarios. The selected case studies include the severe idiosyncratic collapse of Credit Suisse, a moderate contained stress event at Deutsche Bank, and the systemic failure of Lehman Brothers. By investigating crises of varying magnitude and origin, the analysis tests the robustness of the DCL mechanism under diverse market conditions and identifies where its effects are most pronounced.

The methodology leverages real-world historical data and simulation modeling. Actual financial and market data from each case are used to faithfully recreate the crisis conditions, while a simulation model projects the impact of dynamically adjusted leverage triggers on key risk and capital metrics. By calibrating the DCL framework to each scenario, the analysis evaluates how such contingent convertible instruments would have performed if deployed in practice. This approach ensures that the evaluation reflects realistic stress dynamics and institutional details of each crisis scenario.

By comparing outcomes across the three cases, the chapter identifies where the DCL framework provides the greatest benefits and where its impact is more limited. Contrasting the systemic market-wide collapse (Lehman Brothers) with the firm-specific crisis (Credit Suisse) and the contained stress scenario (Deutsche Bank) clarifies the contexts in which dynamic leverage control most effectively bolsters bank resilience. Ultimately, this comparative perspective highlights the conditions under which the DCL CoCo framework yields the largest improvements in financial stability and resilience, and those in which its advantages are attenuated.

Part I

Case Study: Credit Suisse

4.2 Overview of the Credit Suisse Collapse

Credit Suisse's collapse in March 2023 marked a significant event in global financial markets, revealing vulnerabilities within existing regulatory frameworks and highlighting systemic risks associated with traditional contingent convertible (CoCo) bonds. Over several years preceding the collapse, Credit Suisse faced repeated challenges, including substantial financial losses linked to high-profile scandals and investment mishaps, deteriorating investor confidence, and declining stock prices.

The critical moment occurred when Swiss regulators, specifically FINMA, intervened, fully writing down approximately CHF 16 billion of Additional Tier 1 (AT1) CoCo bonds while partially preserving shareholder value. This unconventional regulatory decision led to considerable backlash among bondholders and triggered widespread market panic and uncertainty about the viability and predictability of traditional CoCo instruments. Patrick Bolton et al. (2023) emphasized how this regulatory discretion not only inverted conventional loss hierarchies but also severely undermined investor trust in CoCos, casting doubts on their effectiveness as reliable capital buffers.

Furthermore, traditional CoCo bonds, initially proposed by Flannery (2009) and others, were intended to automatically bolster bank capital during financial stress through predefined conversion triggers based primarily on accounting capital ratios. However, Credit Suisse's experience demonstrated fundamental flaws in this design. The delayed responsiveness of accounting-based triggers and the opaque nature of discretionary regulatory interventions resulted in abrupt, large-scale equity dilution and exacerbated market volatility.

The collapse underscored the urgency to revisit CoCo bond structures, prompting examination into alternative frameworks such as the Dynamic Control of Leverage (DCL). By studying the specific dynamics of the Credit Suisse crisis, this thesis aims to investigate whether the proactive, gradual conversion mechanics of DCL CoCos could have effectively mitigated the severity of the collapse, providing a clearer, more predictable response to financial distress scenarios.

4.3 Application of DCL CoCo Bonds to the Credit Suisse Case

This section presents a detailed empirical analysis investigating the effectiveness of the Dynamic Control of Leverage (DCL) framework for contingent convertible (CoCo) bonds, specifically through the lens of the Credit Suisse collapse. The analysis explores how a DCL-based CoCo structure might have performed differently compared to traditional CoCo bonds during the financial turmoil experienced by Credit Suisse.

4.3.1 Historical data

Figure 4.1 shows data for Credit Suisse gathered from Reuters Refinitiv Eikon API. The timeframe was deliberately chosen to be from 2018 to 2023 to capture the state of the stock during normal times and to contrast with the 2023 crisis. By June 2025, after substantial dilutions and regulatory interventions, the share price had fallen over 95% from 2018 highs, and the stock was finally delisted from the Nasdaq stock exchange.

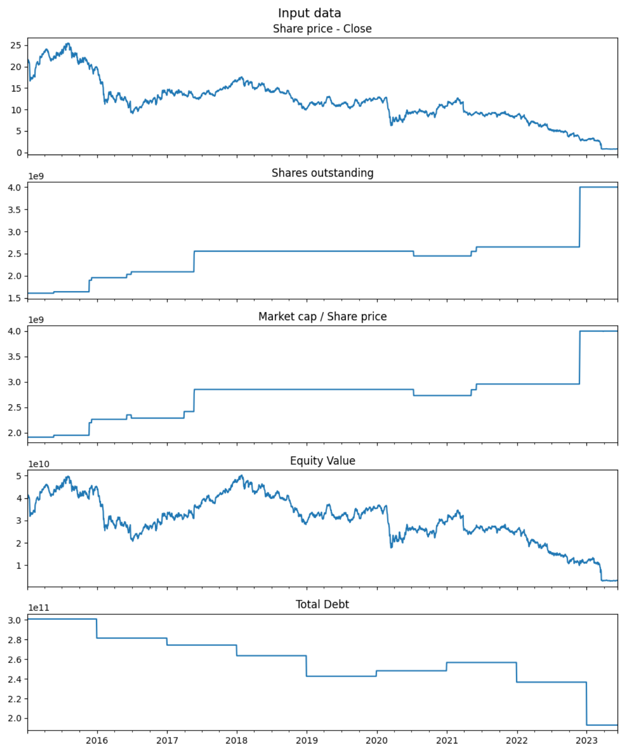

Figure 4.1: Historical data for Credit Suisse

4.3.2 Simulating DCL Contingent Convertible bonds

The DCL framework defines leverage using parameters localized to the DCL CoCo bond, using the proportion of the bond to the total debt of the company to localize the debt-to-asset ratio. The leverage parameter in the DCL bond framework for a company with differing types of debt can be derived as follows:

$$\frac{RQ_k}{RQ_k + \alpha_k \times NS_{k-1} \times S_k} \tag{4.1}$$

Where RQ_k is the residual value of DCL debt at k interval time, α_k is the proportion of the residual value to the total debt of the company, NS_{k-1} is the total number of shares outstanding and S_k is the share price of the company. These values are used as a proxy for the debt-to-asset leverage ratio for the company, used to provide a real-time measure to the bond.

$$RQ_k = Q\left((1+r)^k + \frac{1-(1+r)^k}{1-(1+r)^{-N_n}}\right) \tag{4.2}$$

If the leverage of the company is maintained above the minimum threshold, RQ_k is deterministically drawn down. If the leverage is below the threshold at time k, additional *top-up* DCL bonds are issued with the same maturity to raise the leverage back above the minimum threshold. The other case where RQ_k could deviate is if the regulator determines that the bank has reached a point of non-viability (PONV) and chooses to extraordinarily force a conversion.

If the leverage ratio is above the maximum trigger ratio at interval time k, the interest payment is converted to equity by issuing additional stock using a predetermined conversion share price, S_p. This encourages a gradual dilution of the bondholders, aiming to prevent a sudden collapse by correcting the leverage preemptively over time.

The original thesis introducing the DCL framework simulated a stock using geometric Brownian motion (GBM) with sensible parameters. Many of these parameters can be translated without much change for real-world scenarios. Following are descriptions of the various parameters for the Credit Suisse model.

Banks are generally much more leveraged than non-financial companies. As a result, it is not uncommon to see debt-to-asset ratios for banks in the range of roughly 85% to 95%. source: (https://www.fdic.gov/quarterly-banking-profile). To account for the higher leverage in the banking sector, the minimum leverage threshold was set at 85% and the maximum at 95%. The price of conversion was in every case set at the initial closing price of the shares at issuance.

The initial nominal value of the DCL bond was set to match the size of total AT1 debt at issuance in 2018, to test the case if all traditional CoCo bonds were DCLs instead. This resulted in the initial nominal, Q, to be set at 10.216 billion CHF to match the reported total value of AT1 debt in the 20-f filings. Notably, the total debt of the company does not equal the total amount of DCL bonds, which is why the derivations had to adjust for α_k to be proportional to the total debt of the company.

Similarly, the number of shares outstanding was set at the initial real value in 2018 and allowed to float with the DCL, since it can issue new shares conditional on breach of the lower trigger.

Otherwise, the parameters in the model were set to match those of the simulations from the proposing thesis, which resulted in the inputs shown in table 4.1.

Inputs	**Values**
Nominal debt value, Q	10,216,000,000 CHF
Maturity of loan in years, N	10
frequency of payments per year, n	2
Annual cost of debt, R	5.0%
Initial number of shares NS_0	1,607,168,947
Conversion price, S_p	21,69 CHF
Triggering leverage, L_c	0.90
Lower leverage level, L_{min}	0.85

Table 4.1: Input parameters for modelling a DCL bond on Credit Suisse

Figure 4.2 shows the results of simulating a DCL bond on the input parameters in table 4.1, and it shows how the leverage would change the capital structure of the company over time. Notable for Credit Suisse is the high operating leverage which results in a prevalence and immediacy of additional share issuance (starting in mid-2016) which continued for every subsequent interval date. This is a much earlier intervention than other metrics at the time would permit, since the model set the maximum leverage trigger conservatively at 90% with the aim to adjust for increased stability and preempt or mitigate a potential future crisis.

Comparing the leverage ratios with and without the DCL bond shows that by 2021 the bond had made enough conversions to significantly draw down the leverage ratio, at least to a more sensible level than if the bond had not been in place. This came at the cost of bondholders who only received direct interest on the bonds on the first three payment dates, every later payment being converted into equity. For the shareholders, the resulting dilutions amounted to a total of 5,539,160,028 CHF worth of new shares being issued.

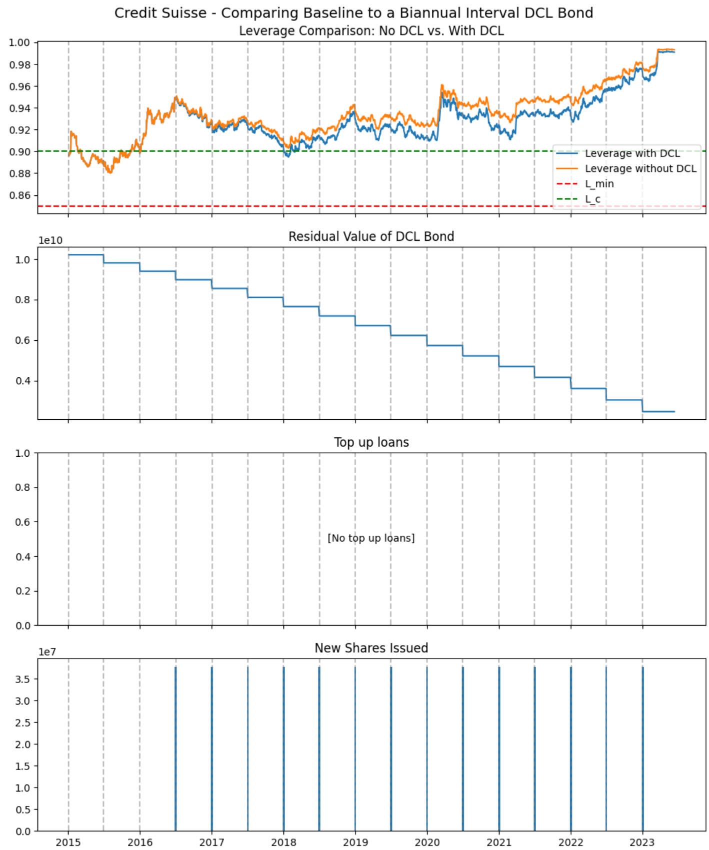

Figure 4.2: Effect of applying a DCL mechanism on AT1 debt for Credit Suisse

4.4 Sensitivity Analysis

Configuring the bond parameters will be vital to balance the interests of bondholders and shareholders, since different parameters can greatly affect the resulting outcomes. The following sensitivity analysis aims to aid management in this decision-making by thoroughly comparing different model parameters and analysing their effect on the bond, and finally deliver some recommendations based on the results.

4.4.1 Frequency of interest payments and leverage adjustments

The DCL contingency mechanism only adjusts at set intervals. Increasing the frequency of checks leads to an increase in the probability of conversion of interest payments and of gradual bondholder dilution. However, it also leads to a more timely and effective adjustment of leverage and decreases the probability of default for the company.

In the Credit Suisse case, the share price and the leverage were highly volatile throughout the period. The leverage frequently crossed the upper threshold, causing the bond to be diluted at interval times. Increasing the frequency of checks also increased the frequency of conversions leading to a larger total adjustment over time, as can be seen in figure 4.3.

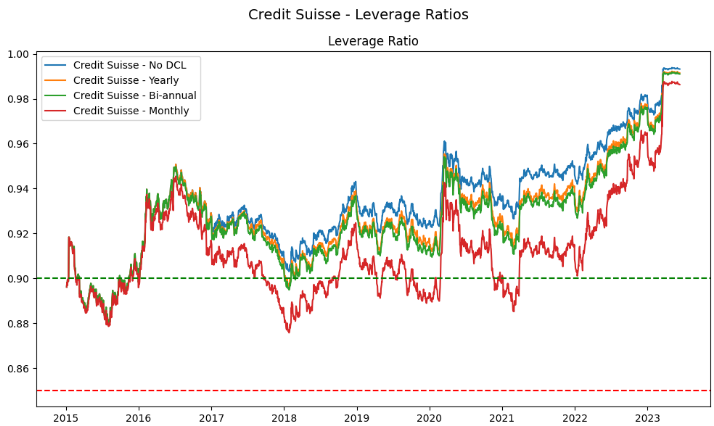

Figure 4.3: Leverage over time for different frequencies of payments (and leverage adjustments)

The effects of the frequency greatly contributes to equity dilution, as can be seen in table 4.2. Note that the initial nominal of the bond was around 16 billion CHF, so in the monthly frequency case the bonds are almost completely converted t equity.

Frequency of payments and adjustments, n	**Total dilution [CHF]**
Monthly	15,865,642,241
Bi-annual	5,539,160,028
Yearly	4,550,818,975

Table 4.2: Dilution to Credit Suisse stock for different conversion prices.

4.4.2 Converison price and bond conversions

The conversion price plays a crucial role in determining the frequency and extent of bond conversions into equity. If set too low, it can cause excessive dilution for existing shareholders; if set too high, it may not effectively recapitalize the bank during financial distress. Figure 4.4 illustrates how different conversion prices affect the leverage over the observed period.

At higher conversion prices (set above the initial market price), fewer shares are issued per interest payment converted, resulting in less immediate dilution but potentially insufficient leverage adjustments during periods of distress. Conversely, lower conversion prices result in a higher number of shares issued per converted interest payment, facilitating faster leverage corrections at the cost of significant dilution.

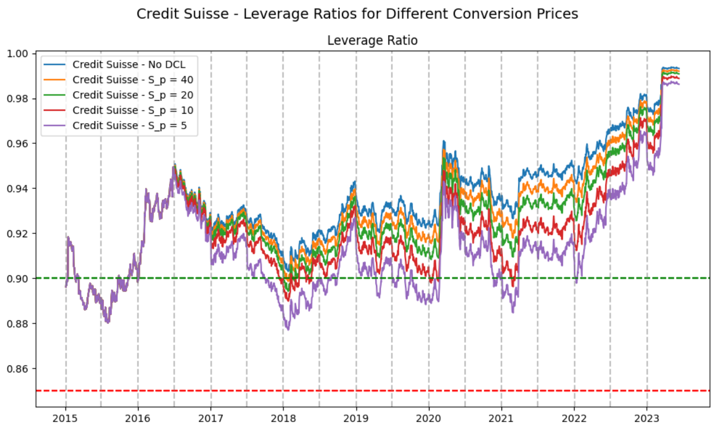

Figure 4.4: Leverage over time for different conversion prices

For Credit Suisse, setting the conversion price near or slightly below the initial share price (around CHF 20) balances recapitalization effectiveness and dilution management. Lowering the conversion price below 10 CHF resulted in excessive shareholder dilution, as can be seen in table 4.3

Conversion price, S_p	**Total dilution [CHF]**
40	3,003,164,177
20	6,006,328,354
10	10,662,511,556
5	15,764,266,353

Table 4.3: Dilution to Credit Suisse stock for different conversion prices.

4.4.3 Leverage triggers

The choice of leverage trigger thresholds significantly impacts the responsiveness and effectiveness of the DCL mechanism. Setting the leverage trigger higher delays conversions, potentially allowing risks to escalate, while a trigger set too low (below 85%) can lead to overly frequent conversions, causing unnecessary risks for bondholders.

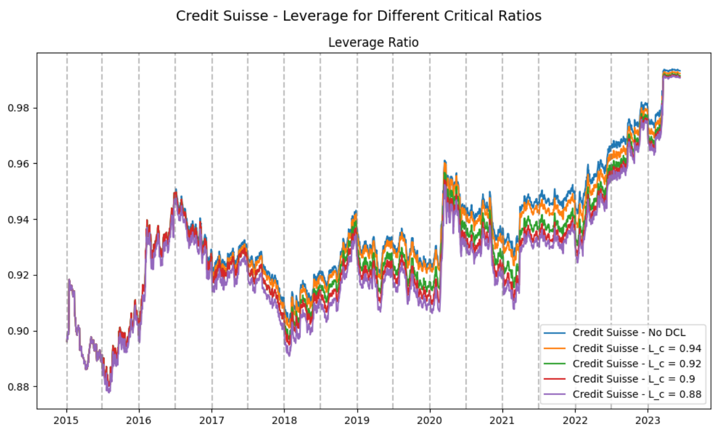

Figure 4.5: Leverage over time for different critical trigger values

Figure 4.5 depicts the impact of varying critical leverage trigger values on Credit Suisse's leverage ratio over time. At a lower trigger, the DCL mechanism responds early to increasing leverage, providing timely but frequent interventions that keep leverage tightly controlled. Conversely, a higher trigger results in fewer adjustments as leverage accumulates closer to critical points.

For Credit Suisse, a sensible leverage trigger around 90% provided a balanced approach, enabling manageable equity dilution while ensuring sufficient leverage corrections to mitigate severe distress scenarios more effectively.

Conversion trigger, L_c	**Total dilution [CHF]**
0.94	1,660,936,706
0.92	3,918,342,039
0.9	5,539,160,028
0.88	7,175,872,082

Table 4.4: Dilution to Credit Suisse stock for different critical triggers.

4.4.4 Conclusions

The sensitivity analysis underscores the importance of carefully calibrating DCL parameters to ensure optimal performance. Setting appropriate conversion prices and leverage triggers can significantly mitigate systemic risks, prevent abrupt dilutions, and enhance stability. Specifically, the analysis recommends a conversion price around the initial market price (approximately CHF 20) to balance dilution and effective recapitalization. Leverage triggers set around 90% to ensure timely yet controlled adjustments to leverage, mitigating both frequent minor and rare significant market disruptions.

Implementing these recommendations would have likely provided Credit Suisse with a more gradual and predictable recapitalization path, potentially preventing the market panic and bondholder wipeout which occurred during the 2023 collapse.

4.5 Comparison to Traditional CoCo Bonds

Compared to traditional CoCo bonds, DCL CoCos offer distinct advantages by addressing critical shortcomings highlighted during the Credit Suisse collapse. Traditional CoCo bonds typically rely on fixed capital ratio triggers or regulatory discretion, which can lead to delayed conversions or abrupt, substantial write-downs. In contrast, the dynamic leverage monitoring and incremental equity conversions inherent in DCL bonds provide a more controlled, predictable approach to recapitalization.

The analysis clearly demonstrates that, under the traditional CoCo bond structure, leverage adjustments were significantly delayed, only occurring once severe distress thresholds were breached. This delay likely amplified market panic and caused excessive investor losses, as seen in the 2023 crisis. Conversely, the DCL framework proactively adjusted leverage through frequent, smaller conversions of interest payments into equity, significantly reducing abrupt equity dilution and investor uncertainty.

Therefore, adopting a DCL structure could have considerably mitigated the magnitude of Credit Suisse's crisis; at least it could have substantially alleviated the catastrophic outcomes experienced under traditional CoCo bond mechanisms.

Part II

Case Study: Application of DCL to other banks

4.6 Introduction

Building on the insights from the Credit Suisse case study, this chapter examines the application of the Dynamic Control of Leverage (DCL) framework to two additional banking institutions: Deutsche Bank and Lehman Brothers. These two cases are chosen to illustrate the performance of DCL under different crisis scenarios. Deutsche Bank represents a bank that underwent periods of financial stress yet ultimately avoided collapse, providing a test of DCL in a moderate distress scenario. In contrast, Lehman Brothers suffered a catastrophic failure during the 2008 global financial crisis – a worst-case scenario that allows us to evaluate the limitations of DCL in the face of systemic collapse.

Similar to the Credit Suisse analysis, historical data and simulations are employed to assess how a DCL-based contingent convertible bond might have operated for each institution. We discuss the frequency and magnitude of DCL-triggered conversions (such as interest-to-equity swaps or contingent debt issuances) and their effect on each bank's leverage trajectory. By comparing these outcomes, we aim to understand how DCL can bolster a bank's resilience or fall short, depending on the severity and nature of a crisis. The following sections detail the findings for Deutsche Bank and Lehman Brothers, respectively, followed by a comparative discussion of all three case studies (Credit Suisse, Deutsche Bank, and Lehman Brothers).

4.7 Deutcshe Bank

Deutsche Bank's financial health in the post-2008 era was characterized by bouts of instability, though it never experienced a complete failure. The bank struggled with high leverage and legal troubles throughout the 2010s, and its stock price and creditworthiness periodically came under severe pressure (for example, during 2016 and 2018). However, unlike Credit Suisse in 2023, Deutsche Bank managed to weather these storms without triggering a crisis or resorting to an external bailout. This makes it an insightful case to apply the DCL framework as a preventive measure in a contained stress scenario.

For the DCL simulation, we consider Deutsche Bank's balance sheet and market data over a multi-year period encompassing its known stress episodes (e.g. the 2015–2018 timeframe). Using this data, we calibrate a DCL-based CoCo instrument with parameters similar to those used in the Credit Suisse case (e.g. a critical leverage threshold and conversion rate appropriate to maintain capital adequacy). The DCL mechanism is applied to monitor Deutsche Bank's leverage ratio. During periods of rising leverage or deteriorating equity (indicative of financial stress), the DCL trigger automatically converts a portion of interest obligations into equity for the CoCo bondholders, thereby boosting equity capital and reducing debt. In periods of stability, no conversion is triggered and the CoCo behaves like normal debt. This dynamic adjustment aims to keep Deutsche Bank's leverage within a safe band, avoiding breaching any regulatory capital triggers or the Point of Non-Viability (PONV).

The results for Deutsche Bank indicate that the DCL framework would have activated only modestly, in sharp contrast to the more frequent interventions observed in the Credit Suisse scenario. Fewer interest-to-equity conversion events are triggered under DCL, each corresponding to moments of notable stress. For instance, during early 2016 when fears of a possible AT1 coupon suspension caused Deutsche Bank's contingent capital bond prices to plunge [4], the DCL mechanism would likely have kicked in preemptively. Instead of allowing panic to fester, DCL would convert that period's coupon payments into equity, shoring up Deutsche Bank's Tier 1 capital. This incremental recapitalization could have reassured investors by demonstrating automatic loss absorption, and indeed in reality Deutsche Bank did manage to continue paying its AT1 coupons after reaffirming its capital strength.

Figure 4.6 illustrates Deutsche Bank's leverage ratio over time with the DCL CoCo in place. The plot shows that leverage stays relatively stable, with upticks during stress periods that triggered DCL conversions. These modest interventions had a cumulative effect of gradually lowering the leverage, without significantly affecting the equity value of the bank. In summary, the Deutsche Bank case demonstrates the DCL mechanism in a scenario of contained distress: the framework adds an automatic stabilizer that converts interest to equity sparingly, ensuring the bank never strays into dangerously high leverage. This contrasts with the Credit Suisse experience, where much larger and more frequent interventions would have been necessary to counteract a far more severe decline in asset value. By avoiding a crisis altogether, Deutsche Bank under DCL highlights how proactive leverage control can maintain bondholder value, rather than having to manage a full-blown collapse.

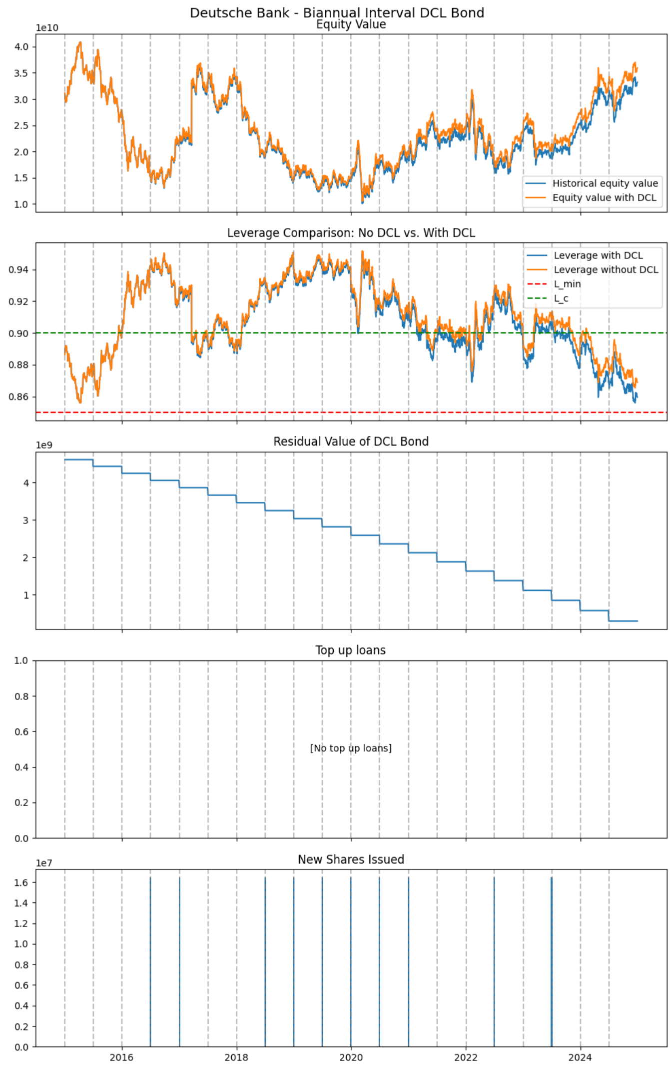

Figure 4.6: Results of simulating DCL for Deutsche Bank show a limited and gradual conversion into equity during times of distress.

4.8 Lehman Brothers

Lehman Brothers presents a starkly different scenario – a case of systemic collapse where the DCL framework's limitations become apparent. Prior to its bankruptcy in September 2008, Lehman Brothers had aggressively expanded its balance sheet, accumulating high leverage during the mid-2000s housing boom. In fact, by 2007 the firm's leverage ratio had climbed to extraordinary levels (over 30:1, meaning over $30 in assets for every $1 in equity)[9]. This made Lehman highly vulnerable to any downturn in asset values. Yet during those boom years, a DCL-based CoCo instrument might not have triggered any conversions at all – Lehman's reported capital ratios remained ostensibly adequate, and the absence of stress signals would mean no automatic interest-to-equity swaps. In other words, through 2006–2007 the DCL mechanism would likely have stayed dormant while Lehman continued to issue debt and grow, inadvertently allowing leverage to remain elevated. The very strength of the pre-crisis market (and Lehman's record profits in 2005–2007) meant that DCL had little reason to intervene early on.

When the situation began to deteriorate in 2007 and especially in 2008, the DCL trigger for Lehman Brothers would belatedly start activating. As mortgage defaults surged and Lehman's asset values plummeted, the bank's leverage would rapidly breach the trigger threshold, forcing the DCL CoCo to respond. In theory, this response would involve converting interest (and possibly portions of principal, if structured to do so) into equity to recapitalize Lehman. Such conversions, however, would have been fighting a losing battle against the swift erosion of Lehman's asset base. Lehman's share price collapsed and its losses mounted dramatically in 2008 – the firm lost $2.8 billion in Q2 2008 and announced an additional $6 billion capital raise in June 2008[9], alongside asset sales to reduce leverage. Despite these efforts (which mirror what DCL conversions aim to achieve, i.e. raising equity and cutting debt), market confidence in Lehman did not recover. The DCL mechanism, similarly, would have added equity incrementally – possibly buying some extra time – but it is unlikely to have reversed the terminal decline. At best, continuous DCL conversions might have slowed the descent into insolvency, delaying the point of non-viability by a matter of weeks or months.

Crucially, Lehman Brothers' collapse was driven by systemic factors that DCL could not address: a fundamental collapse in asset quality and liquidity. Even if DCL had been in place providing automatic recapitalization, the magnitude of Lehman's losses would have overwhelmed those conversions. Scholars such as Andrew G. Haldane provide evidence that conventional CoCo bonds (with static triggers) would not have prevented Lehman's bankruptcy because the triggers would have been tripped too late or not at all [10]. DCL's continuous monitoring could trigger earlier than static ratios, but in Lehman's case the crisis dynamics were so fast and severe that earlier intervention might still not suffice. Eventually, Lehman would run out of time and capital – a fate that DCL can only delay, not avoid, when underlying insolvency is imminent. Indeed, our analysis underscores that DCL is designed to "buy time, not magically cure insolvency". In Lehman's scenario, even if DCL had stretched the timeline, the end result would almost certainly remain a collapse in the absence of an external rescue or broader market stabilization.

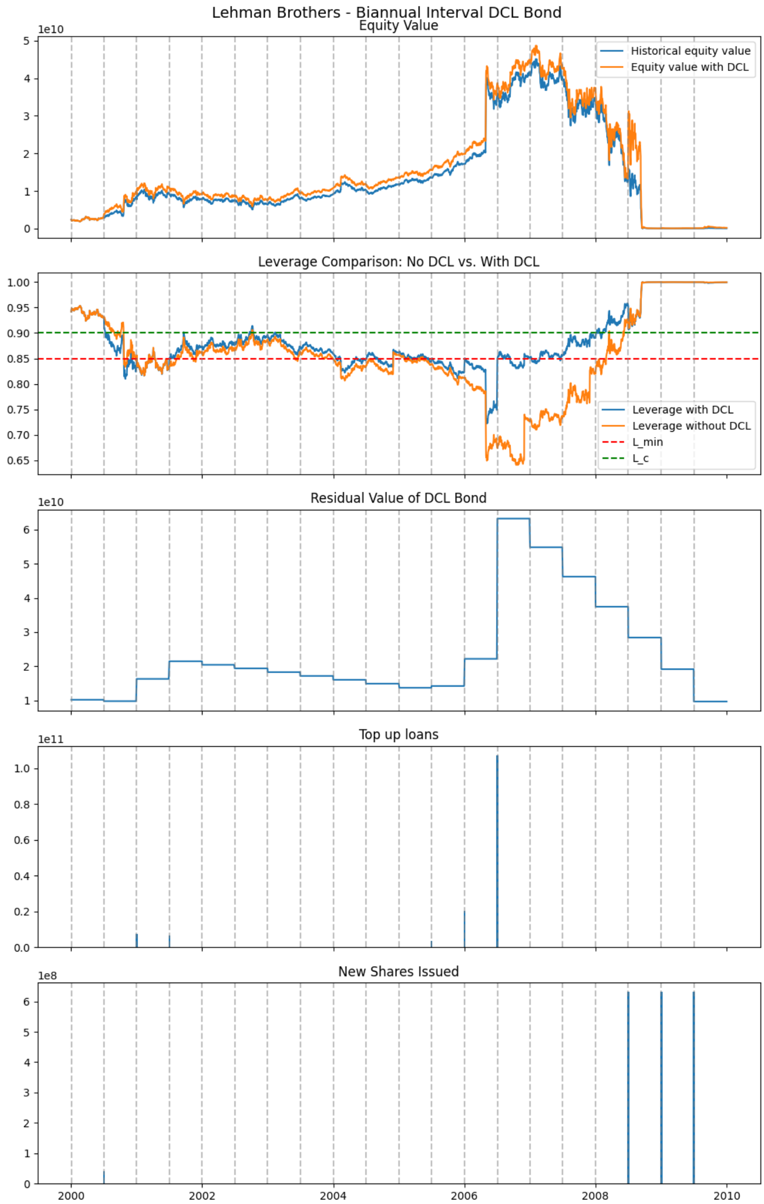

Figure 4.7: The results from simulating DCL on Lehman brothers shows large additional DCL issuances leading to the Great Financial Crisis, therefore raising the leverage at an inappropriate time, considering the need for large capital injections during the crisis.

Figure 4.7 illustrates a hypothetical trajectory of Lehman Brothers' leverage under a DCL regime versus the actual collapse. Due to the rising equity value through 2007, the DCL framework issued additional top-up debt, raising the leverage above the no DCL scenario, potentially exacerbating the following crisis. Then during 2008 we see a series of conversion-driven equity infusions as the crisis unfolds for both scenarios. Ultimately, the DCL-triggered interventions fail to stabilize the firm, reflecting the reality that Lehman declared bankruptcy despite last-minute capital injections. In sum, the Lehman Brothers case highlights a key limitation of the framework similarly to the Credit Suisse case: in an extreme systemic crisis where asset quality collapses across the board, DCL cannot by itself save the bank. It may delay the failure and reduce the chaos of an abrupt collapse, but it cannot compensate for a fundamentally unsustainable balance sheet. This outcome stands in contrast to Deutsche Bank's case (where DCL could gradually stabilize leverage levels) and even to Credit Suisse's case (where DCL could significantly delay the collapse). Lehman's failure emphasizes that DCL, while powerful, is not a panacea for all crises.

4.9 Comparative Discussion of DCL Outcomes

Across the three case studies – Credit Suisse, Deutsche Bank, and Lehman Brothers – we observe that the Dynamic Control of Leverage framework exhibits both significant strengths and clear limitations, depending on the crisis context. Here, we discuss the qualitative differences:

Deutsche Bank (Moderate Stress):

DCL kept Deutsche Bank's leverage under control with only minimal intervention. The bank never reached a critical failure point under the DCL scheme. This demonstrates DCL's efficacy in a moderate, idiosyncratic stress scenario – acting as a protective buffer that prevents a downturn from snowballing into a crisis. In Deutsche Bank's case, the DCL mechanism essentially averted any collapse by stabilizing leverage preemptively.

Credit Suisse (Severe Idiosyncratic Crisis):

The Credit Suisse analysis from the previous chapter showed that DCL would have significantly delayed the bank's collapse, although not completely preventing it. Frequent conversions of interest to equity would have provided vital breathing room (on the order of months of delay in reaching PONV). Thus, for a major bank experiencing a rapid loss of confidence and capital (as Credit Suisse did in 2023), DCL can meaningfully mitigate the severity of the crisis. It buys time for management or regulators to intervene, potentially avoiding the need for an outright bailout or the kind of abrupt AT1 wipeout that occurred [2].

Lehman Brothers (Rapid Systemic Collapse):

In the Lehman scenario, even an optimally designed DCL could not have prevented failure. A conservatively designed DCL might have delayed collapse to some extent but ultimately would not realistically save Lehman without external rescue, due to the sheer scale of losses and system-wide loss of liquidity. This underlines that DCL is not a cure-all; in worst-case systemic crises, its benefit is largely in softening the blow (perhaps enabling a more orderly resolution) rather than fully averting bankruptcy.

Summary

Comparing these outcomes highlights a few crucial points. First, DCL is highly effective at maintaining stability in contained or moderate crises, as evidenced by the Deutsche Bank case. The automatic incremental recapitalizations can keep a bank from ever hitting a danger zone, thereby preventing panic from escalating. Second, in intermediate crises like Credit Suisse's, DCL cannot outright stop failure if a bank's fundamentals are irreparably damaged, but it can significantly delay collapse and reduce its chaos, providing a critical window for corrective action. Third, in extreme systemic crises like Lehman's, DCL's impact is marginal – it serves only to increase the probability of delaying the inevitable, reinforcing the understanding that no contingent convertible mechanism can substitute for broader solutions (such as market-wide support or timely intervention) when a firm's asset base is crumbling.

Overall, the case studies confirm that the Dynamic Control of Leverage framework offers a valuable improvement over traditional CoCos in many scenarios, but it must be viewed as part of a spectrum of tools. In a best-case application (like the Deutsche Bank scenario), DCL can mitigate a crisis by continuously policing leverage. In a mid-case (Credit Suisse), it can absorb shocks and buy crucial time to fix problems or arrange rescues, even if it cannot ultimately save the bank on its own. And in the worst case (Lehman Brothers), DCL's continuous conversion mechanism would still fail to protect the bank from collapse, illustrating the boundary of its effectiveness. This comparative analysis underscores that while DCL can significantly enhance resilience and reaction speed for banks, it is not infallible – extreme scenarios may still require additional measures beyond the scope of contingent capital instruments.

Chapter 5

Discussion

The analysis presented in this study underscores several critical implications regarding the efficacy of the Dynamic Control of Leverage (DCL) framework compared to traditional Contingent Convertible (CoCo) bonds. Primarily, this research contributes significantly to the existing body of literature by empirically validating the theoretical advantages of DCL mechanisms through real-world simulation, particularly in the context of the Credit Suisse collapse.

One of the most salient insights from this study is that the DCL approach substantially enhances bank stability by providing proactive, incremental equity adjustments rather than relying on abrupt, large-scale interventions. The findings demonstrate that, had Credit Suisse implemented DCL-based CoCo bonds, the effect of dramatic market disruptions and the following bondholder wipeout could have been mitigated. These results also address some of the criticisms highlighted in the literature concerning traditional CoCo mechanisms—namely, their reliance on static triggers and the opacity associated with regulatory discretion [2].

The sensitivity analysis revealed that selecting appropriate parameters, particularly conversion prices and leverage thresholds, is crucial to balancing recapitalization efficiency and market impact. The preferred parameters identified through simulation suggest a conversion price close to or just under the initial market price and a leverage trigger around 90%, providing an effective compromise between immediate leverage correction and gradual shareholder dilution. These results should aid issuers and regulators in understanding the effectiveness of choosing appropriate parameters.

Moreover, this research illustrates the limitations of traditional CoCo bonds, especially during periods of market stress. Traditional mechanisms often trigger conversions only after severe financial distress (or leave the decision to regulators at PONV), which tends to exacerbate market instability and investor panic, demonstrated by the abrupt AT1 bond wipeout for Credit Suisse. In contrast, the

DCL framework, with its gradual and rules-based conversions, significantly reduces the likelihood of sudden large-scale losses and systemic disruptions. Essentially, no single drastic event occurs under DCL; instead, the pain is distributed in smaller doses, which may be more manageable for markets and stakeholders (hence, "no pain, no gain" – small pains to avoid a big one, echoing Flannery's original concept of reverse convertible debentures [11].

However, several limitations warrant consideration when interpreting the results. First, the study relies on historical simulation data, inherently carrying assumptions that may oversimplify real-world complexities. Second, investor perception and regulatory acceptance of DCL instruments were not directly modeled, potentially impacting market dynamics differently than predicted, since persistent conversions could adversely affect shareholder perceptions of the health of the company. Future research could address these gaps by conducting more extensive empirical studies across diverse banking environments and assessing investor behavior through surveys or experimental market studies.

Despite these caveats, the evidence presented is robust in showing the theoretical and simulated benefits of DCL over traditional CoCo structures. Importantly, the analysis is grounded in a real-world case study, giving the results practical relevance. The proactive leverage control of DCL appears to address the core weakness identified in traditional CoCos: the delay in response. Our results align with the views of Calomiris and Herring that well-designed CoCos (with high triggers and strong incentives) can motivate banks to strengthen capital well before insolvency [7]. In the DCL model, conversions happen early and often enough to keep the bank out of the danger zone, embodying that principle.

From a regulatory and policy perspective, these findings are significant. They suggest that incorporating a DCL-like mechanism could enhance the resilience of banks and reduce systemic risk. A DCL framework could be seen as an automated stabilizer for bank capital. By embedding market-based, continuous triggers, it removes some discretion from regulators (which, as seen, can be a double-edged sword) and provides more transparency to investors about how a bank will recapitalize under stress. This could, in theory, reduce moral hazard and increase market discipline, as bank management knows that any excessive leverage will promptly dilute shareholders, aligning incentives more with prudent risk management [11].

Naturally, implementing such a framework would require careful design of the trigger and conversion terms (as we have analyzed) and clear communication to the market. There may also be legal and operational hurdles to issuing DCL CoCos, and it would be important to ensure that these instruments qualify as regulatory capital (just as AT1 CoCos do under Basel III).

In summary, the DCL approach addresses many of the shortcomings observed in the Credit Suisse episode and in traditional CoCo literature. It provides a continuous, market-aligned mechanism for recapitalization that could prevent the kind of sudden collapse witnessed in 2023. The potential downsides (dilution and possibly investor wariness of frequent conversions) seem manageable with proper calibration and are arguably a necessary trade-off for greater stability.

5.1 Leverage Breaches in DCL Bonds With High Leverage Thresholds

The simulation results reveal a notable divergence when applying the Dynamic Control of Leverage (DCL) framework to highly levered banks, compared to the original DCL proposal. In particular, breaches of the minimum leverage threshold under DCL lead to alarmingly large “top-up” debt issuances (i.e. new debt that must be issued to restore leverage to the minimum). This outcome was not as pronounced in the original paper’s simulations, largely because that study assumed lower leverage levels and thresholds. Banks and similar financial institutions typically operate with much higher leverage ratios (on the order of 85–90%) than firms in other sectors, so their DCL thresholds (both minimum and maximum) must be set higher. As a result, when a bank breaches its leverage thresholds, the size of the required adjustment (debt or equity issuance) is significantly larger than in the original lower-leverage scenarios (see *Top-up loans* in Figure 5.1). This difference is mainly attributed to the compounding effect of high baseline leverage on the DCL adjustment formulas, leading to much bigger corrections in a banking context.

The DCL framework employs two complementary mechanisms to keep a bank’s leverage within the desired range. First are equity conversions at high leverage. If the bank’s leverage rises above the maximum threshold, DCL triggers the conversion of that period’s interest payments on the CoCo bonds into equity. This effectively injects a small amount of new equity (instead of paying interest in cash) to bring leverage down. Conversely, if the bank’s leverage falls below the minimum threshold, DCL mandates an issuance of additional debt (a “top-up loan”) to raise the leverage back up to the minimum level. This adds debt to the balance sheet, pushing the leverage ratio upward.

For a typical non-financial company with moderate leverage, these DCL adjustments (adding equity or debt) would be relatively manageable. In a highly levered bank, however, two issues arise: *1)* a breach of the minimum leverage threshold necessitates a very large debt issuance to compensate, and *2)* by contrast, a breach of the maximum threshold is corrected with a relatively small equity conversion (since only an interest payment’s worth of equity is added). In other words, when leverage thresholds are set very high (as they would be for banks), the DCL mechanism becomes asymmetric – the downside case (leverage too low) requires a far bigger intervention than the upside case (leverage too high). The following analysis and example illustrate why this is the case and quantify the magnitude of these adjustments.

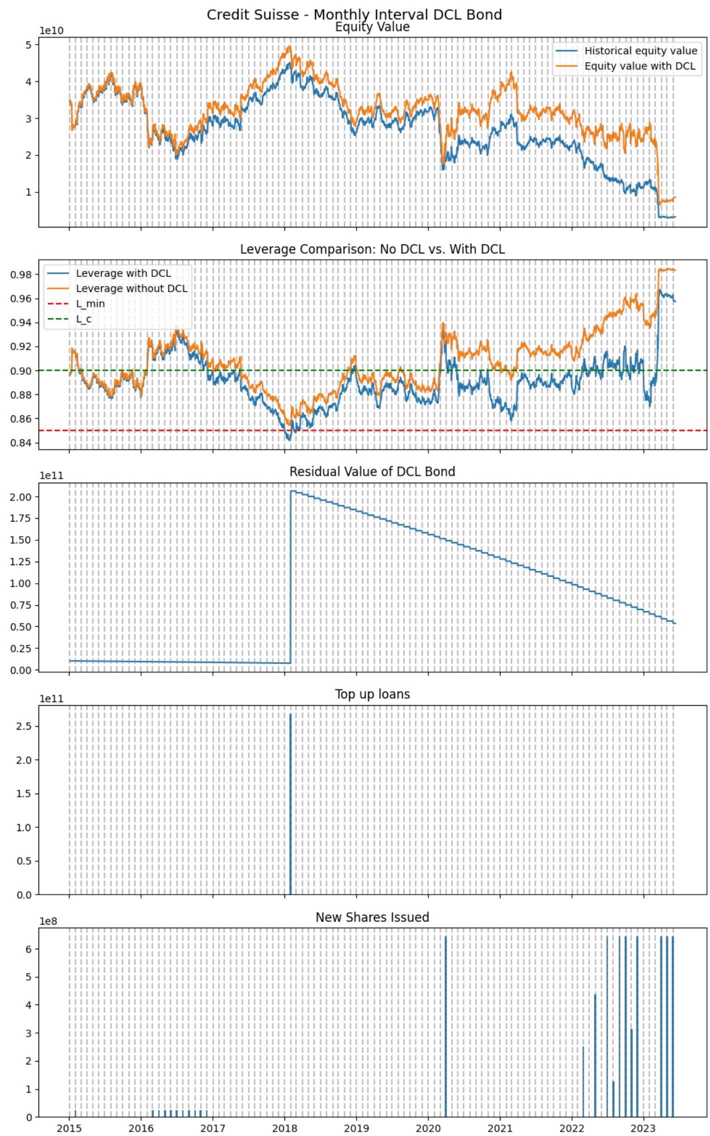

Figure 5.1: For highly levered instituitons, minimum leverage breaches can result in very large top-up loan corrections, required to raise the levereage back up to the minimum leverage threshold.

5.1.1 Adjustments triggered by leverage breaches

Banks generally operate with leverage ratios around 85–90%, which is substantially higher than the leverage assumptions in the original DCL study. Implementing DCL with such high leverage thresholds leads to markedly different adjustment dynamics. In essence, the higher the baseline leverage, the larger the absolute changes in debt or equity needed to correct any deviation. This section uses the DCL formulas to demonstrate how raising the leverage thresholds into the 85–90% range can make the required adjustments much larger when breaches occur.

Leverage Definition:

To begin, recall the definition of leverage. The leverage at time k is given by Equation 5.1 as the ratio of debt to total assets (debt plus equity) at that time:

$$L_k = \frac{D_k}{D_k + E_k} \tag{5.1}$$

where D_k is the total debt and E_k the total equity at time k. A high value of L_k (close to 1) means the firm is predominantly debt-financed (highly levered), whereas a lower L_k indicates a more equity-funded firm.

DCL Adjustment – Breach of Upper Threshold:

If the leverage at time k exceeds the critical maximum leverage threshold L_c (i.e. $L_k > L_c$), the DCL framework responds by converting the CoCo bond's interest payment at time k into equity. In practice, this means the interest that would have been paid to bondholders is instead turned into an equivalent value of new shares, which increases equity by an amount ΔE_k. Because debt remains the same while equity rises, the leverage ratio is reduced. The adjusted leverage after this interest-to-equity conversion is given by Equation 5.2:

$$L_{k,\text{adjusted}} = \frac{D_k}{D_k + E_k + \Delta_{E,k}} \tag{5.2}$$

where ΔE_k is the increase in equity capital due to the interest conversion. This gradual equity injection brings the leverage down closer to the acceptable range. Notably, ΔE_k (the forgone interest payment) is typically a small fraction of D_k, so this mechanism corrects leverage incrementally – frequent small conversions can prevent leverage from straying too far above L_c without dramatically diluting shareholders at any single point in time.

DCL Adjustment – Breach of Lower Threshold:

Conversely, if the leverage at time k drops below the minimum leverage threshold $L_{\min}$ (i.e. $L_k < L_{\min}$), the DCL framework issues additional debt to raise leverage back up. Specifically, an amount of new debt ΔD_k is issued such that the leverage returns to exactly $L_{\min}$. The new adjusted leverage after this "top-up" debt issuance is given by Equation 5.3:

$$L_{k,\text{adjusted}} = \frac{D_k + \Delta_{D,k}}{D_k + \Delta_{D,k} + E_k} \tag{5.3}$$

where ΔD_k is the increase in debt capital. Here, E_k remains unchanged while D_k grows, pushing the leverage ratio upward. This mechanism effectively forces the bank to take on more debt whenever its leverage has become too low (i.e. equity has become too high relative to debt).

It is important to observe the asymmetry between these two adjustments at high leverage levels. Adding a given amount of equity ΔE_k when leverage is high has a noticeable effect in reducing L_k (because it increases the denominator of the ratio), but the amount ΔE_k is inherently limited by the size of an interest payment. On the other hand, adding debt ΔD_k when the institution is already highly levered has a diminishing effect on L_k—as L_k approaches 1, each additional unit of debt yields a smaller increase in the leverage ratio (because debt and total assets increase in tandem). Therefore, to achieve even a minor increase in L_k (back up to $L_{\min}$), the required ΔD_k can be very large if L_k is initially close to the threshold. The following example quantifies this effect for a real case.

Example: Credit Suisse Leverage Breach

To illustrate the scale of adjustments required under DCL for a highly levered institution, we examine a scenario using Credit Suisse's balance sheet data. Table 5.1 summarizes the relevant parameters for Credit Suisse (ticker: CSGN) at a point in early 2023 when its leverage was approximately $L_k = 0.8489$ (about 84.89%). This corresponds to a total debt $D_k \approx 2.7428 \times 10^{11}$ CHF (CHF 274.28 billion) and total equity $E_k \approx 4.8813 \times 10^{10}$ CHF (CHF 48.81 billion). Now, consider a DCL scheme in which the minimum leverage threshold $L_{\min}$ is set to 0.85 (85%). At this moment, the bank's actual leverage (84.89%) has just fallen slightly below the required 85% minimum. According to the DCL rules, this breach would trigger an immediate debt issuance to bring the leverage back up to 0.85.

Parameter	**Value**
Ticker	CSGN
Total Debt, D_k	274,280,000,000
Total Equity (Market Value), E_k	48,813,335,162
Leverage (L_k)	0.8489

Table 5.1: Parameters for minimum leverage distance modelling.

Using sample numbers from Credit Suisse, the leverage shortfall is $L_{\min} - L_k = 0.8500 - 0.8489 = 0.0011$. Table 5.2 shows the size of the "top-up" loan, ΔD_k, required to restore L_k to various possible threshold levels at or above 85%, given the bank's current D_k and E_k. To reach a leverage of 85.0%, the framework must issue approximately CHF 2.32 billion in new debt. This relatively modest amount of debt raises the leverage from 84.89% to 85.0%. However, if the minimum threshold were set even higher, the required capital infusion grows dramatically. For instance, to achieve a leverage of 86% under the same conditions, the bank would need about CHF 25.6 billion in additional debt. Pushing to a 90% leverage threshold would require roughly CHF 165 billion, and for 94% leverage – not far from the upper end of banks' operating range – the necessary top-up debt soars to an astounding CHF 490 billion. These figures underline an exponential growth in required intervention as the threshold rises further from the actual leverage. In fact, the size of the needed top-up loan increases nonlinearly (almost exponentially) as the gap $(L_{\min} - L_k)$ widens (this relationship is visualized in Figure 5.2). Even a 1–2 percentage point increase in the leverage requirement can translate into tens of billions of CHF in extra debt needed.

$L_{\mathbf{min}}$	Distance $(L_{\min} - L_k)$	Top-up loan $\Delta_{D,k}$ $[10^9 CHF]$
0.85	0.001081	2.32
0.86	0.011081	25.57
0.87	0.021081	52.39
0.88	0.031081	83.68
0.89	0.041081	120.66
0.90	0.051081	165.04
0.91	0.061081	219.27
0.92	0.071081	287.07
0.93	0.081081	374.24
0.94	0.091081	490.46

Table 5.2: The size of top-up loans required to increase the current leverage up to a minimum leverage threshold increases exponentially faster as the distance from the current leverage increases

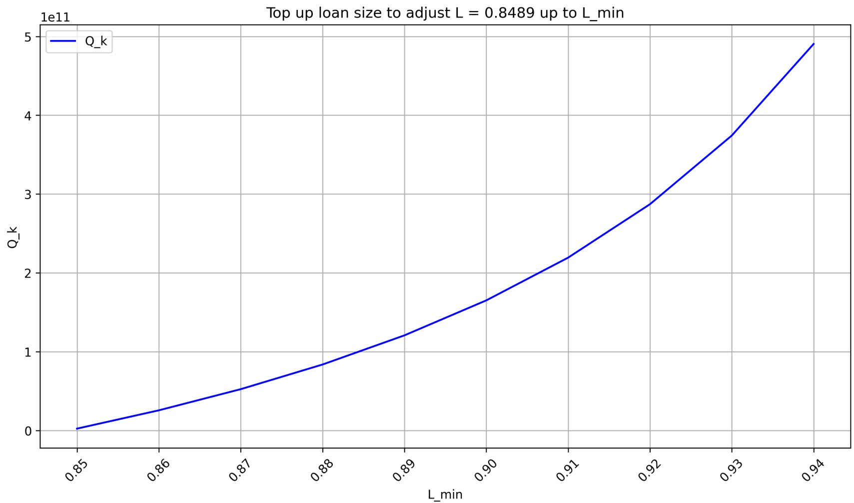

Figure 5.2: The top up loan size to adjust L_k up to L_{min} inccreases in size quickly as the distance of the current leverage from the minimum leverage threshold increases.

This example highlights the practical implications of setting very high leverage thresholds in a DCL framework for banks. When a bank is already highly levered, even a minor shortfall below the minimum leverage ratio can necessitate a prohibitively large recapitalization through debt issuance. Such large interventions could be difficult to implement in reality and might introduce their own risks (for example, straining the bank's borrowing capacity or spooking investors).

Solving Leverage Asymmetry at the Minimum Threshold

The core of the asymmetry problem is that adding debt becomes less effective at raising the leverage ratio when the institution is already highly levered. Each additional unit of debt both increases the numerator (D) and the denominator ($D+E$) in the leverage ratio, so the leverage rises at a slowing rate. To counteract this, a more effective solution is to reduce the equity component in tandem with the debt injection. In practice, this could be achieved by using the new "top-up" debt proceeds to repurchase shares or pay dividends. By returning the injected funds to shareholders (either by buying back stock or distributing cash), the bank's equity value E is drawn down, which amplifies the increase in leverage for a given amount of new debt. This approach essentially swaps equity for debt, maintaining total assets nearly constant, rather than simply adding assets via new debt.

Since adding to the debt component in equation 5.1 has a diminishing effect for raising the leverage for highly levered institutions, a more effective solution would be to draw down the equity component. If the debt issuance from a minimum leverage adjustment is used for share buybacks, or paid out as a dividend, then the value of equity is lowered, while counteracting the asymmetry problem.

For the share buyback case, the number of shares to be drawn down would be equal in value to the top-up loan that is issued for the adjustment, so the change in equity value, $\Delta_{E,k} = -\Delta_{D,k}$. Also, since the DCL framework uses the market value as a proxy for the value of total equity then $\Delta_{E,k} = \Delta_{S,k} S_k$, where $\Delta_{S,k}$ is the change in shares outstanding.

When applying an equity drawdown using the top-up loan the equation for adjusted leverage changes, as is derived seen in Equation 5.4.

$$
\begin{aligned}
L_{\min} \stackrel{!}{=} L_{k,adjusted} &= \frac{D + \Delta_Q}{(D + \Delta_Q) + (E + \Delta_E)} \\
&= \frac{D + \Delta_Q}{(D + \Delta_Q) + (E + \Delta_S S_k)} \\
&= \frac{D + \Delta_Q}{(D + \Delta_Q) + (E - \frac{\Delta_Q}{S_k} S_k)} \\
&= \frac{D + \Delta_Q}{D + E}
\end{aligned}
\tag{5.4}
$$

A key observation is that the leverage function is simply a linear function of ΔD_k. Comparing this result to the original adjustment formula (5.3), we see an important difference: in Equation (5.3), ΔD_k appeared in both the numerator and denominator, whereas in Equation (5.4) the ΔD_k cancels out of the denominator. This means that under the buyback (equity drawdown) strategy, each unit of debt issued has a direct, one-for-one effect on increasing leverage, unencumbered by a growing asset base. In effect, the leverage increase is now linear in the size of the top-up loan, instead of diminishing. As a result, the size of the required top-up loan can be dramatically smaller. Solving Equation (5.4) for the required ΔD_k to reach a given $L_{\min}$ yields:

$$
\Delta_Q = L_{\min}(D + E) - D \tag{5.5}
$$

which is significantly lower than the debt required in the earlier no-buyback scenario. (For comparison, without an equity reduction the required debt was $\frac{L_{\min}(D_k+E_k)-D_k}{1-L_{\min}}$, which for high $L_{\min}$ is much larger due to the division by $(1 - L_{\min})$.)

Table 5.3 illustrates the impact of this combined approach using the same example as before. For each threshold L_{min}, we list the original required ΔD_k (from Table 5.2) alongside the new required ΔD_k if the debt is used for share buybacks (Equation 5.5). The contrast is stark. At $L_{\text{min}} = 0.90$, the necessary recapitalization drops from 165.0 to just 16.5 billion CHF – only about 10% of the original amount. At $L_{\text{min}} = 0.94$, the required debt falls from an unthinkable 490.5 billion to about 29.4 billion CHF. In fact, across the board the buyback strategy reduces the needed debt by a factor of roughly $1/(1-L_{\text{min}})$ (for example, a factor of around 10 at 90% leverage, around 16.7 at 94% leverage), completely eliminating the non-linear blow-up seen earlier.

$L_{\mathbf{min}}$	Distance $(L_{\text{min}} - L_k)$	Top-up loan $\Delta_{D,k}$ $[10^9 CHF]$	Top-up loan with buybacks $\Delta_{D,k}$ $[10^9 CHF]$
0.85	0.001081	2.32	0.35
0.86	0.011081	25.57	3.58
0.87	0.021081	52.39	6.81
0.88	0.031081	83.68	10.04
0.89	0.041081	120.66	13.27
0.90	0.051081	165.04	16.50
0.91	0.061081	219.27	19.73
0.92	0.071081	287.07	22.96
0.93	0.081081	374.24	26.19
0.94	0.091081	490.46	29.42

Table 5.3: The effect of pairing debt issuance with equity reduction (share buybacks) on required top-up loan size shows how the top-up loans scale with the two different methods. The scenario assumes initial $L_k \approx 0.849$ as in Table 5.2. For each minimum leverage target, the table compares the debt needed under the standard DCL approach vs. the debt needed if the same amount is used to repurchase equity. The buyback strategy yields a much smaller required ΔD_k, mitigating the leverage asymmetry problem.

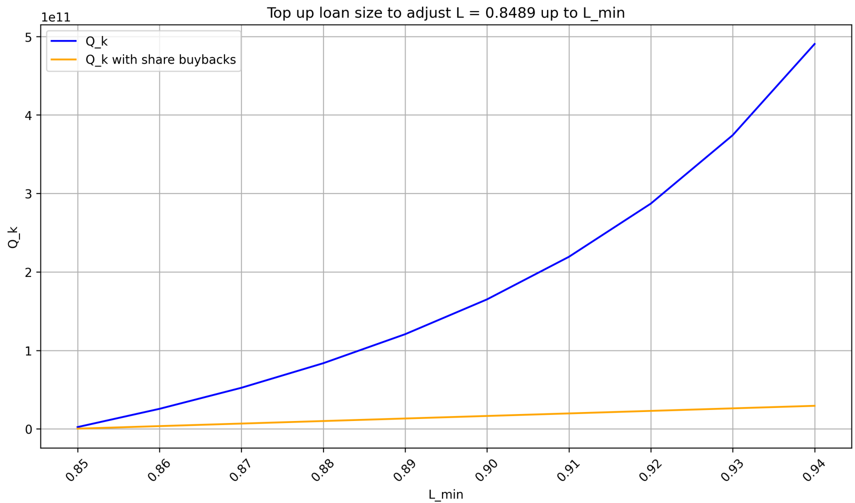

Figure 5.3: Top up loan size to adjust L_k up to L_{min} scales much slower (linearly) if the company draws down equity (using a top-up DCL loan) to raise leverage.

By drawing down equity, the leverage asymmetry is effectively resolved. The size of the required intervention becomes linear in the shortfall, and the magnitudes are much more reasonable for practical recapitalization. In summary, using the DCL bond's debt issuance to retire equity (through buybacks or dividends) can keep a highly levered bank's leverage ratio within the prescribed band without the need for extreme debt issuance. This modification to the DCL mechanism could thus greatly enhance its practicality and effectiveness for banks operating with very high leverage thresholds, ensuring stability is maintained with manageable adjustments rather than outsized, destabilizing ones.

5.2 Time Delta of Collapse

As observed in the case studies, the Dynamic Control of Leverage mechanism did not ultimately prevent a collapse – in every severe stress scenario the bank's equity eventually trended to zero – but it did delay the collapse. In other words, even though DCL could not save the bank from reaching the point of non-viability, it provided an additional buffer of time before that point was reached. This additional survival period is a critical benefit: it gives management and regulators a grace period to react to the crisis (for instance, to raise new capital, de-risk the balance sheet, or execute an orderly resolution) that would not exist under a traditional CoCo bond with no ongoing conversions. We term this benefit the "time gained until collapse," denoted as $\Delta T_{\text{Collapse}}$. In effect, $\Delta T_{\text{Collapse}}$ measures how much longer the bank can survive under distress with DCL in place, compared to the same scenario without DCL.

Mathematically, we define the time to collapse T_{collapse} as the time at which the bank's leverage reaches a terminal threshold corresponding to regulatory failure. Following regulatory terminology, we take this threshold as the Point of Non-Viability (PONV) leverage level, which we set at 0.97 (i.e. 97% leverage, meaning only 3% equity remains). In practice, reaching $L = 0.97$ would trigger regulatory intervention or resolution, so we treat it as the effective "collapse" point. Formally, if $L(t)$ denotes the leverage ratio at time t (on a 0–1 scale where 1.00 would be total leverage with zero equity), then we define the collapse time as the first passage time when leverage hits 0.97:

$$T_{\text{Collapse}} = \inf\{t \geq 0 \mid L(t) \geq 0.97\} \tag{5.6}$$

We can calculate this time for two scenarios: one with the DCL bond in place (which continuously converts interest to equity when leverage is high) and one with a traditional debt (no conversions). Let $T^{(\text{DCL})}_{\text{Collapse}}$ be the collapse time under the DCL framework, and $T^{(\text{No DCL})}_{\text{Collapse}}$ be the collapse time with an equivalent bond that does not convert (the status quo case). The time gained until collapse due to DCL is then defined as the difference:

$$\Delta T_{\text{Collapse}} = T^{(\text{DCL})}_{\text{Collapse},i} - T^{(\text{No DCL})}_{\text{Collapse},i} \tag{5.7}$$

Assuming both scenarios start from the same initial conditions and are subjected to the same stress scenario. By construction, $\Delta T_{\text{Collapse}}$ will be positive (or zero in trivial cases) whenever DCL successfully delays the failure relative to the no-DCL case. A larger $\Delta T_{\text{Collapse}}$ means DCL provided a longer breathing space before collapse – a tangible metric of DCL's effectiveness in buying time. On the other hand, $\Delta T_{\text{Collapse}} = 0$ would indicate that DCL made no difference in the collapse timing (for instance, if losses are so instantaneous and severe that even continuous conversions cannot slow down the failure). In our case study analysis, none of the banks outright avoided collapse under DCL, but each saw a meaningful increase in T_{Collapse} – confirming that DCL serves to delay collapse even if it cannot always prevent it outright.

5.2.1 Time as a Design Objective

Given the importance of this additional survival time, one can envision time gained until collapse as an explicit design objective for DCL instruments. Bank management and regulators might ask: How many extra months or years of viability can this DCL bond assure us under extreme conditions? If DCL can be calibrated to reliably provide, say, an additional two years of survival under a crisis scenario, that is extremely valuable – it could mean the difference between a disorderly failure and a managed recovery. Thus, when structuring a DCL-based CoCo, one could set a target $\Delta T_{\text{Collapse}}$ (for a given stress scenario or probability level) and then choose the bond's parameters – such as the conversion trigger level and conversion rate – to achieve that target.

In practical terms, however, $\Delta T_{\text{Collapse}}$ cannot be known in advance with certainty. It will depend on the path that the bank's finances actually take during a future crisis – which is inherently uncertain. The actual realized time gained in a real crisis will vary: if the crisis is mild, the bank might not collapse at all (so $\Delta T_{\text{Collapse}}$ is essentially the full horizon); if the crisis is extremely severe, DCL might only postpone failure by a short period. Therefore, the best one can do is estimate $\Delta T_{\text{Collapse}}$ under a range of plausible scenarios and use the expected time gained (or some percentile of it) as a guide for setting the DCL parameters. In other words, the goal could be to maximize $E[\Delta T_{\text{collapse}}]$ or to ensure with high confidence that $\Delta T_{\text{Collapse}}$ exceeds a certain minimum.

To estimate this, we can leverage a Monte Carlo simulation approach. By simulating many possible crisis scenarios for the bank's balance sheet, we can observe the distribution of collapse times with and without DCL, and thereby quantify the distribution of $\Delta T_{\text{Collapse}}$. The expected additional survival time $E[\Delta T_{\text{Collapse}}]$ can be calculated as:

$$\mathbb{E}[\Delta T_{\text{Collapse}}] \approx \frac{1}{N}\sum_{i=1}^{N}\left(T^{(\text{DCL})}_{\text{Collapse},i} - T^{(\text{No DCL})}_{\text{Collapse},i}\right) \tag{5.8}$$

where i indexes each simulated scenario (out of N total simulations). This provides a quantitative measure of how much extra time, on average, DCL is likely to buy the bank in a crisis. In addition, the spread of the $\Delta T_{\text{Collapse}}$ distribution across simulations would tell us the risk (variance) in that time benefit – e.g., whether DCL almost always provides a small but consistent time gain, or sometimes provides a huge gain and other times none at all.

5.2.2 Monte Carlo Framework for Delta Collapse Time Estimation

Monte Carlo simulations were conducted to quantitatively estimate the additional time gained before collapse under a DCL CoCo mechanism. This simulation generated 2000 hypothetical equity trajectory scenarios (based on 2018–2023 Credit Suisse financial data and observed volatility), under both a DCL-based CoCo framework and a no-DCL scenario. For each simulated path, the time of collapse (defined as the time when leverage breaches the PONV threshold, leading to non-viability) was recorded for both cases, and the difference $\Delta T_{\text{Collapse}} = T^{\text{DCL}}_{\text{Collapse}} -$

$T_{\text{Collapse}}^{\text{No DCL}}$ computed. The resulting distribution of $\Delta T_{\text{Collapse}}$, as seen in Figure 5.4 reflects how much longer the bank could survive with DCL in place, compared to without it. The Monte Carlo results confirm that DCL provides a significant buffer since in virtually all simulation runs, the collapse is delayed (i.e. $\Delta T_{\text{collapse}} > 0$), sometimes substantially so.

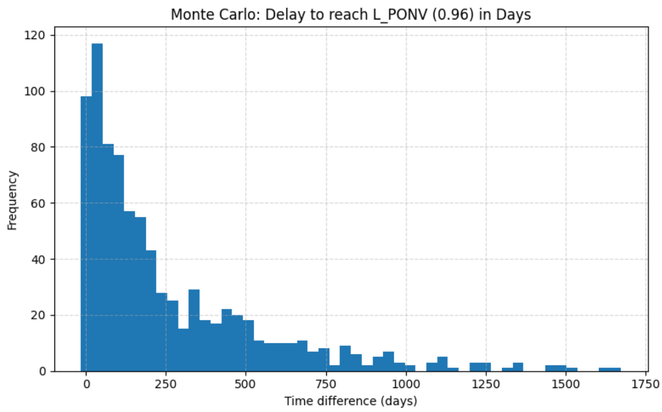

Figure 5.4: The results of the Monte Carlo Simulations show a significant but varied delay for when leverage reaches the *point of non-viability* under the DCL framework compared to non-DCL.

The simulation yielded an expected (mean) additional time to collapse of 261.2 days, with a median $\Delta T_{\text{collapse}}$ of 148.0 days. This indicates that, on average, the DCL mechanism could have extended Credit Suisse's life by roughly three quarters beyond the point at which it would have failed under a traditional CoCo structure. The distribution of outcomes was varied – the standard deviation of $\Delta T_{\text{collapse}}$ is 295.5 days. 99.85% of the simulated paths resulted in $\Delta T_{\text{collapse}} > 0$, meaning that in all but a negligible 0.15% of cases, the DCL framework delayed the collapse compared to the no-DCL baseline. These key statistics are summarized in Table 5.4.

Measure	**Result**
Mean delay	261.2 days
Median delay	148.0 days
Std. dev.	295.5 days
Range	-15 to 1672 days
Negative delays	3

Table 5.4: The results of the Monte Carlo Simulations show a significant delay in reaching the point of non-viability (PONV), though with notably large variance. In only 3 cases did the DCL framework accelerate a collapse.

In summary, the Monte Carlo analysis provides strong evidence that implementing DCL-based CoCo bonds would have substantially delayed the failure of Credit Suisse relative to a traditional CoCo bond framework. The time gained before reaching the point of non-viability can be non-trivial – and importantly represents a critical window in which management and regulators could intervene with corrective actions, asset sales, or capital injections to rescue the bank. This finding quantitatively validates the earlier qualitative observation that *the DCL bond gives the bank an additional buffer during a crisis*, and it aligns with the notion of using time gained as a key objective for DCL design (as proposed in Section 5.2.1). The clear implication is that time is a valuable asset in crisis management, and the DCL mechanism's ability to buy additional time can be decisive in averting collapse.

It is worth emphasizing the value for DCL to "buy time," not to magically cure insolvency. The simulation framework is a way to quantify how much time is bought. If the underlying condition of the bank is terminal (e.g. asset quality keeps deteriorating badly), DCL will not save the bank indefinitely – the case studies confirmed that eventually the leverage will reach L_{PONV} even with continuous conversions. However, the extra time afforded by DCL can be critical. In a crisis, time is one of the most precious commodities: time for asset values to possibly recover, time to restructure or raise new equity, or time for regulators to arrange an orderly resolution or merger. To conclude, the Dynamic Control of Leverage framework cannot completely avert collapse in a worst-case scenario, but it can significantly delay the collapse, and this delay – encapsulated by a positive $\Delta T_{\mathrm{Collapse}}$ – is a key advantage of DCL. Through the Monte Carlo analysis outlined above, one can rigorously estimate this advantage and potentially use it to optimize the DCL instrument's design (for example, setting the maximum trigger might be decided based on which yields a larger expected $\Delta T_{\mathrm{Collapse}}$ without undue side effects).

Chapter 6

Conclusion

In this thesis, we examined the Dynamic Control of Leverage (DCL) framework applied to contingent convertible (CoCo) bonds across three pivotal case studies – Deutsche Bank, Credit Suisse, and Lehman Brothers. The comparative analysis of these cases demonstrates that DCL can significantly bolster bank stability, though its effectiveness varies with the severity of financial distress. Deutsche Bank's scenario (a case of moderate, firm-specific stress) illustrated that DCL CoCo bonds could effectively stabilize leverage, preventing dangerous debt spirals and maintaining capital ratios within safe bounds. The Credit Suisse 2023 crisis, a more severe but contained collapse, showed that DCL would have mitigated the bank's failure by converting interest to equity incrementally – avoiding the abrupt and historical $17 billion write-downs of capital instruments and reducing market panic [2]. In stark contrast, Lehman Brothers' 2008 collapse (an extreme systemic failure) revealed DCL's limits: while the mechanism might only marginally delay Lehman's failure, buying a critical window of extra time, it could not ultimately prevent collapse given the overwhelming scale of losses. These outcomes underscore that DCL is most effective in moderate or contained crises, where it can proactively reinforce capital, whereas in a full-blown systemic meltdown its benefit is largely in gaining time rather than averting insolvency.

Effectiveness and Regulatory Integration

The case study findings highlight where and how DCL adds value. Notably, The strength of DCL lies in its proactive, adaptive recapitalization during distress. By enabling frequent, incremental equity injections, it could effectively lower leverage in the Deutsche Bank case and could have prevented the risk of a sudden loss of investor confidence that static triggers can have. In Credit Suisse's case, the DCL approach would provide a transparent, rule-based path to recapitalization, helping to preserve confidence and financial stability during the bank's resolution. These successes point to a clear policy implication: **DCL CoCos could be integrated into regulatory frameworks as a forward-looking tool to preempt crises**. Regulators could require or encourage banks to issue DCL-based contingent capital, thereby introducing an automatic stabilizer that kicks in before a bank breaches critical capital thresholds. Such integration would enhance transparency and predictability in bank capital regulation. In essence, DCL offers a practical mechanism for keeping banks' leverage in check in real-time, which could guide reforms in Additional Tier-1 capital requirements and strengthen overall financial system resilience. Embracing DCL within the regulatory toolkit can help buy time and buffer for troubled banks, giving management and authorities a chance to intervene early with less disruption.

Limitations

Overall, the findings paint an optimistic outlook for DCL as a next-generation contingent capital solution. Across the case studies, DCL proved its ability to dynamically absorb losses and stabilize banks during distress, validating its theoretical promise as an improvement over traditional CoCo bonds. By avoiding the pitfalls of fixed capital triggers, DCL provides a more effective and transparent loss-absorbing capacity that can bolster market confidence during bank stress. This forward-looking framework exemplifies how gradual, rules-based conversions can mitigate systemic risk and prevent panic, aligning with calls for more flexible crisis management tools in banking [12]. Crucially, DCL delivers what conventional CoCos could not: time. Even if it cannot single-handedly save a bank facing catastrophic losses, DCL buys precious time in a crisis – time for asset values to recover or for corrective actions to take effect. This additional breathing room can mean the difference between a contained episode and a disorderly collapse. That said, it is important to acknowledge DCL's limitations. In a worst-case systemic crisis (as Lehman's case showed), DCL is not a cure-all – if a bank's fundamentals are irreparably damaged, continuous conversions will reach a point of nonviability without much upside. The Lehman scenario reminds us that DCL cannot completely avert failure when underlying insolvency is too deep, underscoring the need to use DCL in tandem with broader systemic safeguards. Despite these caveats, the promise of DCL remains strong: it represents a substantial step forward in bank capital design, offering a more resilient and responsive buffer that can greatly reduce the likelihood and severity of bank failures in most scenarios.

Future works

Future research directions include further empirical investigations across different financial institutions and market conditions, as well as studies on investor perception and regulatory adoption challenges for DCL instruments. For example, it would be worthwhile to test DCL CoCos in a broader set of scenarios or with other banks to see if the benefits hold generally. Additionally, exploring how markets would price DCL CoCos (compared to traditional CoCos) could provide insight into the feasibility of issuing such instruments.

In conclusion, Dynamic Control of Leverage emerges from this research as a highly promising contingent capital tool that can fill critical gaps in the current financial safety net. Its performance in the case studies – stabilizing or salvaging banks under duress – demonstrates that with the right design, CoCo bonds can be far more effective at crisis prevention than previously thought. By pursuing the outlined future research and gradually addressing implementation challenges, scholars and policymakers can refine DCL further and solidify its role in banking regulation. The optimistic outlook is that DCL, as a next-generation capital instrument, could become a cornerstone of a more resilient banking system – one where regulators and banks dynamically contain leverage and avert disaster before it spirals out of control, while also being prepared for the limits of such tools in reacting to short-term events. With continued innovation, DCL CoCo bonds have the potential to significantly strengthen financial stability and reduce the frequency and severity of banking crises in the years ahead.

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Appendix A

Additional Tables and Figures

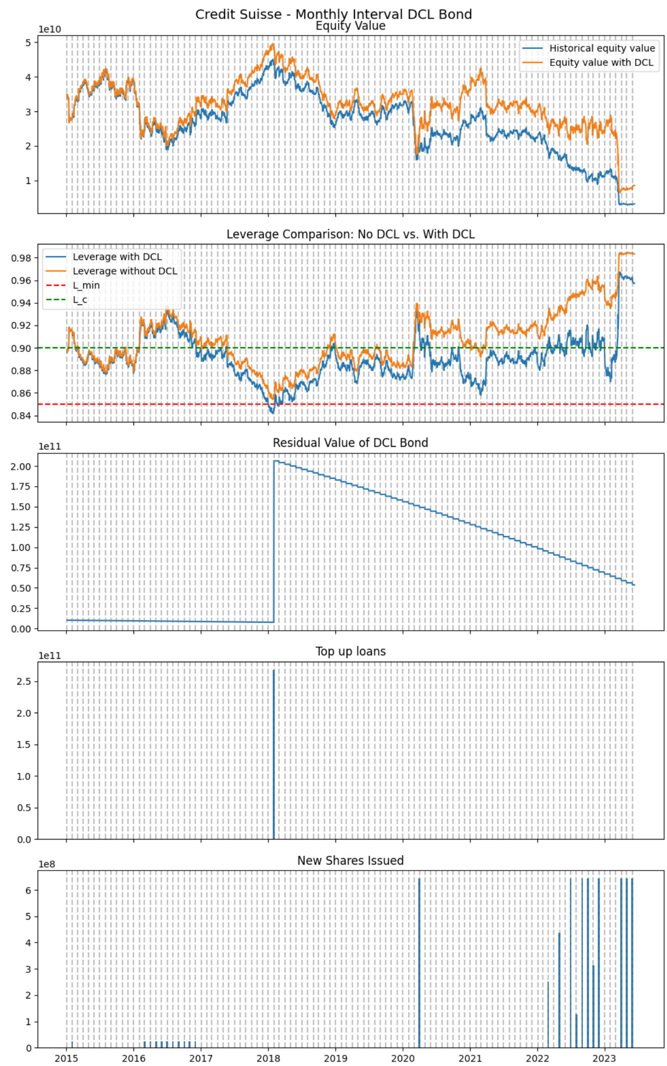

Figure A.1: Results of simulating a monthly interval DCL bond for Credit Suisse

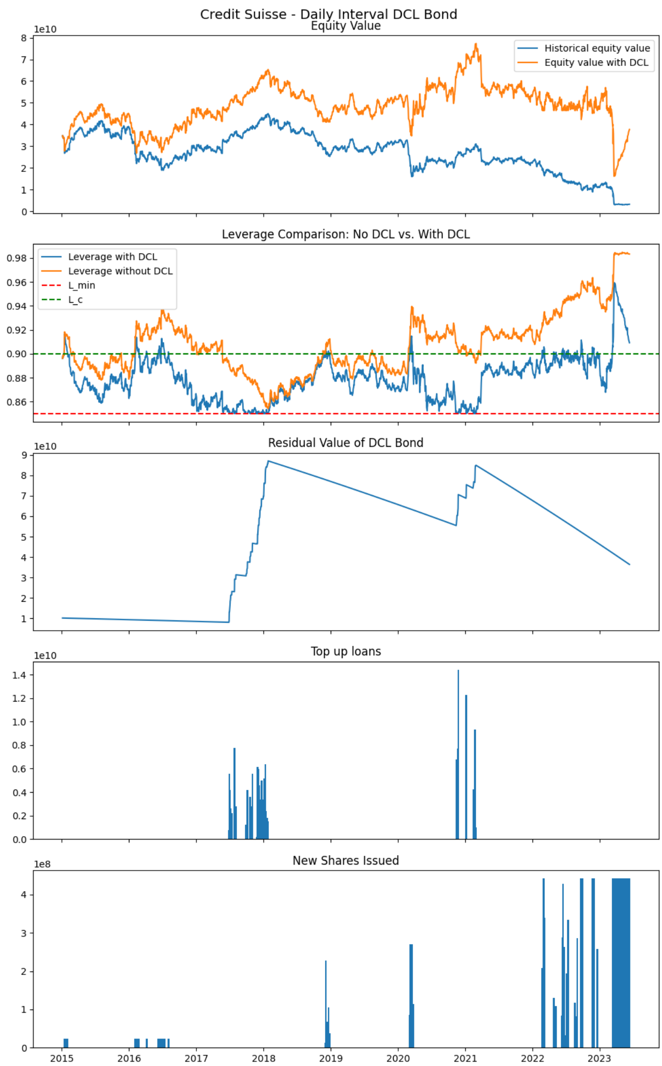

Figure A.2: Results of simulating a daily interval DCL bond for Credit Suisse

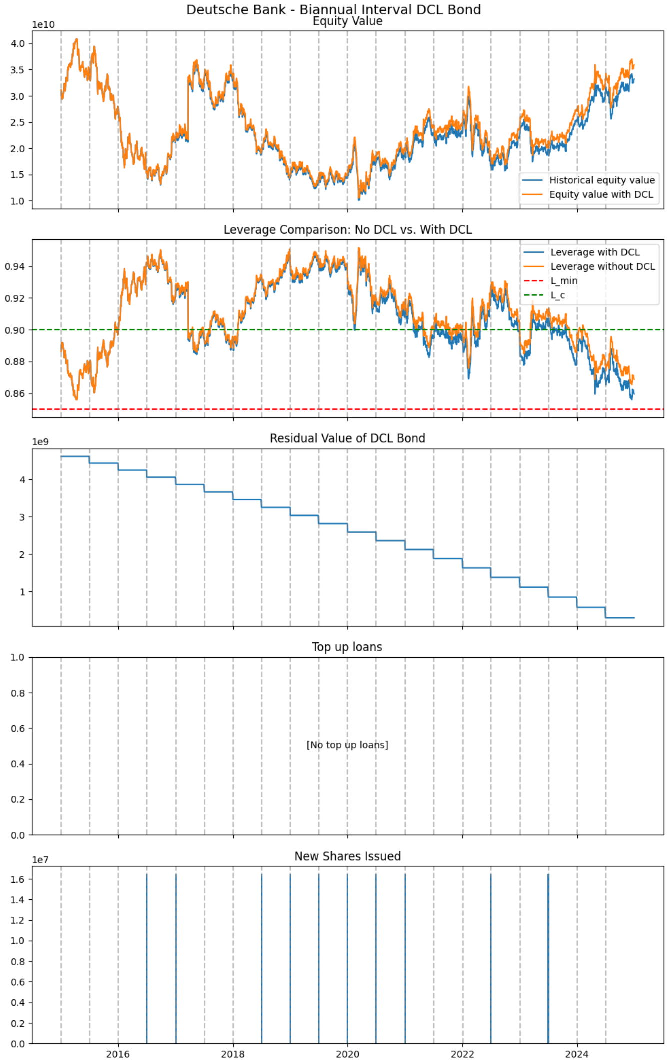

Figure A.3: Results of simulating a biannual interval DCL bond for Deutsche Bank

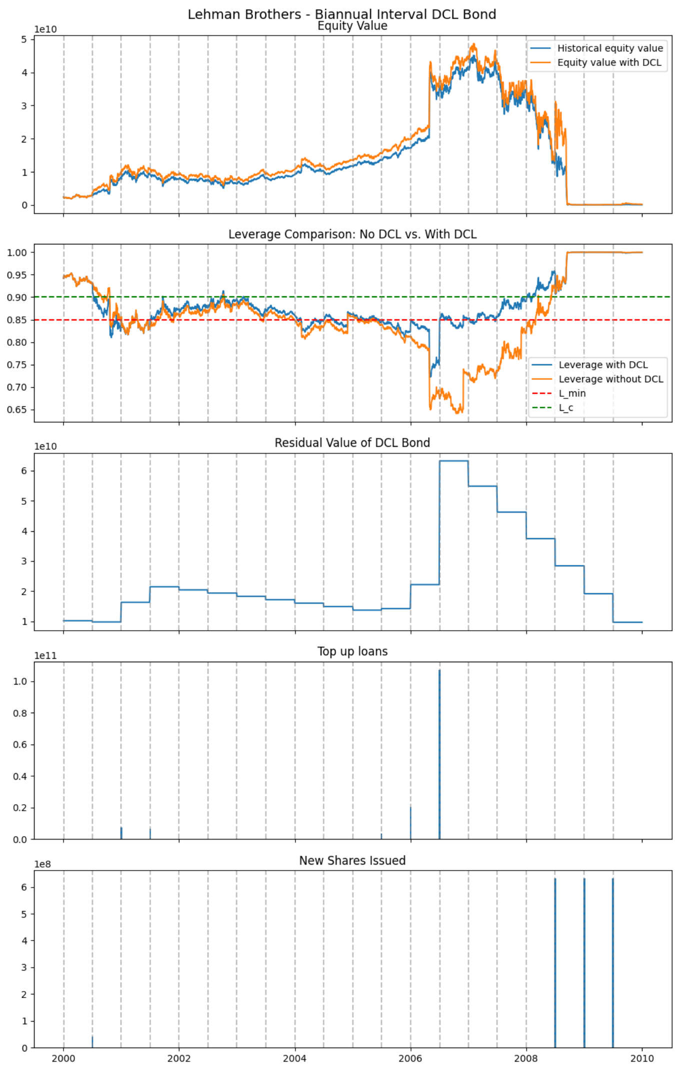

Figure A.4: Results of simulating a biannual interval DCL bond for Lehman Brothers