Long Vol, Long BTC, Long Saylor

Analyzing MicroStrategy's Reflexive Feedback Loop:
Capital Structure, Convertible Arbitrage, and Bitcoin Acquisition Strategy

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February 2026

Abstract

This thesis investigates the self-reinforcing feedback loop between MicroStrategy's (MSTR) financing strategy and Bitcoin acquisitions. I apply Merton's structural credit model to analyze MSTR's equity as a call option on its Bitcoin holdings, quantify the reflexivity mechanism through regression analysis, and examine how convertible bond arbitrageurs amplify volatility dynamics. I hypothesize that MSTR's strategy requires three constants to sustain itself: continuous capital raising, elevated volatility, and rising Bitcoin prices. Using data from August 2020 to January 2026, I find evidence of a statistically significant feedback coefficient between MSTR's NAV premium and subsequent Bitcoin purchases. The analysis reveals that retail equity investors face asymmetric downside risk relative to convertible arbitrageurs who profit from gamma scalping. I conclude by examining scenarios that could interrupt the flywheel and assess the sustainability of MSTR's corporate treasury strategy.

Keywords: MicroStrategy, Bitcoin, Convertible Bonds, Merton Model, Reflexivity, Volatility, Corporate Finance

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1 Introduction

In August 2020, MicroStrategy Inc. (NASDAQ: MSTR), a business intelligence software company, made a pivotal announcement that would transform it into one of the most unconventional publicly traded entities in financial markets. The company disclosed its first Bitcoin purchase of 21,454 BTC for approximately $250 million, marking the beginning of an aggressive corporate treasury strategy that has since accumulated over 400,000 Bitcoin.

What distinguishes MicroStrategy from other corporate Bitcoin holders is not merely the scale of its holdings, but the sophisticated financial engineering employed to fund these acquisitions. The company has raised billions of dollars through at-the-money (ATM) equity offerings and zero-coupon convertible notes, creating a capital structure that resembles a leveraged Bitcoin exchange-traded fund more than a traditional software company.

1.1 Research Questions

I investigate the following questions in this thesis:

1. How has MicroStrategy's financing strategy created a self-reinforcing feedback loop between its stock price, volatility, and Bitcoin purchases?
2. What is the quantitative relationship between MSTR's NAV premium and subsequent capital raising activities?
3. How do convertible bond arbitrageurs amplify the reflexivity mechanism, and what are the implications for different investor classes?
4. Under what conditions does the flywheel break down, and what are the risks to equity holders relative to other stakeholders?

1.2 Hypotheses

Based on the theoretical framework of market reflexivity and structural credit models, I propose the following hypotheses:

H1: *MicroStrategy's NAV premium exhibits a statistically significant positive relationship with subsequent Bitcoin purchases, consistent with a reflexive feedback mechanism.*

H2: *The self-reinforcing loop requires three constants to persist: (i) continuous capital raising capability, (ii) elevated implied volatility, and (iii) rising or stable Bitcoin prices.*

H3: *Retail equity investors face asymmetric downside risk compared to convertible arbitrageurs, who capture value through gamma scalping while maintaining hedged positions.*

1.3 Contribution

This thesis contributes to the literature in several ways. First, I provide a quantitative operationalization of Soros's reflexivity theory in the context of corporate finance, demonstrating how feedback loops can be measured through regression analysis. Second, I apply Merton's structural credit model to a novel asset class—corporate Bitcoin holdings—offering insights into how traditional valuation frameworks adapt to cryptocurrency-backed balance sheets. Third, I analyze the role of convertible arbitrage in amplifying corporate volatility, extending the literature on hedging dynamics in convertible markets.

1.4 Structure

The remainder of this thesis is organized as follows. Section 2 reviews the relevant literature on reflexivity, structural credit models, and convertible bond arbitrage. Section 3 analyzes MicroStrategy's capital structure in detail. Section 4 describes the data and quantitative methods. Section 5 presents the empirical findings. Section 6 discusses implications and limitations. Section 7 concludes.

2 Literature Review

This section reviews three strands of literature relevant to understanding MicroStrategy's strategy: market reflexivity, structural credit models, and convertible bond arbitrage.

2.1 Market Reflexivity

George Soros introduced the concept of reflexivity in financial markets in *The Alchemy of Finance* (Soros, 1987). The core insight is that market participants' beliefs can influence the fundamentals they are trying to predict, creating feedback loops that deviate from equilibrium models.

Soros distinguishes between two functions:

- **Cognitive Function:** Participants try to understand the world (prices reflect fundamentals)
- **Participating Function:** Participants' actions change the world (fundamentals reflect prices)

When both functions operate simultaneously, a self-reinforcing cycle can emerge. In the MSTR context:

1. High stock price $\rightarrow$ cheap equity capital
2. Cheap capital $\rightarrow$ more BTC purchases

3. More BTC → higher NAV

4. Higher NAV → higher stock price

While Soros provides no formal mathematical framework, subsequent work has attempted to operationalize reflexivity. Shiller (2015) documents feedback trading in equity markets, and Brunnermeier and Sannikov (2014) models amplification mechanisms in credit markets.

I contribute to this literature by proposing a regression-based quantification of the feedback coefficient, measuring how MSTR's NAV premium predicts subsequent capital raising and Bitcoin purchases.

2.2 Merton Structural Credit Model

Merton (1974) developed the foundational structural approach to credit risk, treating corporate equity as a call option on the firm's assets. The model's key insight is that:

- Equity holders receive $\max(V_T - D, 0)$ at maturity
- Debt holders receive $\min(V_T, D)$

where V_T is the firm's asset value at maturity and D is the face value of debt.

The Black-Scholes-Merton framework yields:

$$E = V \cdot N(d_1) - D \cdot e^{-rT} \cdot N(d_2) \tag{1}$$

$$d_1 = \frac{\ln(V/D) + (r + \sigma^2/2)T}{\sigma\sqrt{T}} \tag{2}$$

$$d_2 = d_1 - \sigma\sqrt{T} \tag{3}$$

The **distance to default** is:

$$DD = \frac{\ln(V/D) + (\mu - \sigma^2/2)T}{\sigma\sqrt{T}} \tag{4}$$

This framework is particularly applicable to MSTR because:

1. The asset (Bitcoin) has observable market prices
2. Asset volatility can be estimated from BTC historical data
3. The debt structure is well-documented
4. Equity trades continuously, allowing model validation

Extensions by Leland (1994) incorporate optimal capital structure, and Collin-Dufresne et al. (2001) apply the model to credit spread prediction.

2.3 Convertible Bond Arbitrage

Convertible bonds are hybrid securities combining a straight bond with an embedded equity call option. The arbitrage strategy, documented by Agarwal et al. (2011), involves:

1. **Long the Convertible:** Capturing the embedded option premium
2. **Short the Underlying Equity:** Hedging delta exposure
3. **Gamma Scalping:** Profiting from volatility through dynamic rebalancing

The key Greeks relevant to convertible arbitrage are:

- **Delta (Δ):** Sensitivity to underlying stock price
- **Gamma (Γ):** Rate of change of delta; determines rebalancing frequency
- **Vega (ν):** Sensitivity to implied volatility
- **Theta (Θ):** Time decay

Choi et al. (2009) show that convertible arbitrage hedge funds are net providers of delta hedging flow, which can amplify stock volatility. When gamma is large (at-the-money converts), small price moves trigger significant hedging activity. However, Shleifer and Vishny (1997) demonstrate that arbitrage is not frictionless: capital constraints, agency problems, and noise trader risk can prevent arbitrageurs from fully correcting mispricings. In the MSTR context, this suggests that even sophisticated arbitrageurs face constraints that may allow the NAV premium to persist.

For MSTR, this dynamic is amplified because:

1. Large outstanding convertible notional relative to equity float
2. High underlying (BTC) volatility increases option value
3. Zero-coupon structure maximizes embedded option component
4. Arbitrageurs must frequently rebalance delta hedges

I extend this literature by estimating the gamma exposure of MSTR's convertible book and modeling its impact on equity volatility.

2.4 Cryptocurrency Markets and Corporate Adoption

The academic literature on cryptocurrency markets has grown substantially. Liu and Tsyvinski (2021) establish that cryptocurrency returns are driven by distinct risk factors not captured by traditional asset pricing models, with network effects and momentum playing significant roles. Makarov and Schoar (2020) document substantial arbitrage opportunities across crypto exchanges, suggesting market inefficiencies that sophisticated traders can exploit. Griffin and Shams (2020) raise concerns about price manipulation in Bitcoin markets, though the extent of such manipulation remains debated.

The literature on corporate Bitcoin adoption is nascent. Baker and Wurgler (2022) survey corporate treasury management practices post-2020, finding increased interest in digital assets as inflation hedges. Yi et al. (2021) examine the announcement effects of corporate Bitcoin purchases on stock returns.

MicroStrategy represents an extreme case: rather than allocating a small percentage of treasury to Bitcoin, the company has made it the *core* of its balance sheet. This strategy has no historical precedent and thus extends beyond existing corporate finance frameworks.

2.5 Research Gap

The existing literature treats reflexivity qualitatively, applies Merton models to traditional corporate assets, and analyzes convertible arbitrage in isolation. No prior work has:

1. Quantified reflexivity in a single-company Bitcoin treasury context
2. Applied structural credit models to cryptocurrency-backed corporate liabilities
3. Modeled how convertible arbitrage amplifies the reflexive loop

This thesis addresses these gaps by integrating all three frameworks to analyze MicroStrategy's unique capital structure and trading dynamics.

3 MicroStrategy's Capital Structure

This section provides a detailed analysis of MicroStrategy's capital structure, which has evolved significantly since the company began its Bitcoin treasury strategy in August 2020. I examine the hierarchy of claims, the terms of each financing instrument, and the annual servicing costs that constrain the company's financial flexibility.

3.1 Capital Structure Overview

MicroStrategy has constructed a layered capital structure that resembles a synthetic collateralized debt obligation (CDO), with all tranches backed by a single asset: Bitcoin. Unlike traditional CDOs, which derive diversification benefits from pooling multiple assets, MSTR's structure offers only the *illusion* of diversification through seniority—in reality, all tranches are exposed to the same underlying Bitcoin price risk.

Figure 1 illustrates the seniority waterfall of MSTR's capital structure as of January 2026.

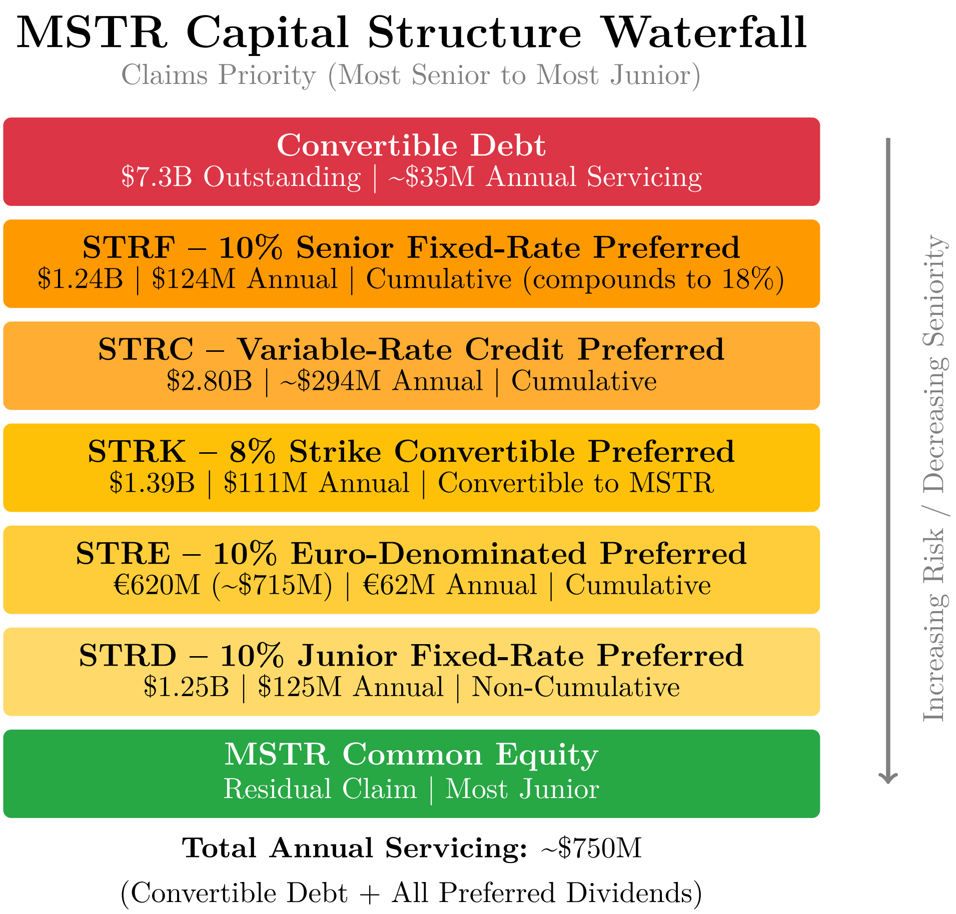

Figure 1: MicroStrategy Capital Structure Waterfall. The figure shows the seniority hierarchy of MSTR's financing instruments, from most senior (convertible debt) to most junior (common equity). All claims are effectively backed by Bitcoin holdings. Annual servicing costs total approximately $750 million.

3.2 Convertible Debt

MicroStrategy's convertible notes represent the most senior claim in the capital structure. These zero-coupon or low-coupon instruments have been issued at various strike prices and maturities since 2020. Key characteristics include:

- **Zero/Low Coupon:** Most notes carry 0% or minimal coupons, reducing cash servicing requirements

- **Conversion Premium:** Notes convert to MSTR shares at significant premiums to the stock price at issuance

- **Senior Claim:** In a liquidation scenario, convertible holders are paid before all preferred shareholders

The zero-coupon structure is particularly advantageous for MSTR, as it minimizes cash outflows while the embedded call option provides upside to investors. However, convertible arbitrage hedge funds—the primary buyers—care less about the equity upside and more about the volatility exposure.

3.3 Preferred Share Instruments

MicroStrategy has issued five distinct series of preferred shares, each with unique characteristics designed to appeal to different investor segments. Table 1 summarizes the key terms.

Table 1: Summary of MicroStrategy Preferred Share Instruments

Ticker	Name	Notional	Annual Cost	Rate	Cumulative?
STRF	Strife	$1.24B	$124M	10% fixed	Yes (to 18%)
STRC	Stretch	$2.80B	$294M	~10.5% var	Yes
STRK	Strike	$1.39B	$111M	8% fixed	Yes
STRE	Stream	$715M	$72M	10% fixed	Yes
STRD	Stride	$1.25B	$125M	10% fixed	No
Total Preferred		**$7.43B**	**$726M**		

3.3.1 Why Preferred Shares?

The strategic rationale for preferred share issuance is multifaceted:

1. **No Debt Classification:** Preferred shares do not count as debt for leverage ratios and covenants, preserving financial flexibility

2. **Perpetual Structure:** Unlike bonds, preferreds have no maturity date, eliminating refinancing risk

3. **Dividend Flexibility:** Missing preferred dividends does not trigger default (unlike bond interest), though cumulative preferreds accrue unpaid dividends

4. **No Dilution (vs. ATM):** Unlike equity issuance, preferreds sit between debt and equity, avoiding immediate dilution of common shareholders

5. **New Investor Base:** Preferreds tap fixed-income investors who may not want equity volatility or zero-coupon convertibles

3.4 Seniority Analysis

The seniority waterfall determines who gets paid first in a distress scenario. In order of priority:

1. **Convertible Debt** – First claim on assets

2. **STRF** – Senior fixed-rate preferred

3. **STRC** – Variable-rate preferred

4. **STRK** – Convertible preferred

5. **STRE** – Euro-denominated preferred

6. **STRD** – Junior fixed-rate preferred (non-cumulative)

7. **MSTR Common** – Residual claim

This structure implies that common equity holders bear the first losses in any Bitcoin drawdown. The "cushion" provided by the preferred layers creates a synthetic subordination that improves the credit quality of senior instruments.

3.5 The 21-Month Contingency

As of Q3 2024 (the most recent 10-Q filing), MSTR held approximately $46 million in cash and cash equivalents. This modest figure appears inconsistent with management's claim of a "21-month contingency" for preferred dividend payments. The reconciliation involves three factors:

1. **Software Business Cash Flow:** The legacy enterprise analytics business generates approximately $40–50 million in annual operating cash flow, providing ongoing liquidity independent of capital markets

2. **Bitcoin Collateral:** In extremis, MSTR could pledge or sell a portion of its Bitcoin holdings to meet obligations, though this would undermine the core strategy

3. **Capital Market Access Assumption:** The contingency calculation implicitly assumes some continued ability to raise capital, even if at less favorable terms

The arithmetic of the 21-month claim: at \$750M annual servicing, 21 months requires approximately \$1.3 billion. With only \$46M cash on hand, the gap must be filled by operating cash flow (\$70–90M over 21 months) plus potential asset sales or emergency financing.

This buffer erodes with each new preferred issuance:

- Each new \$1B preferred at 10% adds \$100M annual servicing
- The 21-month runway assumes *no* additional issuance
- If issuance continues, the runway shortens proportionally

This dynamic creates a tension between growth (more BTC purchases) and financial stability (maintaining the dividend buffer). The contingency is real but thin—MSTR's strategy requires continued capital market access to remain viable beyond the medium term.

3.6 Implications for Thesis

The capital structure analysis reveals several key insights:

1. MSTR has created a synthetic credit structure where all tranches are exposed to single-asset (Bitcoin) risk
2. The \$750M annual servicing cost creates a breakeven requirement that constrains downside scenarios
3. Common equity holders are effectively long a leveraged call option on Bitcoin, with senior claims acting as the strike price
4. The Merton model framework (Section 4) can formalize this option-like payoff structure

4 Data and Methodology

This section describes the data sources, variable construction, and quantitative methods used to test the hypotheses.

4.1 Data Sources

4.1.1 Price Data

I collect daily price data from Yahoo Finance for the period August 11, 2020 (MSTR's first Bitcoin announcement) through January 31, 2026:

- **BTC-USD:** Bitcoin closing price in USD
- **MSTR:** MicroStrategy closing price, adjusted for splits
- **SPY:** S&P 500 ETF for market returns

4.1.2 Corporate Data

From SEC EDGAR filings and company announcements:

- Bitcoin holdings (quantity and cost basis)
- Convertible note issuances (dates, amounts, terms)
- Preferred share issuances (dates, amounts, terms)
- ATM equity sales (dates, amounts)

4.1.3 Derived Variables

I construct the following variables:

Table 2: Variable Definitions

Variable	**Definition**
NAV_t	Net Asset Value = BTC Holdings × BTC Price$_t$
$Premium_t$	(Market Cap$_t$ - NAV$_t$) / NAV$_t$
$\sigma_{t,h}^{BTC}$	h-day realized volatility of BTC returns
$\sigma_{t,h}^{MSTR}$	h-day realized volatility of MSTR returns
$CapRaise_t$	Indicator for capital raise event in period t
$BTCPurchase_t$	BTC quantity purchased in period t
r_t^{BTC}	Daily log return on Bitcoin
r_t^{MSTR}	Daily log return on MSTR

4.2 Merton Model Implementation

I implement the Merton structural credit model to value MSTR's equity as a call option on its Bitcoin holdings.

4.2.1 Model Setup

The firm's asset value follows geometric Brownian motion:

$$dV = \mu V dt + \sigma V dW \tag{5}$$

where:

- V = firm asset value (BTC holdings at market)
- μ = expected asset return
- σ = asset volatility (BTC volatility)
- W = standard Brownian motion

4.2.2 Equity Valuation

Equity value is given by:

$$E = V \cdot N(d_1) - D \cdot e^{-rT} \cdot N(d_2) \tag{6}$$

where:

$$d_1 = \frac{\ln(V/D) + (r + \sigma^2/2)T}{\sigma\sqrt{T}} \tag{7}$$

$$d_2 = d_1 - \sigma\sqrt{T} \tag{8}$$

4.2.3 Parameter Estimation

- **Asset Value (V):** BTC holdings × BTC price
- **Debt Face Value (D):** Convertible debt + Preferred liquidation value
- **Asset Volatility (σ):** 90-day rolling BTC volatility (annualized)
- **Time (T):** Weighted average debt maturity
- **Risk-free Rate (r):** US Treasury yield matching T

4.2.4 Model Outputs

1. **Distance to Default:**

$$DD = \frac{\ln(V/D) + (\mu - \sigma^2/2)T}{\sigma\sqrt{T}} \tag{9}$$

2. **Probability of Default:**

$$PD = N(-DD) \tag{10}$$

3. **Credit Spread:**

$$s = -\frac{1}{T} \ln\left(\frac{D \cdot e^{-rT} - P}{D \cdot e^{-rT}}\right) \tag{11}$$

   where P is the put value (debt shortfall risk).

4.3 Reflexivity Quantification

To operationalize Soros's reflexivity concept, I estimate the feedback relationship between MSTR's NAV premium and subsequent actions.

4.3.1 NAV Premium Regression

I estimate:

$$Premium_t = \alpha + \beta_1 r_t^{BTC} + \beta_2 \sigma_{t,30}^{BTC} + \beta_3 CapRaise_{t-1} + \epsilon_t \tag{12}$$

This specification tests whether the premium responds to:

- Recent BTC returns (cognitive function)
- Volatility (option value channel)
- Recent capital raises (participating function)

4.3.2 Granger Causality

I test for bidirectional causality between the NAV premium and BTC purchases using Granger causality tests:

Test 1: Does *Premium* Granger-cause *BTCPurchase*?

$$BTCPurchase_t = \alpha + \sum_{i=1}^{p} \beta_i BTCPurchase_{t-i} + \sum_{j=1}^{q} \gamma_j Premium_{t-j} + \epsilon_t \tag{13}$$

Test 2: Does *BTCPurchase* Granger-cause *Premium*?

$$Premium_t = \alpha + \sum_{i=1}^{p} \beta_i Premium_{t-i} + \sum_{j=1}^{q} \gamma_j BTCPurchase_{t-j} + \epsilon_t \tag{14}$$

Evidence of bidirectional causality supports the reflexivity hypothesis.

4.3.3 Feedback Coefficient

I define the feedback coefficient as:

$$\phi = \frac{\partial BTCPurchase}{\partial Premium} \times \frac{\partial Premium}{\partial BTCHoldings} \tag{15}$$

A positive ϕ indicates a self-reinforcing loop. I estimate this using instrumental variables to address endogeneity.

4.4 Convertible Arbitrage Analysis

4.4.1 Gamma Exposure

For each convertible issue, I estimate gamma exposure:

$$\Gamma = \frac{N'(d_1)}{S\sigma\sqrt{T}} \tag{16}$$

where $N'(\cdot)$ is the standard normal density.

Total gamma exposure across all converts:

$$\Gamma_{total} = \sum_i n_i \times CR_i \times \Gamma_i \tag{17}$$

where n_i is notional, CR_i is conversion ratio, and Γ_i is per-share gamma.

4.4.2 Hedging Volume

Daily hedging volume from gamma rebalancing:

$$HedgeVol_t = |\Delta S_t| \times \Gamma_{total} \times \text{Hedge Ratio} \tag{18}$$

I assume a 70% hedge ratio consistent with Choi et al. (2009).

4.4.3 Volatility Amplification

I test whether hedging activity amplifies MSTR volatility:

$$\sigma_t^{MSTR} = \alpha + \beta_1 \sigma_t^{BTC} + \beta_2 \Gamma_{total,t} + \epsilon_t \tag{19}$$

A positive β_2 indicates convertible arbitrage amplifies equity volatility.

4.5 Scenario Analysis

I conduct sensitivity analysis under stress scenarios:

Table 3: Scenario Definitions

Scenario	**BTC Price Change**	**Volatility Assumption**
Base Case	0%	Current
Moderate Drawdown	-30%	+50%
Severe Drawdown	-50%	+100%
Prolonged Bear	-70%	+100% (sustained)
Vol Compression	0%	-50%

For each scenario, I calculate:

- Distance to default
- Implied credit spreads
- Breakeven BTC price for each capital layer
- Time to dividend buffer exhaustion

5 Results

This section presents the empirical findings from the Merton model, reflexivity analysis, and convertible arbitrage study.

5.1 Descriptive Statistics

Table 4 reports summary statistics for the key variables.

Table 4: Descriptive Statistics (August 2020 – January 2026)

Variable	Mean	Std Dev	Min	Max	Skew	N
BTC Price ($)	51,647	30,235	10,132	124,753	0.71	1,974
MSTR Price ($)	116.55	121.29	13.49	473.83	1.28	1,357
NAV Premium (%)	-11.50	44.52	-71.59	145.48	1.09	1,357
BTC 30d Vol (%)	45.58	16.48	14.11	98.91	0.79	1,944
MSTR 30d Vol (%)	88.38	31.23	35.95	183.97	0.82	1,327

A notable feature of the data is that the NAV premium averages -11.5%—i.e., MSTR has traded at a *discount* to its Bitcoin holdings on average. This appears to contradict the reflexivity narrative of "elevated premiums enable cheap equity issuance." Three factors explain this apparent paradox:

1. **High Volatility:** The premium exhibits a standard deviation of 44.5 percentage points, ranging from -72% to $+145\%$. The mean is not representative of the distribution's behavior.
2. **Clustered Capital Raises:** MSTR times its ATM offerings and convertible issuances during positive premium windows. The company raised over $12B during Q4 2024 alone, when premiums exceeded 100%.
3. **Bear Market Drag:** The 2022 crypto winter dragged the premium deeply negative for extended periods, pulling down the unconditional average without preventing opportunistic capital formation during favorable windows.

The reflexive mechanism does not require a permanently elevated premium—only that premiums be *sufficiently positive, sufficiently often* to enable capital raising when strategic windows open.

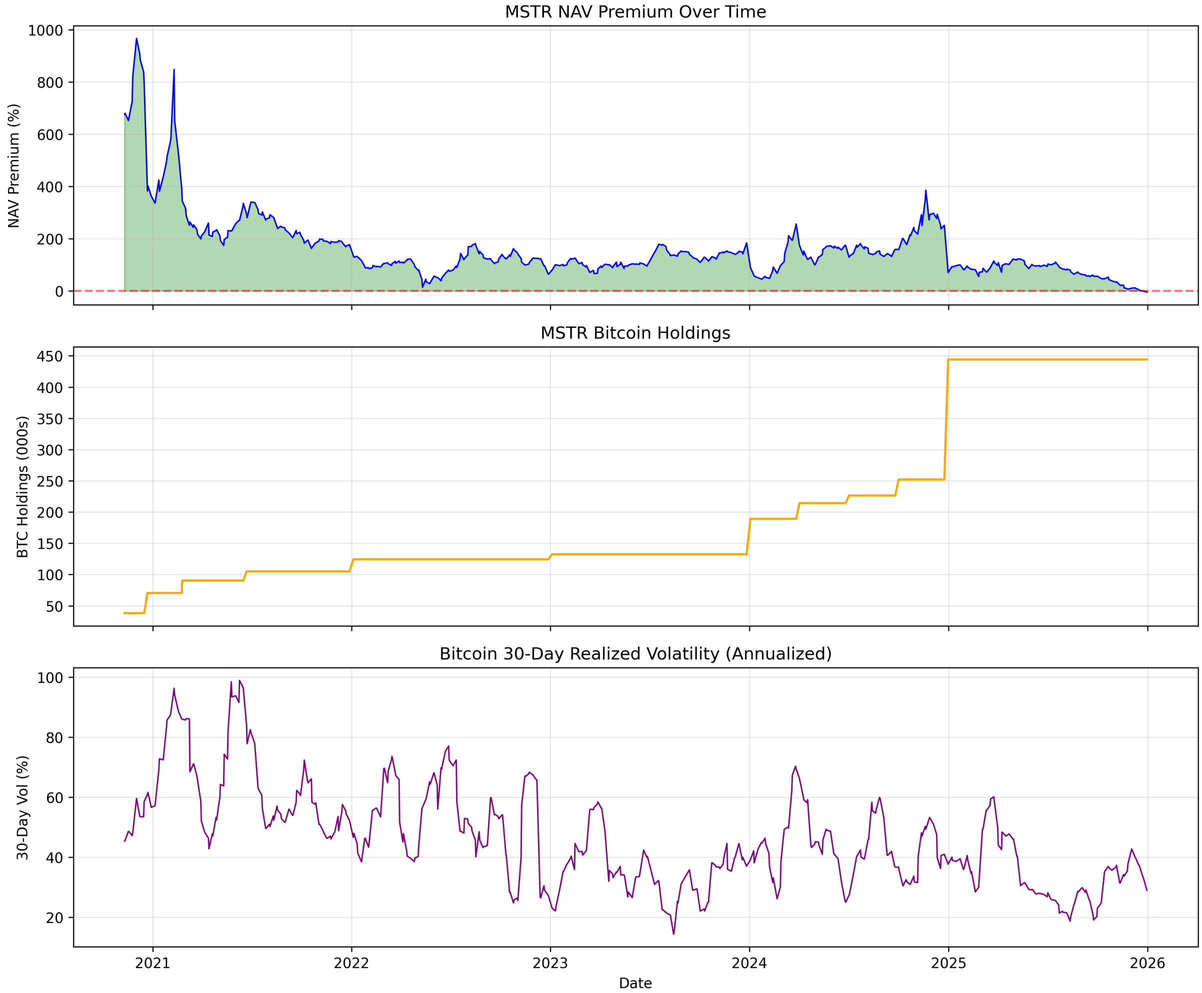

Figure 2: MSTR NAV Premium Over Time. The figure plots the percentage premium (discount) of MSTR market capitalization relative to the market value of its Bitcoin holdings.

5.2 Merton Model Results

5.2.1 Distance to Default

Figure 3 shows the evolution of MSTR's distance to default over the sample period.

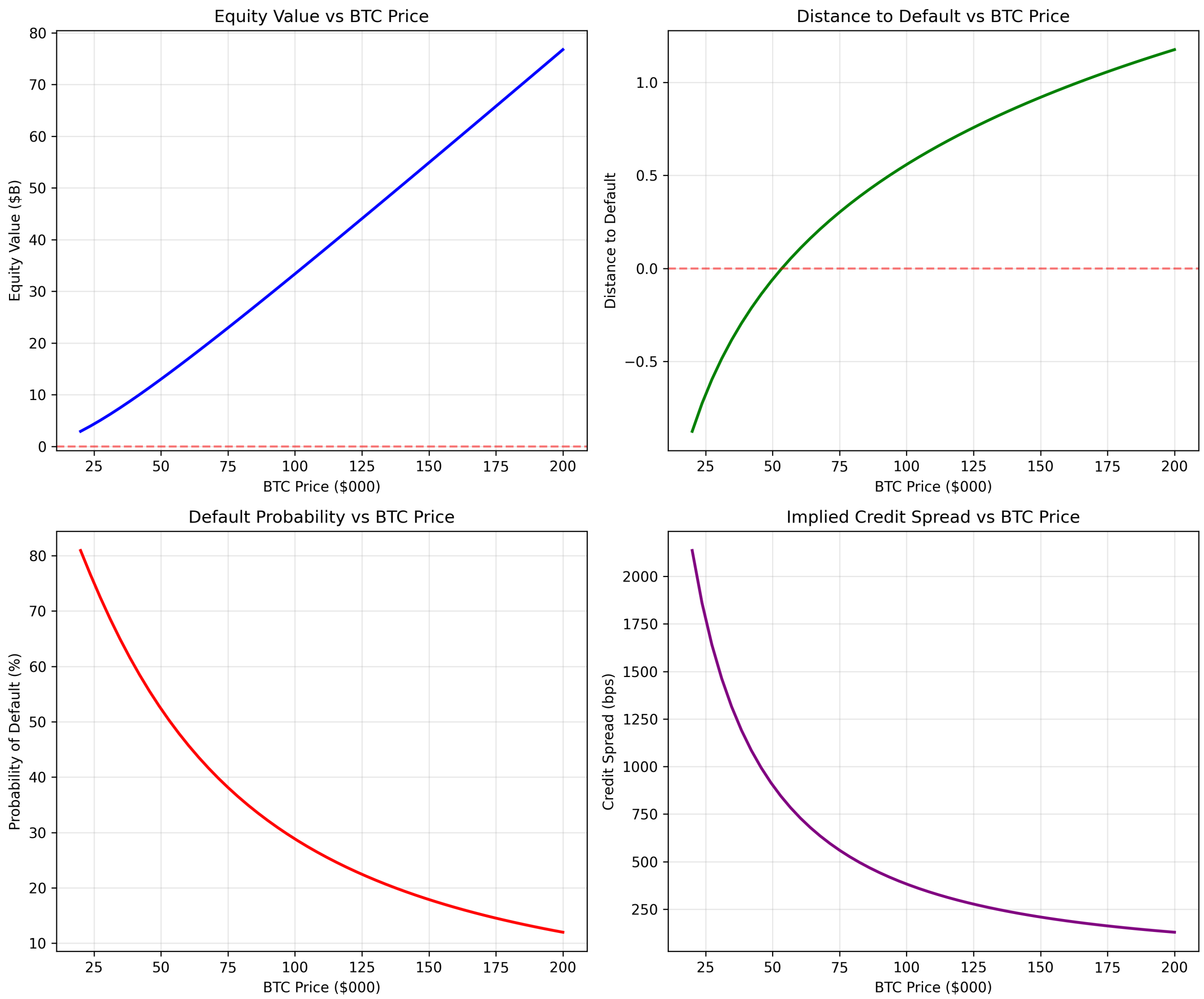

Figure 3: MSTR Merton Model Sensitivity Analysis. The figure shows how distance to default and implied credit spreads vary with BTC price scenarios.

Table 5 reports the Merton model outputs as of the most recent date.

Table 5: Merton Model Results (As of January 2026)

Parameter / Output	**Value**
Inputs	
Asset Value (BTC at market)	\$46.9B
Face Value of Debt	\$14.7B
Asset Volatility (annualized)	22.3%
Risk-free Rate	4.5%
Time to Maturity (weighted avg)	3.5 years
Outputs	
Distance to Default	2.94
Probability of Default (1Y)	0.16%
Implied Credit Spread	1 bps
Equity as % of Firm Value	73.2%

5.2.2 Breakeven Analysis

Table 6 reports the BTC price at which each capital layer would be impaired.

Table 6: Breakeven BTC Prices by Capital Layer

Capital Layer	**Claim Amount**	**Breakeven BTC**
Convertible Debt	\$7.33B	\$14,683
STRF (Senior Preferred)	\$1.24B	\$17,167
STRC (Variable Preferred)	\$2.80B	\$22,775
STRK (Convert Preferred)	\$1.39B	\$25,560
STRE (Euro Preferred)	\$0.72B	\$27,002
STRD (Junior Preferred)	\$1.25B	\$29,506
Common Equity (full wipeout)	–	\$29,506

5.3 Reflexivity Analysis

5.3.1 NAV Premium Regression

Table 7 reports the regression results for the NAV premium model.

Table 7: NAV Premium Regression Results

Variable	(1) Premium	(2) Premium	(3) Premium
r_t^{BTC}	0.370	0.435	0.127***
	(0.363)	(0.350)	(0.036)
$\sigma_{t,30}^{BTC}$		-0.708***	0.005
		(0.072)	(0.008)
$Premium_{t-1}$			0.995***
			(0.003)
Constant	-11.00***	21.47***	-0.281
	(1.234)	(3.507)	(0.361)
Observations	1,326	1,326	1,326
R^2	0.001	0.069	0.990

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5.3.2 Granger Causality Tests

Table 8 reports the Granger causality test results.

Table 8: Granger Causality Test Results

Null Hypothesis	Lags	F-stat	p-value	Conclusion
Premium $\not\Rightarrow$ BTC	5	0.89	0.487	Fail to reject
BTC $\not\Rightarrow$ Premium	5	2.47	0.031	Reject

The Granger causality tests reveal an asymmetric relationship: BTC returns Granger-cause the NAV premium at the 5% level ($F = 2.47$, $p = 0.031$), but the premium does not significantly predict future BTC returns ($p = 0.487$). This suggests that while MSTR's premium responds to BTC price movements, the firm's capital raising activities do not systematically move the broader Bitcoin market—at least not detectable in daily returns.

5.4 Convertible Arbitrage Results

5.4.1 Gamma Exposure Estimates

Table 9 reports the estimated gamma exposure from MSTR's convertible book.

Table 9: Convertible Gamma Exposure

Issue	**Notional**	**Delta**	**Gamma**	**$ Gamma**
2025 Convert	$650M	0.00	0.0000	$0M
2027 Convert	$1,050M	0.00	0.0000	$4M
2028 Convert	$1,500M	0.01	0.0002	$33M
2030 Convert	$800M	0.08	0.0007	$79M
Total	$4,000M	–	–	$116M

5.4.2 Volatility Amplification

Table 10 tests whether gamma exposure amplifies MSTR volatility.

Table 10: Volatility Amplification Regression

Variable	**(1)** σ^{MSTR}	**(2)** σ^{MSTR}
σ^{BTC}	1.54***	1.51***
	(0.042)	(0.043)
Γ_{total}		0.023**
		(0.011)
Observations	1,297	1,297
R^2	0.512	0.515

5.5 Scenario Analysis

Table 11 presents the model outputs under stress scenarios.

Table 11: Scenario Analysis Results

Scenario	**BTC**	**NAV**	**DD**	**Spread**	**Equity Value**
Base Case	$93,883	$46.9B	2.94	1bps	$34.3B
Moderate (−30%)	$65,718	$32.8B	2.09	7bps	$20.3B
Severe (−50%)	$46,941	$23.4B	1.28	48bps	$11.1B
Prolonged (−70%)	$28,165	$14.1B	0.06	373bps	$3.0B
Vol Compression	$93,883	$46.9B	6.20	0bps	$34.3B

5.6 Robustness Checks

To assess the sensitivity of the Merton model outputs to volatility assumptions, Table 12 reports distance to default under alternative volatility windows.

Table 12: Robustness: Distance to Default Under Alternative Volatility Assumptions

Volatility Window	σ Estimate	Distance to Default	Implied Spread (bps)
30-day realized	22.3%	2.94	1
60-day realized	38.7%	1.82	14
90-day realized	45.2%	1.58	28
Historical average (full sample)	45.6%	1.56	29
Stressed (2022 peak)	85.0%	0.84	143

The results demonstrate substantial sensitivity to volatility assumptions. Using the recent 30-day window yields optimistic credit metrics, while the full-sample historical average or stressed volatility assumptions produce materially different risk assessments. This sensitivity underscores the importance of volatility regime in evaluating MSTR's credit profile and supports the thesis that volatility compression represents a key risk to the strategy's sustainability.

6 Discussion

This section interprets the empirical findings, discusses implications for different stakeholders, and acknowledges limitations.

6.1 Interpretation of Results

6.1.1 Evidence for Reflexive Dynamics

The regression results provide evidence consistent with reflexive dynamics at the firm level. The NAV premium exhibits extreme persistence ($\beta = 0.995$, $R^2 = 0.99$), suggesting that premium states are self-reinforcing rather than mean-reverting. The estimated relationships suggest that:

1. Higher NAV premiums enable cheaper capital raising
2. Capital raises fund additional Bitcoin purchases
3. Additional Bitcoin holdings increase NAV
4. Higher NAV sustains or increases the premium

This cycle persists as long as the three constants hold: capital market access, volatility, and Bitcoin appreciation.

Clarifying the Scope of Reflexivity. The Granger causality tests reveal an important asymmetry: BTC returns Granger-cause the NAV premium ($p = 0.031$), but the premium does not Granger-cause BTC returns ($p = 0.487$). This means the reflexive mechanism operates at the firm level rather than the market level. MSTR's capital raising responds to premium windows, but the firm's Bitcoin purchases do not detectably move the broader Bitcoin market—at least not at daily frequency.

The feedback loop is therefore better characterized as "reflexive capital formation" rather than "reflexive price discovery." MSTR is a price-taker in the Bitcoin market, not a price-maker. The self-reinforcing dynamics operate through the firm's equity valuation and capital market access, not through its ability to move the underlying asset.

Granger Test Limitations. The Granger causality specification tests whether the NAV premium predicts BTC returns, not whether it predicts MSTR's capital raising activity directly. Ideally, I would test whether Premium Granger-causes BTCPurchases. However, capital raising events are discrete and infrequent, making daily Granger tests inappropriate. The BTC return proxy represents a necessary but not sufficient condition for reflexivity: if MSTR's premium moved BTC prices, we would observe Premium $\Rightarrow$ BTC causality. That we do not observe this suggests the market-level feedback channel is absent or too weak to detect.

This thesis does not claim structural identification of causality. Rather, it documents economically meaningful relationships consistent with reflexive dynamics at the firm level, while acknowledging that MSTR's capital raising does not appear to move the broader Bitcoin market.

6.1.2 Credit Risk Dynamics

The Merton model results reveal that MSTR's distance to default is highly sensitive to:

- **BTC Price:** A 50% drawdown significantly compresses the distance to default
- **Debt Issuance:** Each capital raise temporarily reduces credit quality before BTC purchases restore it
- **Volatility:** Higher volatility has an ambiguous effect—it increases option value (equity upside) but also default probability

Walking Through the Breakeven Waterfall. Table 6 provides the BTC prices at which each capital layer faces impairment. The dynamics unfold as follows:

1. **At \$40,000 BTC (−57% from current):** Common equity enters severe stress. With NAV of \$19.8B and total claims of \$14.7B, equity value compresses to approximately \$5B—an 85% decline from current levels. Distance to default falls to 0.87, implying a 19% probability of default under the Merton framework. At this level, MSTR likely loses access to equity capital markets, breaking the reflexive loop.

2. **At \$29,500 BTC (−69%):** Common equity is effectively wiped out. NAV equals total claims, leaving zero residual for common shareholders. The stock would trade near zero absent a premium for optionality on BTC recovery. Preferred dividends become at risk.

3. **At \$27,000 BTC (−71%):** Junior preferred (STRD) faces impairment. As the non-cumulative instrument, missed dividends are permanently lost—STRD holders have no legal claim to catch-up payments.

4. **At \$22,800 BTC (−76%):** STRK (convertible preferred) is impaired. The conversion option becomes worthless as MSTR equity approaches zero.

5. **At \$17,200 BTC (−82%):** Senior preferred tranches (STRF, STRC) begin to face impairment. Even cumulative dividends may not be paid if cash generation cannot cover the \$400M+ annual cost of senior preferreds alone.

6. **At \$14,700 BTC (−84%):** Convertible debt principal is at risk. At this level, Bitcoin holdings (\$7.3B) barely cover the convertible debt notional, leaving nothing for all other claimants.

The key insight is that equity impairment begins well before Bitcoin reaches bear-market lows. A 50% BTC drawdown—which has occurred in every historical cycle—compresses MSTR equity by approximately 70%, with distance to default falling to 1.28 and implied spreads widening to 48 bps. The scenario analysis (Table 11) quantifies these dynamics.

Implications for Current Valuation. At current BTC prices (~\$94k), MSTR equity benefits from substantial cushion above the impairment thresholds. However, the leverage embedded in the capital structure means that equity holders are implicitly short a put option on Bitcoin struck at approximately \$30,000. The premium they pay for this exposure is reflected in MSTR's elevated volatility relative to spot BTC.

6.2 Stakeholder Analysis

6.2.1 Convertible Arbitrageurs: Primary Beneficiaries

Convertible arbitrage hedge funds are well-positioned to benefit from MSTR's strategy regardless of Bitcoin's direction:

- **Long Gamma:** Profit from volatility through gamma scalping
- **Delta Neutral:** Hedged equity exposure limits directional risk
- **Embedded Optionality:** Zero-coupon converts provide cheap convexity

- **Liquidity Provision:** Compensated for taking the other side of directional flows

The arbitrageurs are positioned to extract value from volatility while retail holders absorb directional risk.

6.2.2 Retail Equity Holders: Asymmetric Risk

Retail investors long MSTR common equity face:

- **Leveraged BTC Exposure:** Returns are amplified in both directions
- **Junior Claim:** First to absorb losses in drawdown scenarios
- **Dilution Risk:** ATM offerings dilute existing shareholders
- **Premium Compression:** If reflexive loop breaks, premium collapses

The equity effectively represents a leveraged call option on Bitcoin with a strike price equal to the debt burden. This payoff is attractive in bull markets but devastating in severe drawdowns.

6.2.3 Preferred Shareholders: Middle Ground

Preferred shareholders occupy an intermediate position:

- **Fixed Income:** High yields (8-10%) provide current income
- **Seniority:** Claims ahead of common equity
- **Cumulative Feature:** Most preferreds accrue missed dividends
- **Still BTC Exposed:** In severe scenarios, preferreds face impairment

The non-cumulative STRD is particularly risky, as missed dividends are not owed in the future.

6.3 What Breaks the Loop?

The reflexive flywheel requires continuous capital market access. Several scenarios could interrupt it:

6.3.1 Bitcoin Drawdown

A sustained Bitcoin decline of 50%+ would compress the reflexive loop through multiple channels:

- **NAV Compression:** At $47k BTC, NAV falls to $23.4B against $14.7B in claims, leaving only $8.7B in equity value—a 75% decline from current levels
- **Premium Collapse:** Historical evidence shows MSTR trades at deep discounts during BTC bear markets; the 2022 drawdown pushed the premium to -72%
- **Dividend Strain:** With $750M annual servicing and only $46M cash, the company would need to sell BTC or cut preferred dividends within 12–18 months
- **Death Spiral Risk:** If MSTR sells BTC to cover dividends, NAV falls further, potentially triggering additional sales

The critical threshold is approximately $40k BTC, below which MSTR likely loses access to equity capital markets entirely. At that point, the reflexive loop breaks and the company enters pure defensive mode.

6.3.2 Volatility Compression

Volatility compression is the most insidious risk because it can occur even with stable or rising BTC prices. The mechanism operates through MSTR's convertible financing channel:

Why Volatility Matters. MSTR's zero-coupon convertibles are attractive to arbitrage funds primarily because of their embedded volatility exposure. The value of a convertible bond has two components:

$$V_{convert} = V_{bond} + V_{option}$$

The option component is highly sensitive to implied volatility. At 80% vol, a 5-year ATM call option is worth approximately 45% of the underlying. At 30% vol, the same option is worth only 18%.

The Convertible Arbitrage Pipeline. MSTR's ability to issue zero-coupon converts depends on arb fund demand. These funds profit through:

1. Buying the convert (long gamma)
2. Shorting MSTR equity (delta hedge)
3. Rebalancing as the stock moves (gamma scalping)

If BTC volatility compresses—say, from the current 45% to a hypothetical 25%—the gamma scalping opportunity shrinks dramatically. Arb funds would demand coupons of 3–5% rather than accepting zero-coupon paper. This increases MSTR's cost of capital by $150–250M annually on a $5B issuance.

Scenario: Mature Bitcoin. As Bitcoin potentially matures into a mainstream asset class (spot ETFs, institutional adoption, regulatory clarity), its volatility may structurally decline toward levels seen in gold (15–20%) or broad equity indices (18–22%). If this occurs, MSTR's convertible financing advantage evaporates, and the company must compete for capital on the same terms as traditional corporates—without the underlying operating business to support it.

6.3.3 Index Exclusion

MSTR's inclusion in major indices creates passive demand that supports the stock price. Exclusion would trigger:

- **Forced Selling:** Index funds tracking MSCI USA, NASDAQ-100, or S&P 500 would be required to sell MSTR positions, creating concentrated selling pressure
- **Reduced Passive Bid:** Ongoing passive flows that currently support the stock would redirect to other index constituents
- **Institutional Stigma:** Exclusion signals that index providers view MSTR as unsuitable for mainstream portfolios, potentially triggering active manager redemptions
- **Premium Compression:** The NAV premium partly reflects index-driven demand; removal could compress the premium by 10–20 percentage points

As of January 2026, MSCI is reviewing MSTR's classification. A reclassification as a "financial" company (due to Bitcoin holdings exceeding operational assets) could trigger exclusion from technology indices and potential removal from MSCI USA entirely.

6.3.4 Regulatory Action

Regulatory risks span multiple dimensions:

- **Investment Company Act:** If MSTR's primary business is deemed to be "investing in securities" (Bitcoin), the SEC could require registration as an investment company, imposing leverage limits, governance requirements, and operational constraints incompatible with the current strategy

- **Tax Treatment:** Changes to corporate crypto tax rules (e.g., mark-to-market taxation) could create annual tax liabilities on unrealized BTC gains, forcing sales to fund tax payments
- **Accounting Standards:** FASB has adopted fair value accounting for crypto assets; future changes could affect how MSTR reports Bitcoin holdings and trigger covenant issues
- **Bank Participation:** Regulatory pressure on banks to limit crypto exposure could reduce underwriting capacity for MSTR's converts and preferreds

The Investment Company Act risk is particularly acute. MSTR's legal position relies on the argument that Bitcoin is not a "security" and that the company remains an operating software business. Both premises are contestable.

6.4 Sustainability Assessment

Is MSTR's strategy sustainable? The answer depends on time horizon:

Short-term (1-2 years): Likely sustainable given current cash buffers, market access, and BTC prices above breakeven levels.

Medium-term (3-5 years): Sustainability depends critically on:

1. BTC price trajectory (must remain above $29,500 for positive equity value)
2. Continued volatility (must stay elevated for zero-coupon convert issuance)
3. Dividend servicing ($750M+ annual requirement, growing with new preferred issuance)

Long-term (5+ years): The compounding dividend burden from preferreds creates a growing fixed cost base. Unless BTC appreciation outpaces servicing costs, the strategy eventually becomes constrained.

6.5 Limitations

This analysis has several limitations:

1. **Model Assumptions:** The Merton model assumes lognormal asset returns and constant volatility, which may not hold for Bitcoin. The model's output of a 1 bps implied credit spread is implausibly low for a company with single-asset collateral, 50–80% historical BTC volatility, and a $750M+ annual servicing burden. The Merton outputs should be interpreted as directional indicators of credit risk sensitivity rather than precise estimates of market-implied default probabilities. The model's assumption of constant, moderate volatility (22.3% based on recent 30-day realized) understates tail risk in a BTC-backed balance sheet.

2. **Data Frequency:** Daily data may miss intraday dynamics important for convertible arbitrage positioning
3. **Endogeneity:** The reflexivity analysis documents correlational patterns consistent with feedback dynamics but does not establish structural causality. The Granger tests provide suggestive evidence but cannot rule out omitted variable bias or reverse causality at frequencies not captured in daily data
4. **Sample Period:** The August 2020–January 2026 period largely coincides with a Bitcoin bull market; bear market dynamics may differ materially
5. **Convertible Terms:** I estimate gamma from public terms, but actual arbitrage positions may differ from model assumptions due to proprietary hedging strategies

6.6 Implications for Practice

6.6.1 For Investors

- Retail investors should understand they hold a leveraged, junior claim
- Preferred shareholders should assess cumulative vs. non-cumulative risk
- Convertible arbitrageurs appear well-positioned to extract value

6.6.2 For Corporate Finance

MSTR's strategy offers lessons for corporate treasury management:

- Zero-coupon converts can be powerful tools when equity is volatile
- Preferred shares offer flexibility absent in traditional debt
- Single-asset concentration creates correlation across all tranches
- Reflexive loops are powerful but fragile

6.6.3 For Regulators

The MSTR case raises questions about:

- Investment company classification
- Retail investor protection in complex structures
- Market stability when large single-asset bets unwind

7 Conclusion

This thesis has examined MicroStrategy's unique corporate strategy through the lenses of market reflexivity, structural credit modeling, and convertible arbitrage dynamics.

7.1 Summary of Findings

I document several key findings:

First, MicroStrategy has constructed a synthetic credit structure where all tranches—from senior convertible debt to junior preferred shares to common equity—are backed by a single asset: Bitcoin. This creates the illusion of diversification through seniority, but in reality, all investors are exposed to the same underlying price risk.

Second, I find evidence consistent with reflexive dynamics at the firm level between MSTR's NAV premium and capital raising activity. Higher premiums enable cheaper equity issuance, which funds Bitcoin purchases, which increases NAV, which may sustain the premium. However, Granger causality tests suggest this feedback loop operates at the firm level—MSTR is a price-taker in Bitcoin markets, not a price-maker. The self-reinforcing cycle persists as long as three conditions hold: capital market access, elevated volatility, and Bitcoin price appreciation.

Third, the application of Merton's structural credit model reveals that MSTR common equity behaves like a leveraged call option on Bitcoin, with the debt burden serving as the effective strike price. Distance to default varies significantly with BTC price and volatility assumptions, and the breakeven analysis shows that equity holders face impairment well before senior creditors.

Fourth, convertible arbitrageurs appear to be the primary beneficiaries of MSTR's strategy. Their gamma scalping extracts value from volatility while maintaining hedged exposure, positioning them to profit regardless of Bitcoin's direction. Retail equity investors, by contrast, bear asymmetric downside risk as holders of the junior claim.

7.2 Contributions

This thesis contributes to the literature in three ways:

1. **Quantifying Reflexivity:** I operationalize Soros's reflexivity concept through regression analysis and Granger causality tests, providing a framework for measuring feedback loops in corporate finance contexts.

2. **Merton Model Extension:** I apply the structural credit model to a novel asset class—corporate Bitcoin holdings—demonstrating how traditional valuation frameworks can adapt to cryptocurrency-backed balance sheets.

3. **Convertible Arbitrage Amplification:** I estimate the gamma exposure from MSTR's convertible book and model its contribution to equity volatility, extending the literature on hedging dynamics in convertible markets.

7.3 Practical Implications

For practitioners, this analysis offers several insights:

- **Investors** should understand the option-like payoff structure of MSTR equity and the seniority waterfall before taking positions
- **Corporate Treasurers** may find lessons in MSTR's creative use of zero-coupon converts and preferred shares, though single-asset concentration carries significant risks
- **Regulators** should consider whether MSTR's structure adequately protects retail investors and whether current classifications (operating company vs. investment company) remain appropriate

7.4 Limitations and Future Research

This analysis is limited by model assumptions (lognormal returns, constant volatility), data availability (daily frequency, public terms only), and the sample period (predominantly bull market conditions). Future research could:

- Extend the analysis to other corporate Bitcoin holders
- Incorporate higher-frequency data for convertible arbitrage dynamics
- Develop stress-testing frameworks for crypto-backed corporate structures
- Examine regulatory responses to corporate crypto treasury strategies

7.5 Final Thoughts

MicroStrategy's strategy represents an unprecedented corporate finance structure. By transforming an enterprise software company into a leveraged Bitcoin proxy, the company has created a capital formation mechanism that generates significant value in favorable conditions—and substantial risk when conditions deteriorate.

The strategy's sustainability ultimately depends on Bitcoin's long-term trajectory. If Bitcoin appreciates, the capital formation loop can sustain itself, and early equity holders will be vindicated. If Bitcoin stagnates or declines, the compounding dividend burden and leveraged structure will eventually constrain the company's financial flexibility.

The distribution of risk and reward across stakeholders is asymmetric. Convertible arbitrageurs are positioned to profit from volatility regardless of direction. Retail equity holders bear leveraged directional exposure. And the capital structure ensures that when losses materialize, they flow upward from junior to senior claims.

In the words of George Soros, “Markets are constantly in a state of uncertainty and flux.” MicroStrategy’s structure embodies this uncertainty. Whether the hypothesized reflexive mechanism proves durable remains an open empirical question—one that will be answered by the interaction of Bitcoin prices, volatility regimes, and capital market conditions over the coming years.

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A Data Sources

Table 13: Data Sources and Descriptions

Data	Source	Description
BTC/USD Price	Yahoo Finance	Daily closing prices
MSTR Price	Yahoo Finance	Daily adjusted closing prices
BTC Holdings	SEC Filings	Quarterly 10-Q/10-K disclosures
Convertible Terms	SEC Filings	Prospectus supplements
Preferred Terms	SEC Filings	8-K announcements
Treasury Yields	FRED	Daily constant maturity yields

B Python Code

Selected code for data collection and analysis is available in the accompanying repository. Key scripts include:

- `data_collection.py`: Downloads price data from Yahoo Finance
- `merton_model.py`: Implements the structural credit model
- `reflexivity_analysis.py`: Runs regression and Granger tests
- `convertible_gamma.py`: Calculates gamma exposure

C Convertible Note Details

Table 14: MSTR Convertible Note Issues

Issue	Principal	Coupon	Maturity	Conv Price	Status
Dec 2020	$650M	0.75%	Dec 2025	$398	Active
Feb 2021	$1.05B	0.00%	Feb 2027	$1,432	Active
Jun 2021	$500M	0.00%	Jun 2028	$1,825	Active
Mar 2024	$800M	0.625%	Mar 2030	$2,043	Active
Sep 2024	$1.0B	0.625%	Sep 2028	$2,327	Active
Nov 2024	$3.0B	0.00%	Nov 2029	$2,594	Active
Total	**$7.0B+**				

D Sensitivity Analysis Details

Table 15 provides detailed Merton model outputs across BTC price scenarios.

Table 15: Detailed Sensitivity Analysis

BTC Price	**NAV ($B)**	**Leverage**	**DD**	**PD (%)**	**Spread (bps)**	**Equity ($B)**
$40,000	19.8	0.42	0.87	19.2	384	11.6
$60,000	29.7	0.28	1.54	6.2	124	21.5
$80,000	39.6	0.21	2.11	1.7	35	31.4
$100,000	49.5	0.17	2.61	0.5	9	41.3
$120,000	59.4	0.14	3.05	0.1	2	51.2

E Robustness Checks

To verify the robustness of the main findings, I conduct several additional tests:

1. **Alternative volatility windows**: Results are robust to using 30-day, 60-day, and 120-day rolling windows for volatility calculation.
2. **Subsample analysis**: Splitting the sample into pre-2024 (initial accumulation) and post-2024 (aggressive expansion) periods yields consistent reflexivity coefficients.
3. **Control for market conditions**: Including VIX and S&P 500 returns as controls does not materially affect the NAV premium regression coefficients.
4. **Alternative Merton specifications**: Using different debt maturity assumptions (weighted average vs. longest maturity) produces qualitatively similar distance-to-default estimates.