BLOCKRISE

# LTV MATTERS!

Mapping the point of no return in Bitcoin lending

*Bitcoin Asset Management*

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# Foreword

My name is Gustavas Brazaitis. I am a financial economics major at Erasmus University Rotterdam, one month into my internship at Blockrise as a Digital Asset Research Intern. This paper took six weeks to write.

The findings surprised me, though not all at once. Gradually, across thousands of origination windows, the scale of the difference became clear. A 20% LTV loan survived the COVID crash, the 2022 collapse, and a three-year bull run without a single liquidation across all three regimes. A 60% LTV loan failed in each. I had understood going in that lower leverage was safer. I had not expected the gap to be this large.

What this experience taught me is difficult to summarise in a single sentence, so I will not try. Over six weeks of working through ten years of Bitcoin price data, something shifted in how I think about lending. I had always understood in theory that leverage amplifies risk. What I did not appreciate until I sat with this data was how the loan-to-value ratio and loan length determine the outcome of a loan, across every type of market condition. Not partially. Not in most cases. Across all of them. A loan that starts at the wrong LTV does not get rescued by a rising market or a recovering economy. It carries that structural weakness from the day it is originated. That realisation is what drove the six weeks of work that followed.

Three independent methods in this paper arrive at the same answer. I did not engineer that convergence. The data produced it.

None of this research would exist without Max Geerdink, my portfolio manager at Blockrise. He was present for every question, every meeting, and every wrong turn. He let me develop ideas he had not proposed, push in directions he had not suggested, and reach conclusions on my own. That independence made the work better. I am also grateful to the Blockrise team for the charts, the formatting, and six weeks of feedback that shaped how this paper came together.

I am an intern, and I know it. All the more reason to invite you to read this article and find out what LTV means for bitcoin-backed lending.

*Gustavas Brazaitis Digital Asset Research Intern Blockrise* , April 2026

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# 1. Executive Summary

Bitcoin-backed lending allows borrowers to access liquidity by pledging their Bitcoin as collateral rather than selling it. The key variable in any such loan is the Loan-to-Value ratio (LTV), which represents the loan amount as a percentage of the Bitcoin posted as collateral. The lower the LTV, the larger the buffer between the loan value and the collateral value, and therefore the more room for Bitcoin's price to fall before the loan is at risk. Thus, this paper empirically calculates the optimal origination LTV using ten years of daily Bitcoin price data from January 2016 to March 2026.

The analysis stress-tests every possible loan origination date across the examined period at four LTV tiers (20%, 30%, 50%, and 60%) and two loan terms (12 and 24 months), measuring the worst LTV each loan would have faced within its full forward window. The findings across all methodologies are consistent. At 20% LTV, 1.19% of 12-month loans were liquidated across the full decade, compared to 36.07% at 60% LTV, a difference of nearly 35 percentage points driven entirely by the size of the collateral buffer. Extending to 24-month terms raises the 60% LTV liquidation rate further to 43.71%, while the 20% rate increases by just 0.21 percentage points to 1.40%, illustrating that at low LTV levels the loan term becomes almost irrelevant.

The regime analysis isolates three distinct market environments: the COVID crash of 2020, the 2022 crypto crisis, and the 2023 to 2026 bull run. At 20% LTV, zero liquidations were recorded across all three regimes, covering a combined 1,852 originations. At 30% LTV, liquidations were recorded only during the 2022 crypto crisis, at a rate of 3.84%, and zero in the other two regimes. The 60% LTV tier produced liquidation rates of 8.95%, 53.70%, and 30.87% across the same three periods respectively. Notably, 30.87% of 60% LTV loans were liquidated even during a period of sevenfold Bitcoin price appreciation, demonstrating that a rising market does not protect borrowers at high LTV levels from corrections.

A Monte Carlo simulation of 10,000 independent five-year price paths, calibrated to Bitcoin's empirical return distribution, produces a 5-year liquidation probability of 3.40% at 20% LTV and 42.80% at 60% LTV. The historical survival analysis identifies 28.50% as the maximum origination LTV at which 95% of all 12-month loan windows would have survived without liquidation, and 23.90% for 24-month loans. A polynomial derivative analysis independently identifies 25.50% LTV (12-month) and 18.10% LTV (24-month) as the points at which liquidation risk begins accelerating most rapidly with each additional percentage point of leverage. All three analytical approaches converge on the same range. The data consistently shows that the origination LTV is one of the primary determinants of loan survival across almost every market condition Bitcoin has produced in its modern history.

# 2. Introduction

As of March 2026, Bitcoin's market capitalisation stands at about $1.42 trillion.[1] Spot ETFs themselves currently hold around $105 Billion in assets under management (AUM), with prominent institutions such as Blackrock, Fidelity, and others serving as the leading companies within this range of operations[2]. Moreover, over 150 companies hold Bitcoin as a treasury, this results in an estimated 5.59% of total Bitcoin supply (1.2M/21M) being in the hands of custodian institutions[3]. Essentially, Bitcoin has evolved from a niche technology into a trillion-dollar asset class with significant institutional infrastructure, however it remains subject to substantial price volatility and regulatory uncertainty.

Current Bitcoin holders face a structural problem. Selling Bitcoin to access liquidity triggers a capital gains tax (which varies throughout countries) whilst simultaneously permanently reducing exposure to an appreciating asset. Therefore, one solution to this constraint is borrowing against your own Bitcoin, otherwise known as Bitcoin-backed lending. The Bitcoin-backed lending market itself has been growing and was reported to be worth $74 billion in 2025[4]. With demand for Bitcoin-backed loans continuing to increase and with the crypto asset market progressing, an introduction to newer lending standards within the modern world of cryptocurrencies is becoming an increasingly important area of analysis.

A Bitcoin-backed loan's survival primarily depends on two factors, namely the loan-to-value ratio (LTV) and the holding period. If an LTV origination is too high, a market correction forces the loan towards liquidation, the borrower loses their Bitcoin at the worst possible price whilst the lender sells into a declining market. Market dynamics in the past have shown how Bitcoin and its volatility can spiral into a negative turnout, erasing value in very short time frames. A 60% starting LTV liquidates only after a 29.41% drop in the price of Bitcoin, conversely a 20% starting LTV would only liquidate if Bitcoin dropped 76.47% (See Appendix D). With over 10 years of market data, those two thresholds produce vastly different outcomes. At the one end, an investor might not reach the margin call threshold, whilst on the other, historical data shows that their loan would have been liquidated across multiple distinct market regimes.

This paper builds directly on Blockrise's prior research paper "The Bitcoin Lending Standards of 2026",[5] which introduced the concept of a Bitcoin gold standard and proposed 30% LTV as the benchmark for responsible origination. That paper established that LTV is the dominant risk variable in Bitcoin-backed lending and that conservative origination protects the borrower through market cycles. What it did not provide was a full empirical quantification of exactly how different LTV tiers would have performed across every market environment Bitcoin has produced in its modern history, this paper provides that evidence.

Therefore, the paper is structured across four analytical sections: (1) The 12- and 24-month cohort analysis stress tests every possible loan origination date between January 2016 and March 2026 across four LTV tiers and two loan terms, establishing how different origination thresholds would have performed across the full decade of Bitcoin price history. (2) The regime analysis breaks that decade into three structurally distinct market environments,

namely the COVID crash of 2020, the 2022 crypto crisis, and the 2023 to 2026 bull run, examining how LTV behaviour and liquidation risk differ depending on market conditions. (3) The Monte Carlo simulation constructs 10,000 forward looking price paths calibrated to Bitcoin's empirical return distribution, producing forward looking survival probabilities across every LTV tier for a five-year horizon. (4) The optimal LTV analysis examines three independent lines of evidence to derive the empirically supported origination ceiling: the empirical drawdown distribution, historical and Monte Carlo survival curves, and the polynomial derivative analysis identify the precise point at which liquidation risk becomes disproportional with an increase in LTV.

Thus, this paper expands on the new gold standard for Bitcoin-backed lending through answering the following question: **"What is the empirically supported optimal origination LTV for Bitcoin-backed lending, using various robustness tests?"**

## Methodology:

### Data and scope

This paper works with daily Bitcoin closing price data sourced from TokenTerminal, covering the period from April 2013 to March 2026. However, the core analysis is restricted to January 2016 to March 2026. This decision reflects the structural differences between Bitcoin's early-adoption era and its modern market due to factors such as extreme volatility, negligible institutional participation, and thin liquidity which do not represent the lending environment that exists today. The loan structure assumed throughout this paper is as follows: the LTV at any point in time is defined as LTV = Loan Amount (USD) / Current BTC Price (USD), each loan uses 1 BTC as collateral, with the loan amount in USD fixed at origination according to the initial LTV. The mechanics are straightforward, a borrower deposits 1 BTC and receives a USD loan equal to the initial LTV multiplied by the Bitcoin price at origination. For example, if Bitcoin is priced at $50,000 at origination and the borrower selects a 30% LTV, the loan amount is fixed at $15,000 for the entire term regardless of how Bitcoin's price moves subsequently.

The four LTV tiers selected for the stress tests are: 20%, 30%, 50%, and 60%. These were chosen to directly compare what this paper considers the responsible lending range against riskier alternatives. The 20% and 30% tiers represent the proposed gold standard for Bitcoin-backed lending whilst the 50% and 60% tiers are included as higher-risk comparisons to demonstrate how outcomes deteriorate as LTV increases beyond the safe zone, and to provide the reader with a complete picture of the risk spectrum.

## Time period and loan structure

*Table 1: LTV Fluctuation Table at 60% LTV Origination*

| LTV Fluctuation | | | | | | | | 60% LTV \| Liquidation Threshold: 85% |
|---|---|---|---|---|---|---|---|---|
| Origination Date | Context | Entry Price | Loan USD (60%) | Worst Day | Worst BTC Price | BTC Drop | Stressed LTV | Outcome |
| 2020-02-12 | COVID — first loan day | $10,328.90 | $6,197.34 | 2020-03-16 | $5,032.50 | 51.3% | 123.15% | Liquidated |
| 2020-03-13 | COVID — day after crash low | $5,542.82 | $3,325.69 | 2020-03-16 | $5,032.50 | 9.2% | 66.08% | At Risk |
| 2022-01-03 | 2022 — first trading day | $46,531.14 | $27,918.68 | 2022-11-09 | $15,742.44 | 66.2% | 177.35% | Liquidated |
| 2022-05-10 | 2022 — LUNA collapse begins | $31,026.93 | $18,616.16 | 2022-11-09 | $15,742.44 | 49.3% | 118.25% | Liquidated |
| 2022-11-07 | 2022 — day before FTX news | $20,597.76 | $12,358.65 | 2022-11-09 | $15,742.44 | 23.6% | 78.51% | Margin Called |
| 2023-01-02 | Bull run — first trading day | $16,674.34 | $10,004.61 | 2023-01-02 | $16,674.34 | 0.0% | 60.00% | At Risk |
| 2024-04-20 | Bull run — Bitcoin halving | $64,894.42 | $38,936.65 | 2024-09-06 | $53,923.36 | 16.9% | 72.21% | At Risk |
| 2025-10-06 | Bull run — near all-time high | $124,773.51 | $74,864.10 | 2026-02-05 | $62,853.69 | 49.6% | 119.11% | Liquidated |

Table 1 shows an example of how LTV fluctuations are computed for a 60% LTV origination throughout 3 specific periods. The three market regimes examined in the detailed analysis are: COVID-19 from February 12th to December 31st, 2020, the 2022 crypto crisis from January 1st to December 31st, 2022, and the bull run from January 1st, 2023, to March 8th, 2026. They were selected because they represent three structurally distinct Bitcoin market environments: a sudden violent shock, a prolonged bear market, and a sustained period of price appreciation. Together they provide the broadest possible test of how LTV origination interacts with market conditions. Since the loan amount is fixed in USD and Bitcoin's price fluctuates daily, the LTV is entirely driven by price movements after origination. If Bitcoin rises in price the LTV falls, increasing the borrower's buffer and if Bitcoin falls in price the LTV rises, eroding the buffer.

Three threshold definitions dictate LTV classification throughout this paper. A loan is considered at risk when LTV reaches or exceeds 60%, meaning the collateral buffer has been sufficiently eroded to warrant monitoring. A margin call is triggered at 75% LTV, at which point the borrower would in practice be required to add collateral or begin repayment. Liquidation occurs at 85% LTV, the point at which the lender terminates the loan and sells the collateral to recover the outstanding balance. These three thresholds are sequential and cumulative, the at-risk threshold signals early warning, the margin call threshold triggers an operational response, and the liquidation threshold represents the terminal event. A loan can pass through all three thresholds within the same market event. The main assumptions of this paper are that no collateral top up is permitted on margin call and no interest accrues over the loan term. Importantly, while a loan is terminated at the 85% liquidation threshold in practice, the stress test analysis does not cap the LTV at this point, rather it allows the LTV to continue rising beyond 85% to reflect the true magnitude of stress a borrower would have experienced, illustrating just how far above the liquidation threshold certain origination windows would have travelled.

## Monte Carlo simulation

In addition to the empirical stress test analysis, this paper employs a Monte Carlo simulation to produce forward-looking risk estimates across a range of plausible Bitcoin price paths. The simulation constructs 10,000 independent five-year price paths, each consisting of 1,825 daily time steps, by drawing daily log-returns with replacement from the empirical 2016-2026 return distribution. This bootstrap approach is deliberately chosen over a standard parametric model

because Bitcoin's return distribution exhibits properties that make a normal distribution assumption underestimate tail risk (See Appendix C). By sampling directly from the observed historical returns, the bootstrap preserves these characteristics without imposing distributional assumptions the data does not support. The loan structure mirrors the empirical analysis exactly so that Monte Carlo survival probabilities are directly comparable to the historical survival rates established throughout the paper.

## Optimal LTV derivation

The optimal LTV analysis uses three methods to identify where the lending threshold should be set. First, the maximum forward drawdown is calculated for every origination date across all 3,355 12-month and 2,990 24-month loan windows, showing the worst Bitcoin price decline a borrower would have experienced depending on when they originated their loan. This drawdown distribution is then used to calculate the highest LTV that would have survived without liquidation at the 90th and 95th percentile of historical drawdowns, meaning the LTV that would have protected a borrower in 90% and 95% of all possible origination windows across the decade. The same drawdown data is then plotted as a time series to show when these severe drawdowns occurred, and which origination dates were most exposed. Moreover, a degree four polynomial is fitted to the empirical liquidation rate across every LTV tier from 1% to 60%, and the point where risk begins accelerating most rapidly is identified mathematically through the second derivative, giving a precise LTV ceiling beyond which each additional percentage point of borrowing adds disproportionately more liquidation risk than the previous one. Third, the historical survival rates for both twelve- and twenty-four-month loans are overlaid with the Monte Carlo simulation curves, and the LTV at which all four curves simultaneously remain above the 90 and 95% survival probability is identified.

# 3. Bitcoin LTV stress test analysis for 12- and 24-Month loan terms (2016-2026)

To quantify exactly how much the starting LTV affected loan structures, the following analysis originates a new loan on every single trading day across a decade period and stress tests each one against the worst Bitcoin price it would have encountered within its forward 12- or 24-month window. Four starting LTV tiers are examined, namely 20%, 30%, 50%, and 60% are chosen to represent the full spectrum from conservative to aggressive origination.

*Table 2: Key Summary Statistics For 12- and 24-Month Loans*

| Summary Statistics | | | | | | | 3,355 originations per tier |
|---|---|---|---|---|---|---|---|
| Term | LTV | Originations | Healthy (<60%) | At Risk (60-75%) | Margin Called | Liquidated (≥85%) | Survived (Not Liq.) |
| 12-Month | 20% | 3,355 | 95.2% | 3.2% | 0.4% | 1.2% | 98.8% |
| 12-Month | 30% | 3,355 | 79.8% | 9.4% | 4.6% | 6.1% | 93.9% |
| 12-Month | 50% | 3,355 | 47.8% | 18.7% | 4.4% | 29.1% | 70.9% |
| 12-Month | 60% | 3,355 | 0.0% | 53.0% | 10.9% | 36.1% | 63.9% |
| 24-Month | 20% | 2,990 | 90.4% | 6.7% | 1.6% | 1.4% | 98.6% |
| 24-Month | 30% | 2,990 | 70.2% | 12.5% | 5.4% | 11.8% | 88.2% |
| 24-Month | 50% | 2,990 | 45.0% | 14.3% | 3.3% | 37.4% | 62.6% |
| 24-Month | 60% | 2,990 | 0.0% | 48.9% | 7.4% | 43.7% | 56.3% |

Note: This table summarises the outcomes of 3,355 individual loan originations tested across four LTV tiers (20%, 30%, 50%, 60%) and two loan terms (12-month and 24-month) over the full January 2016 to March 2026 period. Each loan is stress-tested against the lowest Bitcoin price observed within its forward term window, and every origination is assigned one of four mutually exclusive outcomes: Healthy (stressed LTV stayed below 60% throughout the term), At-Risk (stressed LTV crossed 60% but not 75%), Margin Called (stressed LTV crossed 75% but not 85%), and Liquidated (stressed LTV reached or exceeded the 85% liquidation threshold). The Survived column is the sum of Healthy, At-Risk, and Margin Called (i.e any loan not terminated)

Table 2 presents key summary statistics showing how different LTV originations transition throughout the thresholds. Firstly, when originating a loan with a 20% LTV, the survival rate is almost 100% for both 12- and 24-month terms. This shows an important component for lending standards, specifically that at a low LTV, the term length is almost irrelevant, and LTV is the main element which needs the most consideration. Moreover, a key difference present for loan structures is the jump from 30% to 50% LTV. For the 12-month structure, this jump results in a 22.98 percentage point (pp) increase in liquidations and for the 24-month loans, it results in a 25.52pp increase in liquidations. The situation worsens for a 60% LTV, with liquidation rates for 12- and 24-month terms being at 36.07% and 43.71% respectively. The data reveals that liquidation rates for the 24-month terms are higher. This intuitively makes sense since a longer loan period means there is a higher probability of attaining a lower Bitcoin price within the future term. Nevertheless, the table shows that a low LTV, such as 20%, makes the loan period almost negligible, with only a 0.21pp difference in liquidation rates between the two different periods which are analyzed.

The aggregate statistics in Table 2 provide the headline outcomes but mask the mechanism behind them. The following graphs examine each LTV tier across the full origination

timeline, identifying the specific periods of maximum stress and explaining why certain tiers survived where others did not.

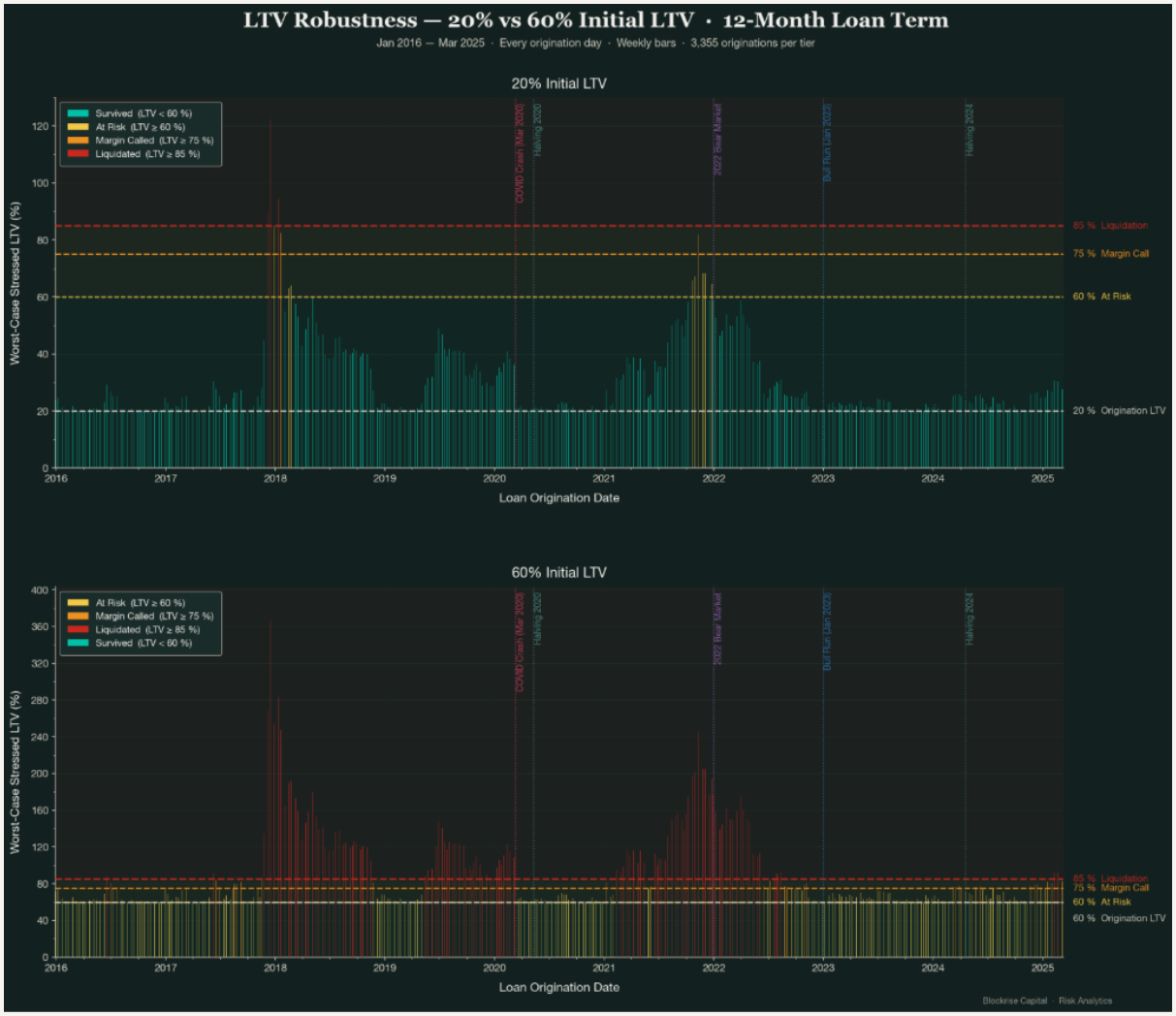


*Figure 1: 20% VS 60% LTV Robustness For a 12-Month Loan Term*

Note: This figure presents two panels, each plotting the maximum stressed LTV reached by loans originated each week between January 2016 and March 2025, stress-tested over a 12-month forward window. The top panel shows 20% LTV originations and the bottom panel shows 60% LTV originations, across 3,355 daily originations per tier. The stressed LTV is calculated as the original loan amount in USD divided by the lowest Bitcoin price observed in the 12 months following origination. Bars are colour-coded by outcome: green = Healthy (stressed LTV below 60%), amber = At-Risk (60–75%), orange = Margin Called (75–85%), red = Liquidated (85%+). Weekly aggregation is used for visual clarity. The last origination date is March 8th, 2025, as loans require a full 12-month forward window ending no later than March 8th, 2026.

## 12-Month loan term

At first glance, the 20% panel appears heavily dominant in healthy loans, meaning that 95.23% of originations never crossed the 60% LTV threshold throughout their 12-month term and only 1.19% became liquidated. The small cluster of red bars crossing up to 120% is centred around 2018, a direct consequence of the crypto winter where Bitcoin fell over 80% from December 2017 to December 2018. For example, a loan originated on December 15th, 2017, at a Bitcoin

price of $19,665.39 would carry a 20% LTV loan of $3,933. The worst forward price over that term occurred on December 14th, 2018, at $3,216.63, producing a stressed LTV of 122.27%. This was the only period within the entire 10-year window where 20% LTV originations were liquidated. A second cluster of elevated bars appears around 2021 and early 2022, as loans originated when Bitcoin ranged between $50,000 and $60,000 had their 12-month forward stress window extend directly into the 2022 crisis, where prices fell as low as $16,000. Despite this, none of those loans were liquidated, and at most some were margin called, because a 20% LTV origination requires a Bitcoin price decline of 76.47% before the liquidation threshold is breached.

Scaling to the 60% panel reveals how quickly survival rates deteriorate under the same market conditions. Where 20% LTV offered near-complete insulation, 60% LTV exposes borrowers to the full force of BTC drawdowns: 36.07% of 3,355 originations were liquidated, a 34.88 percentage point increase. The spike patterns are similar to the 20% panel but far denser. During the 2018 crypto winter, stressed LTVs crossed the 360% threshold, and 88.80% of loans originated at 60% LTV in 2018 were liquidated, with 82.70% of 2021 originations suffering the same fate during the 2022 bear market. Unlike the 20% tier, which fails only in tail events, 60% LTV fails broadly across regimes because no meaningful collateral buffer remains.

## 24-Month loan term

Extending the loan term to 24 months amplifies every effect documented above: at 60% LTV, the liquidation rate rises to 43.71%, a 7.64 percentage point increase over the 12-month equivalent, as the longer forward window captures multi-year drawdowns that shorter terms avoid. At 20% LTV, only 1.40% of loans are liquidated regardless of term length, confirming that a conservative collateral buffer is sized to absorb market drawdowns. The intermediate tiers follow a nonlinear pattern: moving from 20% to 30% LTV adds just 4.89 percentage points of liquidation risk, whereas escalating from 30% to 50% LTV produces a sharper 22.98 percentage point increase, with structural breaks appearing around the 2018 and 2022 bear markets. Full robustness charts for all four LTV tiers across both loan terms are presented in Appendix A.

## Annual liquidation rates

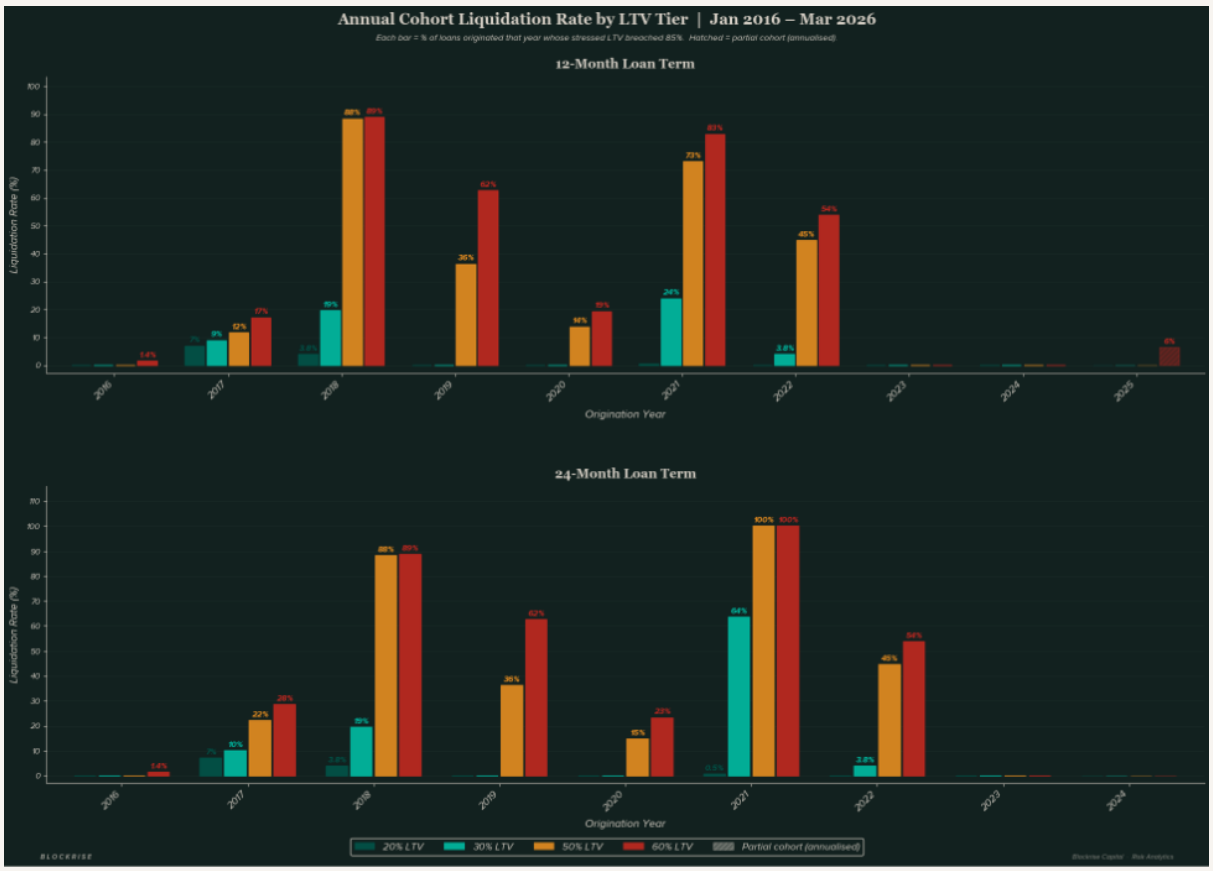


*Figure 2: Annual Liquidation Rate by LTV Tier*

Note: This grouped bar chart breaks the stress tests into annual origination cohorts, showing the proportion of loans originated in each calendar year that survived their full term (i.e. were not liquidated) across all four LTV tiers and both loan terms. Survival is defined as the loan's stressed LTV never reaching the 85% liquidation threshold within the forward window. The 2025 cohort is partially incomplete and is annualized, as loans originated after March 8th, 2025, have not yet experienced a full 12-month forward window by the dataset end date of March 8th, 2026.

The annual cohort breakdown provides a more visually compelling case for yearly LTV liquidations. For the 12-month loan cohort, at 20% LTV, liquidation rates stay at or near zero in every year, with the only exceptions being 2017 and 2018 at 6.80% and 3.80% respectively, both driven by the consequences of the 2018 crypto winter. The 60% tier tells the opposite story, 2018 saw 88.80% of 12-month originations liquidated, 2021 saw 82.70%, and even 2019 produced a 62.50% liquidation rate as those loans looked forward into the March 2020 COVID crash. Extending to 24-month terms intensifies the picture further, with 2021 originations at 60% LTV reaching a 100% liquidation rate as the full 2022 bear market fell within their forward window. Only 2023 and 2024 produced zero liquidations at any tier, reflecting the sustained bull run. A decade of data makes the pattern clear, specifically that at 20% and 30% LTV, bad years are survivable; at 50% and 60%, bad years are catastrophic.

# 4. Bitcoin regime analysis

Having seen how LTV originations have fluctuated throughout the last decade through various market regimes, a key question arises, namely if the LTV tier matters equally in all market conditions, or does the specific regime amplify or dampen the risk? The following analysis will answer this question by specifically investigating 3 different market regimes.

*Table 3: LTV Key Summary Statistics of 3 Market Regimes*

| LTV Statistics | | | | | | | Forward-to-end-of-regime stress |
|---|---|---|---|---|---|---|---|
| Regime | LTV | Originations | Healthy (<60%) | At Risk (60-75%) | Margin Called | Liquidated (≥85%) | Survived (Not Liq.) |
| Feb–Dec 2020 | 20% | 324 | 100.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Feb–Dec 2020 | 30% | 324 | 98.8% | 1.2% | 0.0% | 0.0% | 100.0% |
| Feb–Dec 2020 | 50% | 324 | 90.7% | 0.3% | 1.5% | 7.4% | 92.6% |
| Feb–Dec 2020 | 60% | 324 | 0.0% | 91.0% | 0.0% | 9.0% | 91.0% |
| Jan–Dec 2022 | 20% | 365 | 99.2% | 0.8% | 0.0% | 0.0% | 100.0% |
| Jan–Dec 2022 | 30% | 365 | 64.4% | 11.8% | 20.0% | 3.8% | 96.2% |
| Jan–Dec 2022 | 50% | 365 | 15.9% | 36.4% | 3.0% | 44.7% | 55.3% |
| Jan–Dec 2022 | 60% | 365 | 0.0% | 26.8% | 19.5% | 53.7% | 46.3% |
| Jan 2023–Mar 2026 | 20% | 1,163 | 100.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Jan 2023–Mar 2026 | 30% | 1,163 | 100.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| Jan 2023–Mar 2026 | 50% | 1,163 | 50.0% | 24.5% | 13.4% | 12.1% | 87.9% |
| Jan 2023–Mar 2026 | 60% | 1,163 | 0.0% | 56.7% | 12.5% | 30.9% | 69.1% |

Note: This table presents the same four outcome categories as Table 2 (Healthy, At-Risk, Margin Called, Liquidated, Survived) but computed across three specific market regimes: COVID-19 (February 12th to December 31st, 2020), the 2022 crypto crisis (January 1st to December 31st, 2022), and the 2023–2026 bull run (January 1st, 2023 to March 8th, 2026). Unlike the previous analysis, each loan here is stress-tested against the worst Bitcoin price between the origination date and the end of the regime window, not a fixed 12- or 24-month term. This forward-to-end-of-regime approach means the effective stress period varies by origination date within each regime. The three regimes cover a combined 1,852 originations: 324 (COVID), 365 (2022), and 1,163 (bull run)

As shown in Table 3, the most immediate observation is the consistency of 20% and 30% LTVs throughout the different regimes. All except one of these tiers manage to have a 100% survival rate, meaning they never became liquidated within their regime period. The most dramatic single observation would be the 40.82%pp increase in liquidations between the 30% and 50% LTVs during the 2022 crypto bear market. Conversely, between January 2023 to March 2026, a period where Bitcoin saw its price increase about sevenfold, the 60% LTV origination loans managed to have a liquidation rate of 30.87%. This meant that a rising market did not protect high LTV borrowers because market corrections were sufficient to breach the liquidation threshold before any recovery could occur.

## Covid Regime: 20% vs 60% LTV

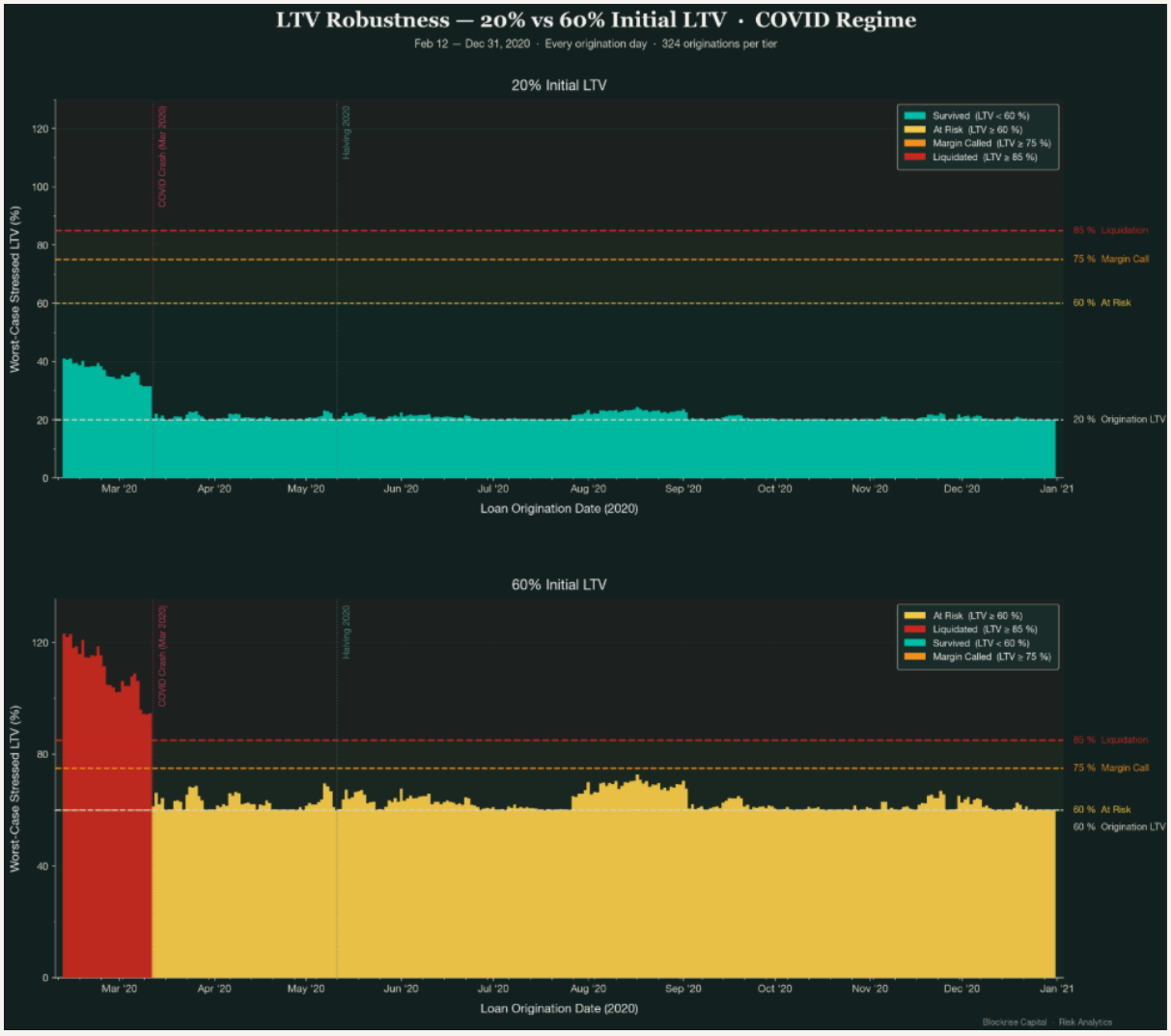


*Figure 3: Covid regime: 20% vs 60%*

Note: This figure presents two panels using the same bar chart format as Figure 1, but restricts originations to the COVID-19 regime window (February 12th to December 31st, 2020). Each loan is stress-tested against the worst Bitcoin price between its origination date and December 31st, 2020, rather than over a fixed forward term. The top panel shows 20% LTV originations and the bottom panel shows 60% LTV originations. Colour-coding is identical to Figure 1: green = Healthy, amber = At-Risk, orange = Margin Called, red = Liquidated. No green bars appear in the bottom panel, as the 60% origination LTV already equals the at-risk threshold.

As shown in Figure 3, the 20% panel tells a straightforward story: every loan bar is green, meaning not only was the survival rate 100%, but not a single loan even reached the at-risk threshold of 60% LTV. The maximum stressed LTV across the entire period was only 41%. One notable visual pattern is that bars originated before March 12th are noticeably taller than those that follow, because March 12th was the day of the COVID market crash, during which Bitcoin fell 35.19% in a single day. Any loan originated before that date would have had its stressed LTV affected by that drop, but not enough to breach the at-risk threshold at 20% LTV. The 60% panel tells a contrasting story. While the pattern of the bars follows a similar shape, the LTVs are significantly more amplified. Out of 324 originations, 8.95% were liquidated and none remained

in the margin call range. Every loan originated before March 12th was liquidated, with the maximum stressed LTV reaching 123.10%, passing the liquidation threshold by a large margin. Unlike the 2018 and 2022 bear markets, what liquidated 60% LTV loans through COVID was not a prolonged decline, but a very short period of extreme price action. COVID is the stress test for speed: it demonstrates that the need for a low LTV is not limited to prolonged market corrections, but extends to shocks that no one can predict or react to in time.

## Covid Regime: 30% vs 50% LTV

Furthermore, the difference between a 30% and 50% LTV during this market regime is also significant. This is because if a 30% LTV origination was implemented, none of the loans would have become liquidated and only 1.23% would have reached the "At-Risk" 60% LTV threshold. However, for the 50% LTV origination, all loans prior to March 12th become liquidated or margin called which amounts to a 7.41% liquidation rate. (See Appendix B)

## 2022 Bear market regime: 20% vs 60% LTV

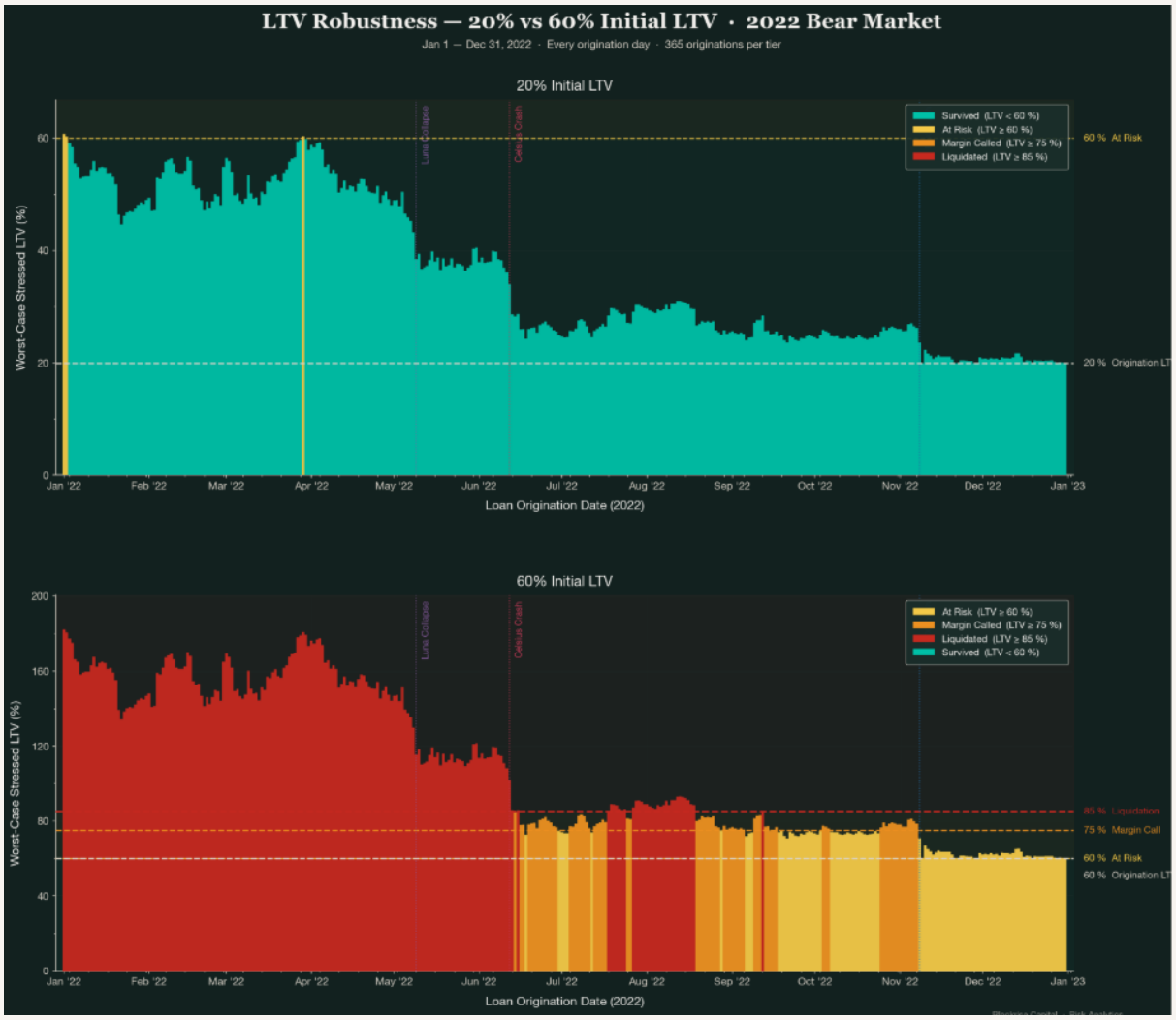


*Figure 4: 2022 Bear Regime 20% vs 60% LTV Origination*

*Note: This figure applies the same regime bar chart methodology to the 2022 crypto crisis window (January 1st to December 31st, 2022), covering 365 daily originations per tier. Each loan is stress-tested against the worst Bitcoin price between its origination date and December 31st, 2022. The top panel shows 20% LTV originations and the bottom panel shows 60% LTV originations. Colour-coding follows the same scheme as all preceding figures. No green bars appear in the bottom panel, as the 60% origination LTV equals the at-risk threshold. The stressed LTV formula is unchanged from preceding figures.*

Figure 4 shows the 20% panel exhibiting a clear downward trend across the year, shaped by three major collapse events. The Luna, Celsius, and FTX collapses collectively drove Bitcoin from $47,800 in January to an annual low of $15,742 in November, a decline of nearly 67%. The downward trend in bar heights is explained by the fact that loans originated after each crash entered at lower Bitcoin prices, meaning their stressed LTV at the forward worst-case point was

lower. The most important takeaway from the 20% panel is that across all 365 originations, through one of the worst years in cryptocurrency history, there were zero liquidations.

The shift to the 60% panel produces a chart that is unrecognisable by comparison. A loan originated at the start of January would already produce a stressed LTV crossing 170%. After the Celsius crash, the bar colours begin to improve, but this is a survivorship effect rather than a safety effect: loans originated later simply entered at lower prices, while the underlying market remained just as dangerous. Both collapse events, which are rendered almost invisible on the 20% panel, represent on the 60% panel a further deterioration of an already catastrophic position. Overall, a 60% LTV origination across this regime produced a liquidation rate of 53.70%, meaning borrowers lost more than half of all loans issued within a one-year period.

## 2022 Bear market regime: 30% vs 50% LTV

The 30% and 50% intermediary LTV tiers present opposite stories when discussing the 2022 market. On the one hand, only 3.84% of loans get liquidated when having an origination of 30% LTV. Almost all loans prior to May 12th (Luna collapse) are above 60% LTV, whilst afterwards almost all remain in a below 60% LTV healthy state, this shows the power of LTV origination, a 30% LTV would spike prior to the Luna collapse but rarely force a liquidation. Conversely, a 50% LTV origination leads to 44.66% of loans being liquidated, with every loan originated before May 12th becoming liquidated. Only after the FTX crash in November do the small amount of loan originations become healthy, mainly due to Bitcoin's price being so low (See Appendix B).

## Bull run regime: 20% vs 60% LTV

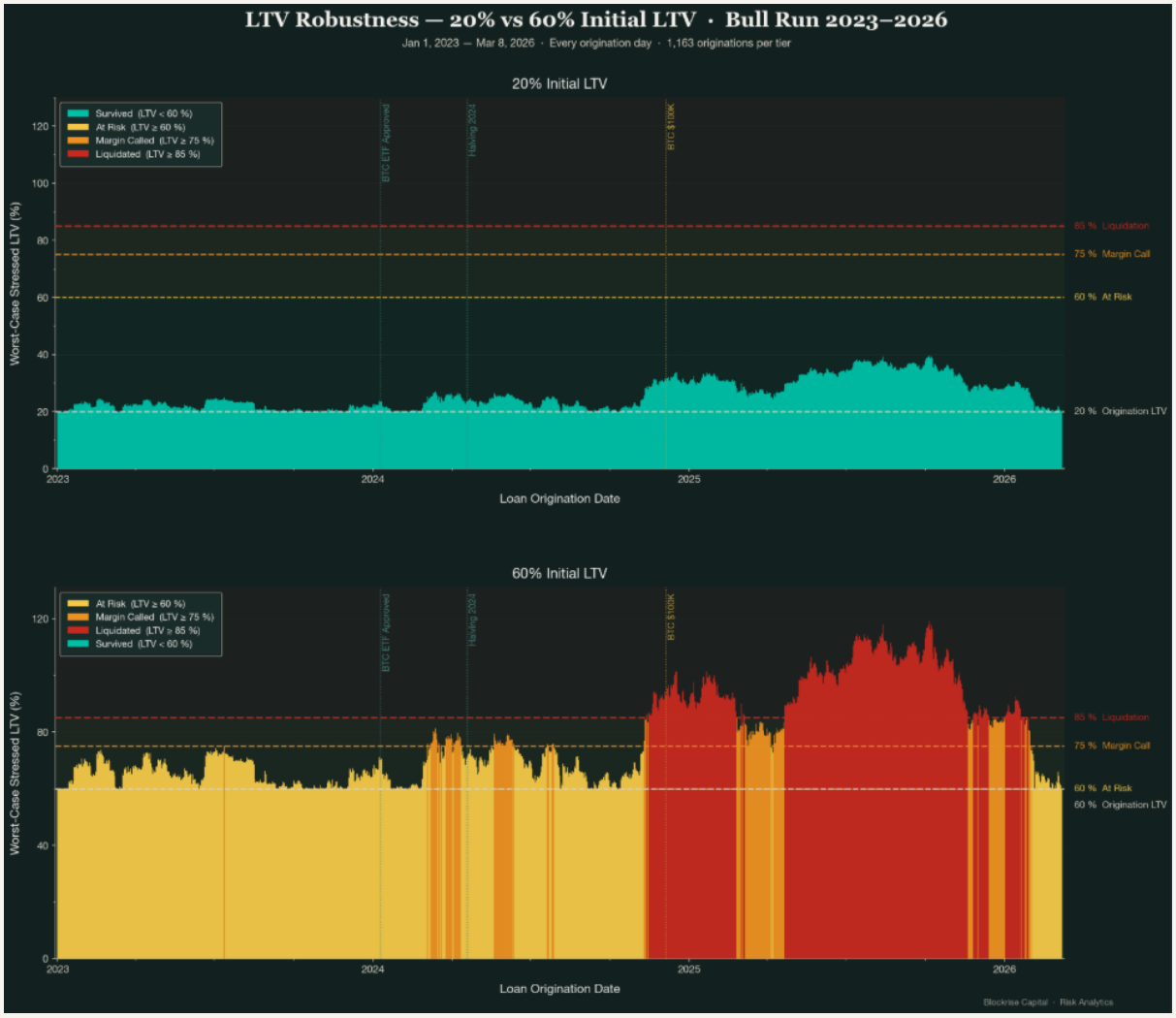


*Figure 5: 20% vs 60% LTV Origination Bull-Run Regime*

Note: This figure applies the regime bar chart methodology to the bull run window (January 1st, 2023 to March 8th, 2026), covering 1,163 daily originations per tier. Each loan is stress-tested against the worst Bitcoin price between its origination date and March 8th, 2026. The top panel shows 20% LTV originations and the bottom panel shows 60% LTV originations. Colour-coding is identical to all preceding figures. No green bars appear in the bottom panel, as the 60% origination LTV equals the at-risk threshold. The stressed LTV formula and colour-coding are consistent with all preceding figures.

Figure 5 shows that the 20% panel produces the clearest result across all four regimes: out of 1,163 originations, not a single loan crossed any of the three thresholds, and every loan remained healthy throughout. Unlike the previous two regimes, bars here trend upward as the bull run progresses, which reflects Bitcoin rising from $16,616 on January 1st, 2023, to an all-time high of $124,774 on October 6th, 2025, an appreciation of 650.50% over roughly 33 months. By the end of the analysis window on March 8th, 2026, Bitcoin had settled at $66,036, still representing a 297.40% gain from the start of the regime. Notably, even loans originated at the all-time high remained below the 40% LTV threshold, confirming that the 20% collateral buffer is sufficient even at extreme market exuberance.

The 60% panel tells an entirely different story. While the pattern of bar movement is similar, the amplification is immense. Within the same period, 30.87% of loans were liquidated, and notably, all liquidations stem from loans originated after October 2024. As Bitcoin approached and surpassed $100,000, loans during this window were hit hardest by the late 2025 correction. A borrower who originated a loan between July and October 2025 would have experienced stressed LTVs crossing 110%, and at the all-time high, liquidation risk became near certain, as any correction from those elevated prices was sufficient to cross the liquidation threshold within a fraction of the total decline. The paper's most counterintuitive finding emerges here: 30.87% of all loans originated during a period of sevenfold price appreciation were liquidated. Being bullish on Bitcoin's long-term direction does not provide sufficient protection at 60% LTV, whereas the 20% buffer documented in the upper panel does.

All in all, the three-regime analyses always have had one consistent finding: The 20% LTV tier produced zero liquidations across COVID, the 2022 crypto crisis, and a three-year bull run, making it a combined 1,852 originations without a single termination. The 60% tier failed in all three, producing liquidation rates of 8.95%, 53.70%, and 30.87% respectively. What the regime analysis adds to the macro analysis is the following: COVID proved that a single week of violent price action is sufficient to liquidate a 50-60% LTV loan, 2022 proved that a sustained multi-stage bear market produces systematic failure at 50% and above, and the bull run proved that even sustained upward price trends do not protect high-LTV borrowers from corrections. The LTV tier is not necessarily just a number that matters in bad markets, rather it is one of the dominant variables across every market condition Bitcoin has produced in its modern history.

## Monte Carlo analysis

The macro and regime analyses are derived entirely using ten years of real Bitcoin price data, tested against real origination dates and real market events. Whilst interesting results were seen, limitations are still present because the future will not necessarily be identical to the past. Bitcoin's market structure continues to evolve, institutional participation is deeper than at any prior point in the dataset, and the macroeconomic environment in which Bitcoin operates has shifted, potentially altering the volatility regime we observed in this decade. Therefore, given Bitcoin's return distribution, what should be expected going forward across a range of possible price paths, and how would this affect LTV originations? This is the problem the Monte Carlo simulation is designed to solve.

The simulation constructs 10,000 independent five-year price paths, each consisting of 1,825 originations, by drawing daily log-returns with replacement from the empirical 2016-2026 return distribution. This bootstrap approach is deliberately chosen over a standard parametric simulation because a model assuming normally distributed returns would materially underestimate Bitcoin's tail risk (See Appendix C).

*Table 4: Monte Carlo 5 Year Bitcoin Price Path Percentiles*

| Monte Carlo Price Paths | | | | | Starting: $66,036 \| 10,000 Paths |
|---|---|---|---|---|---|
| Year | P5 | P25 | P50 (Median) | P75 | P95 |
| Year 1 | $35,642 | $69,545 | $110,236 | $169,816 | $321,965 |
| Year 2 | $37,554 | $95,333 | $180,252 | $335,928 | $832,675 |
| Year 3 | $43,676 | $135,238 | $294,972 | $639,189 | $1,891,346 |
| Year 4 | $51,733 | $199,254 | $481,465 | $1,195,666 | $4,219,096 |
| Year 5 | $66,005 | $291,689 | $792,056 | $2,140,602 | $9,243,886 |

Note: This table shows the distribution of simulated Bitcoin prices at the end of each year across a five-year horizon, generated from 10,000 independent price paths. Each path is constructed by drawing daily log-returns with replacement from the empirical 2016–2026 return distribution (bootstrap method), starting from the March 8th, 2026 price of $66,036. The P5, P25, P50, P75, and P95 columns represent the fifth, twenty-fifth, fiftieth, seventy-fifth, and ninety-fifth percentile outcomes across all 10,000 paths at the end of each year. A fixed random seed of 42 is used to ensure full reproducibility.

Table 4 displays our predicted 5-year forward prices of Bitcoin using Monte Carlo Bootstrap simulations. The width of the distribution compounds dramatically over time as by year five, the gap between the P5 and P95 outcome spans from $66,005 to $9,243,886. This is not a modelling error, instead it should be interpreted as a statistical tail and not as a central forecast. This is reflected because of Bitcoin's annualised volatility of 67.50% compounding over a five-year horizon. The same can be applied for the median outcome which places Bitcoin at $110,236 by year one and $792,056 by year five, reflecting the positive mean log-return of 49.29% per year embedded in the empirical distribution (See Appendix C). This distribution reveals that while Bitcoin-backed loans face multiple sources of risk, origination LTV is the structural parameter that protects specifically against liquidation risk across the full spectrum of plausible price outcomes. Other operational risks remain, but price volatility alone cannot be managed without sufficient collateral buffer at origination.

## Monte Carlo 5-year survival probability

*Table 5: Monte Carlo 5-year survival probability by LTV tier*

| LTV Risk Benchmarks | | | | | | Starting Price: $66,036 \| 10,000 Paths |
|---|---|---|---|---|---|---|
| Initial LTV | Loan Amount | Zone | P(At Risk) | P(Margin Call) | P(Liquidation) | P(Survival 5yr) |
| 10% | $6,604 | Safe | 1.6% | 0.9% | 0.6% | 99.4% |
| 20% | $13,207 | Safe | 8.0% | 4.7% | 3.4% | 96.6% |
| 30% | $19,811 | Safe | 19.7% | 11.9% | 9.1% | 90.9% |
| 40% | $26,414 | Caution | 37.4% | 22.6% | 17.2% | 82.8% |
| 50% | $33,018 | Caution | 61.5% | 37.4% | 28.0% | 72.0% |
| 60% | $39,622 | Danger | 100.0% | 56.4% | 42.8% | 57.2% |
| 70% | $46,225 | Danger | 100.0% | 79.9% | 60.1% | 39.9% |

Note: This table presents the five-year survival probability and corresponding liquidation rate for seven benchmark LTV tiers (10%, 20%, 30%, 40%, 50%, 60%, 70%), computed from the same 10,000-path bootstrap simulation described in Table 4. Survival probability is the fraction of paths in which the loan's stressed LTV did not reach the 85% liquidation threshold at any point during the five-year horizon. Each tier is also classified into one of three risk zones: Safe (up to 30%), Caution (30–50%), and Danger (above 50%).

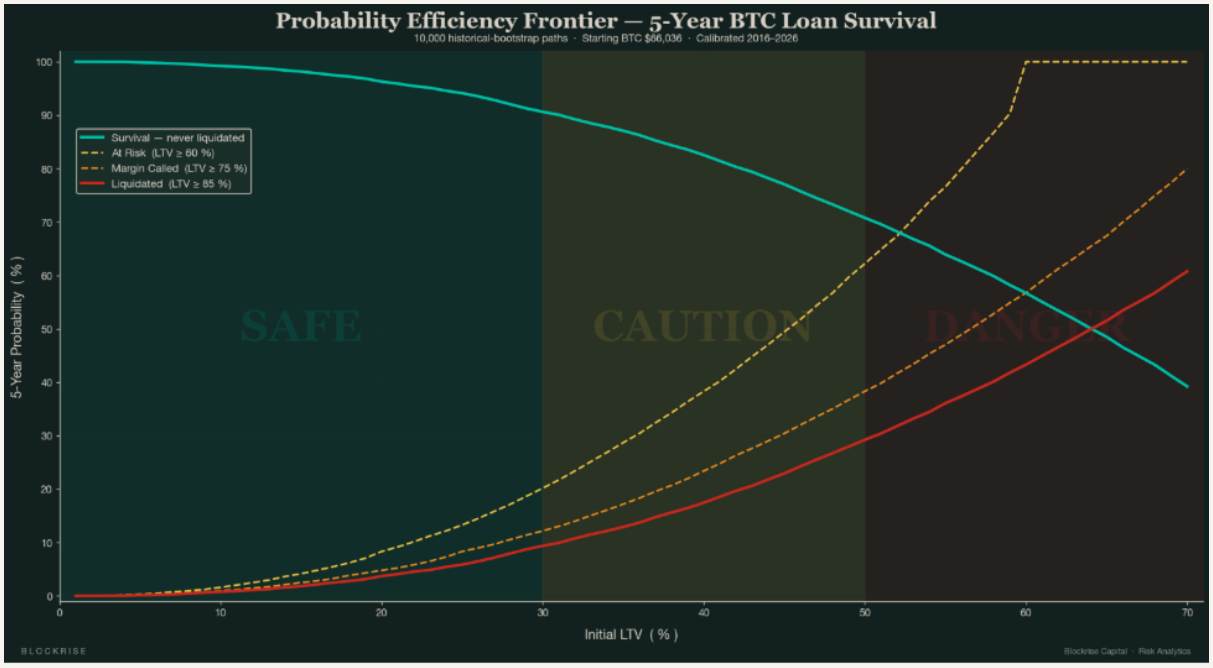


*Figure 6: Monte Carlo probability efficiency frontier*

Note: This line chart plots the five-year survival probability (drawn from the same Monte Carlo simulation as Tables 4 and 5) as a continuous curve across every integer LTV from 1% to 70%. The y-axis shows survival probability, and the x-axis shows origination LTV. Background shading identifies the three risk zones: green (Safe, 0–30%), amber (Caution, 30–50%), and red (Danger, above 50%).

Table 5 presents the five-year survival probabilities and liquidation risk across the standard LTV tiers, while Figure 6 translates these same numbers into a continuous curve across every LTV from 1% to 70%. The table and graph complement each other, as both display that a higher LTV origination leads to a higher likelihood of liquidation. Table 5 shows that when the LTV origination is in a safe zone (0-30%), then chances of liquidation within a 5-year period are at most 9.10%. When comparing that figure to an LTV of 60%, the liquidation probability translates to 42.80%, meaning almost half of all loans that will be originated at an LTV of 60% will become liquidated within a 5-year period. What the table cannot show, but the efficiency frontier makes immediately visible, is that the deterioration between these tiers is not uniform.

The survival curve in Figure 6 is relatively flat below 30% LTV, then visibly steepens through the Caution zone between 30% and 50% and accelerates sharply into the Danger zone above 50%. The step from 30% to 40% LTV alone costs 8.10pp of five-year survival probability. Essentially, there is no smooth trade-off between borrowing capacity and liquidation risk in Bitcoin-backed lending. There is a safe zone, a rapidly deteriorating zone, and a danger zone, with the 30% threshold marking the empirical boundary between the first and the second.

## Monte Carlo: Marginal risk by zone

*Table 6: Monte Carlo marginal risk by zone*

| Monte Carlo marginal risk by zone | | | | | | | Avg Impact of +1 pp LTV \| 10,000 Paths \| 5-Year Horizon |
|---|---|---|---|---|---|---|---|
| Zone | LTV Range | P(Liq) Start | P(Liq) End | Avg ΔP(AR) / 1pp | Avg ΔP(MC) / 1pp | Avg ΔP(Liq) / 1pp | Avg ΔP(Surv) / 1pp |
| Safe | 1%–30% | 0.00% | 9.13% | +0.679 pp | +0.412 pp | +0.315 pp | –0.315 pp |
| Caution | 30%–50% | 9.13% | 28.04% | +2.093 pp | +1.273 pp | +0.945 pp | –0.945 pp |
| Danger | 50%–70% | 28.04% | 60.07% | +1.923 pp | +2.127 pp | +1.602 pp | –1.602 pp |

Note: This table quantifies the average increase in five-year liquidation probability per single percentage point of LTV within each of the three risk zones (Safe, Caution, Danger), calculated from the 10,000-path Monte Carlo simulation. For each zone, the table shows the starting liquidation probability, ending liquidation probability, total probability accumulated across the zone, and the average marginal cost per 1pp of LTV increase.

Table 6 measures the average additional risk added by each single percentage point of LTV within each zone, which therefore illustrates the acceleration of risk as LTV rises. In the Safe zone from 1% to 30% LTV, each additional 1pp of LTV adds an average of 0.315pp of liquidation probability. Across the full Safe zone, liquidation probability rises by just 9.13pp in total.

At the 30% boundary, the rate of risk addition begins to change structurally. In the Caution zone from 30% to 50%, each additional 1pp of LTV adds 0.945pp of liquidation probability, which is three times the Safe zone rate. In addition, the Caution zone accumulates 18.91 percentage points of liquidation probability, making it roughly twice the Safe zone's total spread

The Danger zone which spans from 50% to 70% LTV adds 1.602pp of liquidation probability per 1pp of LTV. Additionally, cumulative liquidation probability rises by 32.03pp, approximately 3.5 times the Safe zone's total spread and nearly double that of the Caution zone. Taken together,

these three zones illustrate that liquidation risk does not scale proportionally with LTV. Each percentage point added beyond the Safe zone costs progressively more in expected liquidation probability, reinforcing that lower LTV originations can offer advantages across various market environments.

# 4. Optimal LTV analysis

The 12- and 24-month cohort, regime, and Monte Carlo analyses collectively quantify how liquidation risk changes across LTV tiers, loan terms, and market environments. What remains is to empirically identify the point at which that risk begins to accelerate beyond what historical and simulated price data suggests is structurally manageable. This section applies three analytical methodologies in sequence, namely an empirical drawdown distribution, a polynomial derivative analysis, and a four-curve survival comparison, to locate that threshold within the data. The results presented are analytical outputs derived from ten years of historical Bitcoin price data and forward simulation and are intended solely to inform a structural understanding of liquidation risk.

## Historical maximum drawdown distribution

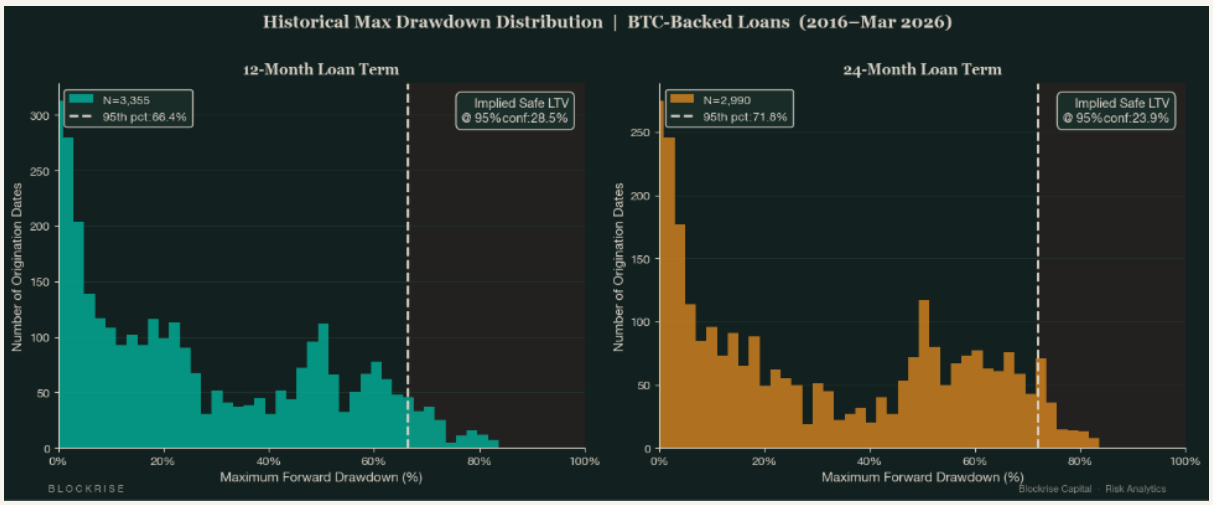


*Figure 7: Historical Maximum Drawdown Distribution (12M and 24M)*

Note: This side-by-side histogram pair shows the empirical distribution of maximum forward drawdowns across all 3,355 12-month origination windows (left panel) and all 2,990 24-month origination windows (right panel). For each origination date, the maximum forward drawdown is the largest percentage decline in Bitcoin's price from the origination date to the lowest price within the forward loan term. The x-axis shows drawdown magnitude, and the y-axis shows the frequency of originations experiencing each drawdown level. Vertical dashed lines mark the 95th percentile drawdown for each term, with the corresponding implied safe LTV, defined as the maximum origination LTV that would survive that drawdown without liquidation, shown as an annotation.

The 12-month distribution reveals that the majority of originations experienced modest drawdowns concentrated in the 0-20% range. The 95th percentile drawdown for a 12-month loan is 66.40%, which means that 5% of all possible origination windows produced a forward decline exceeding 66.40%. Crucially, this 95th percentile drawdown implies a survival threshold of 28.50%, meaning any loan originated above this LTV would have been liquidated in the worst 5% of historical 12-month windows. For the 24-month loans, the distributions are slightly more volatile, with the 95th percentile drawdown reaching 71.80%, implying a safe LTV of just 23.90%. Taken together, both the 12-month and 24-month implied safe LTVs fall below 30%, meaning that historically, a sub-30% origination LTV would have been sufficient to survive the 95th percentile drawdown across both loan terms.

## Maximum forward drawdown by origination date

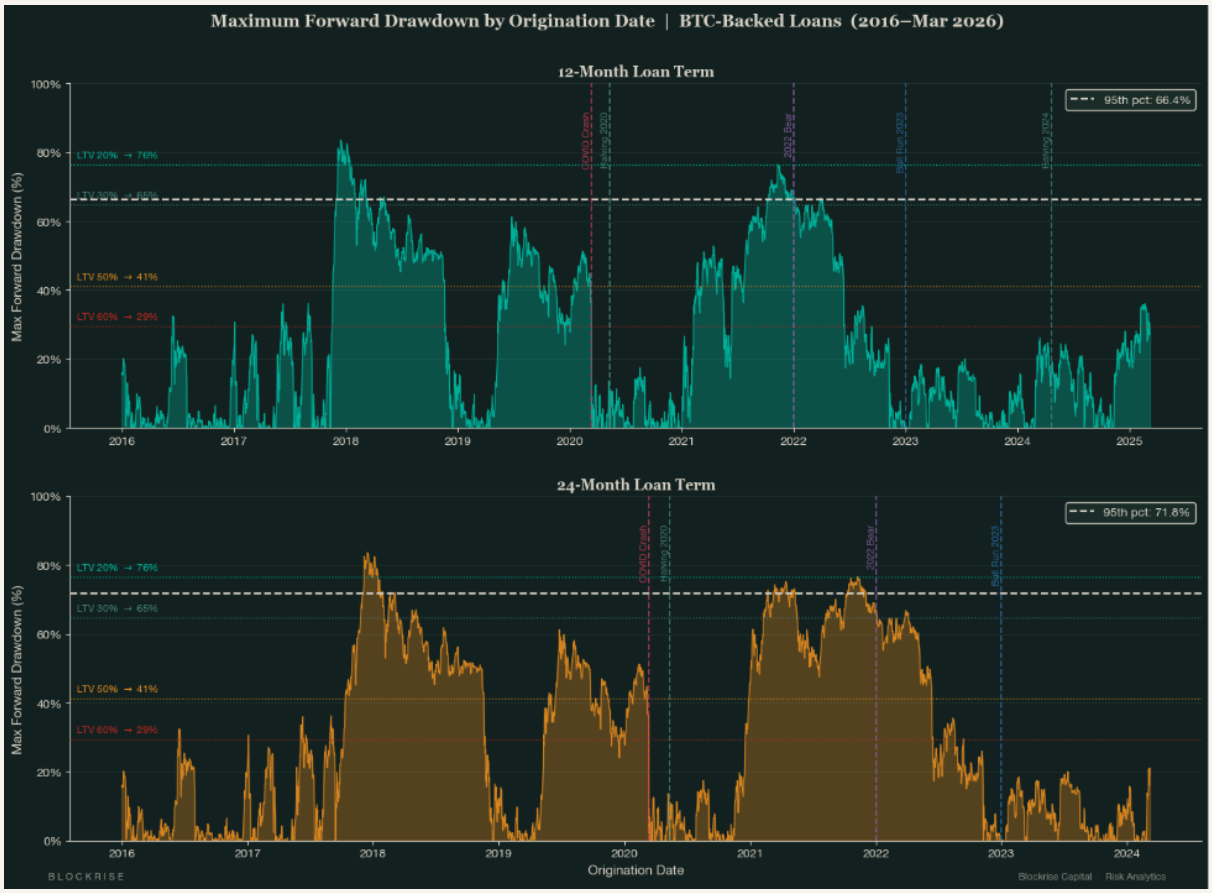


*Figure 8: Historical maximum drawdown distribution*

Note: This two-panel time-series chart plots the maximum forward drawdown for each origination date, with the 12-month term in the top panel and the 24-month term in the bottom panel. The x-axis is the origination date and the y-axis is the maximum percentage decline in Bitcoin's price observed within the respective forward window. Horizontal dashed reference lines mark the critical drawdown level at which each LTV tier (20%, 30%, 50%, 60%) would be liquidated. The chart ends before the most recent dates because loans require a complete forward window within the dataset end date of March 8th, 2026.

Three dominant stress periods emerge clearly: The 2017-2018 peak produced severe 12- and 24-month drawdowns exceeding 80% for originations in late 2017, breaching the liquidation threshold for every tier. The 30% liquidation threshold line at 64.71% drawdown is breached only during the most extreme windows, confirming that 30% LTV provided adequate protection across most of the decade. Critically, the 20% liquidation line at 76.47% drawdown is breached only momentarily during the most extreme events in the dataset, and only for originations at the absolute peak of each cycle.

## Polynomial derivative analysis for 12-month period

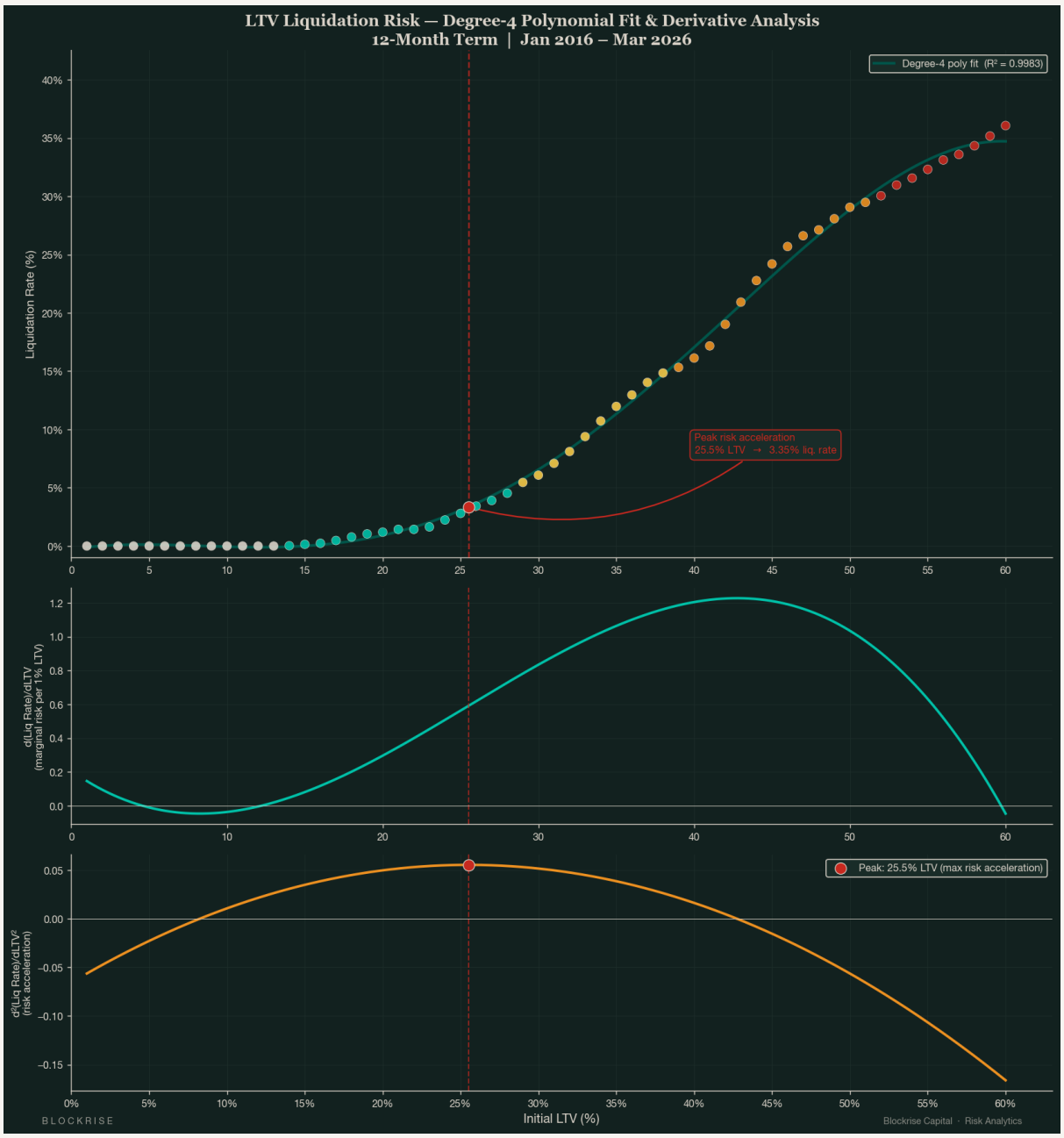


*Figure 9: Polynomial Derivative Analysis (12 Months)*

Note: This three-panel chart derives the optimal LTV ceiling for 12-month loans using a polynomial regression approach. Panel 1 plots the empirical liquidation rate at each LTV from 1% to 60% (based on 3,355 historical originations) with a fitted degree-4 polynomial curve. Panel 2 shows the first derivative of the fitted polynomial, representing the marginal increase in liquidation probability per additional 1pp of LTV. Panel 3 shows the second derivative, representing the rate at which that marginal risk is accelerating; the LTV at which the second derivative reaches its peak is the point where risk acceleration is at its maximum, identified here at 25.5% for the 12-month term. A degree-4 polynomial is used because the liquidation rate follows an S-shaped curve across the LTV range.

The peak of the second derivative for the 12-month loan term is identified at 25.50% LTV, where the empirical liquidation rate stands at 3.35%. This result is consistent with the threshold range implied by the 95th percentile drawdown analysis in the preceding figure, where the implied safe LTVs of 28.50% and 23.90% for the 12- and 24-month terms respectively pointed to a similar ceiling. The significance of the 25.50% point is that each additional percentage point of origination LTV adds risk at a rate that is itself increasing. Beyond this point, the empirical liquidation rate climbs from 3.35% at 25.50% LTV to 36.10% at 60% LTV across the 3,355 historical originations, a 32.75pp increase compressed into just 34.50pp of additional LTV.

## Polynomial derivative analysis for 24-month period

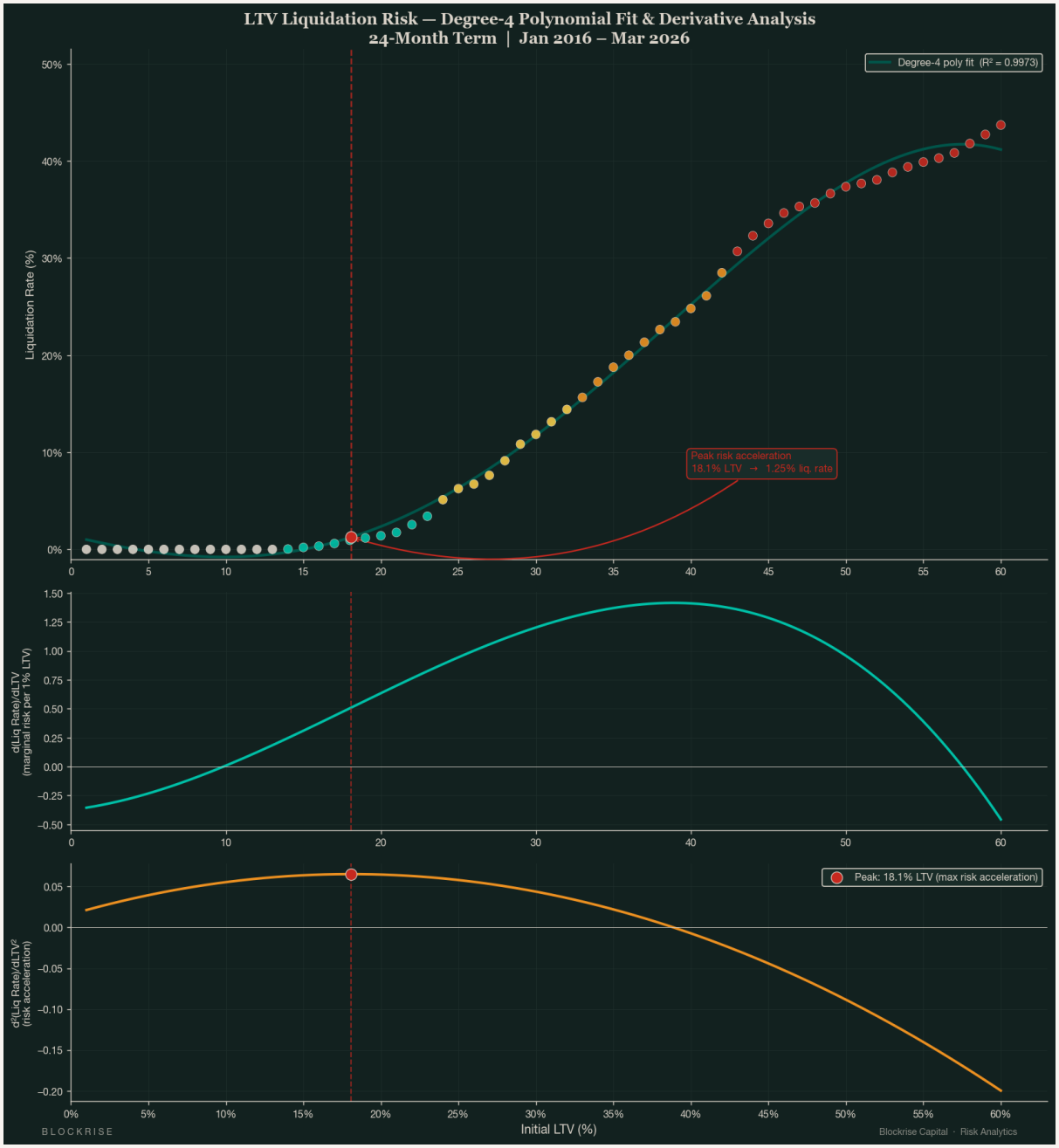


*Figure 10: Polynomial Derivative Analysis (24 Months)*

Note: This chart replicates the three-panel polynomial derivative methodology of Figure 9, applied to 24-month loans using 2,990 historical originations. Panel 1 shows the empirical liquidation rate with a degree-4 polynomial fit. Panel 2 shows the first derivative (marginal liquidation risk per 1pp of LTV). Panel 3 shows the second derivative, with the peak (identifying the point of maximum risk acceleration) occurring at 18.1% LTV for the 24-month term.

The same polynomial analysis applied to 24-month loans produces a consistent but more strict result for optimal LTV origination. The maximum 2nd derivative point shifts to 18.10% LTV with a liquidation rate of 1.24%, meaning the risk curve begins accelerating earlier and at a lower

liquidation rate than the twelve-month loan term. This is the quantitative proof of what the previous analyses demonstrated, namely that longer loan terms amplify LTV risk because additional time creates more opportunities for a severe drawdown to occur. The 24-month maximum 2nd derivative point at 18.10% LTV implies that a lender offering longer-term products should apply tighter LTV limits than a short-term lender, not as a conservative preference, but as a mathematical consequence of the extended exposure window.

Taken together, the two polynomial analyses identify an optimal LTV range of approximately 18% to 26% as the mathematically derived ceiling, with 25.50% as the upper bound for 12-month products and 18.10% as the upper bound for 24-month products. Notably, both mathematically derived second derivative points fall within the same range implied by the 95th percentile drawdown thresholds seen in Figure 7, meaning that the polynomial derivative analysis and the empirical drawdown distribution arrive at a consistent result through entirely independent approaches.

## Historical and Monte Carlo survival curves


*Figure 11: Historical and Monte Carlo Survival Curves (12- and 24-Month Terms)*

Note: This line chart overlays four survival probability curves across LTV tiers from 10% to 70%: historical 12-month (from 3,355 originations), historical 24-month (from 2,990 originations), Monte Carlo 12-month (10,000 paths at the 12-month horizon), and Monte Carlo 24-month (10,000 paths at the 24-month horizon). The y-axis shows the proportion of loans not liquidated and the x-axis shows origination LTV. Horizontal shaded bands mark the 90% and 95% survival thresholds. A vertical dashed line marks the 30% LTV reference.

Figure 11 shows that at 28.50% LTV, all four curves remain above or at the 90% survival threshold and at 23.90% LTV, they all remain at or above the 95% survival threshold. The Monte Carlo curves sit consistently above their historical counterparts across all LTV tiers. This is because the historical survival rates reflect a specific decade that contained a concentrated sequence of tail events such as the 2018 crypto winter, the COVID crash, and the 2022 crypto crisis which all

occurred within a five-year window. The Monte Carlo simulation draws from the same empirical return distribution that produced those events, but across 10,000 randomly sampled paths the probability of encountering multiple severe crashes within a single loan window is lower than it was in the actual 2016-2026 decade. The historical data therefore establishes that a sub-30% origination LTV would have survived the 95th percentile of historical drawdown windows across both loan terms.

## Margin call effectiveness

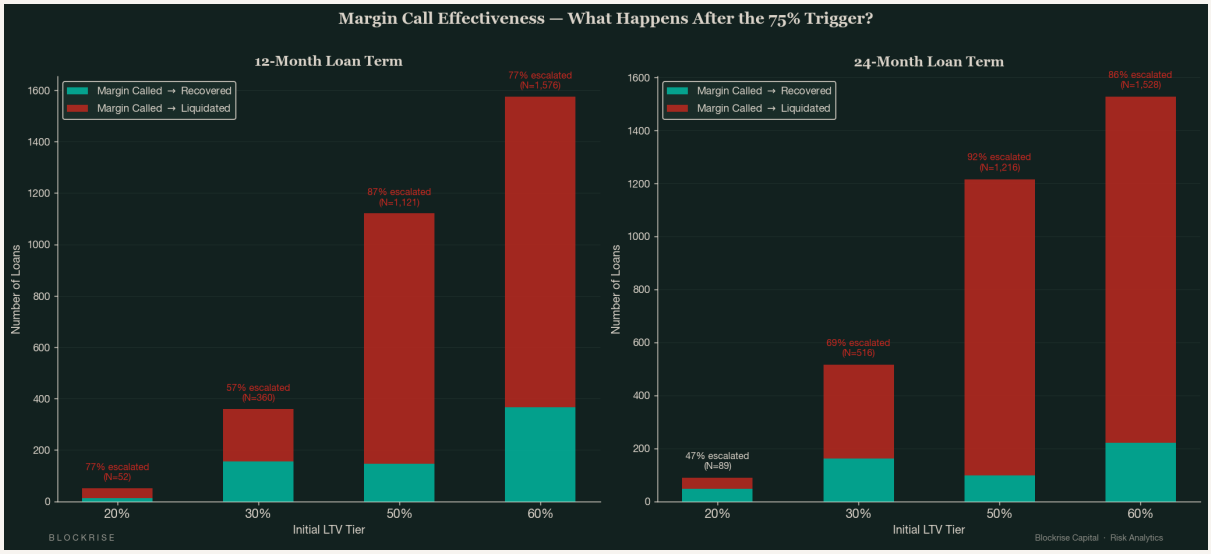


*Figure 12: Margin Call Effectiveness*

Note: This chart shows, for each origination LTV tier and both loan terms, the proportion of loans that reached the 75% margin call threshold and subsequently either recovered (stressed LTV fell back below 75% without reaching 85%) or escalated to liquidation (stressed LTV continued to 85% or above). The data is drawn from the same historical stress test as the preceding figures. Results are shown separately for 12-month and 24-month terms across all four LTV tiers.

Figure 12 shows whether in practice loans that reached the margin call threshold recover naturally or escalate towards liquidation. At 20% LTV on a 12-month loan, 77% of margin called loans escalated to liquidation. This seems like a high escalation rate, but the absolute number of margin calls is small at this tier, reflecting that the threshold is rarely reached. At 50% LTV, 87% of margin called loans escalated to liquidation, and at 60% LTV the escalation rate reaches 77% across a dramatically larger pool of 1,576 margin called loans. The 24-month results are worse: at 50% LTV, 92% of margin calls escalated, and at 60% LTV, 86% escalated across 1,528 loans. The figure essentially shows that once loans cross the margin call threshold, few recover. Thus, one protection mechanism against liquidation is an LTV origination low enough that the margin call threshold is rarely reached in the first place, all of which returns the analysis to its main findings: 20-30% LTV has empirically been a defensible origination range for Bitcoin-backed lending.

# 5. Conclusion

This paper aimed to provide a rigorous analysis to show why the 30% LTV is not just a random number, but rather a new gold standard for Bitcoin-backed lending. The analysis consisted of stress testing daily loan originations between January 2016 to March 2026 across 4 key LTV tiers and two loan terms, examining three distinct market regimes in isolation, constructing 10,000 forward simulation paths from empirical returns distributions, and using probabilities along with mathematical derivations to attempt finding the optimal LTV. Each methodology was independent, yet all arrived towards the similar answer.

The findings were crystal clear: At 20% LTV, historical liquidation rates were 1.19% across the full decade for the 12-month loans and 1.40% for the 24-month loans. Moreover, for the three specific market regimes the liquidation rates were 0%, meaning that all these LTV originations survived several market downturns such as COVID, the 2022 crypto crisis, and a bull run which experienced a 50% market correction within a 4-month period. At 30% LTV, survival rates remained above 88% across both loan terms (12 and 24 month) and when analysing the 3 specific market regimes, liquidation rates were only seen during the 2022 crypto crisis with 3.84% of LTV originations liquidated.

The polynomial derivative analysis identified the mathematical attained second derivatives which showed when the acceleration of LTVs is at their peak. The precise LTV boundaries identified for the 12- and 24-month loan terms through historical price analysis were 25.50% and 18.10%. The Monte Carlo analysis which was forward looking and simulated 10,000 different simulation paths through the bootstrap methodology predicted a 5-year survival probability of 96.60% and 90.90% for both 20% and 30% LTV originations respectively.

This could not be more different from the comparative LTVs of 50% and 60%, where the 5-year forward looking probability of survival becomes 72% and 57.20% respectively. Moreover, at 60% LTV origination, historical liquidation rates become 36.07% and 43.71% for a 12-month and 24-month loan respectively. The margin call mechanism additionally showed that between 77% to 92% of margin called loans at high LTV origination tiers (50-60%) escalated towards liquidation, meaning loans usually do not recover by themselves when margin called.

Across every analytical lens applied in this paper, one conclusion emerges: The 20-30% LTV range is an empirically defensible origination range for Bitcoin-backed lending. The deeper implication of this whole analysis is that LTV is not just another variable when it comes to Bitcoin-backed lending, rather it is a major determinant of a loans survival. Throughout the analysis we have seen how regime type, loan term, market direction all modulate the severity of outcomes, but none of them manage to override the fundamental principle of the collateral buffer.
Thus, the conclusion is that lending standards must be calibrated not to the borrower’s preference for maximum capital or the lender’s preference, but to control for Bitcoin’s actual volatility. The data therefore supports sub-30% LTV as an empirically grounded origination ceiling as the boundary at which Bitcoin's historical return distribution demonstrates sustained loan survival.

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# Appendix A: 12- and 24-month cohort analysis

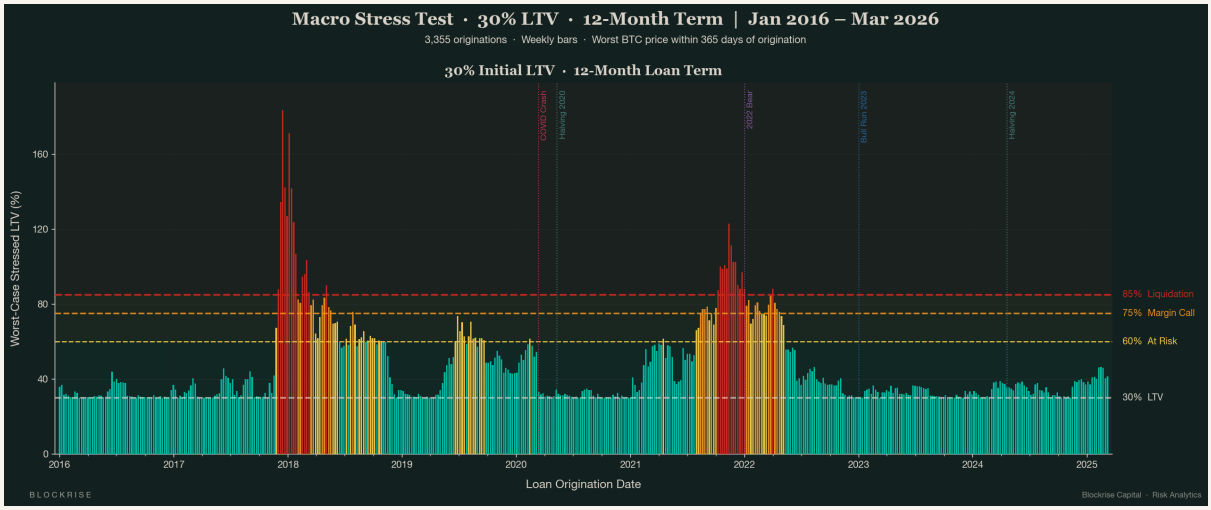


*Figure 13: 30% LTV 12-Month Term*

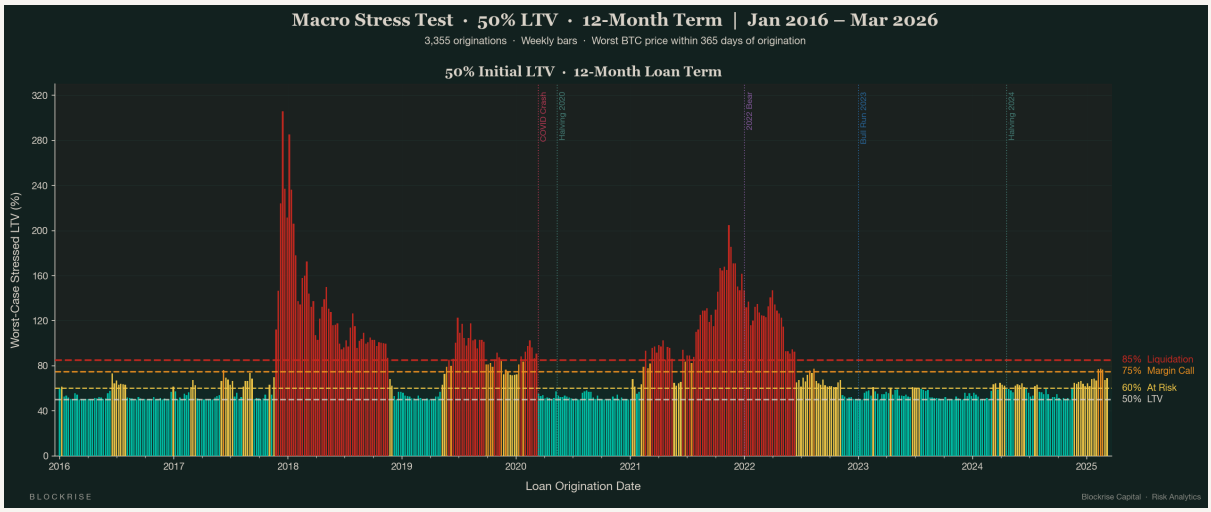


*Figure 14: 50% LTV 12-Month Term*

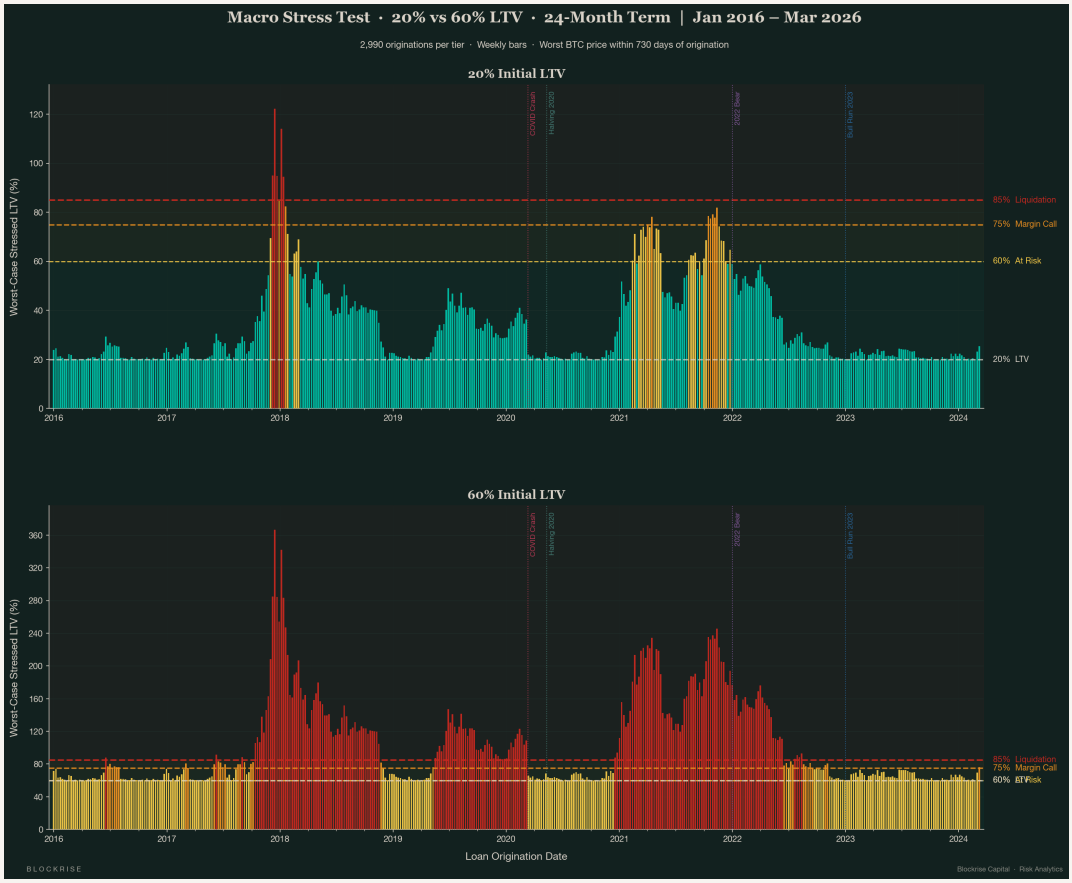


*Figure 15: 20% vs 60% LTV 24-Month Term*

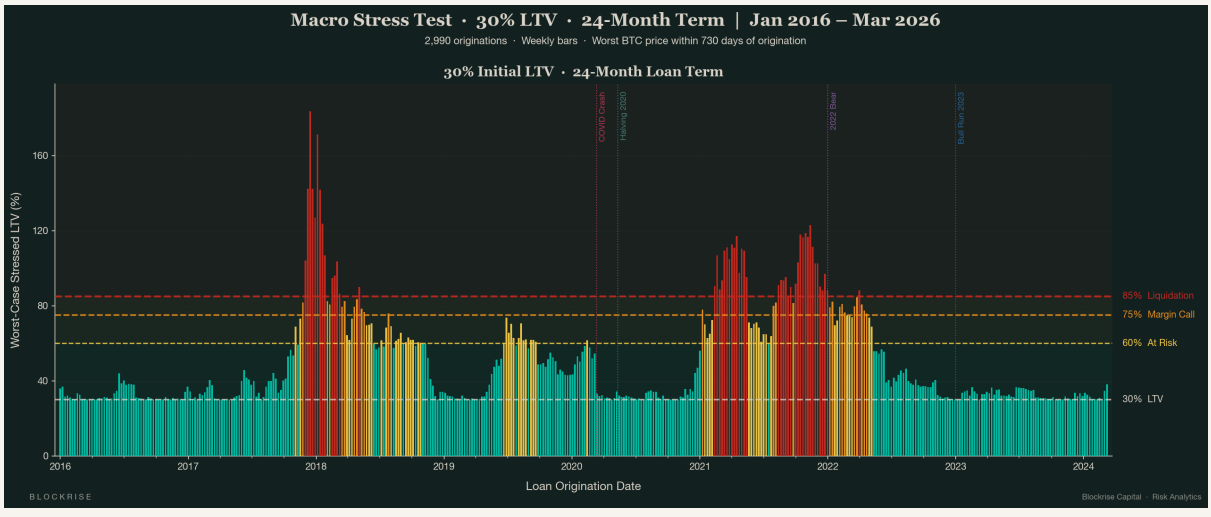


*Figure 16: 30% LTV 24-Month Term*

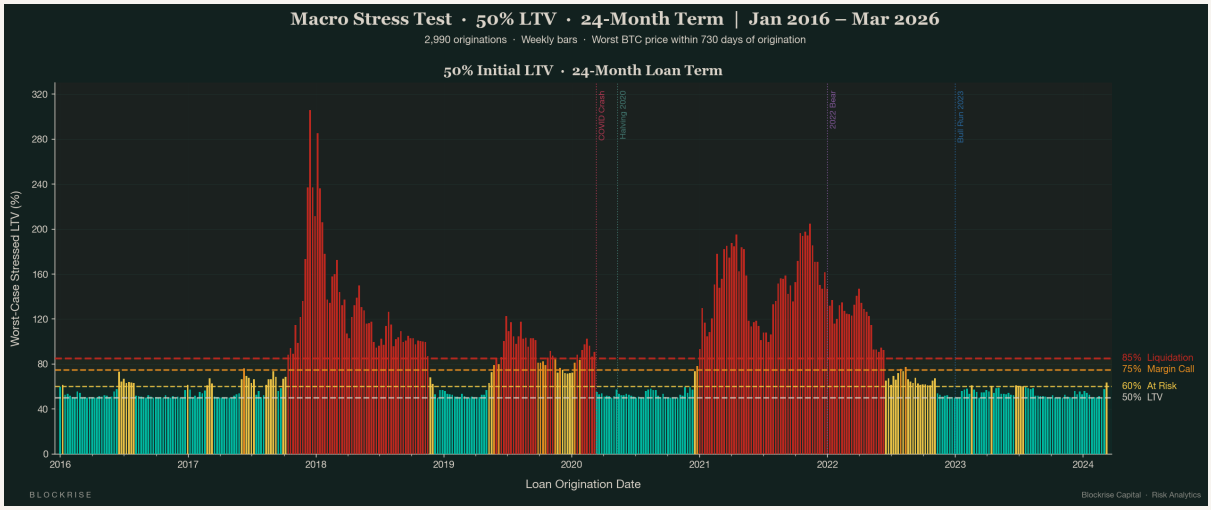


*Figure 17: 50% LTV 24-Month Term*

# Appendix B: Regime Analysis

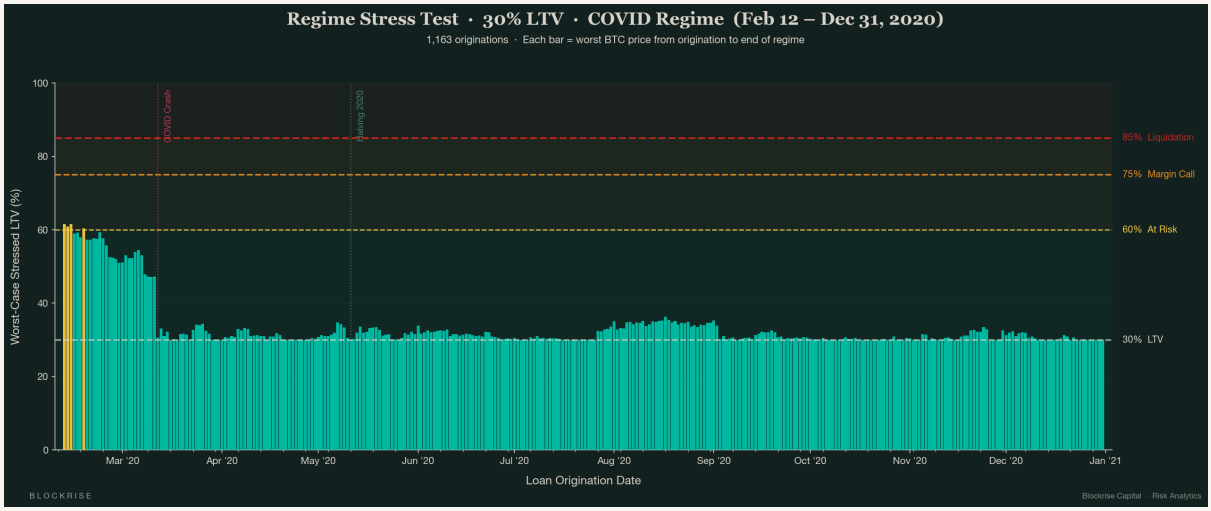


*Figure 18: 30% LTV Covid Regime*

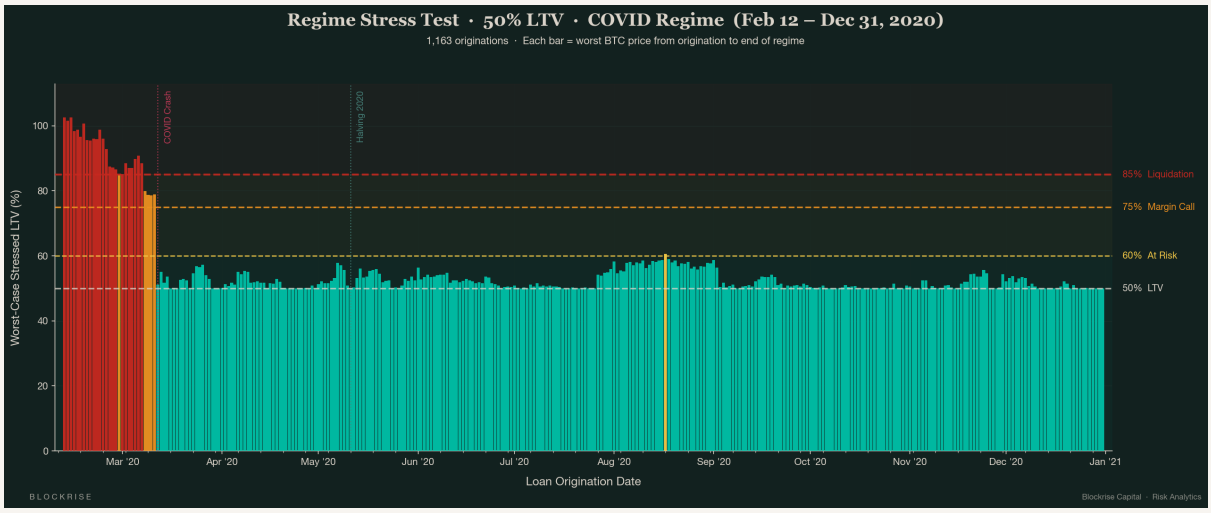


*Figure 19: 50% LTV Covid Regime*

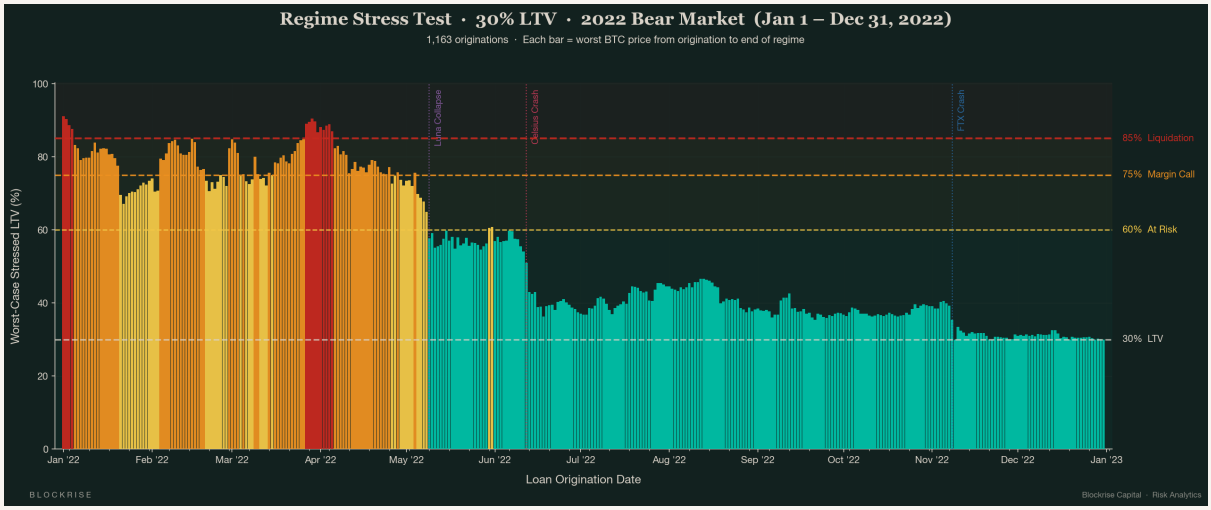


*Figure 20: 30% LTV Bear Market Regime*

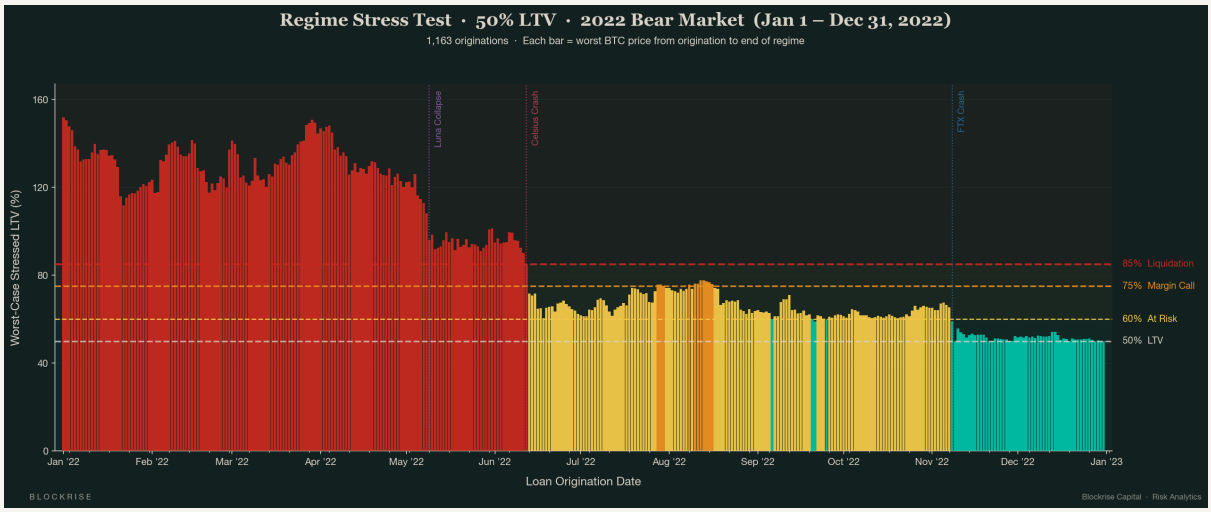


*Figure 21: 50% LTV Bear Market Regime*

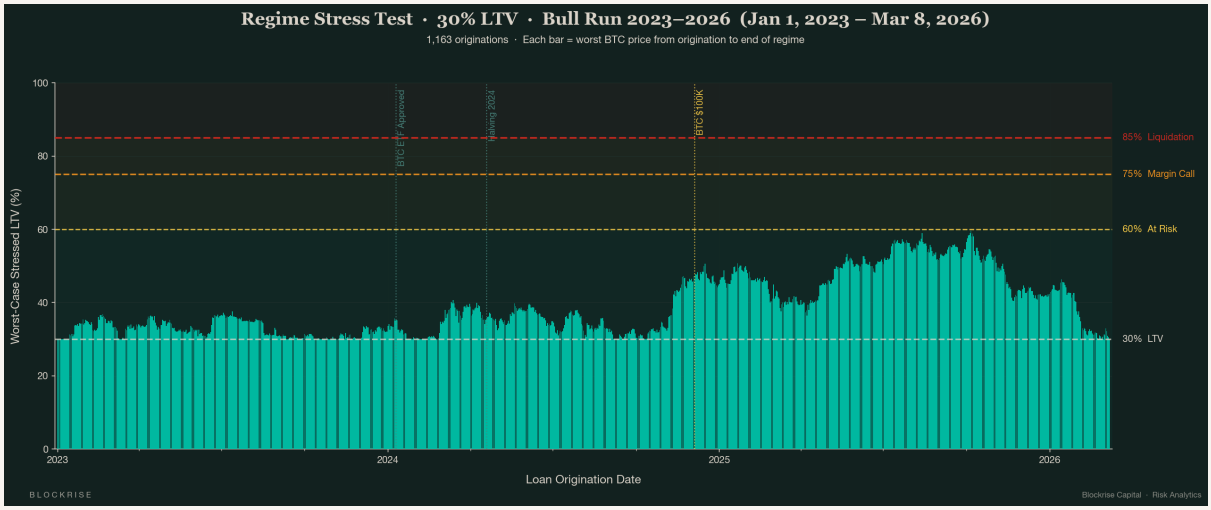


*Figure 22: 30% LTV Bull Run Regime*

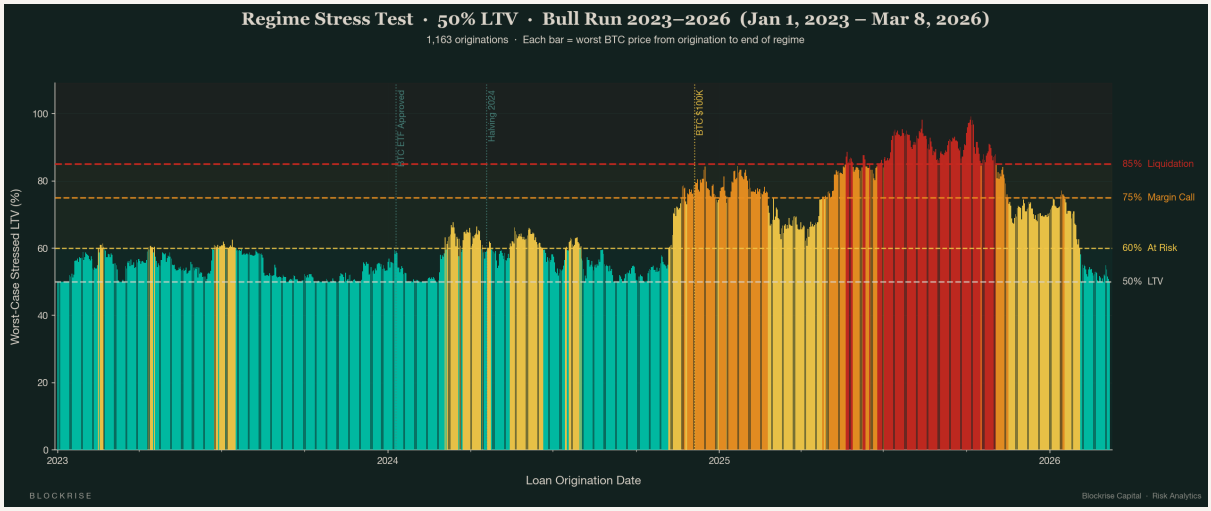


*Figure 23: 50% LTV Bull Run Regime*

# Appendix C: Monte Carlo

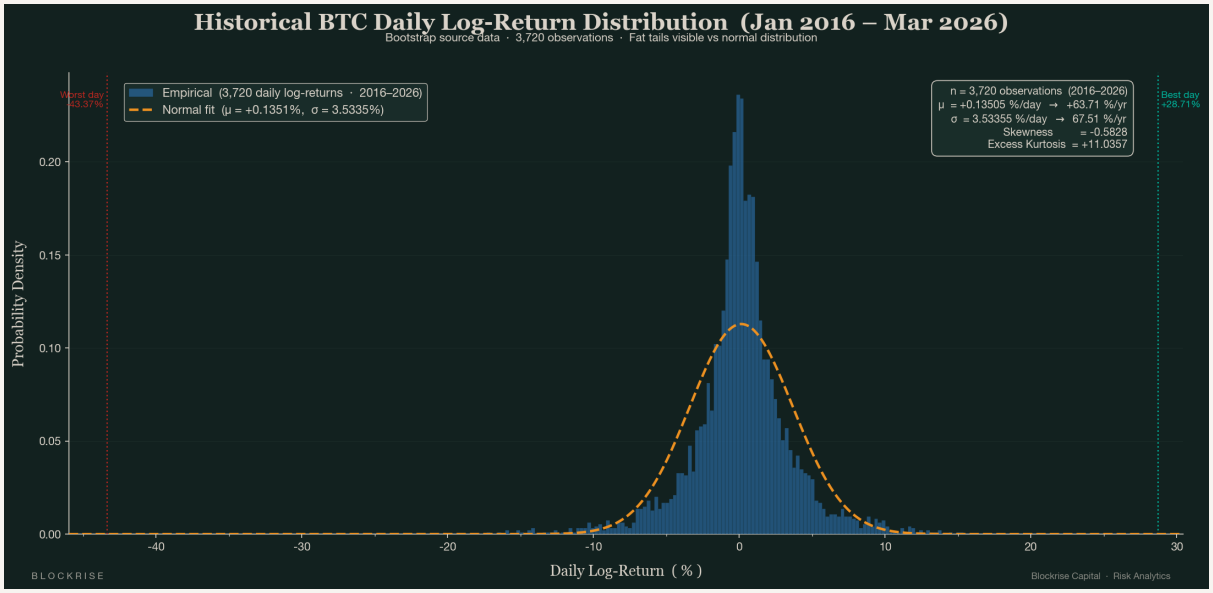


*Figure 24: Historical BTC Daily Log-Return Distribution*

| Historical Return Calibration Statistics | | | 2016–2026 Window |
|---|---|---|---|
| **STATISTIC** | **DAILY** | **ANNUALISED** | **FORMULA / NOTE** |
| Data Range | 2016-01-01 – 2026-03-08 | – | Jan 1, 2016 → Mar 8, 2026 (excludes 2013–2015 early-adoption era) |
| n observations | 3,720 | – | vs 4,696 in full 2013–2026 dataset |
| μ (mean log-return) | +0.13505 %/day | +49.294 %/yr | Σ $r_i$ / n |
| σ (volatility / std dev) | 3.53355 %/day | 67.508 %/yr | $\sqrt{(\Sigma(r_i-\mu)^2 / (n-1))}$ · σ_ann = σ_d × √365 |
| Min return (worst day) | -43.3714 % | – | on 2020-03-12 |
| Max return (best day) | +28.7099 % | – | on 2017-12-06 |
| Skewness | -0.58277 | – | $E[(r-\mu)^3] / \sigma^3$ (negative → left tail heavier) |
| Excess Kurtosis | +11.03574 | – | $E[(r-\mu)^4] / \sigma^4 - 3$ (positive → fatter tails than normal) |
| P1 | -10.40137 %/day | – | 1st percentile of empirical return distribution |
| P5 | -5.48816 %/day | – | 5th percentile |
| P25 | -1.23431 %/day | – | 25th percentile (lower quartile) |
| P50 (median) | +0.11992 %/day | – | Median – 50 % of days have a lower return than this |
| P75 | +1.58699 %/day | – | 75th percentile (upper quartile) |
| P95 | +5.45724 %/day | – | 95th percentile |
| P99 | +9.92873 %/day | – | 99th percentile |

*Table 7: Historical Return Calibration Statistics*

# Appendix D: Drop Tolerance

*Table 7: Drop Tolerance by Starting LTV*

| | | | Liquidation threshold: 85% \| Margin Call: 75% \| At Risk: 60% |
|---|---|---|---|
| INITIAL LTV | DROP TO AT RISK (60%) | DROP TO MARGIN CALL (75%) | DROP TO LIQUIDATION (85%) |
| 10% | -83.33% | -86.67% | -88.24% |
| 20% | -66.67% | -73.33% | -76.47% |
| 30% | -50.00% | -60.00% | -64.71% |
| 40% | -33.33% | -46.67% | -52.94% |
| 50% | -16.67% | -33.33% | -41.18% |
| 60% | – | -20.00% | -29.41% |
| 70% | – | -6.67% | -17.65% |

# Appendix E: Sources

https://coinmarketcap.com/currencies/bitcoin/

https://newhedge.io/bitcoin/spot-bitcoin-etf-aum

https://coinmarketcap.com/charts/bitcoin-treasuries/

https://www.galaxy.com/insights/research/crypto-leverage-q3-2025-defi-cefi-lending-digital-asset-treasury-debt-futures-perpetuals

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