Leo Heart

Cracking the Code: Bitcoin Price Models for Precise Predictions

Summary

Bitcoin's price dynamics exhibit a remarkable confluence of log-linear trends and damped harmonic oscillations, driven by the recurring supply shocks introduced by halving events and market cycles, respectively. This study presents a power law model that accurately captures the interplay between these two fundamental components, periodic providing a concise yet powerful representation of Bitcoin's price evolution over an extended period spanning multiple halvings and market cycles.

$$\mathrm{BTC}(h) = \$30h^{5.44}$$

$$log_{10}\big(\mathrm{BTC}(h)\big) = 1.48 + 5.44 \cdot log_{10}(h)$$

$$h = \frac{block\ height}{210{,}000}$$

The block height measures the height of the blockchain. Each block has its height that eventually means its number if counting the genesis block as block number 0. The log-linear component, represented by the $log_{10}(h)$ term, accounts for the long-term trend influenced by the periodic halvings, which reduce the rate of new Bitcoin minting and introduce supply shocks to the market. Remarkably, the oscillatory fluctuations around this trend can be modeled as a damped harmonic oscillation, described by the term $sin(2\pi h - h^{-1.4}) \cdot 0.8^{h+1}$, capturing the cyclical behavior with decaying amplitude due to market stabilization and dissipation of speculative forces.

$$log_{10}\big(\mathrm{BTC}(h)\big) = 1.48 + 5.44 \cdot log_{10}(h) + sin(2\pi h - h^{-1.4}) \cdot 0.8^{h+1}$$

By combining these two essential elements with offset and scaling parameters, the proposed power law model achieves an exceptional fit to 14 years of Bitcoin price data, spanning from the first third (*h* = 1/3) of the period between the first and the second halving events until almost the fourth halving (*h* = 4). This remarkable accuracy, despite the model's simplicity, underscores the potential of power law models in describing the complex dynamics of cryptocurrency prices.

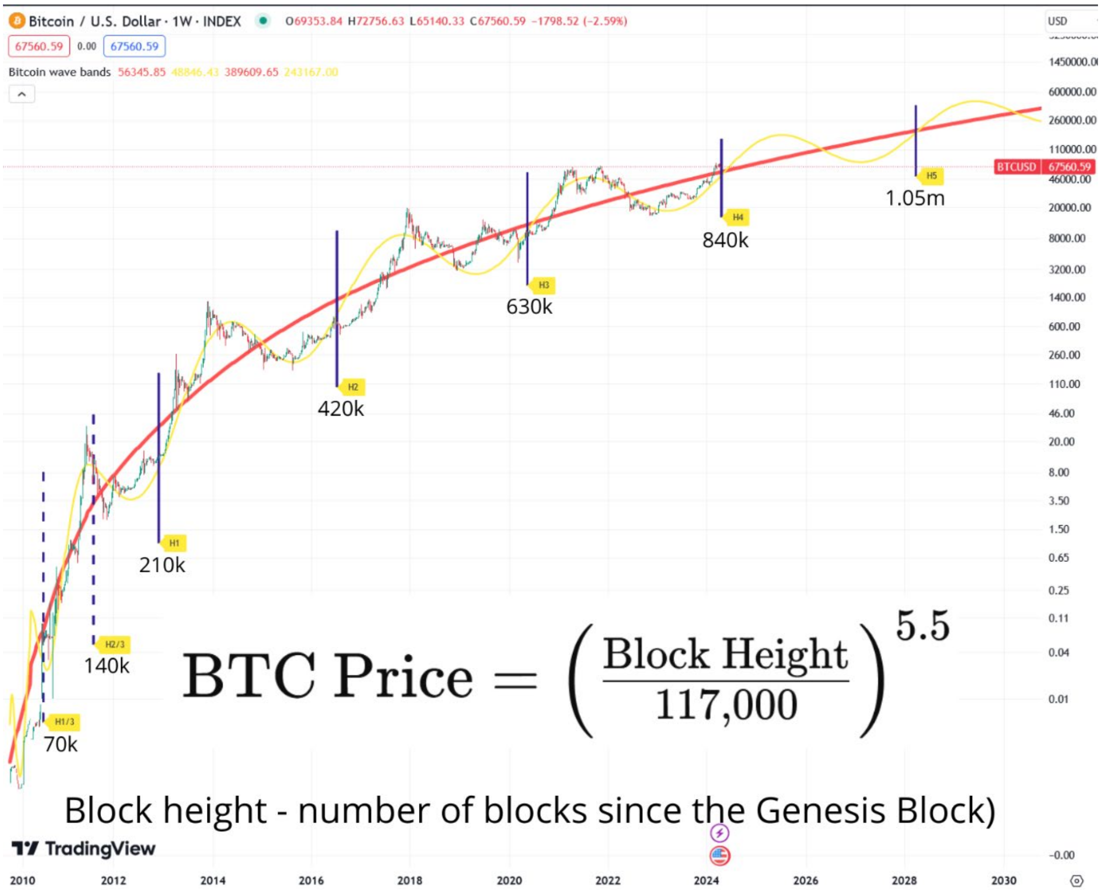
The study not only provides a concise mathematical representation but also offers insights into the fundamental drivers shaping Bitcoin's price dynamics, paving the way for enhanced investment strategies, risk management approaches, and a deeper understanding of the interplay between recurring supply shocks and market cycles in the evolving cryptocurrency landscape.

Introduction

The world of cryptocurrencies, pioneered by the groundbreaking invention of Bitcoin, has captivated the attention of investors, technologists, and economists alike. At the heart of this digital revolution lies a tantalizing challenge – deciphering the intricate patterns that govern the volatile price movements of these decentralized assets. While the forces of supply and demand undoubtedly play a pivotal role, the dynamics of Bitcoin's price evolution exhibit a remarkable confluence of log-linear trends and damped harmonic oscillations, intricately woven into a tapestry of recurring supply shocks and market cycles.

In this pioneering study, we embark on a quest to unravel the mathematical underpinnings that govern Bitcoin's price trajectory, unveiling a powerful predictive model that harnesses the synergy between log-linear regression and damped harmonic oscillation components. By embracing the intrinsic temporal rhythm of the Bitcoin blockchain, embodied in the concept of the "Bitcoin Halving Clock," we shed light on the profound impact of halving events – seismic supply shocks that reverberate through the entire market, catalyzing long-term trends and cyclical fluctuations.

Our exploration delves deep into the realm of power-law dynamics, revealing a remarkable mathematical expression that encapsulates the relationship between Bitcoin's price growth and its adoption rate across multiple dimensions of global society. This multidimensional perspective provides a profound framework for interpreting and modeling the evolving dynamics of Bitcoin's growth, transcending traditional boundaries.



Guided by a meticulous analysis of historical data spanning over 14 years, encompassing four halving events and a multitude of market cycles, we unveil a concise yet extraordinarily accurate power-law model. This model, with merely three numeric parameters, impeccably captures the timing and amplitude of Bitcoin's price oscillations, aligning seamlessly with both peaks and troughs observed in the data.

Beyond its theoretical elegance, our model holds immense practical value, offering a robust foundation for predicting Bitcoin's future price movements at any given point in time. By artfully blending the damped harmonic oscillator with logarithmic regression, we equip investors and risk managers with a potent tool for navigating the complexities of the cryptocurrency landscape, informing investment strategies, and enhancing risk management approaches.

Moreover, our study culminates in the crafting of meticulously defined price range bands, which encapsulate Bitcoin's overall price movements within well-defined boundaries. This comprehensive model, relying on a mere six numerical parameters, exhibits remarkable precision in forecasting market tops and bottoms, substantiated by its ability to accurately model the dynamics of the past four bull runs.

As we venture into the uncharted territories of the digital asset revolution, this groundbreaking research invites us to embrace a paradigm shift – a departure from conventional timekeeping and a seamless integration with the heartbeat of the Bitcoin blockchain. By synchronizing with the pulsating rhythm of halving events, we unlock a profound understanding of Bitcoin's temporal dynamics, paving the way for precise predictions and a deeper appreciation of the intricate forces shaping the future of decentralized finance.

Decoding the Bitcoin Halving Clock

In the realm of Bitcoin, time marches to the beat of its own drum - the relentless ticking of new blocks being mined. Let us introduce the concept of the "Bitcoin Halving Clock" - a mechanism that taps into the core of Bitcoin's temporal rhythm and pre-programmed supply schedule.

Bitcoin is designed to have its supply of new coins decrease over time through a process called the "halving" that occurs roughly every four years. During each halving, the rewards miners receive for validating transactions are cut in half, acting as a supply shock that slows the rate at which new bitcoins enter circulation.

$$h = \frac{block\ height}{210{,}000}$$

The integer (whole number) part of h indicates the number of halvings that have already occurred. The fractional (decimal) part tracks the progress towards the next halving event. For example, if h = 4.33, it means that the forth halving has occurred, and Bitcoin is 33% of the way towards its fifth halving event.

What is the block height?

The Bitcoin blockchain is a chain of data blocks. Each block contains:

1. Block Height: A unique sequential number identifying the block's position in the chain, starting from block 0 (the genesis block).

2. Timestamp: The approximate time when the block was mined and added to the blockchain.

The bitcoin halving clock (*h*) serves as a normalized unit of measurement of the height of bitcoin blockchain itself, where blocks are grouped into batches of 210,000 blocks per "halving cycle" (when the mining reward is halved).

There is a direct correlation between a block's timestamp and its height (*h*). This relationship allows tracking the chronological order of blocks and transactions recorded in the blockchain.

Block explorers, like the one at https://explorer.btc.com/btc/insights-difficulty , provide visualizations of the relationship between block height and timestamp, along with other blockchain metrics.

This halving clock *h* emerges as an invaluable variable, seamlessly intertwining with Bitcoin's core mechanics. Aptly named the "Bitcoin Halving Clock", *h* mirrors the heartbeat of Bitcoin's cyclical controlled supply issuance. It captures the essence of these halving cycles, providing an accurate internal perspective that transcends conventional calendars.

In the world of Bitcoin, the driving force behind these cycles is not the changing seasons, but the seismic halving events themselves. By adopting *h*, we gain a consistent internal timekeeper perfectly aligned with the blockchain's fundamental dynamics.

While the real-world timing of halving cycles can vary slightly due to incremental mining difficulties, the variable *h* allows us to synchronize with and analyze Bitcoin's pre-coded monetary cycles in a precise manner. As we navigate Bitcoin's future, this novel perspective invites us to embrace a clock that ticks to the rhythm of halvings rather than regular seconds.

Converting Between Time and the Halving Clock h

While the halving clock variable h provides an elegant representation of Bitcoin's coded supply cycles, converting between *h* and traditional time units involves some degree of approximation.

On average, there are approximately 147 blocks mined per day in the Bitcoin network. This means that the value of h increases by around 0.0007 (147/210,000) each day as new blocks are added to the blockchain.

Conversely, one full unit of *h* represents the number of days between consecutive Bitcoin halvings. Based on data since halving #3, this period is approximately 1,439 days. Therefore, to convert a change in *h* (Δh) to a change in time in days (Δt), we can multiply Δh by 1,439.

$$\Delta t = \Delta h \times 1439$$

For example, if *h* increases by 0.25 over a certain period, this translates to roughly 0.25 * 1,439 = 360 days.

However, it's important to note that perfect precision remains elusive due to the dynamic nature of block generation times, which can fluctuate based on factors such as mining difficulty adjustments and overall network hash rate.

By understanding this halving clock scale and its relationship to time, analysts can better model and predict how Bitcoin's price may respond to these recurring halving supply shocks. The halving clock *h* allows us to synchronize with and analyze the core cyclical mechanism underpinning Bitcoin's halving policy in a consistent and straightforward manner, enabling robust projections about future price dynamics.

Date and time	Event	Block Height	h = B.H./210,000	Days per halving cycle
03.01.2009 19:15	Genesis Block	0	0	
28.11.2012 16:24	First Halving	210,000	1	1,424
09.07.2016 18:46	Second Halving	420,000	2	1,319
11.05.2020 21:23	Third Halving	630,000	3	1,402
20.04.2024	Forth Halving	840,000	4	1,439

The Power Law model

The power law $y = A \cdot t^5$ is a specific form of a power-law relationship where a variable is proportional to the fifth power of another variable. This type of power-law behavior is observed in various natural phenomena across different scientific disciplines. Here are a few examples:

1. Physics - Fluid Dynamics:

In fluid dynamics, the power-law behavior can be observed in certain situations, such as the flow of fluids through pipes. The relationship between flow rate and pressure drop may follow a power law, with the exponent determined by the specific characteristics of the fluid and the geometry of the system.

2. Biological Growth:

Some biological growth processes exhibit power-law behavior. For example, the growth of certain types of tumors or the increase in the size of biological organisms over time may follow a power-law relationship.

3. Astronomy - Stellar Luminosity:

In astrophysics, the luminosity (brightness) of stars can be related to their age through a power-law relationship. The luminosity of a star might be proportional to the fifth power of its age in certain models.

4. Economics - Economic Growth:

Economic models sometimes incorporate power-law relationships. For instance, the growth of certain economic indicators like GDP might be modeled with a power-law exponent of 5 in specific contexts.

5. Material Science - Creep Deformation:

In material science, the deformation of materials under constant stress (creep) can follow a power-law relationship with time. The fifth power may appear in certain situations depending on the material and conditions.

6. Geophysics - Earthquake Magnitude:

The magnitude of earthquakes is often related to the energy released during seismic events. In some earthquake magnitude scales, the relationship may involve a power-law relationship with the fifth power.

In mathematics, the power-law relationship finds application in the calculation of area or volume for multidimensional figures.

This concept extends to the determination of the "volume" for an n-dimensional sphere, where the following formulas are employed, with R representing the radius of the n-sphere: $V_n = A_n \times R_n$.

Examining these formulas reveals a general power-law behavior analogous to the "volume" of a continually expanding sphere with radius h in an n-dimensional space with more than 5 dimensions.

For instance, in the context of Bitcoin pricing dynamics, this power-law relationship is represented by the formula:

$$\text{BTC}(h) = \$30h^{5.44}$$

This mathematical expression illustrates the relationship between Bitcoin price growth and its adoption rate, with the variable h representing the pace of Bitcoin adoption. Drawing an analogy to a multidimensional space with 5.44 “dimensions”, it implies that the impact of adoption extends like a spherical wave, spreading into 5 to 6 distinct dimensions within global society. These dimensions may encompass factors such as income level, education, geographic region, native language, age, and industry involvement, among others. This conceptualization provides a mathematical framework for interpreting and modeling the evolving dynamics of Bitcoin growth across diverse facets of societal engagement.

The Logarithmic Regression price model

Let us explain how the **power-law model**

$$\text{BTC}(h) = \$30h^{5.44}$$

and the **logarithmic regression model**

$$log_{10}(\text{BTC}(h)) = 1.48 + 5.44 \cdot log_{10}(h)$$

are related and how one can be derived from the other.

Deriving Logarithmic Regression from Power-Law:

Start with the power-law model: $\text{BTC}(h) = \$30h^{5.44}$.

Take the logarithm (base 10) of both sides:

$$\log_{10}(BTC(h)) = log_{10}(30h^{5.44})$$

Use logarithmic properties (specifically the power rule):

$$log_{10}(\text{BTC}(h)) = log_{10}(30) + 5.44 \cdot log_{10}(h)$$

Compute the $log_{10}(30) \cong 1.48$ and obtain the form of the logarithmic regression model:

$$log_{10}(\text{BTC}(h)) = 1.48 + 5.44 \cdot log_{10}(h)$$

Deriving Power-Law from Logarithmic Regression:

Start with the logarithmic regression model above.

Exponentiate both sides to eliminate the logarithm: $\text{BTC}(h) = 10^{1.48} \cdot 10^{5.44 \cdot log_{10}(h)}$

Simplify the terms:

$$\text{BTC}(h) = \$30h^{5.44}$$

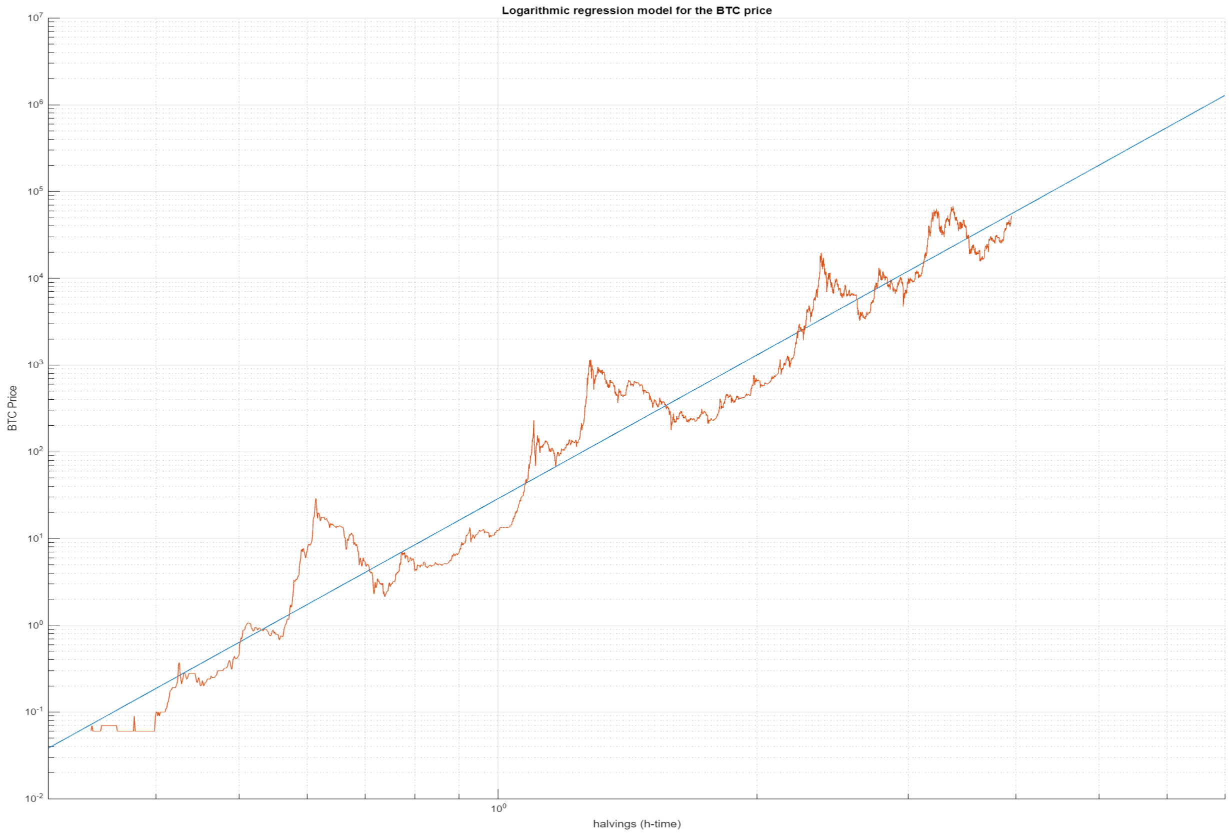
Linear Regression

To find the coefficients for these models, perform linear regression on the log-transformed axes. Take $log_{10}(\text{BTC}(h))$ as the dependent variable and $log_{10}(h)$ as the independent variable.

Linear regression provides coefficients that minimize the sum of squared deviations from the linear model.

$$log_{10}(\text{BTC}(h)) = 1.48 + 5.44 \cdot log_{10}(h)$$

Regression statistics: a=5.4357, b=1.4854, SEa=0.0176, SEb=0.0065, r^2=0.9523 SEy=0.3236



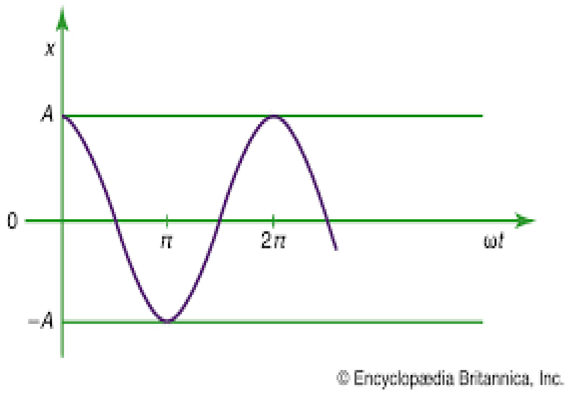
Interchangeability of Forms:

Once the linear coefficients are determined, they can be used to express the model in either the power-law form or the logarithmic regression form interchangeably.

In summary, the power-law and logarithmic regression models are equivalent representations, and the choice between them often depends on interpretability and convenience. The coefficients obtained through linear regression on log-transformed data allow a seamless transition between these forms, providing flexibility in expressing the mathematical relationship between BTC price and halving events.

The Damped Harmonic Oscillation model

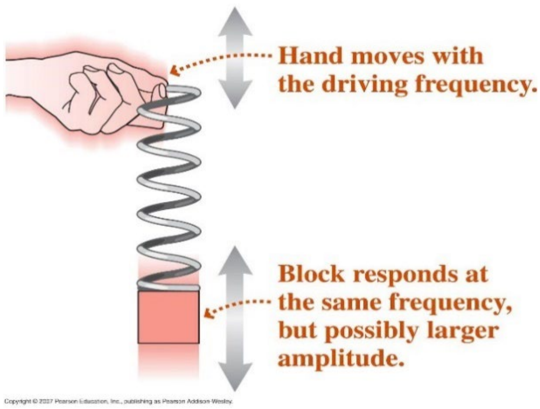
In the realm of physics, harmonic oscillations describe the periodic motion of a system where the restoring force is proportional to the displacement from an equilibrium position. In an ideal, undamped harmonic oscillator, this motion would continue indefinitely with a constant amplitude and frequency determined by the system's properties.



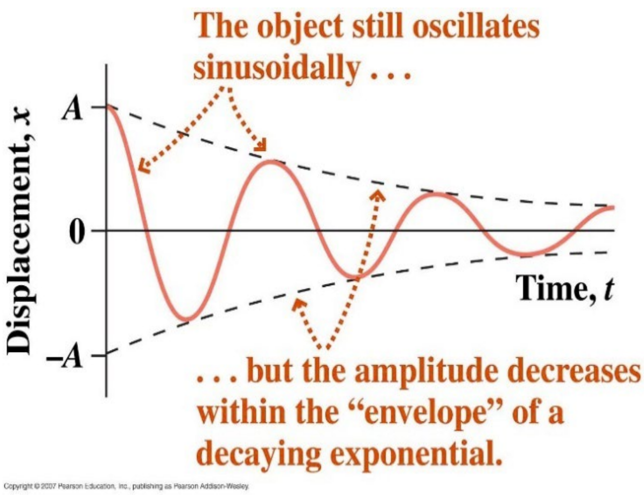
$$A \cdot cos(2\pi\omega t)$$

Applying this concept to Bitcoin, halving events serve as the periodic force that influences the price 'oscillator.' These events, which halve the reward for mining new blocks every four years, introduce a regular perturbation to the system, akin to the hand nudging a pendulum. In the absence of external factors, one would expect the price to oscillate with a frequency corresponding to the halving events.

$$A \cdot sin(2\pi h)$$



However, economic factors introduce damping to this idealized system. The 'decay' in Bitcoin's oscillation manifests as reduced volatility over time due to market saturation, increased liquidity, and larger market capitalization. These factors act like resistive forces in a physical system, dissipating energy and gradually reducing the amplitude of price fluctuations after each halving. Thus, while the halvings provide a regular interval for potential price surges, the 'damping' imposed by economic realities ensures that the system gradually stabilizes, reflecting a damped harmonic oscillator model.



$$A \cdot sin(2\pi h) \cdot e^{-d \cdot h}$$

Damped harmonic oscillations are commonly found in various natural phenomena and real-world systems. Here are some examples of where damped harmonic oscillations can be observed:

1. Mechanical systems:

- A mass suspended by a spring and immersed in a viscous fluid (e.g., a damped pendulum or a mass-spring system with air resistance)
- The motion of a car suspension system after a bump
- The oscillations of a tuning fork, which eventually decay due to air resistance.

2. Electrical systems:

- The discharge of a capacitor through a resistor and an inductor (an RLC circuit)
- The oscillations of a crystal oscillator circuit, which are dampened by internal resistance.

3. Acoustics and vibrations:

- The decay of sound waves in a room or an enclosed space due to absorption by walls and objects
- The vibrations of a struck tuning fork or a plucked string, which eventually die out due to energy dissipation.

4. Astrophysics:

- The oscillations of a binary star system, where the stars orbit around a common center of mass while losing energy due to gravitational wave emission.

5. Structural dynamics:

- The oscillations of a building or a bridge after an external force (e.g., an earthquake or wind) is applied, which are damped by internal friction and other dissipative mechanisms.

6. Quantum systems:

- The damped oscillations of atoms or molecules in a dissipative environment, such as in the presence of electromagnetic radiation or interactions with other particles

Damped harmonic oscillations are important in various fields of physics, engineering, and applied sciences, as they provide a fundamental model for understanding and analyzing the behavior of oscillatory systems in the presence of energy dissipation or damping forces.

Exploring the Harmonic Dance of Bitcoin Prices

Bitcoin's price landscape is a fascinating symphony of long-term trends and mid-term cycles, with the former primarily orchestrated by the rhythmic cadence of periodic Bitcoin halving events, occurring approximately every four years. These halvings, reducing the rate at which new Bitcoins are minted, introduce recurrent supply shocks that reverberate through the whole market.

In response to these rhythmic supply shocks, the Bitcoin price engages in a mesmerizing dance, resonating with the frequency of the halvings over its log-regression overall price trend. This dance manifests as oscillatory fluctuations, a complex interplay influenced by market cycles, speculative behaviors, and the ebb and flow of supply and demand dynamics.

Remarkably, the ebb and flow of Bitcoin prices can be effectively modeled as a damped harmonic oscillation, succinctly represented by the term $sin(2\pi h - h^{-1.4}) \cdot 0.8^{h+1}$. This mathematical expression captures the cyclical nature of the price movements, with the oscillations gradually losing amplitude over time. Various damping factors, including market stabilization, regulatory influences, and the dissipation of speculative forces, contribute to this diminishing amplitude.

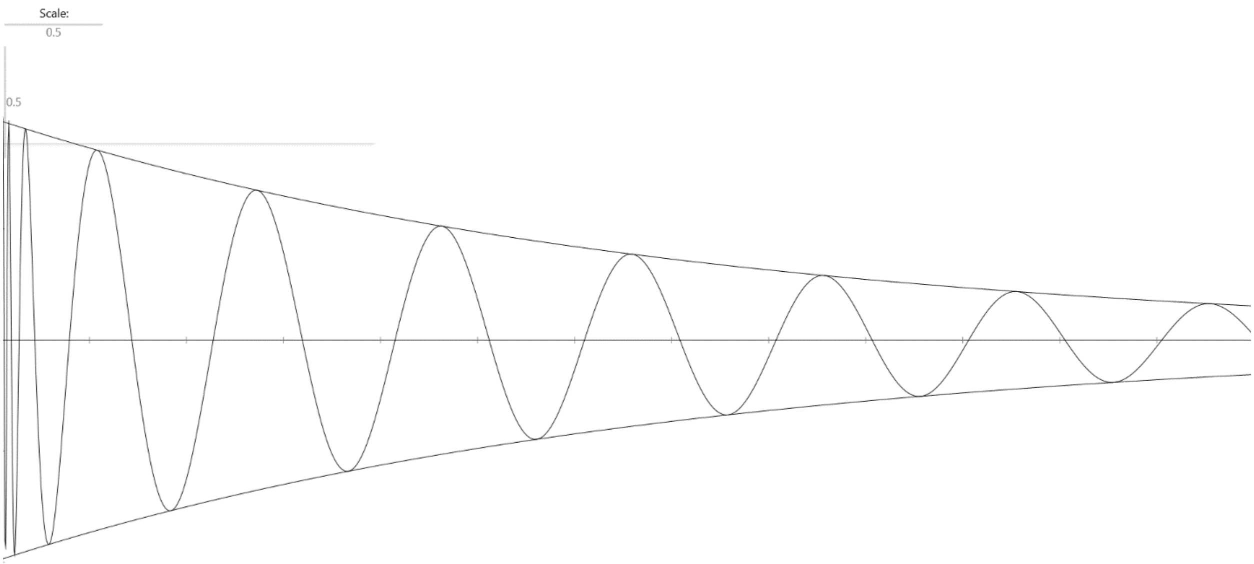
The synergy of the log-regression trend and the damped harmonic oscillations results in a remarkably accurate power-law fit for Bitcoin's price data spanning multiple halving events and market cycles. This robust fit, tested and proven over an extensive 14-year period, underscores the potential of such models in deciphering the intricate dynamics of cryptocurrency prices. Beyond mere theoretical significance, these models hold practical value, offering insights that could inform investment strategies and enhance risk management approaches in the ever-evolving realm of cryptocurrencies.

Delving Deeper into the Bitcoin Cycles:

The mathematical expression $sin(2\pi h - h^{-1.4}) \cdot 0.8^{h+1}$

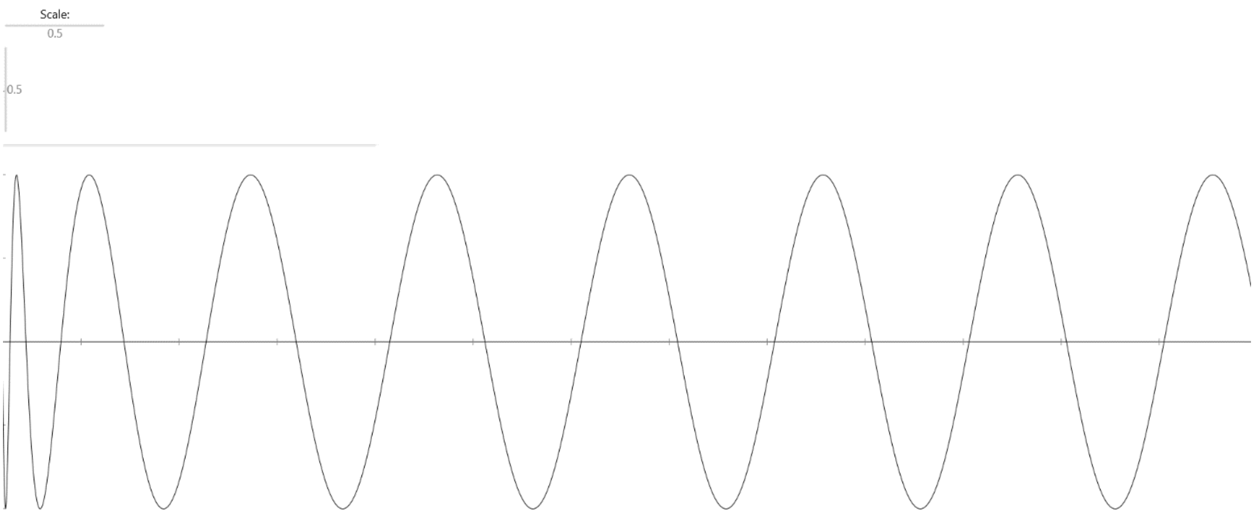
encapsulates the essence of a damped harmonic oscillator, further refined as:

$$sin\big(2\pi h - \phi(h)\big) \cdot e^{ln(0.8)\cdot(h+1)} = sin\big(2\pi h - \phi(h)\big) \cdot e^{-0.223\cdot(h+1)}$$



Let us unravel the components of this intricate expression:

Harmonic Oscillation Term: $sin(2\pi h - h^{-1.4})$



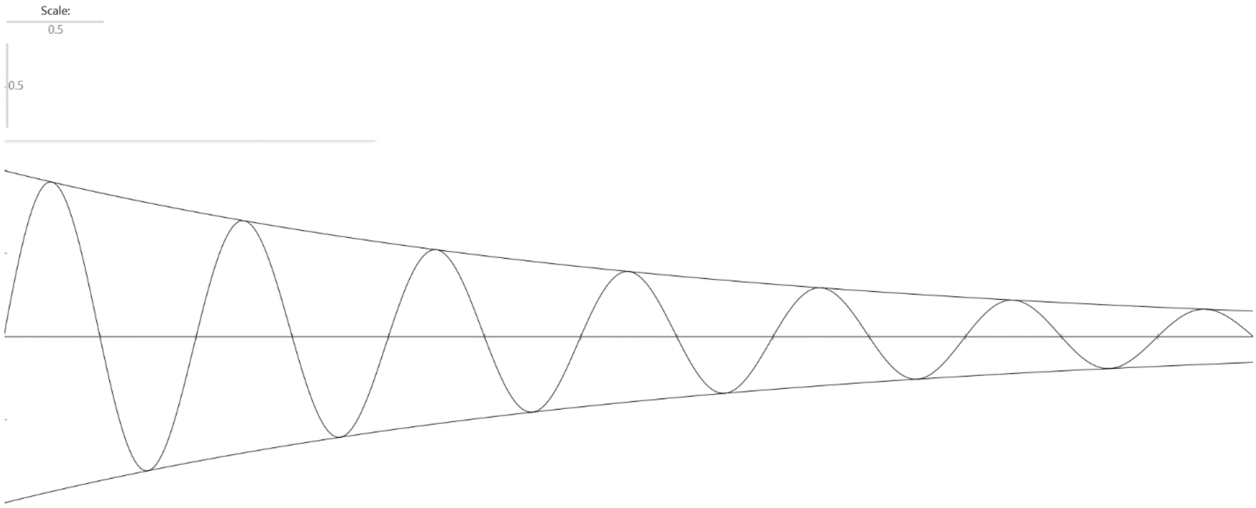
This component signifies a harmonic oscillation, where h acts as the “time” variable. The sine function introduces periodic oscillations, precisely one oscillation per unit of h—equivalent to one oscillation per halving period. The function

$$\phi(h) = h^{-1.4}$$

introduces a temporal (phase) shift. This shift diminishes over time, mirroring the learning curve among traders. As time progresses, traders enhance their ability to predict the effects of future halving events on prices, leading to a reduction in reaction delay (temporal shift) that eventually approaches zero.

The choice of the $h^{-1.4}$ function form is not rigidly predetermined. We need to somehow account for the mechanism of reducing the temporal shift while ensuring that the parameters describe the peaks of all cycles, both in the early (volatile) stages before the first halving and in later cycles, when temporal delays are already approaching zero values. The power function form $h^{-1.4}$ is both very elegant and models the learning curve with astonishing precision.

The exponential decay factor, $e^{-0.223\cdot(h+1)} \approx 0.8^{h+1}$.



As h increases, the exponential term decreases, causing damping in the oscillation. The factor of 0.8^{h+1} ensures a gradual reduction in amplitude, diminishing the oscillation's impact with each iteration by 20%. This damping effect encapsulates numerous factors such as market stabilization, regulatory influences, and the natural dissipation of speculative forces, contributing to the nuanced dynamics of Bitcoin price cycles.

Together, the harmonic oscillation and exponential damping terms synergize within the damped harmonic oscillator, intricately mirroring the cyclical behavior of Bitcoin prices. This model not only encapsulates historical trends but also provides a nuanced understanding of the evolving dynamics within the cryptocurrency market. As we continue our exploration, we will uncover the practical implications of these mathematical insights for predicting and navigating Bitcoin's future price movements.

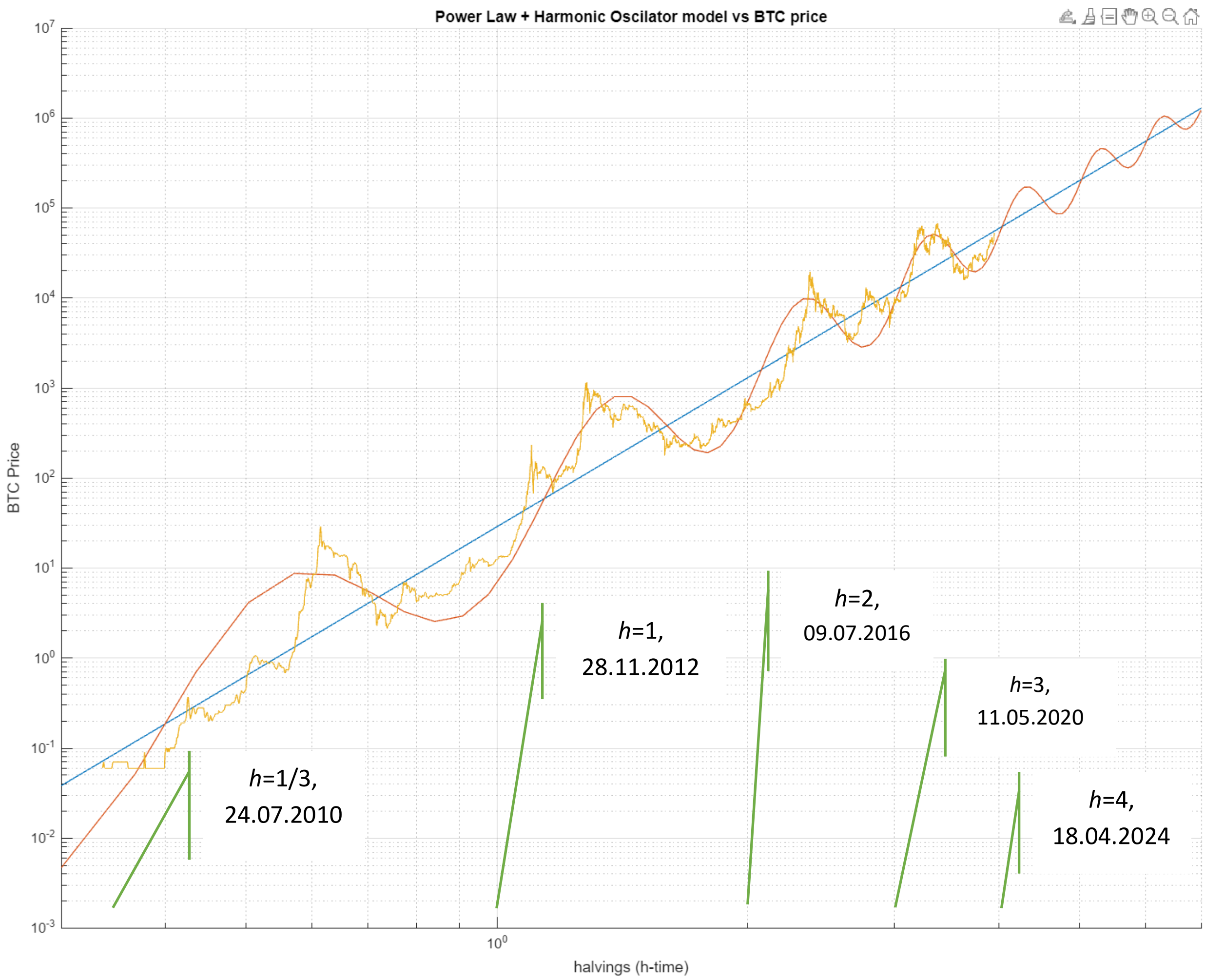
The Synergy of Logarithmic Regression and Damped Harmonic Oscillation Models

Let us merge the Logarithmic Regression model $log_{10}\big(\mathrm{BTC}(h)\big) = 1.48 + 5.44 \cdot log_{10}(h)$,

and the Damped Harmonic Oscillation model $y(h) = sin(2\pi h - h^{-1.4}) \cdot 0.8^{h+1}$, to create a comprehensive representation of Bitcoin's price dynamics:

$$log_{10}\big(\mathrm{BTC}(h)\big) = 1.48 + 5.44 \cdot log_{10}(\mathrm{h}) + sin(2\pi h - h^{-1.4}) \cdot 0.8^{h+1}$$

Now, let us visualize how this model aligns with actual Bitcoin data:



The dataset spans from the first third of the period between the genesis block and the fourth halving (h = 1/3) to (h = 4), encompassing approximately 14 years of Bitcoin history.

Surprisingly, this model, with only four numeric parameters, remarkably fits the historical data. It accurately captures the timing and amplitude of the four Bitcoin cycles to date, impeccably matching both peaks and troughs.

The model's formula,

$$log_{10}\big(\mathrm{BTC}(h)\big) = 1.48 + 5.44 \cdot log_{10}(h) + sin(2\pi h - h^{-1.4}) \cdot 0.8^{h+1}$$

unveils its robust predictive power. The incorporation of the damped harmonic oscillator with logarithmic regression not only traces historical trends but propels the model into a realm of effective forecasting.

Expressing this formula as $\mathrm{BTC}(h) \approx f(h)$, where $f(h)$ boasts an analytical form, underscores its potential for accurate future predictions. This unique blend of power-law dynamics and a damped harmonic oscillator empowers the model to navigate the complexities of Bitcoin's price movements, offering a solid foundation for robust predictions at any future point in time.

One can also write this formula in a power law form:

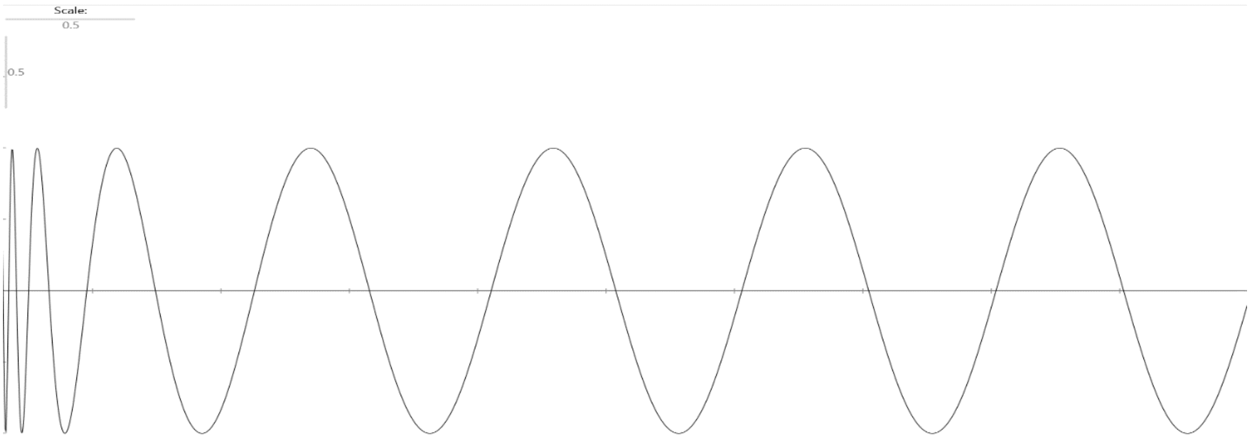
$$\mathrm{BTC}(h) \cong f(h) = 30 \cdot h^{5.44} \cdot 10^{sin\left(2\pi h - h^{-1.4}\right) \cdot 0.8^{h+1}}$$

symbolizing a powerful tool for understanding and anticipating the dynamic evolution of Bitcoin prices.

Crafting Bands to Predict Bitcoin Price Movements

Let us delve into the creation of bands that accurately encapsulate the overall Bitcoin price range based on our meticulously built model. The starting point is our harmonic oscillation model:

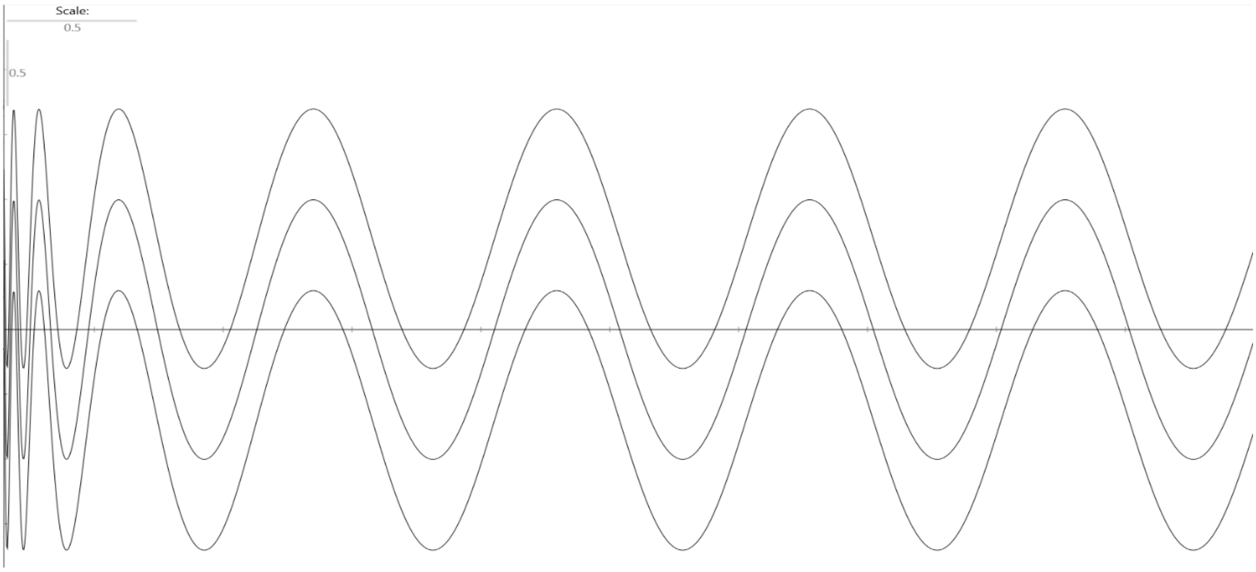
$$y(h) \ = sin(2\pi h - h^{-1.4})$$



To enhance our predictions, we introduce upper and lower bands by adjusting the wave vertically. The upper curve, $y_{\text{up}}(h)$, is formed by adding 0.7 to the harmonic oscillation, and the lower curve, $y_{\text{down}}(h)$, is created by subtracting 0.7.

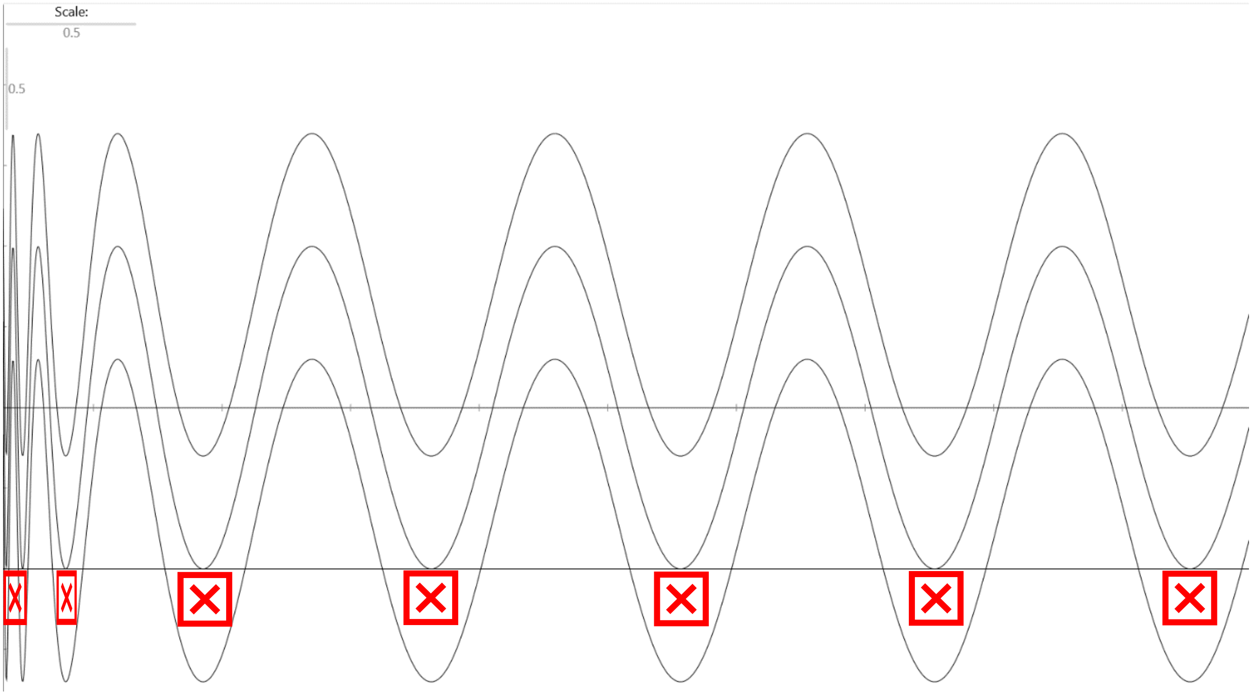
$$y_{up}(h) \ = sin(2\pi h - h^{-1.4}) + 0.7$$

$$y_{down}(h) = sin(2\pi h - h^{-1.4}) - 0.7$$



To refine the price bands or ranges for Bitcoin, extreme low values that significantly deviate from the major trendline (represented by the power-law line) are trimmed or excluded. The lower curve or boundary is set at level -1. This lower boundary represents an absolute minimum possible price for Bitcoin.

$$y_{cut\_down}(h) = max[y_{down}(h), -1] = max[sin(2\pi h - h^{-1.4}) - 0.7, -1]$$



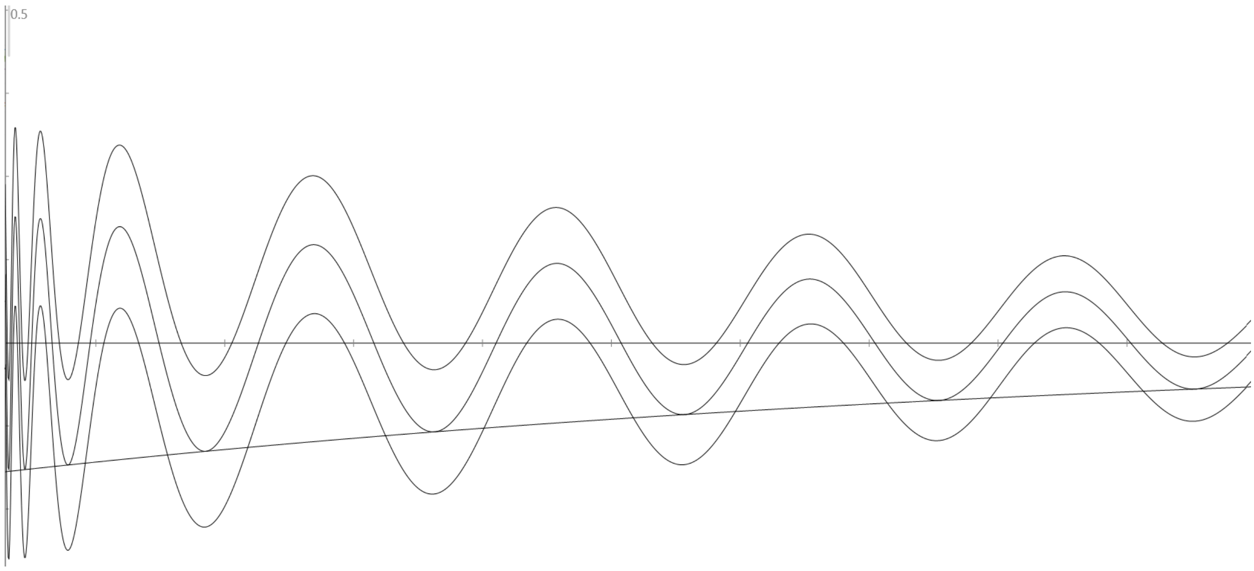
One possible explanation for the existence of this lower boundary line is that it reflects the overall cost incurred by miners to mine one Bitcoin. Miners and other Bitcoin holders are generally unwilling to sell Bitcoin below this fair value price, as it would result in losses relative to their mining costs.

In essence, this lower boundary at level -1 acts as a support level, below which the price of Bitcoin is unlikely to fall significantly, as it would make mining and holding Bitcoin economically unfavorable for most participants in the network. This boundary helps define a reasonable price range or band for Bitcoin based on the underlying mining costs and economic incentives of the participants.

To further refine our bands, we introduce a damping (decay) multiplier, 0.8^{h+1}. This adds an exponential decay element that reduces the amplitude of oscillations over time:

$$y_{dump\_up}(h) = [sin(2\pi h - h^{-1.4}) + 0.7] \cdot 0.8^{h+1}$$

$$y_{dump\_cut\_down}(h) = max[sin(2\pi h - h^{-1.4}) - 0.7, -1] \cdot 0.8^{h+1}$$



Now, combining all these elements with our logarithmic regression model, we form the definitive price range bands:

$$log_{10}\big(\mathrm{BTC}(h)\big) < 1.48 + 5.44 \cdot log_{10}(h) + y_{dump\_up}(h)$$

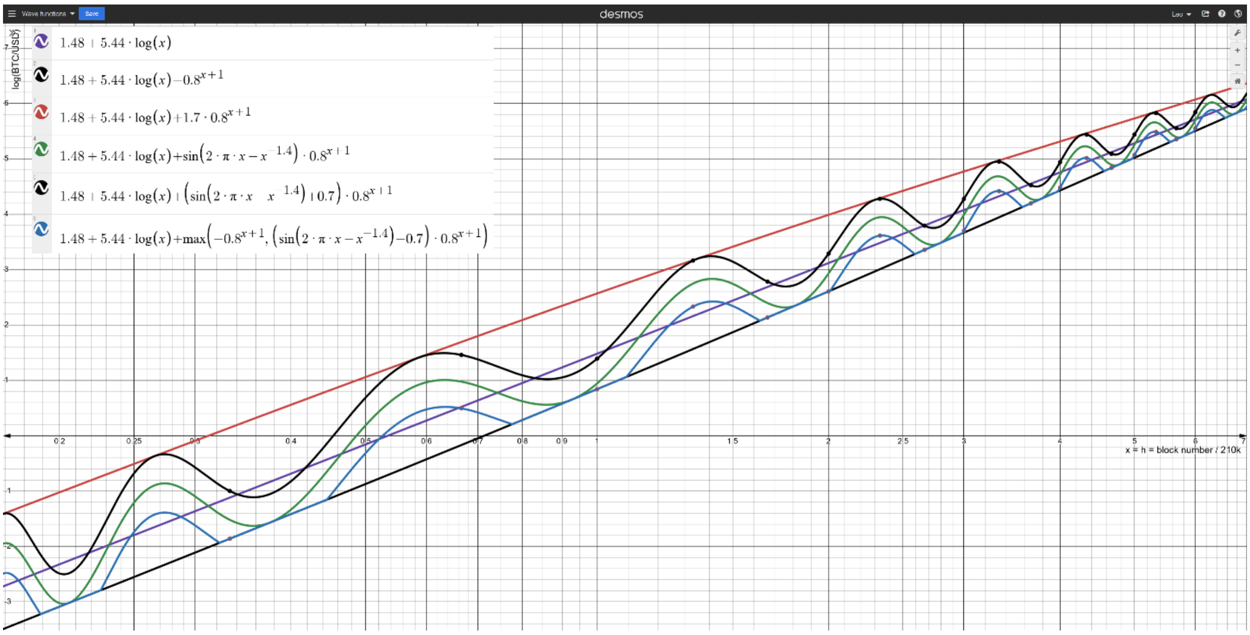
$$log_{10}\big(\mathrm{BTC}(h)\big) > 1.48 + 5.44 \cdot log_{10}(h) + y_{dump\_cut\_down}(h)$$

This comprehensive model integrates harmonic oscillation, trimming of extreme values, and damping effects. It not only captures historical trends but also equips us with a powerful tool for predicting Bitcoin price movements within well-defined bands. The beauty lies in its versatility, offering both depth and accessibility in understanding the intricacies of Bitcoin price dynamics.

The final form of the price range bands is presented as follows:

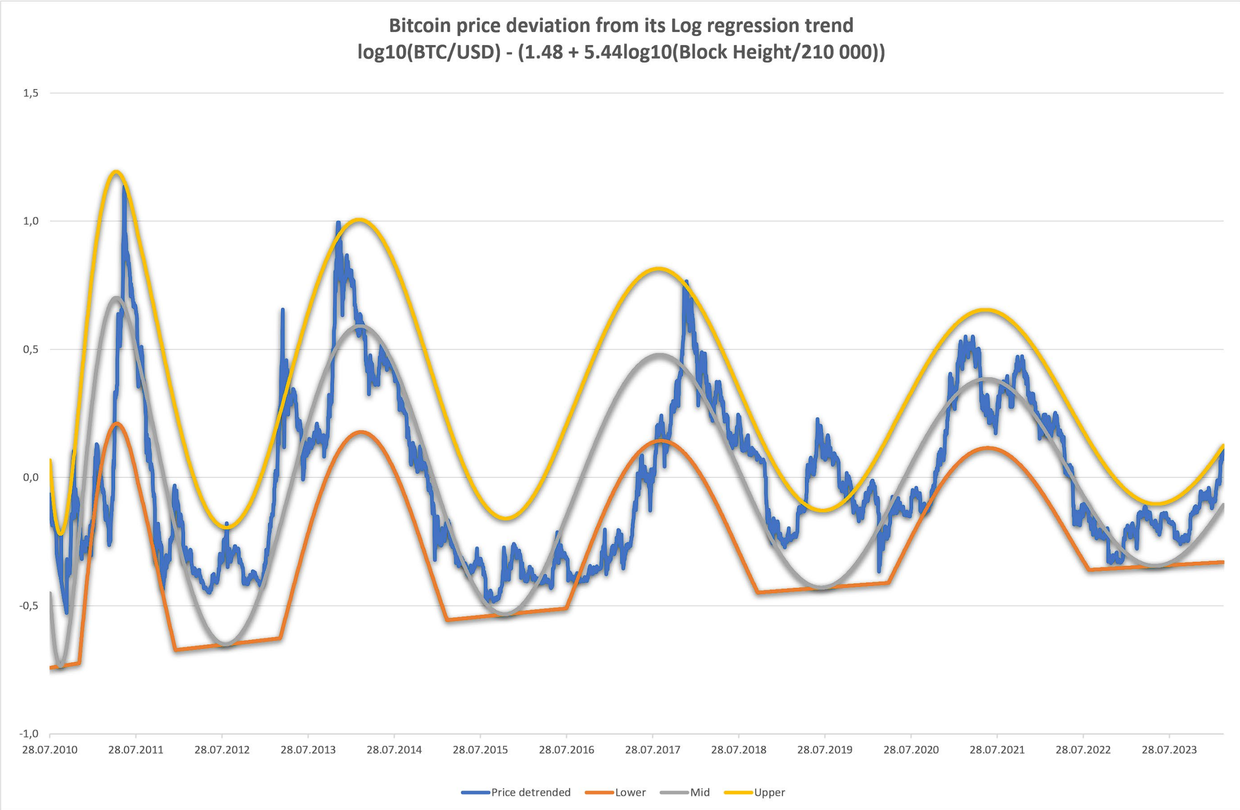
$$log_{10}\big(\mathrm{BTC}(h)\big) < 1.48 + 5.44 \cdot log_{10}(h) + [sin(2\pi h - h^{-1.4}) + 0.7] \cdot 0.8^{h+1}$$

$$log_{10}\big(\mathrm{BTC}(h)\big) > 1.48 + 5.44 \cdot log_{10}(h) + max[sin(2\pi h - h^{-1.4}) - 0.7, -1] \cdot 0.8^{h+1}$$



It is possible to check and test the parameters of all the formulas above at this link: https://www.desmos.com/calculator/tmsllzhaxf

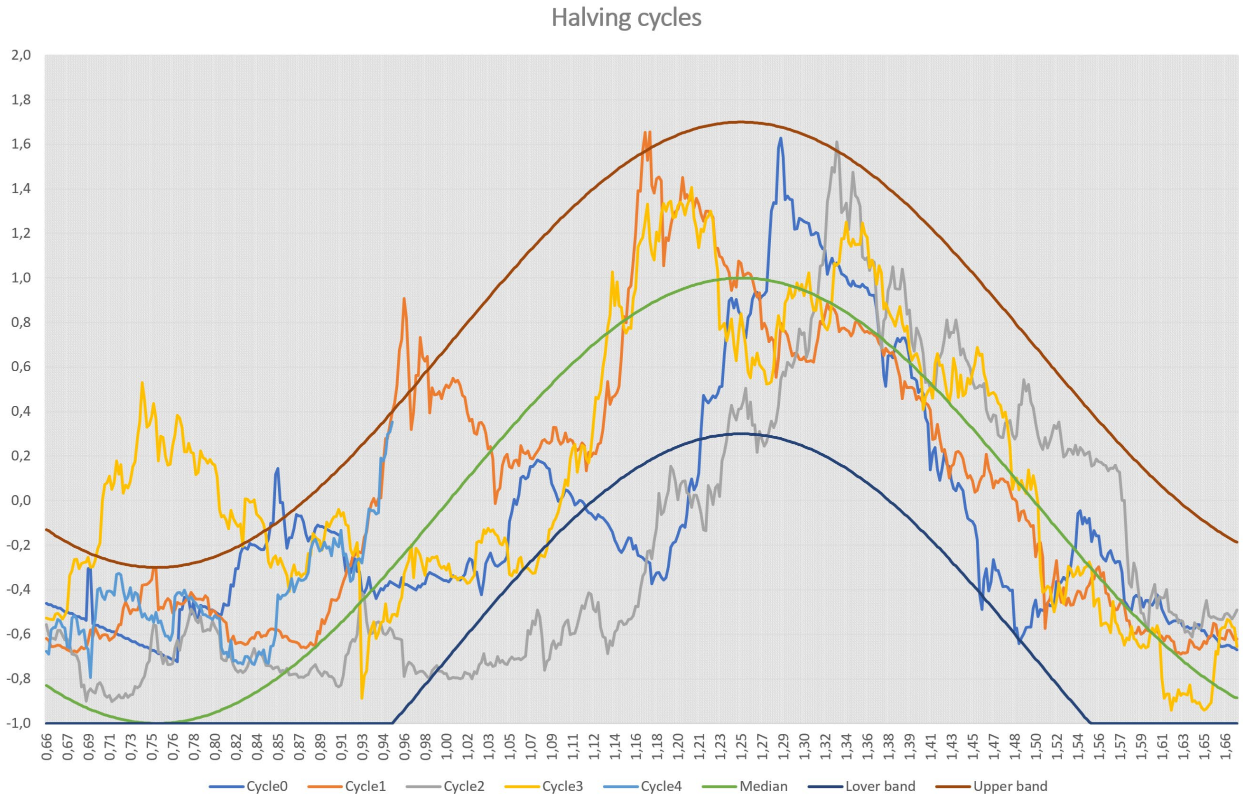
Remarkably, this model of the bands relies on only 6 numerical parameters: 2 parameters for the power law (1.48 and 5.44) + 2 parameters for the damped harmonic oscillation (-1.4 and 0.8) + 2 parameters for the bands (0.7 and -1). Yet it holds the remarkable capability to accurately predict both upper and lower bands for Bitcoin price movements. Furthermore, the model excels in forecasting the optimal timing for market tops and bottoms. Its predictive power is substantiated by successfully modeling the dynamics of the past four bull runs, positioning it as a valuable tool for anticipating future price targets. The simplicity and precision embedded in this model underscore its efficacy in navigating the intricacies of Bitcoin price trends.



Bitcoin price deviation from its Log regression trend
log10(BTC/USD) - (1.48 + 5.44log10(Block Height/210 000))
1,5
1,0
0,5
0,0
-0,5
-1,0
28.07.2010
28.07.2011
28.07.2012
28.07.2013
28.07.2014
28.07.2015
28.07.2016
28.07.2017
28.07.2018
28.07.2019
28.07.2020
28.07.2021
28.07.2022
28.07.2023
Price detrended
Lower
Mid
Upper

Power Law + Harmonic Oscilator model vs BTC price
BTC Price / Trend
halvings (h-time)
Power Law model
Damped harmonic oscillator model
Model Upper band
Model Lower band
BTC Price

All five cycles are detrended, scaled, and arranged side by side.



Conclusion

In this pioneering study, we have unveiled a groundbreaking approach to modeling the intricate dynamics of Bitcoin's price evolution. Through an in-depth exploration of the interplay between log-linear trends (power law dynamics) and damped harmonic oscillations, we have crafted a powerful predictive model that harnesses the synergy of these fundamental components.

$$log_{10}\left(\mathrm{BTC}(h)\right) = 1.48 + 5.44 \cdot log_{10}(h) + sin(2\pi h - h^{-1.4}) \cdot 0.8^{h+1}$$

Our journey commenced with an examination of the "Bitcoin Halving Clock," a novel temporal framework that aligns with the inner workings of the Bitcoin blockchain. By synchronizing our analysis with the cadence of halving events, we unlocked a profound understanding of the recurring supply shocks that reverberate through the cryptocurrency market, catalyzing long-term trends and cyclical fluctuations.

$$h = \frac{block\ height}{210{,}000}$$

Guided by a meticulous analysis of historical data spanning over 14 years, we developed a concise yet extraordinarily accurate power-law model. This model, with merely three numeric parameters, impeccably captures the timing and amplitude of Bitcoin's price oscillations, aligning seamlessly with both peaks and troughs observed in the data. By artfully blending the damped harmonic oscillator with logarithmic regression, our model equips investors and risk managers with a potent tool for navigating the complexities of the cryptocurrency landscape, informing investment strategies, and enhancing risk management approaches.

Furthermore, we have crafted meticulously defined price range bands that encapsulate Bitcoin's overall price movements within well-defined boundaries. Remarkably, this comprehensive model, relying on a mere six numerical parameters, exhibits remarkable precision in forecasting market tops and bottoms, substantiated by its ability to accurately model the dynamics of the past four bull runs.

$$log_{10}\big(\mathrm{BTC}(h)\big) < 1.48 + 5.44 \cdot log_{10}(h) + [sin(2\pi h - h^{-1.4}) + 0.7] \cdot 0.8^{h+1}$$

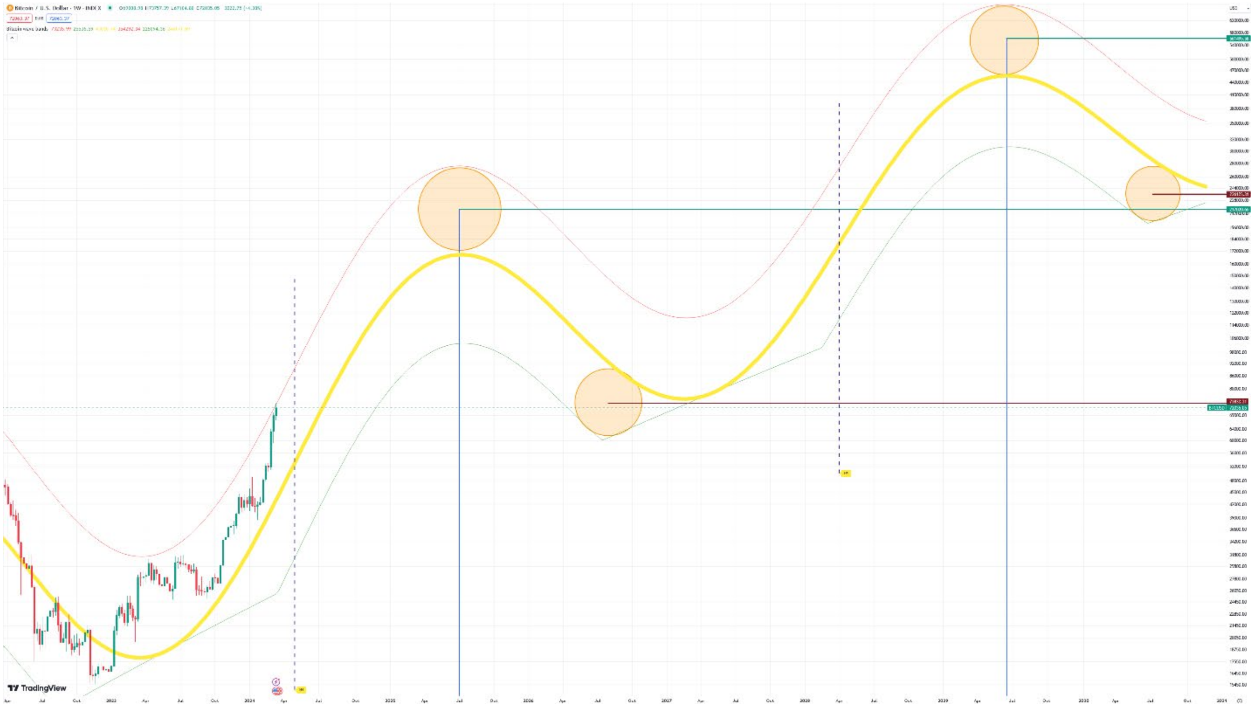
$$log_{10}\big(\mathrm{BTC}(h)\big) > 1.48 + 5.44 \cdot log_{10}(h) + max[sin(2\pi h - h^{-1.4}) - 0.7, -1] \cdot 0.8^{h+1}$$

As we venture into the uncharted territories of the digital asset revolution, this groundbreaking research invites us to embrace a paradigm shift – a departure from conventional timekeeping and a seamless integration with the heartbeat of the Bitcoin blockchain. By synchronizing with the pulsating rhythm of halving events, we unlock a profound understanding of Bitcoin's temporal dynamics, paving the way for precise predictions and a deeper appreciation of the intricate forces shaping the future of decentralized finance.

While our model stands as a testament to the power of mathematical analysis in decoding the complexities of cryptocurrency markets, it also opens new avenues for future exploration. Potential areas of investigation include the examination of other cryptocurrencies and their unique dynamics, the integration of additional market factors, and the development of advanced machine learning algorithms for real-time price predictions.

In the ever-evolving landscape of digital assets, our research emerges as a beacon, illuminating the path towards a deeper comprehension of the forces that shape this nascent and transformative economic phenomenon. By embracing the synergy of mathematical rigor and technological innovation, we pave the way for a future where cryptocurrencies can be understood, predicted, and harnessed with unprecedented precision, ushering in a new era of financial empowerment, and decentralized economic prosperity.

Making predictions



By understanding the halving clock scale and combining it with models capturing Bitcoin's log-log price trends and damped harmonic oscillations, analysts can make predictions about future price peaks and bottoms.

According to the obtained curves and surrounding price bands, here are some estimations:

The next market top is projected to happen around July 2025 at a level of around $220,000. The subsequent local bottom may then occur in July 2026 at around $73,000.

After that, the next cycle top could manifest in July 2029 at a level of approximately $560,000, followed by a bottom around July 2030 at $240,000.

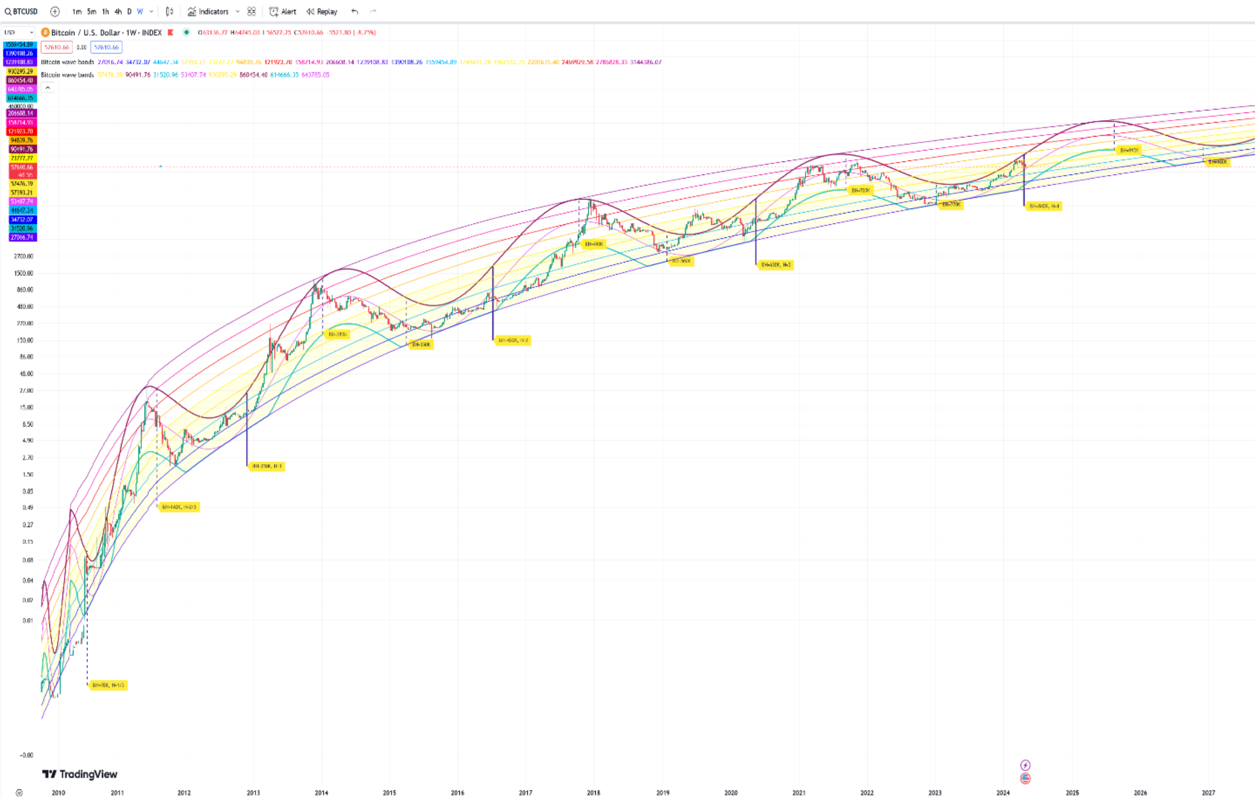
Given the current Bitcoin price above $70,000, this model suggests we can only observe prices below $70,000 until around November 2024 and possibly briefly in July 2026, but not after that time frame.

By understanding this halving clock scale, analysts can better model and predict how Bitcoin's price may respond to these recurring supply shocks as adoption grows. The halving clock *h* allows us to synchronize with and analyze the core cyclical mechanism, enabling robust projections about future price dynamics.

About the Author

Leo Heart is a mathematical and economic virtuoso whose brilliance has illuminated the realms of cryptography, blockchain technology, and the intricate dynamics of cryptocurrency markets. With over two decades of profound analytical prowess, he stands as a pioneering figure, unveiling groundbreaking models that unlock the secrets of Bitcoin's price oscillations.

Heart's magnum opus, the "Bitcoin Wave Model," is a testament to his extraordinary ability to harness the synergy of mathematical rigor and technological innovation. This predictive model, born from a meticulous analysis of historical data spanning multiple halving events and market cycles, encapsulates the interplay between log-linear trends and damped harmonic oscillations that govern Bitcoin's price trajectory.



This indicator is programmed in Trading View and is available for free at this link https://www.tradingview.com/chart/sYoshOvO/?symbol=INDEX%3ABTCUSD

It can also be found as a community indicator “Bitcoin wave model” by leoum. Use any bitcoin chart in weekly timeframe or this indicator will not work correctly. It does not work with other assets.

At the core of Heart's accomplishments lies a deep understanding of the fundamental drivers shaping cryptocurrency dynamics, including recurring supply shocks, market cycles, and the dissipation of speculative forces. His models not only provide concise mathematical representations but also offer profound insights into the intricate forces molding the future of decentralized finance.

To know more: https://bitcoinwave.net

Content