

A vibrant, abstract painting featuring three white lambs as the central focus. The lambs have black eyes and small black noses. They are set against a background of bold, expressive brushstrokes in shades of red, yellow, blue, and green. The style is reminiscent of a child's artwork or a modern pop-art interpretation of farm animals.

LAMM with lamb

Lunch and Learn Presentation Oct 2019



# Overview

- Derivative markets and institutions in antiquity (pre crypto world)
- Derivatives in the crypto asset universe
- Mechanics of a derivatives exchange
- The LAMM project
- VaR Method



# Short history of futures

## Osaka, Japan, 17<sup>th</sup> century

- Dojima, Osaka, Japan, in 1670s
- Dojima was center for rice trade, with 91 rice warehouses in 1673
- Dojima futures exchange had precise definitions of quality, delivery date and place, experts who evaluated rice quality, and clearinghouses for contracts
- Trading floor, daily resettlement, burning fuse, and watermen

## Chicago, USA 19<sup>th</sup> century

- The first modern futures exchange was the Chicago Board of Trade (CBOT), formed in 1848
- Chicago Mercantile Exchange (CME) was formed in 1874 when the Chicago Product Exchange was organized to trade butter.
- Sellers primarily farmers from the mid west looked to hedge the price risk associated with owning inventories of grain or butter while buyers wanted to establish prices for these products ahead of delivery



# Institutional Structure

- Rigid standardized contracts
  - Binding agreement between a seller and a buyer to make and take delivery of the underlying assets at a specified future date with agreed upon payment terms
  - Contracts are standardized with respect to delivery month, underlying quantity, quality, and delivery location; and the payment terms
- Rules of conduct
- Centralized market place
- ***Settlement mechanism*** via ***clearinghouse***
- Disputes settlement apparatus bypassing court system



# What does a derivative market do?

- Risk transfer / Hedging
  - Futures give buyers and sellers an opportunity to transfer risk
- Information aggregation / Price discovery
  - Futures markets provide a central market place where buyers and sellers from all over the world can interact to determine prices
- Information dissemination
  - Market prices serve as a focal point for prices across the market
- Risk amplification / leverage
- Clearing/Custody solution



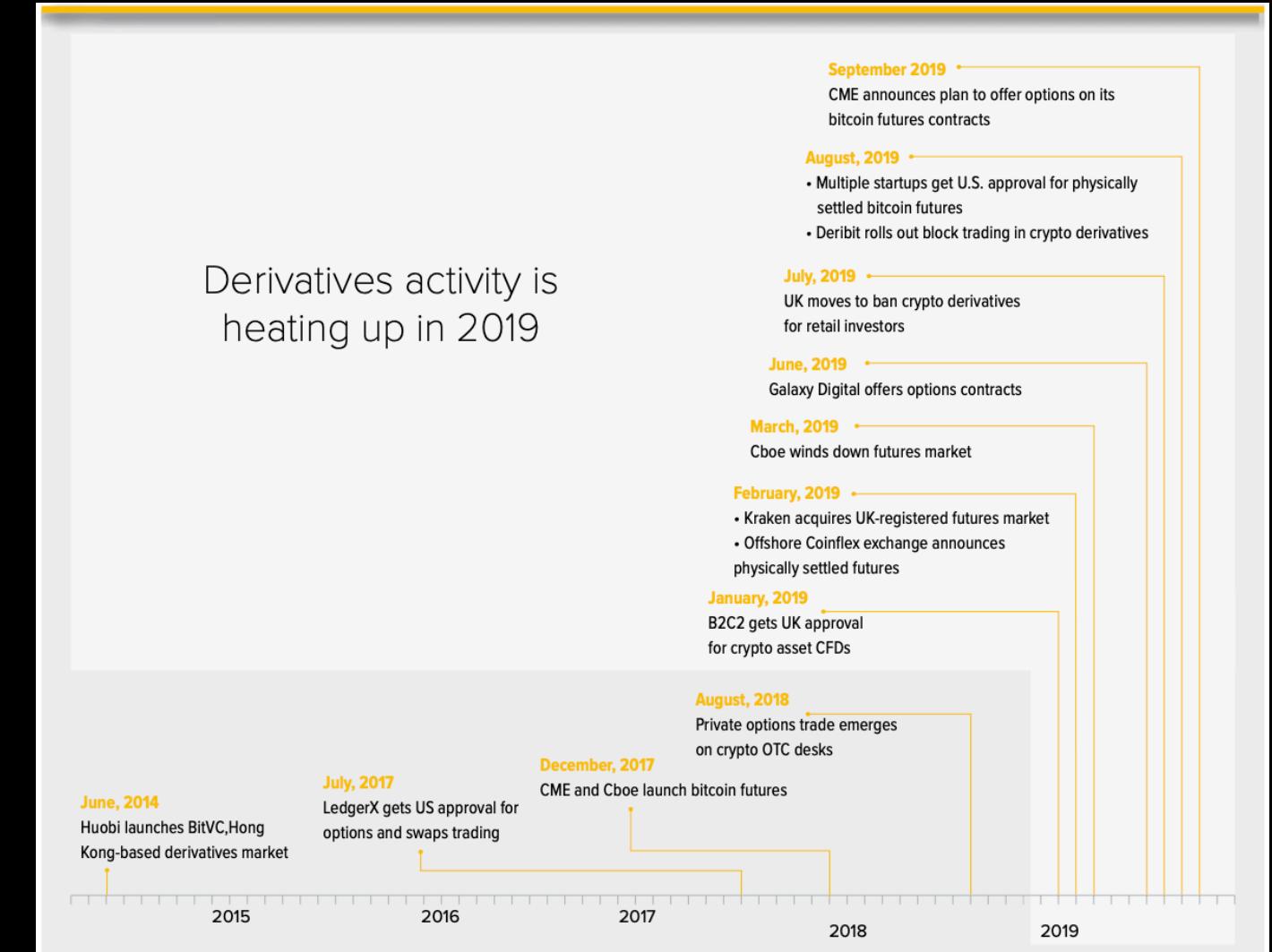
# Risk, Manipulation and Regulation

- Famine in the 1730's and Tokugawa regulation
- Onion Futures Act, 1958
- Long-Term Capital Management crisis, 1998
- Subprime mortgage crisis, 2008



# Derivatives market heating up

Derivatives activity is heating up in 2019





# Key Players

## BitMEX

Perpetual swaps and futures contracts with up to **100X leverage**

Headquartered Hong Kong, domiciled Seychelles

## OKEx

Futures contracts with up to **20X leverage**

Headquartered Hong Kong domiciled Malta

## HuobiDM

Futures contracts with up to **20X leverage**

Headquartered and domiciled Singapore

## BitFlyer

offers up to **5X leverage**

Headquartered and domiciled Japan

## CoinFlex

Futures contracts with up to **20X leverage**

Headquartered Hong Kong, domiciled Seychelles

## CME Group

Futures contracts with up to **2.7X leverage**

Headquartered and domiciled U.S.

## Deribit

Perpetual contracts, futures contracts and “European-style” options, with up to **100X leverage**

Headquartered and domiciled Netherlands, but not subject to Dutch financial regulations

## Crypto Facilities (now Kraken Futures)

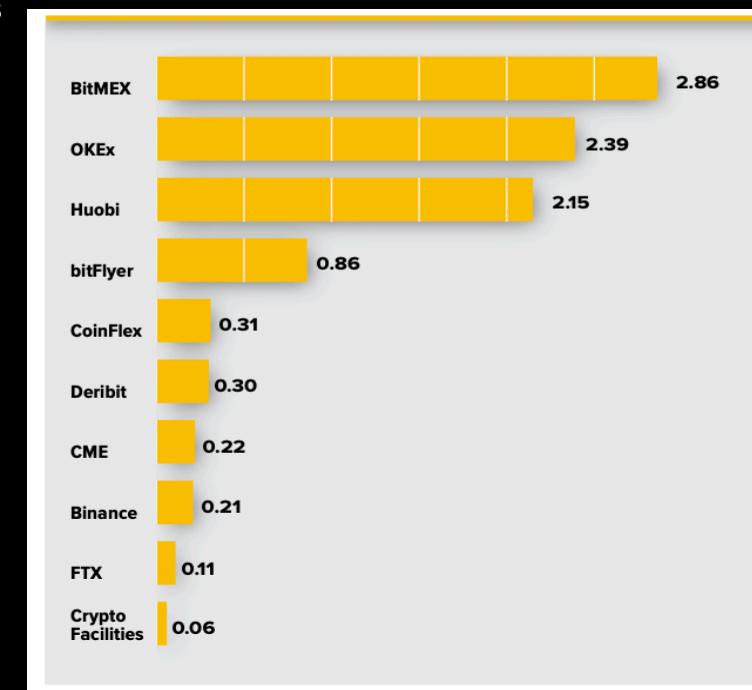
Perpetual, month and quarter futures contracts with up to **50X leverage**

Headquartered and domiciled in the U.K.

## Bakkt

Subsidiary of NYSE parent ICE, launched in September

Derivatives include physically settled bitcoin futures, daily contract that settles in T+2,





# Up and Coming Players

## ErisX

- Indirect subsidiary of Eris Exchange
- Offered trading in interest rate swap futures
- Preparing to offer a market for **physically settled** bitcoin futures

## LedgerX

- Offers regulated venue for trading bitcoin swaps and options
- Preparing to match orders in **physically settled** bitcoin futures, pending regulatory approval

## Seed CX

- Preparing to offer trading in **physically settled** bitcoin margin swaps

## Tassat (fka TrueDigital)

- Preparing to offer trading in **physically settled** bitcoin swaps and other derivatives



# Array of Products

## Perpetual swaps

Reportedly invented by BitMEX, an Asia-based derivatives exchange, perpetual swaps act like futures, but do not have a closing date; instead, longs and shorts settle to the index periodically, in cash.

## Futures and forwards

Notional volume in standardized futures and forwards contracts is dominated by a handful of lightly regulated exchanges, mostly based in Asia. In the U.S., regulated bitcoin futures are available through the CME, and a handful of startups are preparing to offer alternative bitcoin futures under CFTC regulations.

## Exchange-traded products

Crypto asset derivatives are compelling in part because of their ability to provide exposure to bitcoin and other crypto assets via regulated markets and familiar financial instruments. Several offerings today may not be “derivatives” per se, but answer that demand. In Europe, bitcoin-backed exchange-traded notes (ETNs) have been available since at least 2015.<sup>7</sup> So far, efforts in the U.S. to replace such synthetic derivatives with an Exchange-Traded Fund have not met with regulatory approval. In the meantime, Grayscale Investments’ Bitcoin Trust (GBTC), another synthetic derivative that tracks the price of bitcoin, is open to accredited investors and trades on OTC markets.

## Custom derivatives OTC

OTC trading represents an extraordinarily large share of crypto markets activity--as much as 60 to 65 percent, by some estimates.<sup>8</sup> OTC desks, some with minimum trades in the six figures, offer a number of bespoke derivatives products to clients, potentially including options, swaps, forwards and, where legal, contracts for difference.



# What do crypto derivative markets do?

- Risk transfer
  - Miners
- Information aggregation / Price discovery
- Information dissemination
- **Risk amplification / leverage**
- **Clearing/Custody solution**

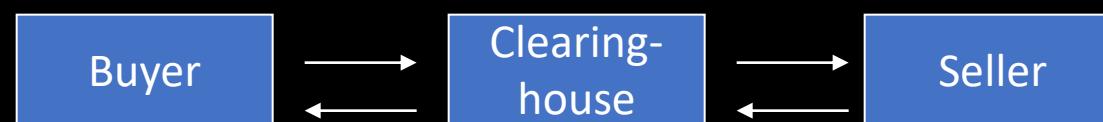


# Clearinghouses

Obligations without a clearinghouse



Obligations with a clearinghouse

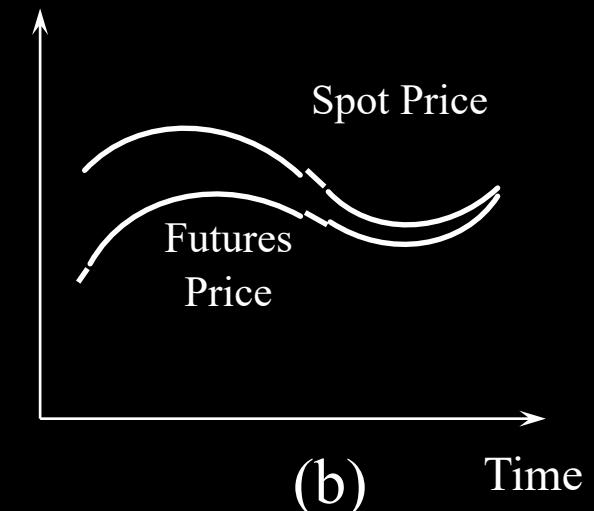
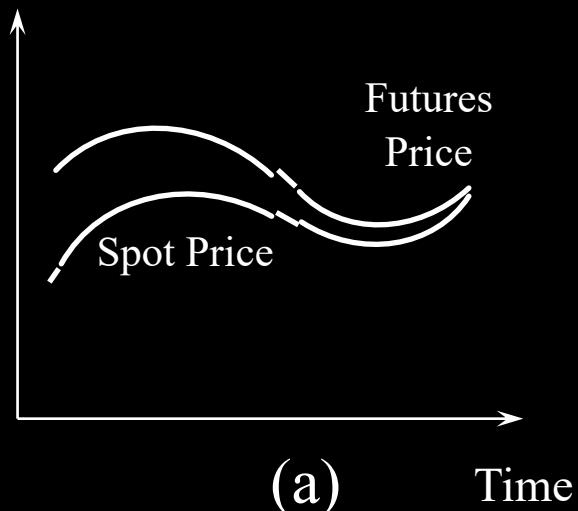


- Guarantee that the traders will honor their obligations (solves issues of trust)
- Each trader has obligations only to the clearinghouse, not to other traders
- ***Each exchange*** uses a futures clearinghouse
- Clearinghouses may be part of a futures exchange (division), or a separate entity
- Due to 2000 CFMA, clearing arrangements vary across industries
- Clearinghouses are “perfectly hedged” by maintaining no futures market position of their own



# Daily Settlement

- Every day, the **exchange defines a price** called the “settle” price, which is essentially a benchmark derived the derivative and/or spot market prices
- Every day until expiration an investor’s margin account is credited (or debited if negative) with the amount: change in settle price  $\times$  contract amount
- Every day, if an investor’s margin account is depleted he or she get a **margin call** and must recapitalize their account appropriately
- If contract is cash settled, on the last day the margin account is credited with (cash settle price-last settle price) $\times$ contract amount.
- If contract is physical delivery, on last day buyer must receive commodity





# Margin Maintenance Mechanics

- **Daily settlement** based on **CME benchmark** at end of funding period,
  - **maintenance margin (MM)** is the level of margin required to guarantee solvency
  - **initial margin (IM)** is the level of margin required to keep the margin above maintenance throughout the funding period
- falling below maintenance margin triggers an intraday margin
- failing to meet margin requirements triggers a partial or full **forceful portfolio liquidation**
  - **market impact** and exposure while unwinding position is another risk that must be accounted for in SPAN
  - both factors depend on the liquidation strategy, this could be a very significant when liquidity is thin
  - sourcing liquidity from multiple exchanges helps reduce this risk
- Margin credits for opposing risk exposures for the same underlying
- credit risks will not be set to null even for perfectly offsetting risk to reflect unwinding risks

A vibrant, abstract painting by Wassily Kandinsky. It depicts a horse's head and neck in profile, facing left. The horse's mane is composed of thick, expressive brushstrokes in shades of yellow, orange, red, and purple. The background is a mix of soft, blended colors like blue, green, and white, creating a dreamlike atmosphere. The overall style is expressionist and non-representational.

# LAMM Project

**Objective:** Develop a model to determine initial and maintenance margins such that with high confidence the clearing house is always *solvent / perfectly hedged*

**Questions:**

1. What horizon is appropriate? *A day, a month, or a year? should the holding period correspond to the longest period needed for an orderly portfolio liquidation.*
2. What confidence level to consider?  
*What is the risk appetite?*

**The more risk averse => (1) the higher confidence level necessary & (2) the lower VAR desired.**

A vibrant, abstract painting of a horse's head and neck. The horse's face is white with expressive, swirling patterns in red, yellow, green, and blue. Its mane and tail are composed of dark, bold strokes. The background is a mix of light blues, yellows, and purples. In the bottom right corner, there is a signature that reads "Kandinsky 85".

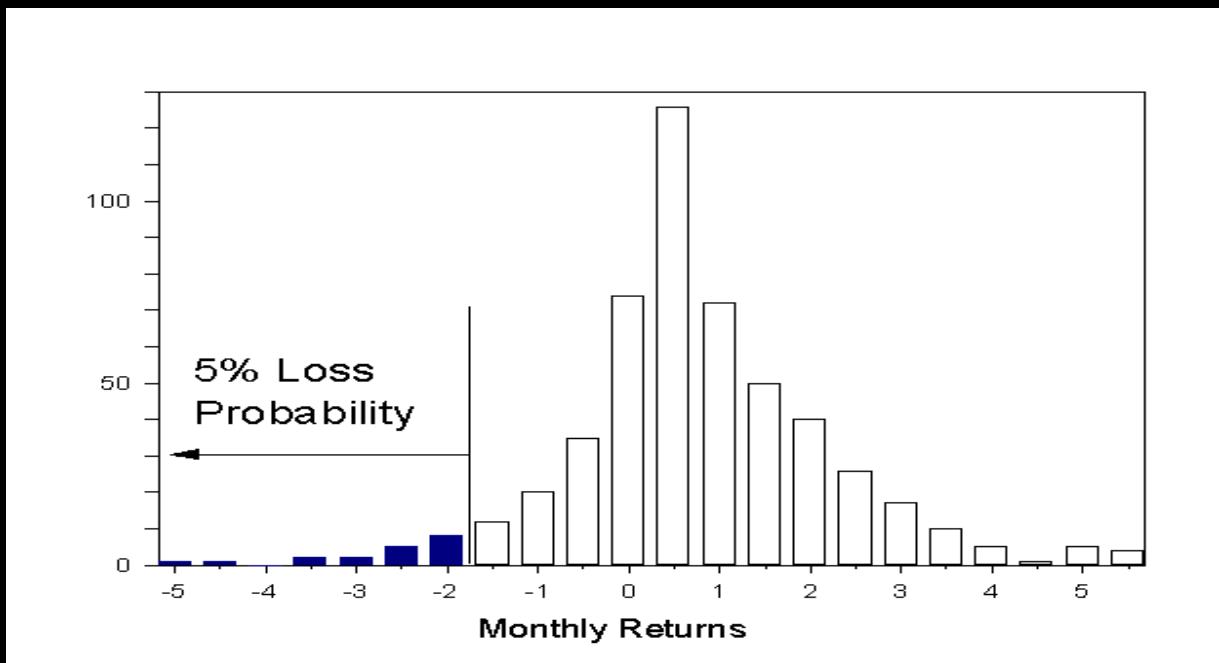
# Standard Portfolio Analysis of Risk (SPAN)

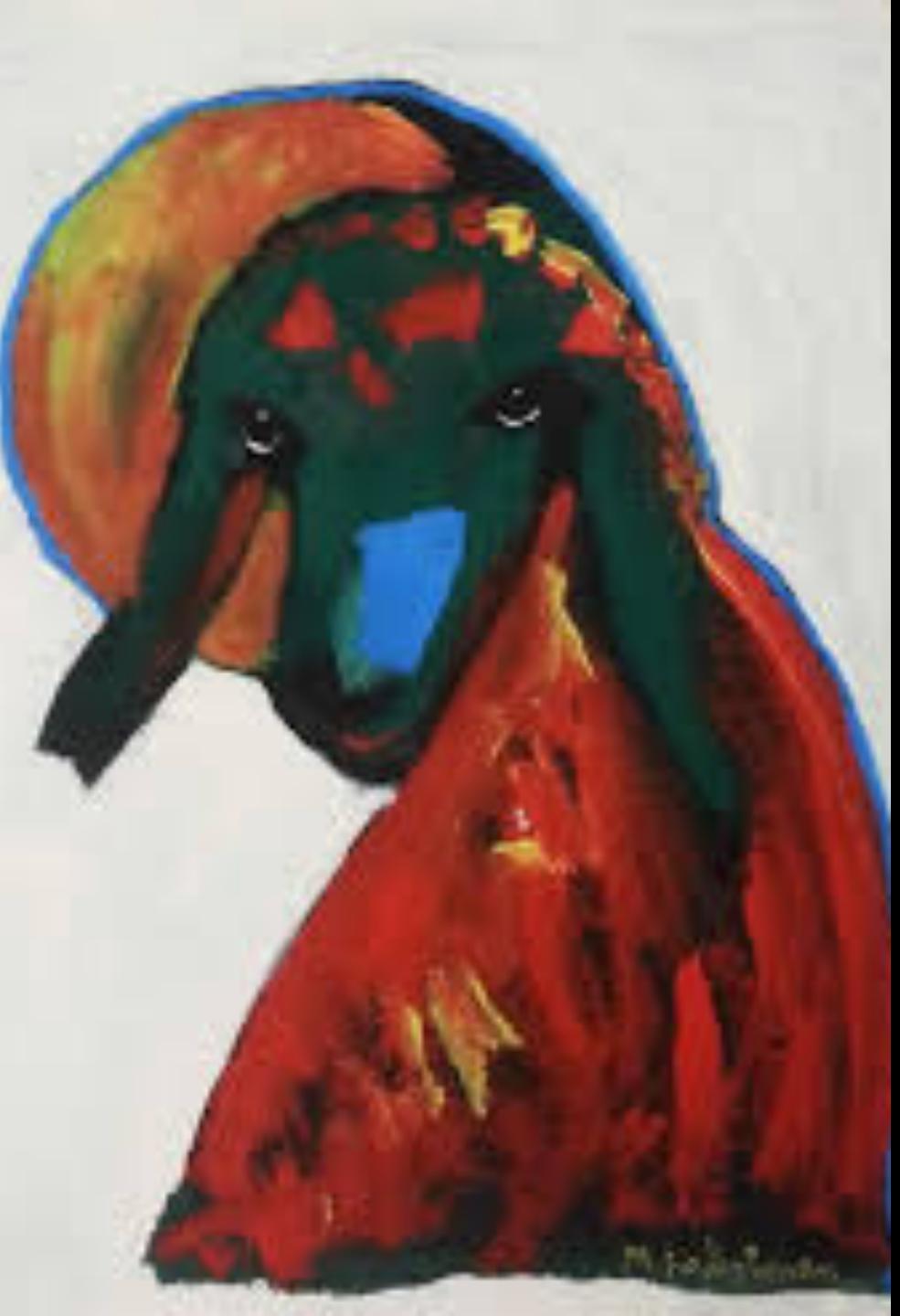
- Value at Risk system based on the CME SPAN developed in 1988. The objective is to reduce the risk of insolvency while reducing the level of capital tied up as collateral
- Risk assessment for individual instruments and portfolio based on extreme adversarial scenarios
- Applies market simulation to assess the losses caused from different market scenarios
- Risk credits are applied for offsetting exposures



# Value at Risk framework

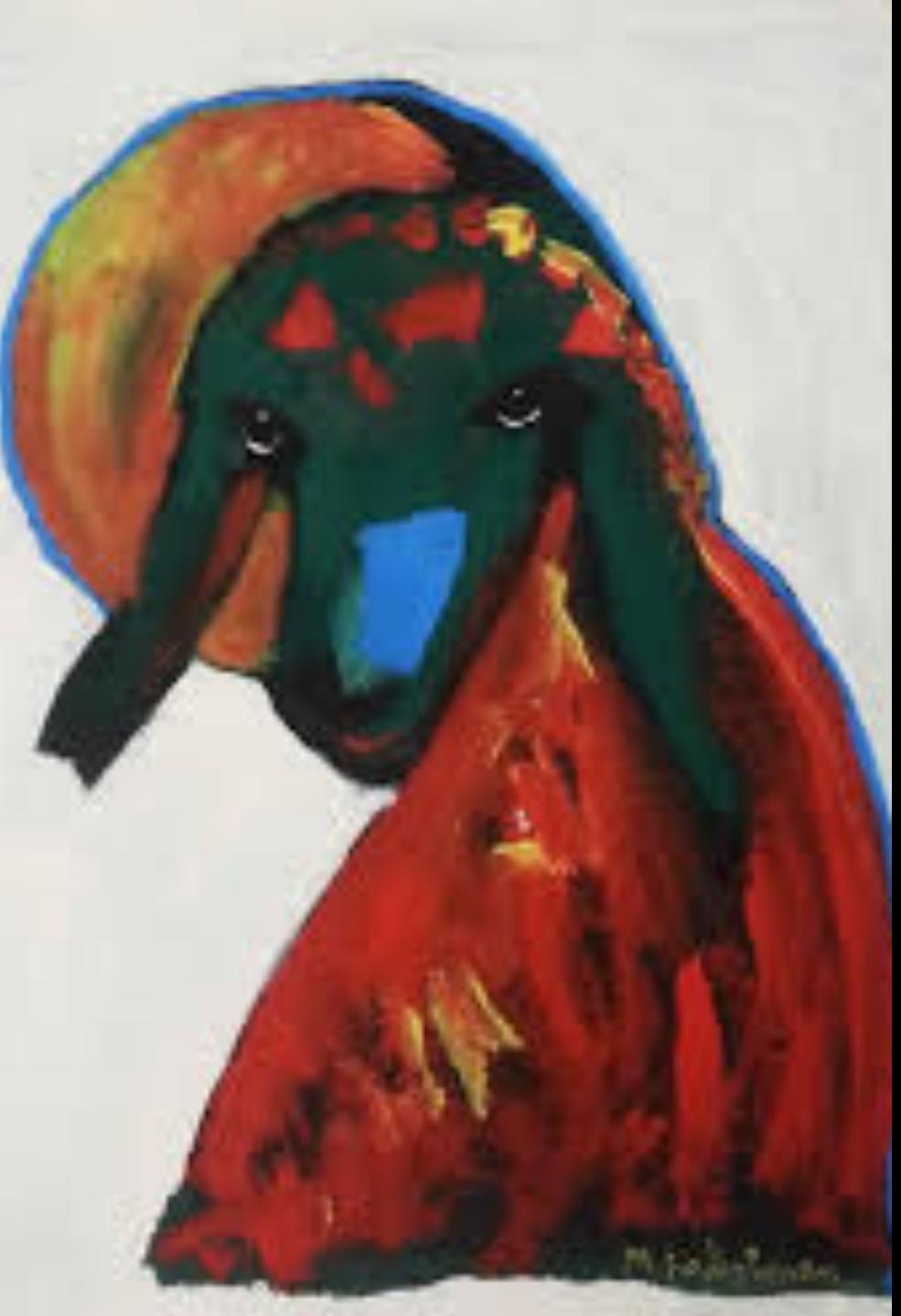
***Value at Risk (VaR)***: The maximum loss over a target horizon within a confidence interval



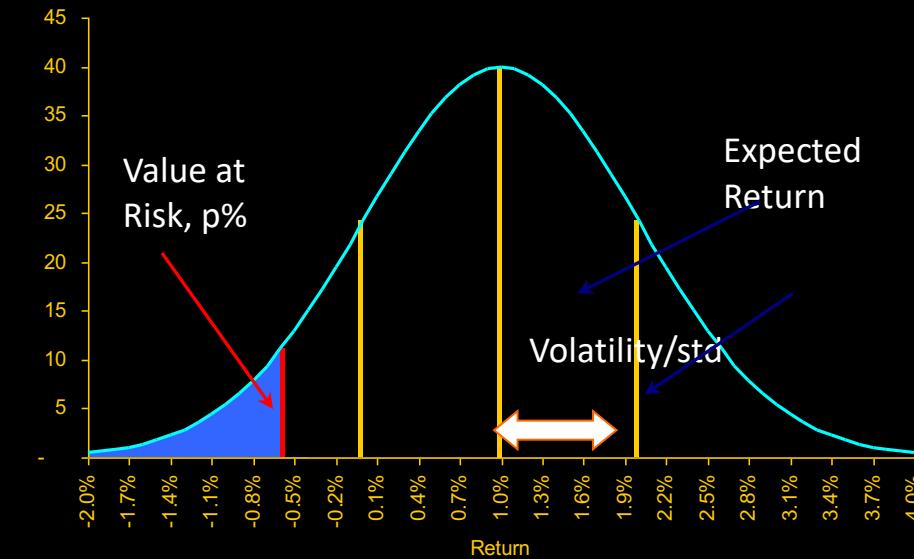


# Methodology for VaR Computation

- Single asset VaR
- Variance/Covariance
- Closed Form
- Monte Carlo Simulation
- Historical Simulation

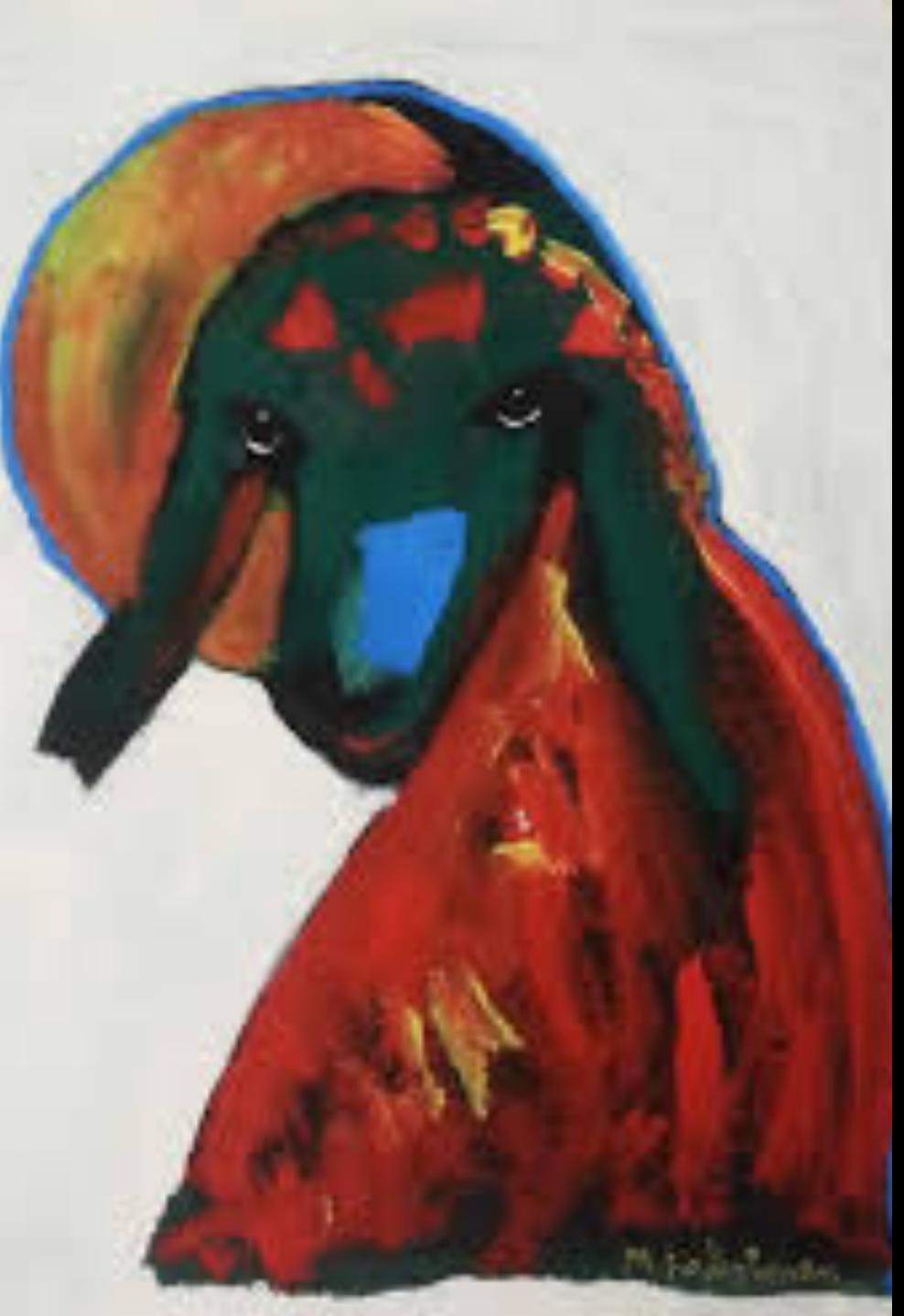


# Single Asset VaR



## Weakness

- Assumes Gaussian price process with constant volatility
- Assumes single asset, not applicable to multiple assets
- Requires estimation of underlying volatility
- Would not be sufficient for derivative contracts involving more than one asset (like future contract with both underlying and collateral crypto assets)

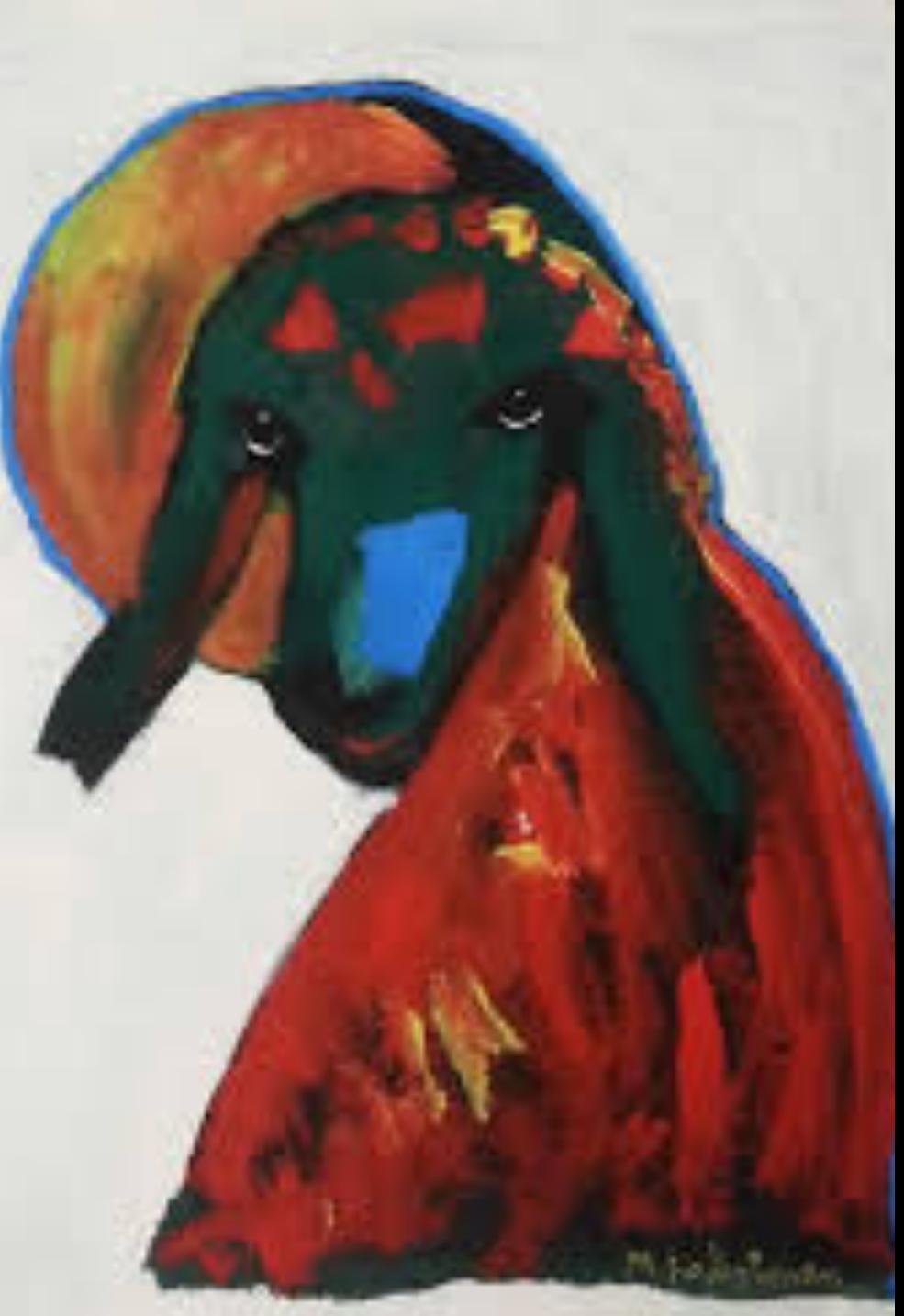


# Variance/Covariance

- Compute the full covariance matrix for all assets in portfolio
- Compute portfolio volatility  
$$R = \omega^T \cdot \Sigma \cdot \omega$$
- Identify VaR as before

## Weakness

- Assumes Gaussian price process with constant volatility
- Requires estimation of underlying volatility and correlation
- Correlation/covariance varies significantly throughout the day, significant for perpetual contract with 8h horizon



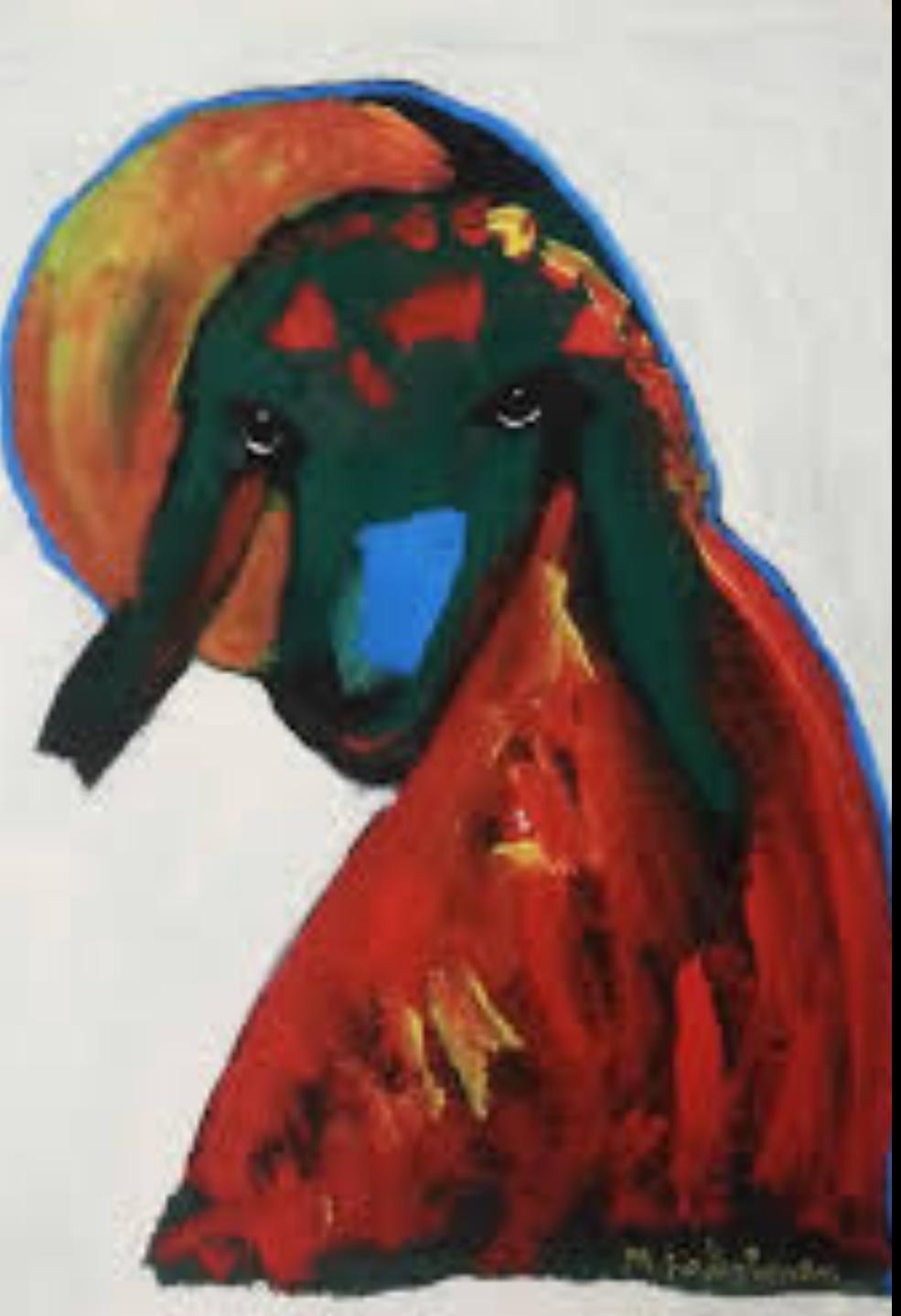
# Closed Form

- Build a theoretical model and derive the a closed form formula for the margin
- Compute portfolio volatility

$$M > m \cdot p_{t_0} \cdot \left( e^{\sigma_t \Phi^{-1}\left(1 - \frac{\alpha}{2}\right)} - 1 \right)$$

## Weakness

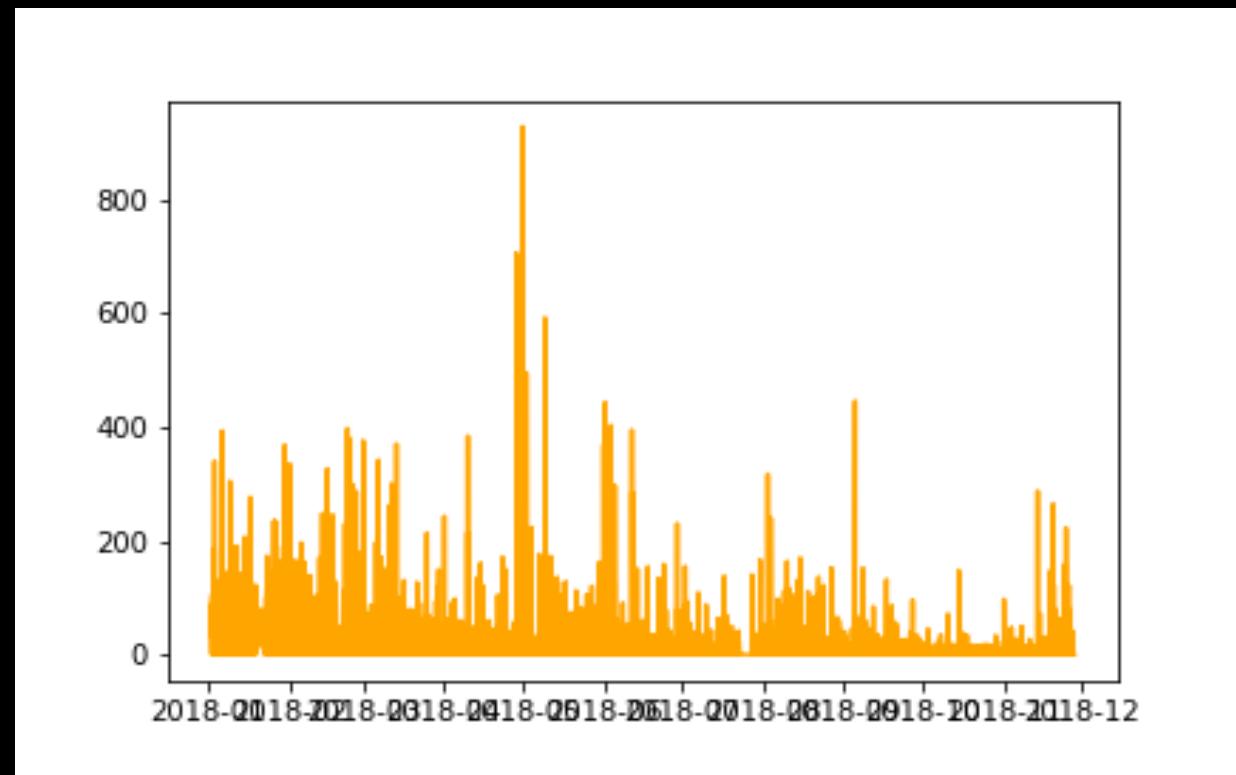
- Assumes parametric price process
- Requires estimation of underlying parameters
- May not be sensitive to intraday variation of parameters



# Intraday Volatility

Price dynamic:

$$dp_t = \sigma_t \cdot p_t \cdot dW_t$$





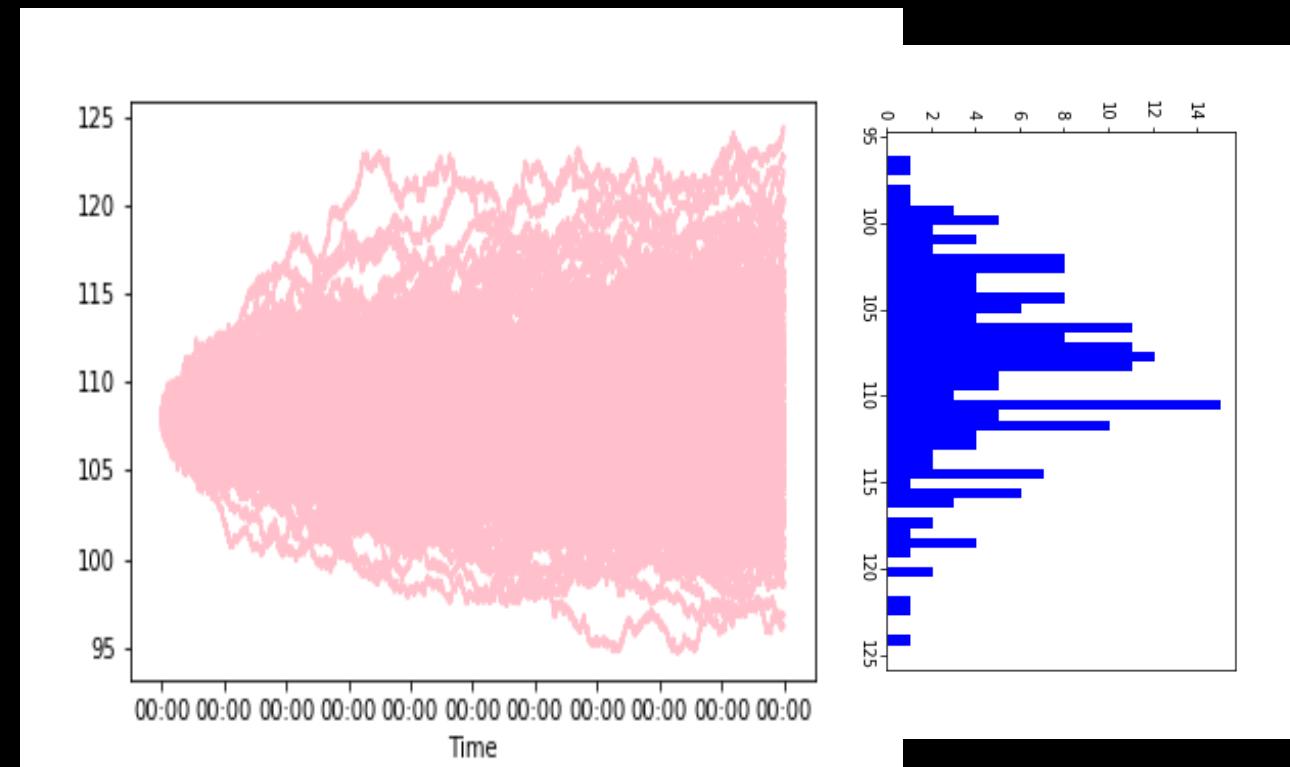
# Monte Carlo Methods

- Immolation method using sequences of random numbers to approximate values which cannot be determined analytically
- Phrase coined in Manhattan project due to similarity to games of chance
- Only requirement is that system be describable in terms of p.d.f.'s

$$dp_t = \sigma_t \cdot p_t \cdot dW_t$$

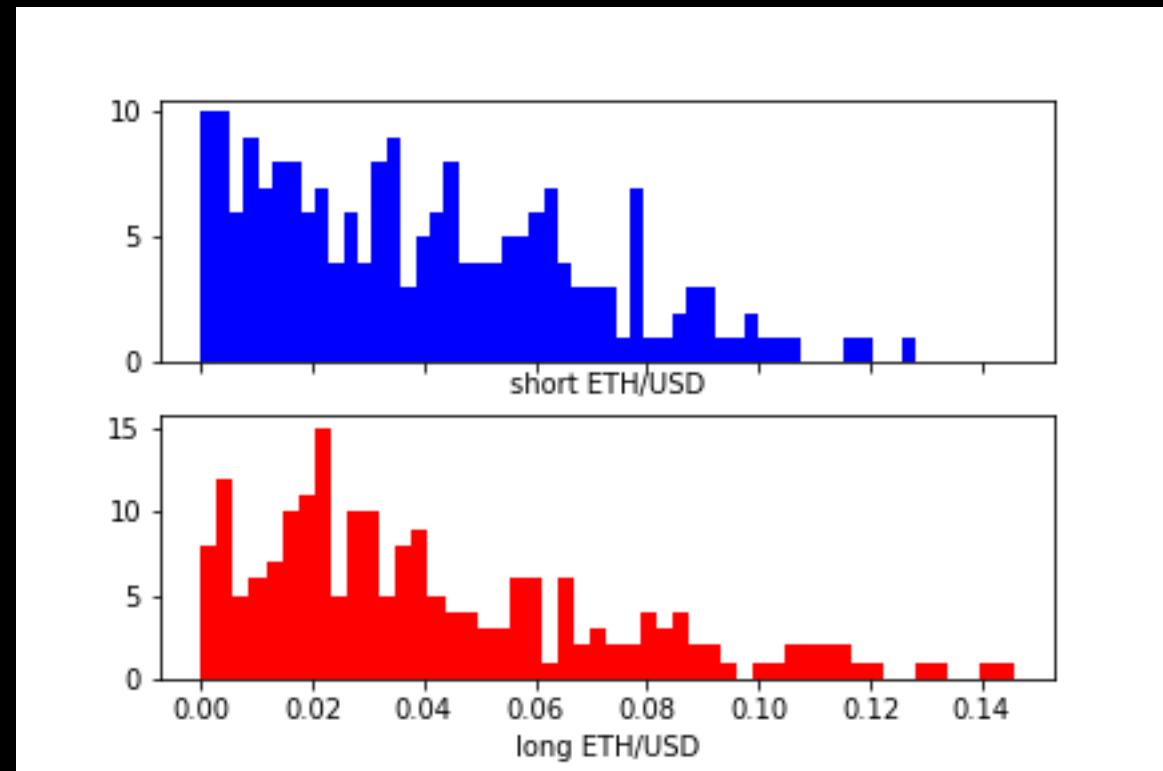


# Monte Carlo Methods



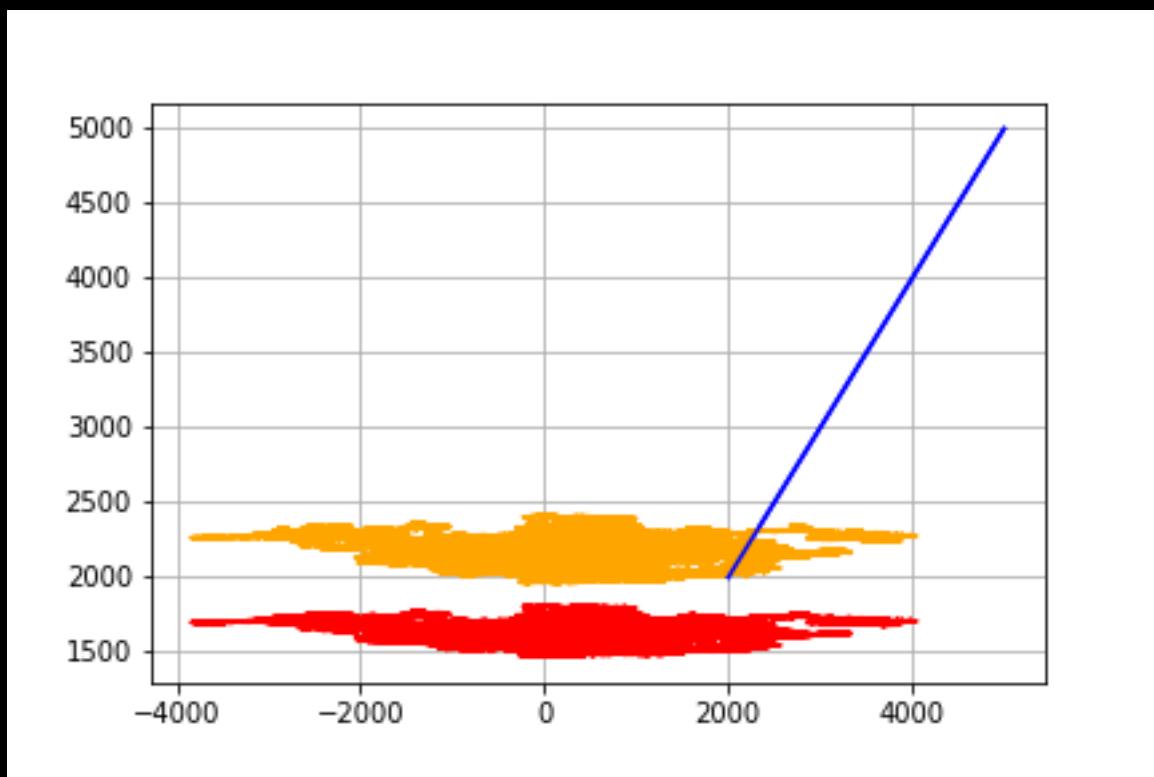


# ETH/USD collateralized with ETH





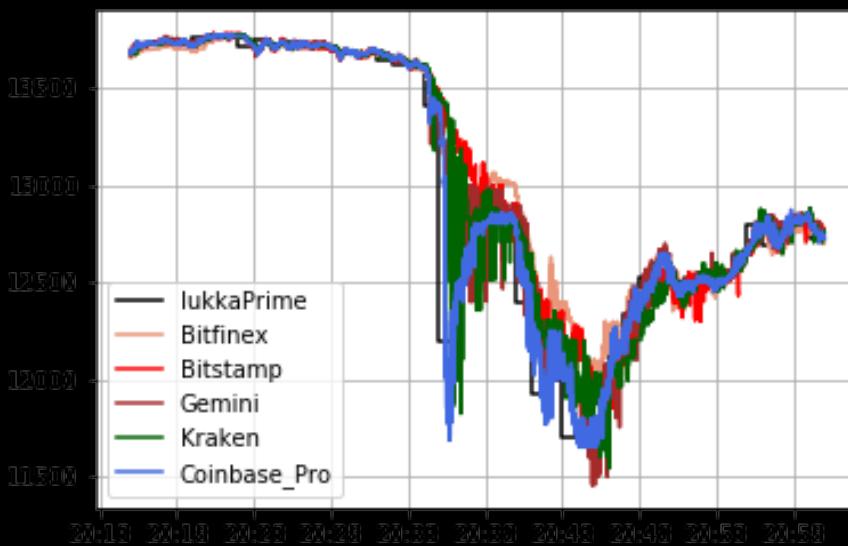
Oil collateralized with ETH





# Historical Simulation

- Immolation method using sequences of numbers derived from historical data to approximate values which cannot be easily generated in an analytic model
- Marks to market using the rates and prices observed over a certain historical period; or changes in terms of standard deviations
- Effective to reply past events, for instance when testing alerts, circuit breakers, etc.





# Risk and Margin

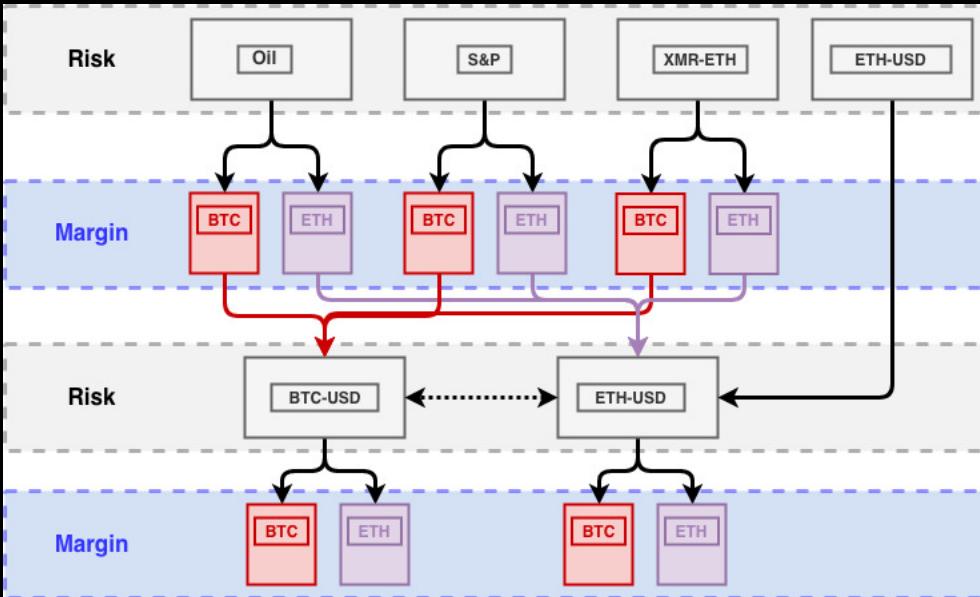
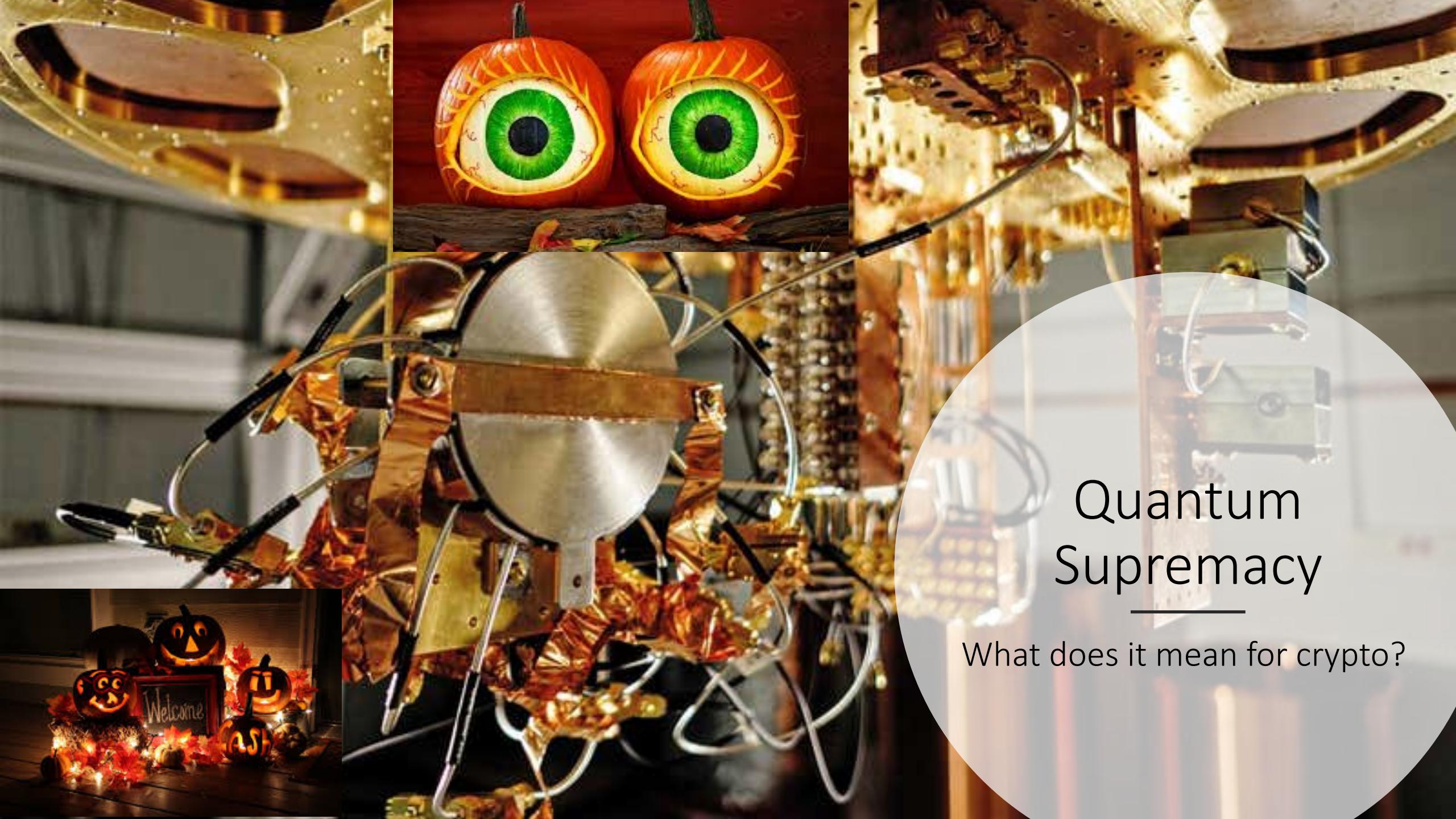


Table: Collateral Assets - conf 95%

underlying	direction	horizon	base risk	step size	liquidation	maintenance	initial
BTC-USD	short	8	100 BTC	50 BTC	2%	4.932%	7.398%
BTC-USD	long	8	50 BTC	50 BTC	2%	5.188%	7.782%
BTC-USD	short	24	50 BTC	50 BTC	2%	8.388%	12.582%
BTC-USD	long	24	50 BTC	50 BTC	2%	9.156%	13.734%
ETH-USD	short	8	100 BTC	100 BTC	3%	7.311%	10.967%
ETH-USD	long	8	50 BTC	50 BTC	3%	7.888%	11.833%
ETH-USD	short	24	100 BTC	100 BTC	3%	12.323%	18.484%
ETH-USD	long	24	50 BTC	50 BTC	3%	14.055%	21.083%



# Quantum Supremacy

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What does it mean for crypto?