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Research & Publications

Crypto Modelling: an Institutional Framework

Bitcoin DV01 and Crypto Risk Management

May 2021

Introduction

Search the internet for 'cryptocurrency portfolio management' and a wealth of well-meaning enthusiasts are cementing misconceptions about the appropriate valuation and risk treatment of digital assets. By addressing a few of the more common misunderstandings in this article, we hope to help advance the evolution of cryptocurrency investments as an institutional asset class.

1. Yes, there is an implied Bitcoin interest rate curve

In fact, it is possible to calibrate an implied interest rate curve specific to every exchange that offers active futures strips for each currency. Multiple exchange-specific rate curves lead naturally to basis between curves, or Bitcoin ("BTC") and Ethereum BROs (the value of a 1 basis point move of a spread on a portfolio).

Let's examine a simple example. If the 1 year interest rate is 1%, our expectations are that the present value of \$101 in a year is \$100. Similarly, if the 1 year future price on a particular exchange indicates a price of \$60k vs today's \$55k, then 1 BTC is the present value of 0.92 BTC in 1 year. The implied rate difference in between BTC and USD is -9.09%. By aggregating the implied rate differentials back to USD interest rates we obtain an outright BTC implied discount curve (this is an oversimplified calculation; please reach out if you would like a discussion on how to bootstrap the discount curves for institutional purposes). This is foundational finance and not new, commodities practitioners have relied on this construct for decades. Yet there are numerous derivatives papers and blogs promoting their version of derivative code in R and Python that set the interest rate 'r' at '0', as well as credible systems suggesting that an equity option model 'will do'. Can we ignore interest rate curves in an institutional setting? The greatest growth in the digital space stems from (i) lending based activity, where an important driver of loan valuation is interest rates and (ii) derivatives where implied volatility levels and Greeks will be inaccurate if relying on a rate of 0. Ignoring interest rates curves may therefore lead to inaccuracies in official NAVs, risk measure, collateral calculations and investment-decision making.

2. Yes, implied crypto interest rates are negative. Why?

Negative implied interest rates are consistent with BTC Futures trading at a significant premium to spot. Explanations for this could be that market players do not have access to the spot market, or that achieving a leveraged position in BTC spot is difficult given the large haircuts required when posting it as collateral. Futures may be the only way to access crypto for certain pools of capital (e.g. US regulated persons) and are considered safer given there is exposure without the security or data storage risks.

Perpetual futures also imply a high cost of carry when funding costs are taken into account. For example, when Deribit perpetual futures trade more than 0.05% above spot, the long holders have to pay the short holders a funding charge. A basis between the perpetual future and spot of about 0.14% corresponds to a deposit rate of -10%.

3. Black and Scholes is not the right model for options on crypto futures

The Black and Scholes model is a useful framework for European options, despite many of the underlying markets contradicting the list of assumptions that the model is founded on. The model assumes lognormal distributions whereas many markets, especially crypto markets, have leptokurtic properties that are often overcome from a modelling perspective by creating implied volatility surfaces rather than a single figure.

Retail investors that don't have the systems to bootstrap implied rates curves, and just trade listed options on crypto futures should use the Black-76 (not Black and Scholes) option pricing model. The Black-76 model does not need a crypto interest rate curve.

However, if you are an institutional market participant, it is imperative that your platform is backing out the correct implied volatility surfaces, and that this is being done with the right implied rate curves per exchange. If calibrating prices from one exchange to value instruments to another counterparty of different credit quality, fair value pricing further requires the credit risk of that new counterparty be considered.

Managing changes in volatility as the market moves is also essential. It is appropriate to choose a model that can switch (or better still blend) the choice between sticky-by-strike and sticky-by-delta properties so that changes to Vega (Vanna and Volga) are accurately managed in the portfolio alongside delta slides. This cannot be done with a simple equity option framework.

A further nuance is required to cater for the fact that BTC is traded 24/7. For most assets it is appropriate to calibrate volatility surfaces which allocate volatility on a business day basis with only a small residual amount of volatility allotted to weekends. This means that option theta endured from Friday to Monday is roughly the same as from Monday to Tuesday.

For cryptocurrencies this is not appropriate as they experience significant moves at the weekend.

The table below compares realized volatility by weekday for BTC vs EURUSD over the last 5 years:

	EURUSD	BTC
Friday to Monday	0.38%	5.89%
Monday to Tuesday	0.43%	4.15%
Tuesday to Wednesday	0.41%	4.50%
Wednesday to Thursday	0.48%	4.72%
Thursday to Friday	0.46%	3.48%

Source: Coremont

Data as at: 4th May 2021

A properly calibrated volatility surface will reflect the extra weekend volatility.

4. Stable coins cannot be discounted with fiat USD rate curves

Stable coins are a digital representation of the US dollar. They have different supply/demand, liquidity, operational and safekeeping risks, risks directly linked to the quality of the stable coin issuer. The US dollar has numerous liquid rate curves, specific different index fixing/funding. It is extremely tempting to apply US dollar discount factors to PV USDC. Just as an equity warrant has a different price to a listed equity option due to differences in credit quality of the issuer, so too is the valuation of a derivative with US dollar different to one with a digital version of US dollar. Given there is no visibility into what the implied default rates are, it is tempting use the US dollar fiat rate curves for discounting. Assuming some small level of default is better than assuming none to manage the US dollar to stable coin basis appropriately, and not offset these in risk stresses.

5. Correlations rarely assist risk management

Correlation matrices are fun, but have limitations in risk management. Firstly, correlation is a single number representing how two time series move together 'on average'. For risk management, a field typically interested in multiple layers of how to mitigate losses in extreme events, looking at a figure representing an average provides less useful content. For example, the treasury and equity markets have a correlation on a longer time horizon of around 10%, yet correlations in shorter time frames range between +90% or -90%. It is the more extreme or 'tail' properties of underlyings that will allow risk managers better calculation power for decisions in this market, such as how much BTC collateral should be put forward for a 5 month loan in ETH. Secondly, correlation is planar, uses backward looking data, and does not capture the multiple dimensions that drive all considerations of potential loss.

6. VaR doesn't capture all the risks

As cryptocurrencies become more institutional, traditional risk measures such as VaR are being increasingly used. There are two main calculation approaches, the VaR-Cov suite and historical VaR, each have their pros and cons. The VaR-Cov uses 'average correlations' rather than tail correlations, and as just discussed, these methods remove the valuable scenarios of how a portfolio of tokens behave in more extreme movements. As a result, VaR will be understated and is more pronounced where there are relative value trading strategies across tokens, exchanges and tenors. Historical VaR methods are generally the preferred approach for a liquid portfolio, cryptocurrencies included. Results from Historic methods do include the empirical correlations but are also at risk of being understated in certain circumstances, albeit such biases are easier to monitor. The most relevant bias is where instruments have a history that is a long positive or negative trend. Let's examine an extreme example. If a token has increased 0.2% every day in the horizon of data being used, the resultant Historical VaR will be positive 0.2%, an unlikely projection of future potential losses. VaR monitoring is more informative when it is not a single number, but a table comparing VaR across multiple look-back horizons, examining both the 1% and 5% alongside the 99% and 95% one day VaR to extract the upside biased. Further, if VaR is amalgamating both cryptocurrencies and traditional assets, breaking the results out per asset class will also assist in highlighting skewed results, and encourage better decision making.

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Should VaR be calculated? The benefits to VaR are wide ranging and not the main focus of this document. Yes, VaR is incredibly useful for multiple market risk and collateral management functions and serves traditional assets well because other risks to liquidating a position are low and operational processes are well oiled. Crypto markets carry unique operational issues that as an industry, we have less experience with, especially in extreme events. The more pertinent losses in these markets are unlikely to be caused from classic 'market risk' drivers. 'Risk management' requires a comprehensive understanding of the entire ecosystem, including but not limited to the financial health of exchanges, how 24/7 markets affect liquidity when trading activity isn't concentrated in a short 'daily' session, the robustness of safekeeping infrastructure, the likely steps on the regulatory framework and the secure transferability of assets. 'Risk management' starts with live reconciliation technology, powered by high levels of STP, and accurately tracking the location of positions not simply aggregating them as one and diversifying the counterparty risks. VaR is useful, but less useful than a complete front to back and more forward looking understanding of the liquidation risks being managed.

OTC trading increases the complexity of an operating model. The crypto markets are still trading off long form documents, and documents that are not templated or overseen by an ISDA style body. This introduces legal interpretation and operational risks for every trade, and gives rise to whether the position is even in effect at all given multiple conditions for termination that we are yet to see being monitored as part of the full risk reporting.

Lastly, systematic risk is real. The entire crypto ecosystem is supported by numerous and key institutions whose existence and credit quality are heavily dependent on crypto maintaining the value it has. In no other time has a 'same-way risk' been so concentrated across an industry of comparable size. Regulators refer to this as 'systemic risk' and will require very small stepwise enhancements and oversight to manage the industry without spooking the market and creating the downfall.

Conclusion

We hope that by applying the sound risk management principles of financial markets to the digital assets sector, including an understanding of the multiple new risk dimensions that characterise the market structure, Coremont can help crypto become institutional in class.

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