DELPHI DIGITAL

The State of Bitcoin

Long-Term Value Potential & Analysis

December 2018
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Executive Summary

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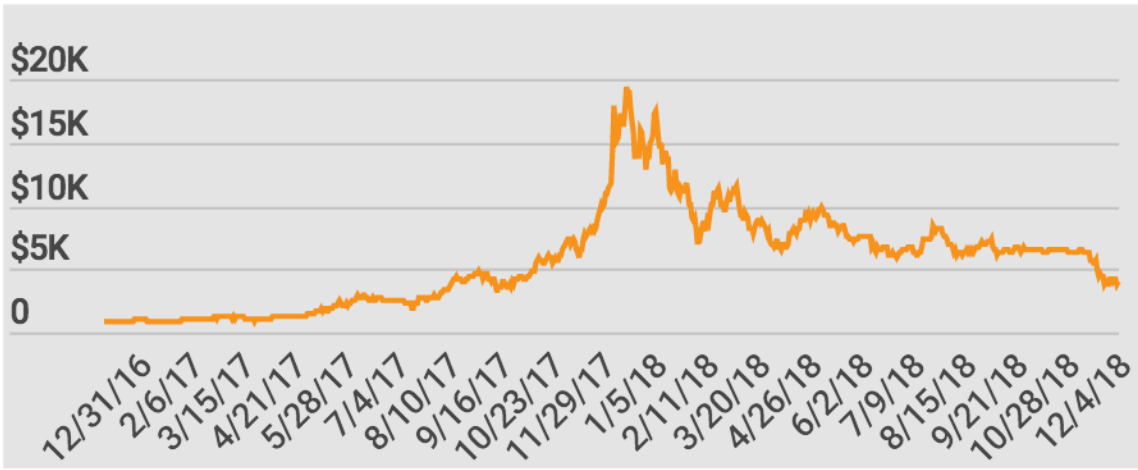
Bitcoin is a censorship-resistant, disinflationary digital currency designed to facilitate trust minimized, peer-to-peer transactions without a centralized intermediary. Leveraging public-key cryptography, transactions are written and stored on a distributed public blockchain. The software is open source, dating back to 2009 when it was released by an unknown creator under the pseudonym Satoshi Nakamoto.

Details	
Ticker	BTC
Price (USD)	$3,858
Market Cap	$67,163,150,400
Circulating Supply	17,408,800 BTC
Maximum Supply	21,000,000 BTC



Data as of December 4th, 2018

Sources: Blockchain.com

Key Takeaways:

- Bitcoin may face additional selling pressure in the near-term, but we believe prices will bottom in Q1 2019 based on our analysis of holder dynamics during prior boom-bust cycles.
- Lightning Network development has progressed rapidly, allowing Bitcoin to scale without sacrificing security. The success of this technology will be crucial and may prove superior to other scaling solutions in the long run.
- Total Bitcoin supply is finite at 21 million given that its inflation schedule is predefined and governed by a mathematical algorithm. The vast majority of Bitcoin have already been mined with a significant amount (~2-3 million) presumed to be lost.

Global Demand:

- As global debt rises to new heights, Bitcoin can serve as a check on government institutions by offering a viable alternative to today's reserve currencies. This is especially true of many developing market economies prone to high inflation (e.g. Venezuela, Argentina), because of weak or harmful governance. Bitcoin offers anyone with internet access the ability to transact and store wealth in a vehicle unrelated to local fiscal and monetary policies.

Value Drivers:

- Bitcoin can serve as a complement to investments like gold given similar traits like scarcity, while offering unique advantages in a digital age.
- Its censorship-resistant nature provides an attractive alternative to the private offshore banking system currently estimated to hold ~$8 trillion for individuals.
- An allocation to Bitcoin can enhance risk-adjusted returns for traditional investment portfolios, but proper position sizing is crucial given its historical volatility.

Thematic Overview

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Short-Term Outlook

UTXO Analysis

We believe we are in the midst of an accumulation period taking a similar form to the one in the second half of 2014. Current UTXO trends suggest we are likely to see a bottom in bitcoin's price by the first quarter of 2019, and the recent acceleration in bitcoin's downward price trend may indicate we are more likely to see this bottom in the first half of the quarter.

Network Value to Transaction Signal

Using an improved variation of the Network Value to Transaction Ratio, we examine how this historically accurate Bitcoin trading multiple is finally out of the sell region and descending quickly towards buying territory.

Long-Term Value Drivers

Store of Value

Bitcoin's scarce, disinflationary characteristics make it an attractive investment alternative to gold. It may provide a useful hedge for inflation, especially if global central banks reduce the rate of quantitative tightening in the face of an economic slowdown against the backdrop of record debt levels. Bitcoin also has the potential to capture a portion of global wealth held in the offshore banking system, reducing the risk of asset seizure.

Medium of Exchange

Emerging markets and developing economies represent an opportunity for Bitcoin. It offers the residents of those countries an alternative to local currency vulnerable to monetary and fiscal policy mishaps. The ability to directly hold and transfer one's wealth without the need of a trusted third party (i.e. banks) can reduce fees and settlement times for payments, remittances, etc. Bitcoin's potential in these countries will be limited, however, by the penetration of internet-connected devices and education around its use. Over the long term, Bitcoin could become an integral part of an internet-powered, global payment network if scaling solutions like Lightning Network succeed and people grow comfortable accepting and perceiving Bitcoin as a store of value.

Portfolio Diversification

Small allocations to Bitcoin can enhance risk-adjusted returns as it has largely maintained a low correlation with most traditional asset classes. Position sizing is critical, however, as larger allocations significantly increase a portfolio's volatility and drawdown risk. We determined that a portfolio with a 3% allocation to Bitcoin produced the best Sharpe Ratio, and had a smaller drawn down by ~150 bps compared to a traditional 60-40 allocation.

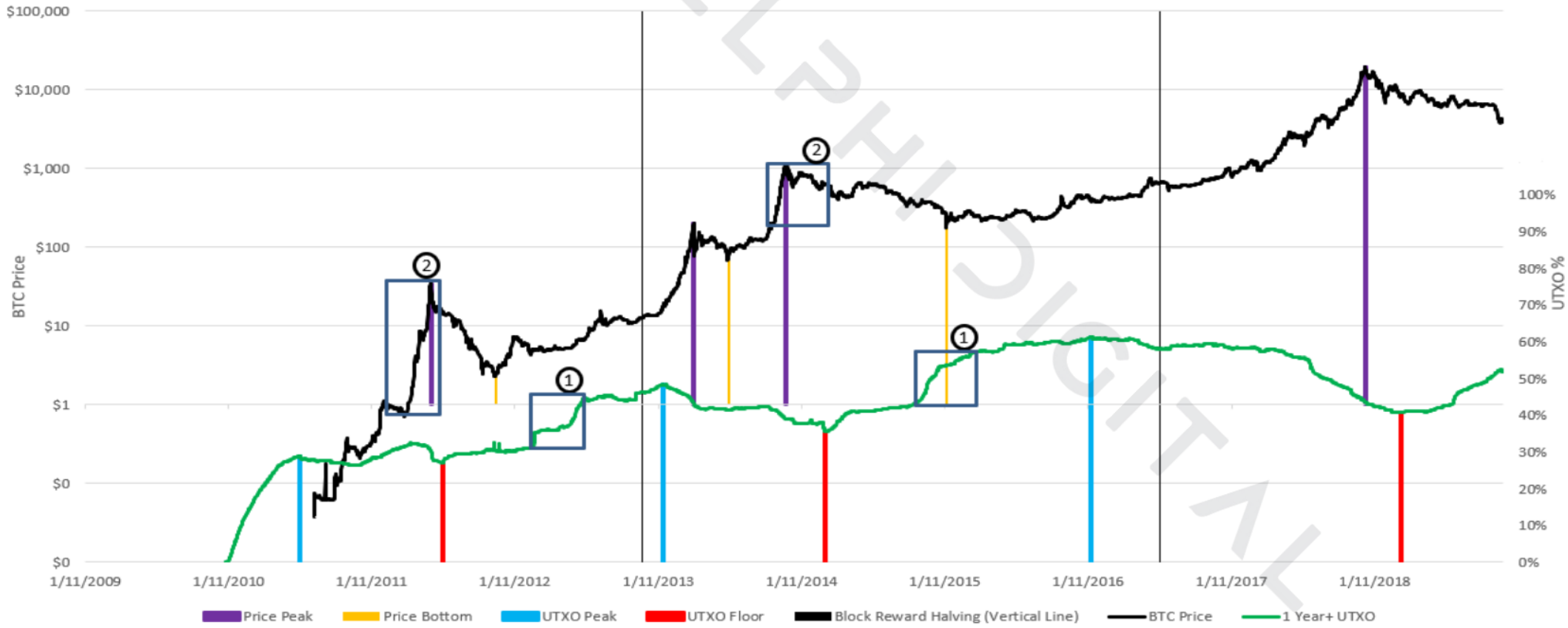
We will delve into each section individually while providing the necessary data analysis to support our opinions. It is important to note that investing in Bitcoin is risky and any decision made should be evaluated in the context of an individual investor's capability and appetite to take risk.

Short-Term Outlook

UTXO Analysis & Market Cycles

The purpose of this chart is to illustrate the underlying movement of specific bitcoins through previous market cycles using UTXO (unspent transaction output) data. This concept was previously posited by Unchained Capital in their Hodl Waves Analysis piece. We expand on this analysis to identify when selling pressures will likely wane to forecast the timing of upcoming market cycles*.

Methodology: The **black line** represents the price of BTC on a logarithmic scale and the **green line** shows the percent of bitcoin UTXO's that have not been used in a transaction in at least a year. We will refer to this line simply as the "**UTXO line**". The boxes[1] sectioning off portions of the **UTXO line** begin with times where it grows significantly and end after said rapid growth tapers off in that cycle. In order for a coin to move into the 1 Year+ UTXO band, it must be untouched for at least one year. We section off the corresponding box[2] on the price chart that indicates the price at which they were last moved to provide timing context. The trend here clearly shows the rapid growth in the UTXO line corresponding with boom and bust cycles. As we saw at the end of 2017, continued price appreciation leads to a rapid influx of new users/additional money into bitcoin, often deep into a rally, subsequently followed by a significant price collapse. In other words, these individuals became the "bag holders" of their time.



For a more detailed explanation, reach out to us: team@delphidigital.io

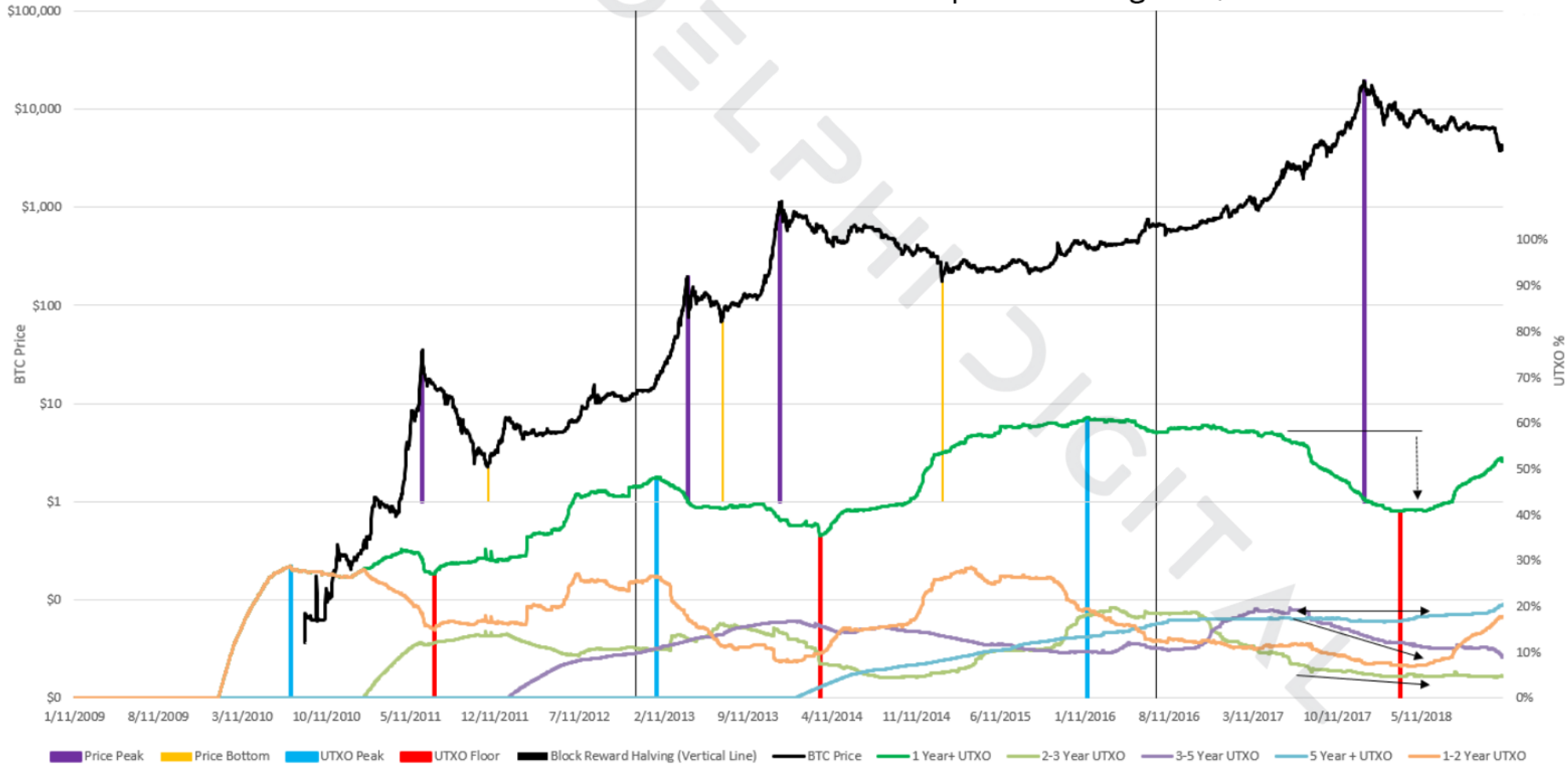
Data as of December 3rd, 2018

Sources: Unchained Capital

UTXO Analysis & Market Cycles

There are a few key trends we've identified by analyzing current UTXO shifts along with prior boom and bust cycles to help zero in on where we likely stand today.

- There's a pretty clear reduction of natural selling pressure leading into a block reward halving (though it's difficult to isolate the direct impact on price as market participants likely price it in).
- We derived the primary source of selling in the most recent downturn for bitcoin came from coin owners who have been holding for 3-5 years.
- It appears these 3-5 year holders are close to exhausting their selling efforts, evident in the flattening of the older UTXO bands and the **1-Year+ UTXO band** remaining relatively flat through the first half of 2018 after finding a floor. Understanding that the 5-Year+ band is primarily made up of lost coins is crucial to this analysis because it allows us to back into the movement of coins in preceding bands.
- In the second half of 2018, the **1-Year UTXO band** began exhibiting a positive growth trajectory directly in tandem with the **1-2 Year band** as older UTXO bands remain flat. We believe we are in the midst of an accumulation process taking form, similar to the one in the 2nd half of 2014.



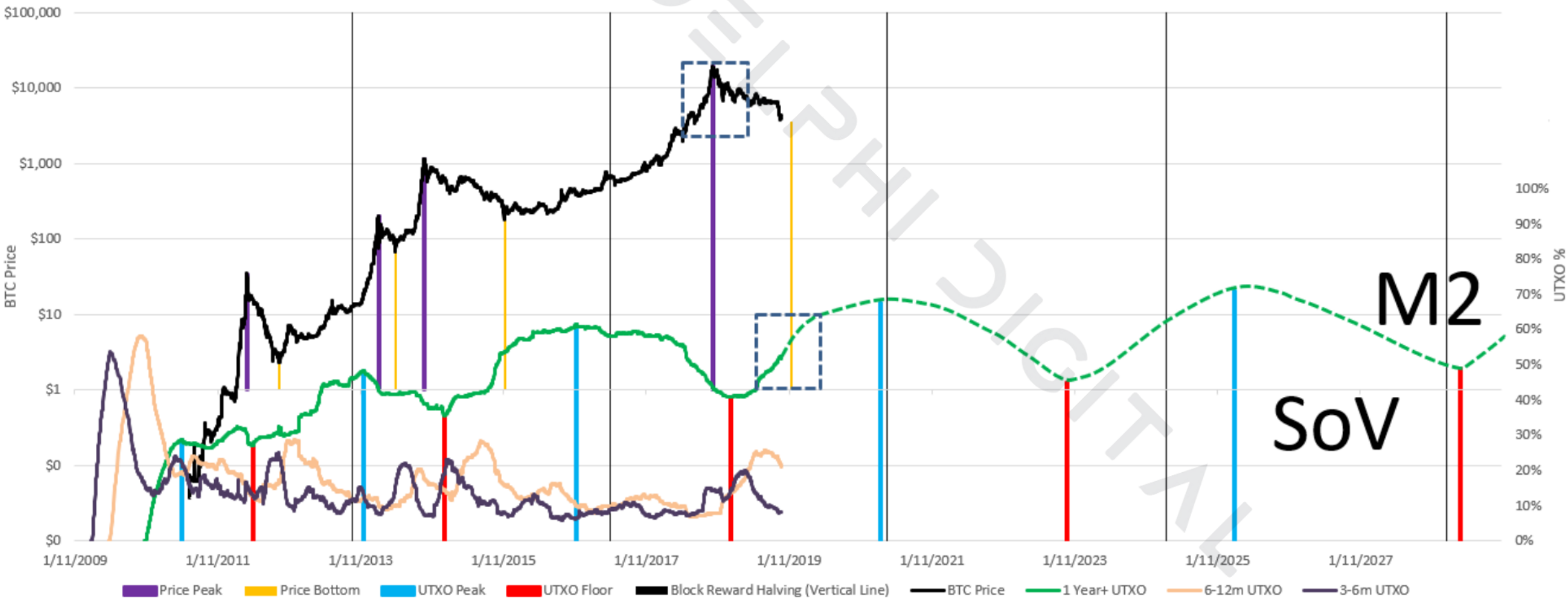
Data as of December 3rd, 2018

Sources: Unchained Capital

UTXO Analysis & Market Cycles

UTXO trends have shown to be an impressively reliable predictor, albeit with a limited sample history, for price bottoms, future accumulation timing, and UTXO wave amplitudes. We believe their accuracy is a function of their ability to illuminate when selling pressures, the real driver of price, begin to abate and eventually cease.

- Current UTXO trends suggest we are likely to see a bottom in bitcoin's price by the first quarter of 2019, and the recent acceleration in bitcoin's downward price trend may indicate we are more likely to see this bottom in the first half of the quarter.
- This accumulation pattern and subsequent price appreciation will line up with the 2020 block reward halving, as miner's selling propensity is reduced. We do, however, believe this will be the last reward halving to have a very significant impact on price.
- We can see how bitcoin has gradually shifted to a store of value throughout its existence. This shift has occurred despite block rewards that meaningfully increased circulating supply. Bitcoin's disinflationary nature will only strengthen this store of value narrative.



Data as of December 3rd, 2018

Sources: Unchained Capital

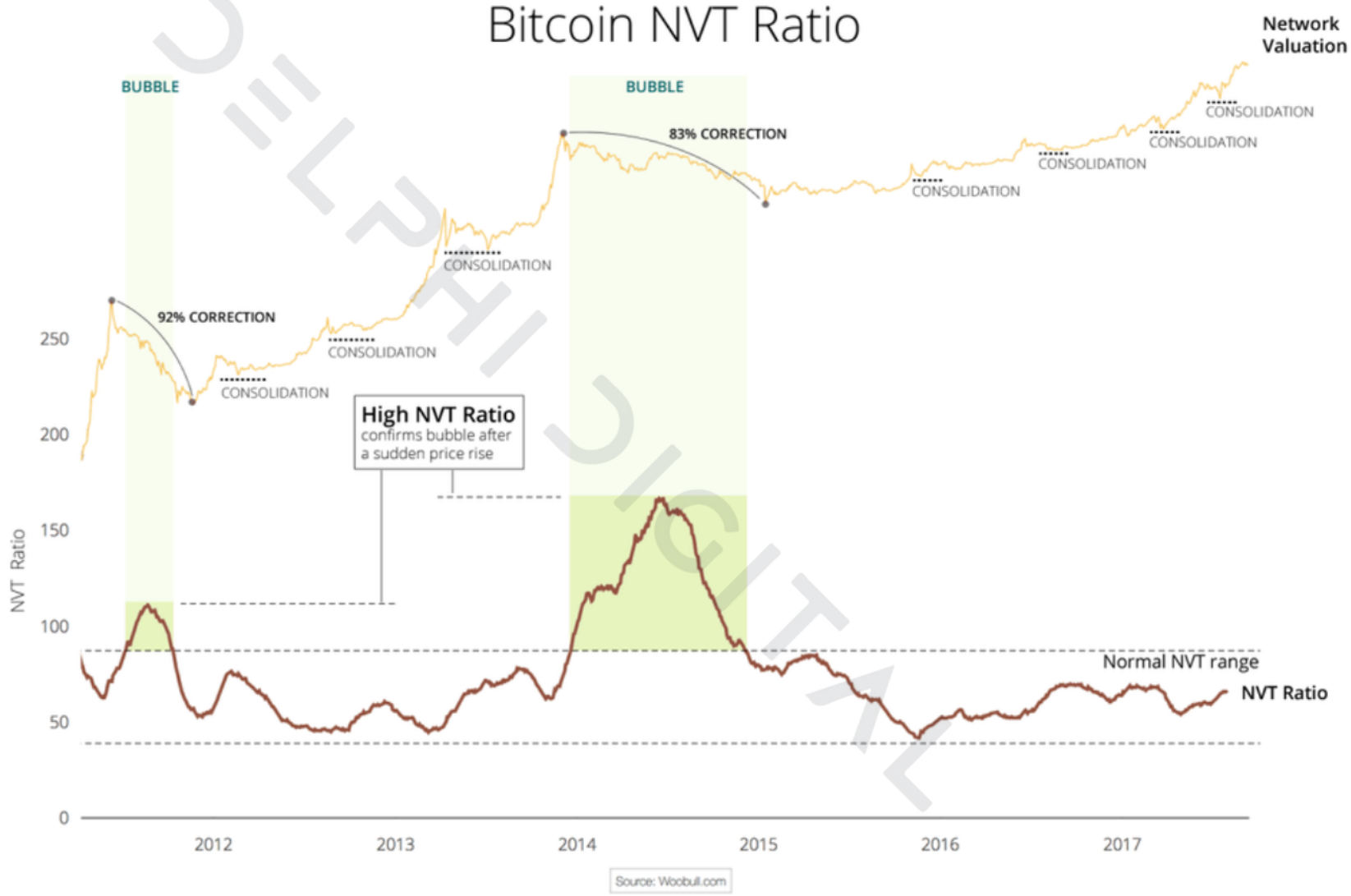
Network Value/Transactions Ratio (NVT)

Traditional markets have dozens of proven indicators to evaluate the potential value of assets. Equity markets, for example, have trading multiples (Price to Earnings (P/E) ratio, etc.) while credit markets track metrics to gauge a borrower's ability to repay. Bitcoin, on the other hand, does not have cash flows and is not issued by any single government or corporate entity. Therefore, a proxy indicator needs to be used to evaluate how "cheap" or "expensive" it is at a given point in time.

The NVT Ratio (Network Value to Transactions), introduced by Willy Woo and Chris Burniske in early 2017, provides a metric to gauge whether price appreciation is significantly exceeding network use growth. It's a multiple of the overall Network Value to On-Chain Daily Transaction Volume. The basic premise is that the value of a network can be derived from the transaction volume that it's facilitating. It's important to note this does not include trading volume.

The chart on the right shows how the NVT ratio was able to identify previous instances from 2011 and 2013 where price grew well beyond expectations given the underlying level of on-chain volume, resulting in a significant price collapse.

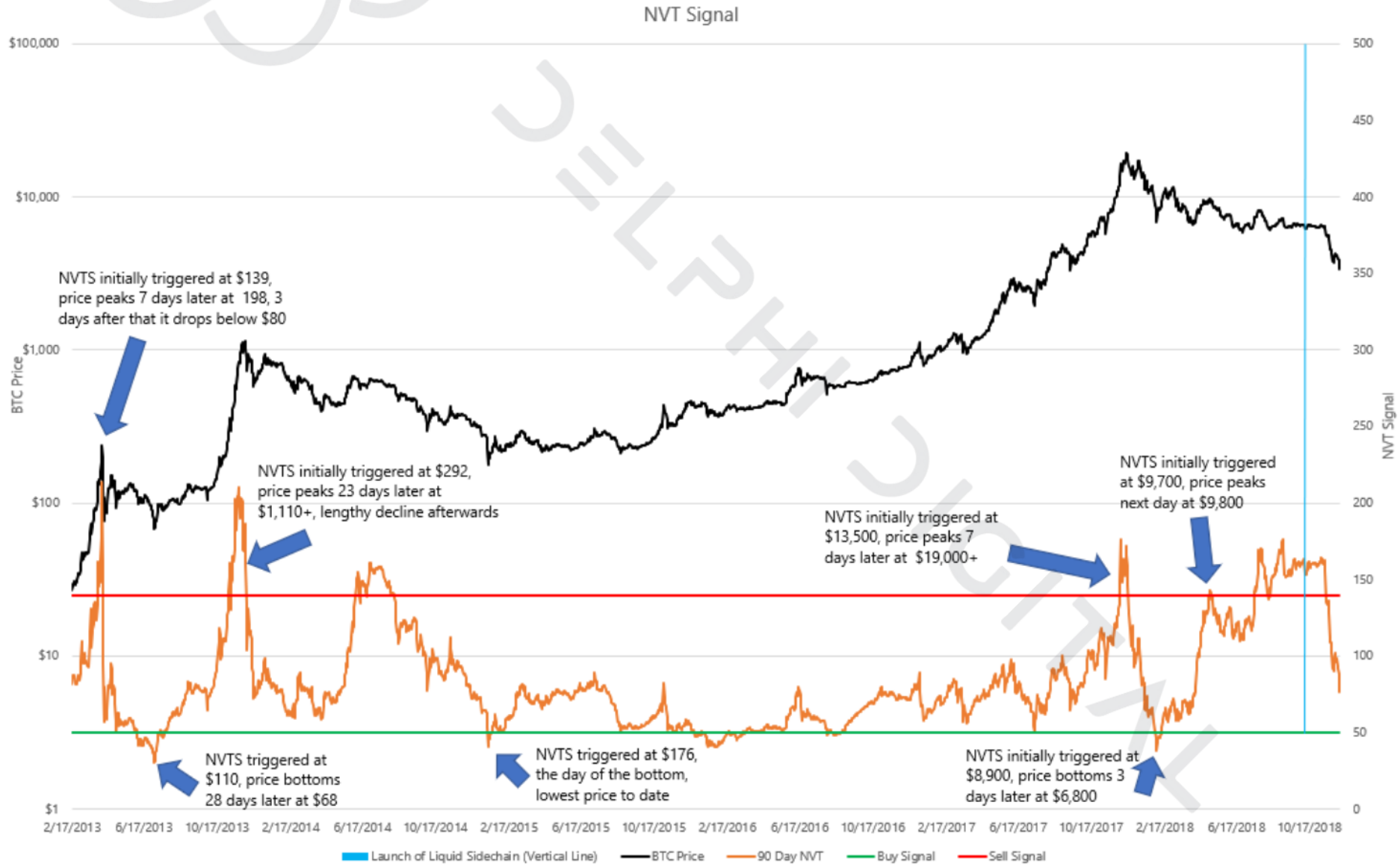
A key issue with the with NVT Ratio is it's a lagging, not leading or coincident, indicator. The NVT ratio peak occurs during the middle of the correction, and as a result, is best suited to identify previous bubbles.



Sources: Woobull

Network Value/Transactions Signal (NVTS)

This issue was identified and addressed by Dmitry Kalichkin of Cryptolab Capital, with his modified version known as Kalichkin's NVT, or the NVT Signal. Rather than just using Daily Transaction Volume as in the NVT Ratio, the NVT Signal uses a 90 Day Moving Average of the Daily Transaction Volume. The logic behind using a moving average is to offset the speculation driven growth in on chain transaction volume that accompanies price movement in the short run. When price increases rapidly, you'll typically have an influx of individuals that are looking to sell. This actually drives on chain volume as individuals move coins from wallets to exchanges and exchanges move coins across their own wallets to facilitate the influx of transaction activity. This early speculation driven transaction volume is what causes the NVT Ratio to function as a lagging indicator. Here we can see how the NVT Signal was a leading indicator for the last 3 major rallies, while also proving to be a successful indicator of when to rebuy afterwards.



Data as of December 7th, 2018

Source: Blockchain.info Cryptolab Capital

Results of NVTS Analysis

Selling right as the ratio crosses the threshold would've avoided the pain of the subsequent price crash, but it would've also forced you to forgo additional upside in the near term. Historically, prices didn't officially peak for a few days (or occasionally weeks) afterwards, but hindsight is always 20/20. This indicator can be used as a warning to tread with caution if you're still holding BTC at such high NVT values. Typically, the peak in price is right around the corner.

Another crucial benefit of this metric is that it provided leading buy/sell signals during periods outside of significant price rallies and declines. It differentiated "quiet periods" that were a true bottom (the accumulation period through most of 2015 that eventually lead up to the most recently rally) from those that weren't (the past several months of 2018 in the $6,000 range before the bottom fell out in November).

The NVT Signal thresholds we chose were based on empirical evidence, with one of the criteria being a sufficient sample size. The results on the right are aggregated under the assumption that Bitcoin was purchased every day that it spent above or below each respective threshold.

We include the median and mean return to illustrate the consistency of the results while also presenting the inherent positive skew that's a result of Bitcoin's positive price trajectory. The success rate indicates how often the signal is correct and the instances are there to show the sample size.

Results From Buying Below 50 NVTS

90 Day NVT	30 Day	60 Day	90 Day	180 Day	1 Year
Median Return	4%	8%	19%	63%	182%
Mean Return	4%	11%	22%	233%	316%
Success Rate	66%	76%	88%	94%	100%
Instances	157	157	157	157	146

Results From Buying Above 140 NVTS

90 Day NVT	30 Day	60 Day	90 Day	180 Day	1 Year
Median Return	-8%	-18%	-36%	-49%	-55%
Mean Return	-6%	-12%	-25%	-43%	-32%
Success Rate	76%	84%	89%	92%	87%
Instances	225	195	165	113	99

Data as of December 7th, 2018
Source: Blockchain.info

Risks of Using NVTS

Reliable Information

The Coinmetrics team put together an extensive piece addressing the difficulties of estimating on-chain transaction volume. The main takeaway is that reported volume is likely overstating real on-chain transaction volume. We sourced our values from Blockchain.info as, even Coinmetrics admits, their values are more conservative. Blockchain.info's proprietary method is attributable to the fact that they run a wallet service, so they're likely able to use individual user trends and apply that information to the entire universe of users.

Liquid

Liquid, Bitcoin's first sidechain, went live on October 10th, 2018 and now the transaction volume going through liquid isn't being incorporated into the NVT calculation.

Velocity

The NVT ratio is an inverse function of velocity based on the equation of exchange, MV=PQ. PQ for Bitcoin is the annual total of all its transactions (annualized T), and M can be thought of as the total market cap, or NV in this case. By plugging in the equivalent NV/T variables into the question of exchange, you get 1/V=NV/T annual. This implies that velocity needs to be kept constant for NVT to be consistent over time, something we know hasn't held true. The NVT Signal's use of moving averages helps reduce the relationship, as seen in the correlation matrix between different moving average NVT values and different annualized velocity figures, but it doesn't address it entirely.

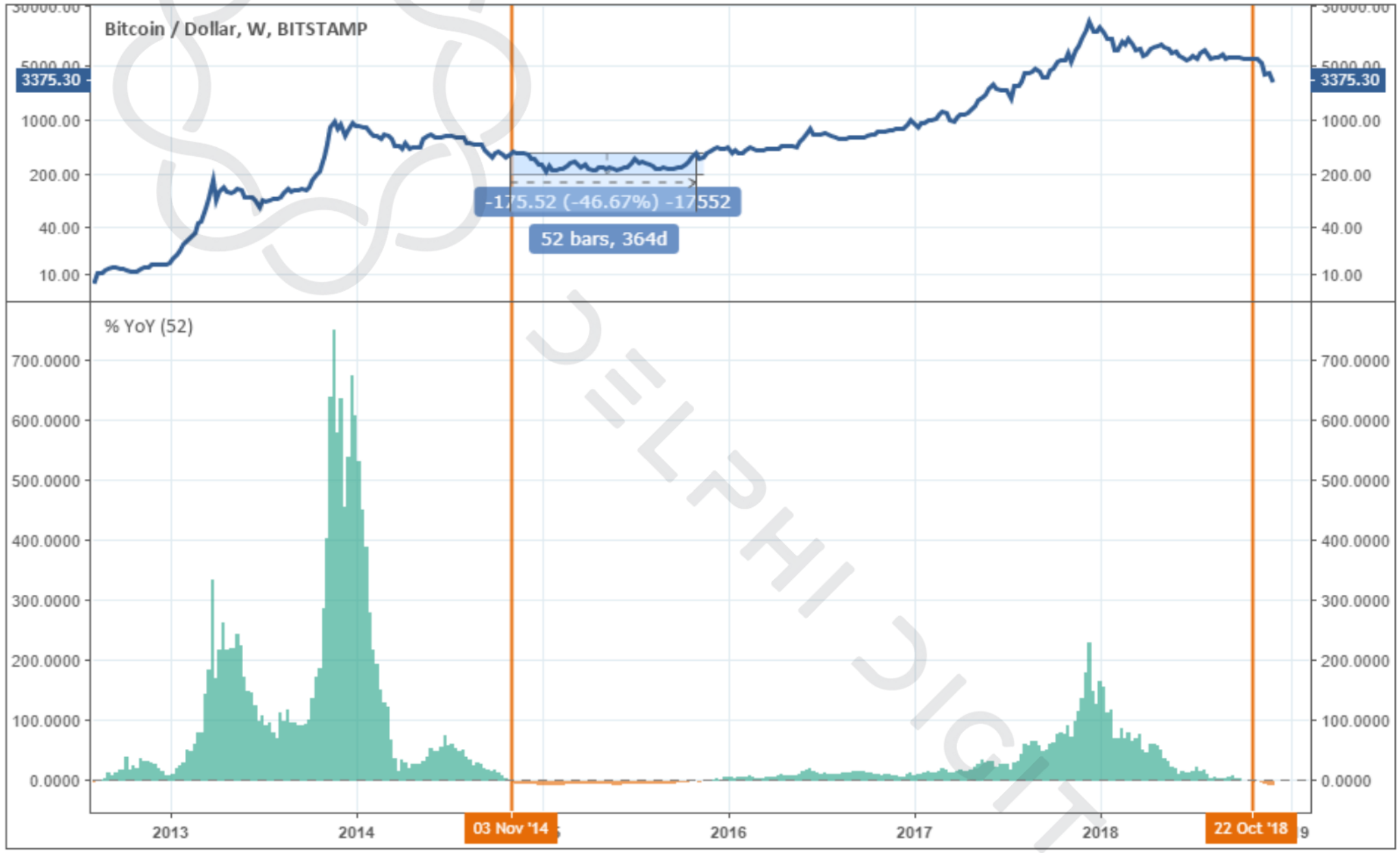
Correlation (NVTS vs. Velocity)

		NVTS		
	Days	**30**	**60**	**90**
Velocity	**30**	-0.84	-0.67	-0.48
	90	-0.82	-0.75	-0.61
	365	-0.57	-0.54	-0.45

Data as of December 6th, 2018
Source: Blockchain.info

Short-Term Outlook

Bitcoin Year-Over-Year Returns (%)



Bitcoin selling has accelerated since the beginning of November as speculators who purchased BTC a year ago are now staring at losses rather than the sizable gains many experienced in 4Q2017 - 1H2018. Following the late 2013 peak in BTC, price continued to slip even after year-over-year returns turned negative. It was roughly a year before bitcoin returned to similar price levels.

Data as of December 6th, 2018

Source: Bitstamp

Short-Term Outlook

Bitcoin's parabolic rise in the second half of 2017 experienced similar price action to it's moves in 2013. Peak valuations were followed by an extended bear market, characterized by multiple relief rallies on the way to drastically lower prices. The most recent collapse in Bitcoin's price followed a similar trajectory, but appears to be creeping closer to a cycle-bottom, aligning with our UTXO analysis. There is significant upside risk over the next 12 months as a number of catalysts (ETF approval, etc.) could propel Bitcoin prices higher.

Data as of December 6th, 2018
Source: Blockchain.com

Long-Term Value Potential

Value Drivers

Bitcoin as a Store of Value

It is our team's opinion that the investment case for bitcoin is multi-faceted, primarily serving as a store of value in the near-to-intermediate term. It is unlikely bitcoin will entirely replace gold in traditional investment portfolios, nor will it be used to store 100% of the world's offshore wealth. The key characteristics of bitcoin (censorship resistance, verifiable ownership, immutability, etc.) make it an attractive alternative to today's instruments for hedging against inflation or storing one's wealth without the risk of seizure.

The U.S. Dollar has remained relatively strong compared to other fiat currencies in recent years (with the exception of 2017) largely because of the divergence in global monetary policy (Fed raising rates while other major central banks continued with more accommodating policies). The longer-term outlook for the USD seems more bleak, however, as the U.S. government continues to add to its already burdensome debt load.

Bitcoin offers an alternative to the long-term detrimental effects and devaluation the dollar may face given current forecasts for domestic economic growth and size of the fiscal deficit.

Keeping Governments in "Check"

While we remain optimistic on the long-term outlook for bitcoin, we do not believe it will replace traditional fiat currencies (i.e. U.S. Dollar, Euro, etc.), especially in the coming decade. We do, however, hold the view that bitcoin will offer the world a viable alternative to government-backed currencies.

Currently, the U.S. Dollar is still widely regarded as the global reserve currency for numerous reasons (the size and depth of U.S. financial markets, high percentage of global commodities priced in USD, etc.). As a result, the Fed has become one of the most powerful institutions on the planet. While price stability is one of the Fed's core mandates, few alternatives exist today to securely store wealth without the dampening effects of inflation, even as price increases the last several years have remained rather tame relative to prior cycles.

As an alternative reserve currency, bitcoin could encourage governments and government agencies to exercise more responsible fiscal and monetary policy for fear of losing market share to a programmable digital currency. This is not to say bitcoin will be become the world's universal currency in the near term, but we believe it could serve as a "check" on government policy, especially in developing economies.

Value Potential: Private Offshore Wealth

Challenging Swiss Bank Accounts

The ability to transfer and store wealth in a censorship-resistant way is one of the major value drivers for Bitcoin over the next decade. Offshore bank accounts have been relied upon for generations to store wealth, most notably because of the security and privacy they offer, but account owners are still subject to seizure risk by local jurisdictions. Foreign accounts will continue to be the dominant means for storing wealth outside one's country for the foreseeable future, but we are confident more individuals will turn to Bitcoin as an alternative solution as they become more comfortable with digital assets.

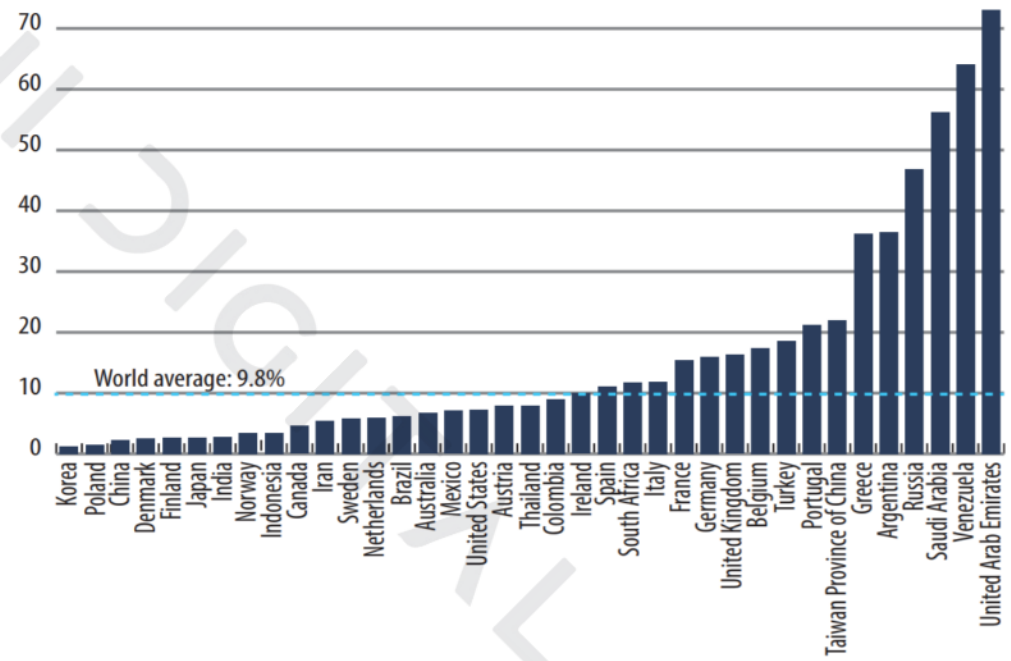
This trend may be accelerated by those seeking greater privacy for their wealth, especially as many of the world's traditional offshore havens have begun automatically sharing client information with appropriate tax authorities. Individuals should provide relevant information to proper authorities when necessary, regardless of how they store their wealth. The key difference, however, is the individual has true ownership of their wealth by directly holding their Bitcoin private key and, therefore, cannot have them wrongfully seized or frozen.

A reliable and secure way of storing one's wealth may seem like an afterthought for some, but no where is it more pronounced than developing countries with unstable economies and weak institutions. As Exhibit 1 highlights, citizens in countries like Venezuela and Greece store a sizable amount of wealth offshore. It is reasonable that the proliferation of Bitcoin as a secure store of wealth would begin in these countries, eventually trickling into more developed nations as early adopters see the advantages.

Creating a wallet and purchasing Bitcoin is already easier than setting up an offshore bank account, though the margin for error when sending funds is much greater given the current process for transferring and storing digital assets. Bitcoin's price volatility is also likely to remain an impediment to widespread adoption for some time, though we believe this will subside in the coming years as the market for digital assets matures. User-friendly applications and smaller price fluctuations should provide individuals with a safe, more convenient way to store their wealth than today's current options.

Exhibit 1

Private individuals use tax havens on a large scale in many parts of the world.
(offshore wealth as percent of GDP)



Source: Alstadsæter, Johannesen, and Zucman (forthcoming).
Note: Includes countries whose GDP exceeded $200 billion in 2007.

Data as of 2018

Sources: Boston Consulting Group ; Jannick Damgaard, Thomas Elkjaer, & Niels Johannesen

Value Potential: Private Offshore Wealth

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Projecting the amount of offshore wealth Bitcoin can absorb or the rate of adoption for such a use case is difficult, but even capturing a small portion of the demand for global offshore accounts creates significant upside for Bitcoin. It is estimated that individuals hold ~$8.2 trillion of wealth in offshore accounts globally, according to The Boston Consulting Group (BCG), which equates to roughly 10% of global GDP. Assuming this ratio remains unchanged and global GDP grows at an average rate of 3% for the next 10 years, the amount of wealth stored in foreign accounts will be just over $11 trillion.

Model Assumptions	
Time Horizon (Years)	10
Current BTC Price	$3,858
Bitcoin Supply in 10 Years	20,425,781
Global GDP	~$80 Trillion
Offshore Accounts % of Global GDP	10%
Total Wealth in Offshore Accounts	~$8.2 Trillion
Offshore Account CAGR Forecast (10yr)	3%
Total Offshore Accounts in 10 Years	~$11 Trillion

Given there are no projected cash flows to discount, we've used probability to account for risk. Conservatively assuming there's only a 10% chance that Bitcoin captures a quarter of that asset pool, the expected value of its total market size would be roughly $275 billion. Accounting for future coin inflation, this would result in a ~$13,500 price level for BTC, implying a ~13% compound annual growth rate over the next decade.

Total Market Value Captured by BTC in 10 years (Millions)

		Market Share			
		10%	25%	50%	75%
Probability	10%	$110,201	$275,503	$551,006	$826,509
	25%	$275,503	$688,757	$1,377,514	$2,066,271
	50%	$551,006	$1,377,514	$2,755,029	$4,132,543
	75%	$826,509	$2,066,271	$4,132,543	$6,198,814

Price of BTC in 10 Years (USD)

		Market Share			
		10%	25%	50%	75%
Probability	10%	$5,395	$13,488	$26,976	$40,464
	25%	$13,488	$33,720	$67,440	$101,160
	50%	$26,976	$67,440	$134,880	$202,320
	75%	$40,464	$101,160	$202,320	$303,480

10-Year Compound Annual Growth Rate (CAGR)

		Market Share			
		10%	25%	50%	75%
Probability	10%	3.4%	13.3%	21.5%	26.5%
	25%	13.3%	24.2%	33.1%	38.6%
	50%	21.5%	33.1%	42.7%	48.6%
	75%	26.5%	38.6%	48.6%	54.7%

**This analysis focuses exclusively on individual wealth storage. Many companies also store significant amounts of cash overseas, though the motivations typically differ (i.e. multinationals funding operations of foreign subsidiaries).*

Data as of December 4th, 2018

Sources: Boston Consulting Group, Blockchain.com, IMF

Key Attributes

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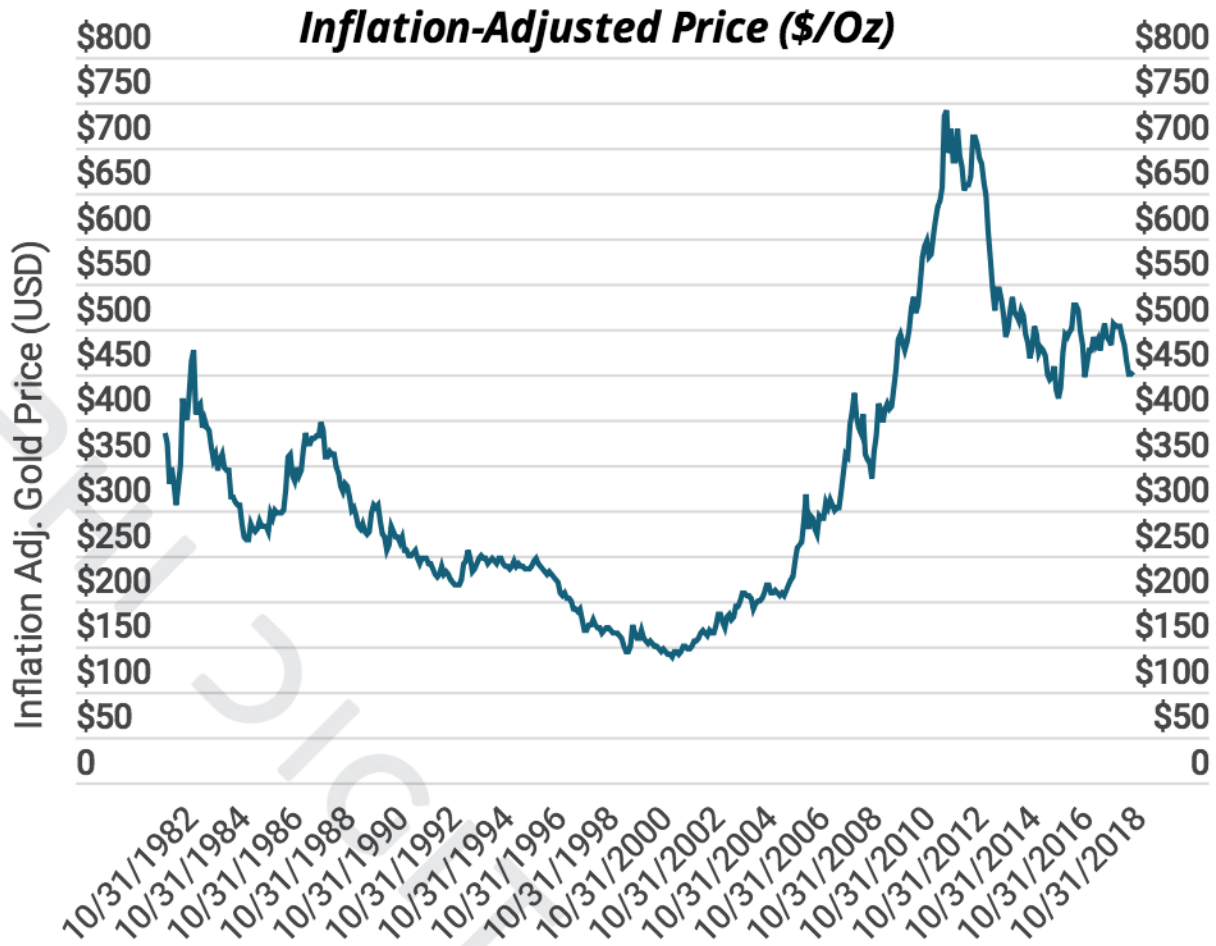
	Bitcoin	Gold	Fiat
Censorship Resistant	Perhaps it's most important feature. Centered around the idea that no entity should have the ability to seize your wealth or block a transaction.	While an improvement over fiat, gold's physical nature can make it difficult to shield from seizure.	Governments and banks can intervene to seize or freeze bank accounts and block transactions.
Divisible	Bitcoin is divisible out to 8 decimal places, which opens up the possibility for micropayments where txs can be completed for fractions of a cent.	While gold can be divided into smaller amounts, it becomes impractical to use small specks of gold in commerce.	Fiat currencies are easily divisible given they can go out to 2 decimal places.
Durable	Bitcoin will remain durable as long as the network remains secure. However, it has a short history and risks associated with it.	Gold is nearly indestructible, highly resistant to corrosion, and does not rust.	Fiat is only as durable as the institution issuing it. History is littered with situations where fiat currencies failed to maintain their value over the long term.
Established History	Bitcoin has a far shorter history than both gold and fiat, dating back roughly a decade.	Gold has a track record that dates back millennia and has arguably proven to be the best store of value in human history.	Fiat currencies in their current form are a product of the 20th century and largely the result of Nixon taking the US off the gold standard in 1971.
Fungible	Due to the transparency of the blockchain, bitcoins used for illicit purposes could be traced and refused as payment.	An ounce of melted down gold is always equivalent to another ounce of gold.	There have been instances where fiat denominations have been treated differently due to government policies.
Portable	Bitcoin can transfer value around the world in minutes, and there is no limit to the amount of wealth an individual can directly carry on them.	It can be moved and transacted in small amounts but becomes impractical when dealing with larger values because of its weight.	The digital transfer of fiat is easy, but can take a few days to settle and be subject to capital controls. Physically moving large quantities is difficult.
Scarce	Bitcoin's maximum supply is 21 million BTC with its inflation schedule predefined and governed by a mathematical formula.	While there clearly exists the possibility for the discovery of new reserves both on and off earth, it remains highly scarce.	Fiat lacks any true scarcity as governments can create more as needed and have the potential to issue an unlimited amount.
Verifiable	The underlying blockchain ensures authenticity and cryptographic signatures prove ownership.	Can easily be identified, however, gold can be faked or secretly filled with cheaper metals.	While fiat currencies are relatively easy to identify, fiat can be counterfeited.

Sources: Vijay Boyapati (although some ratings and analysis vary)

Gold as a Store of Value

Gold has served as the quintessential store of value for a large portion of human history, and more recently is often regarded as a hedge against adverse central bank policy or currency devaluation. While nearly every criteria we previously touched on plays a role in this narrative, we would argue durability, scarcity, and an established history are among the most important factors. Gold is difficult to destroy, incredibly rare, and boasts a track record spanning millennia. However, gold is not without its limitations. It is a poor medium of exchange in modern times, difficult to purchase (physical ownership), and is relatively costly to store. Most people gain exposure to gold through their brokerage account or financial advisor, which merely represents a digital claim on the physical asset, trust of a third-party to store the respective amount of gold.



An investment in gold is often regarded as a way to hedge against inflation given its store-of-value characteristics. While this is typically true over the long-term, there have been periods where gold lost a significant amount of purchasing power over the last few decades. An investment in the precious metal in 1Q 1982 rendered a 60%+ loss in purchasing power 20 years later. Gold prices have since rebounded on an inflation-adjusted basis, but it is important to note the old adage gold is a strong inflationary hedge depends on the time period.

Data as of October 31st, 2018

Sources: Federal Reserve Bank of St. Louis

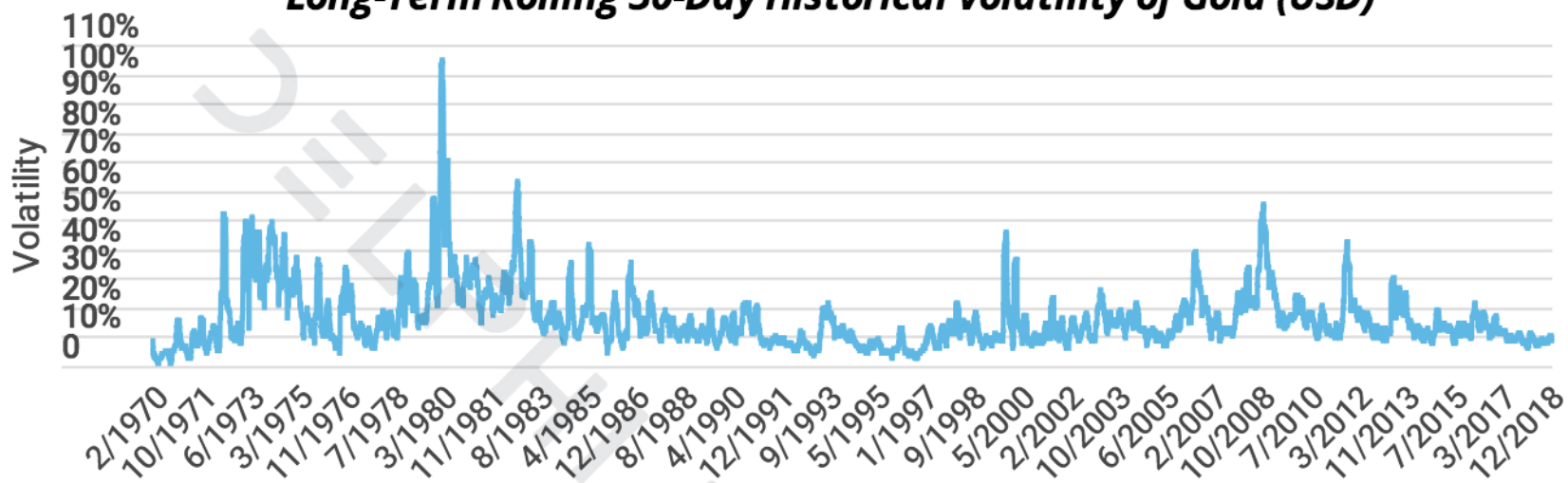
Bitcoin as An Alternative Store of Value

Bitcoin in its current state trails gold in some categories, but long-term we believe it is poised to thrive in an increasingly digital age. A reliable internet connection is arguably one of the biggest barriers to entry for purchasing bitcoin, opening the doors to ownership for countless individuals globally. Its programmable scarcity is a key feature earning it the nickname "digital gold."

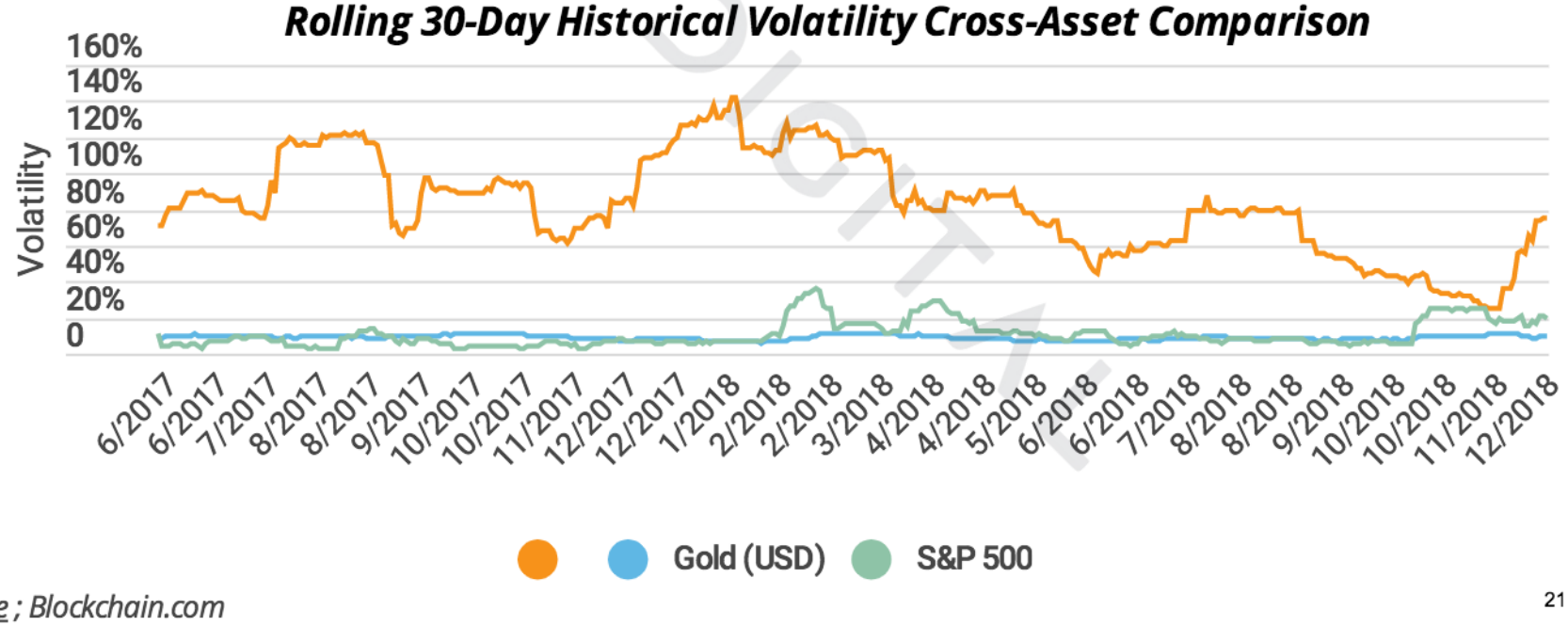
One of the primary criticisms to bitcoin's store of value use case is its price volatility. Bitcoin has been one of the most volatile assets in recent years, but we expect this trend to decline over time as it matures. The price of gold fluctuated substantially in the initial years following the United States' break from the gold standard before eventually settling to a more subtle trading range as we're accustomed to today. As expected, Bitcoin's volatility has followed a similar trajectory, albeit to a significantly larger degree, given its relatively short existence.

A long track record inspires trust, a crucial element for any asset to be accepted as a store of value. The Lindy effect implies that each additional year Bitcoin survives extends its remaining life expectancy. This may seem overly simplified, as Bitcoin certainly faces its fair share of risks (covered later in this report), but the longer the track record for a new and revolutionary technology, the more likely it is to survive in the future. Would companies invest so much capital in e-commerce if people weren't on the internet yet? Would the government build highways if only a few people had cars? Bitcoin is an evolution in money and value transmission, but it will likely take time to build broad-based trust as gradual progress continues to be made.

Long-Term Rolling 30-Day Historical Volatility of Gold (USD)



Rolling 30-Day Historical Volatility Cross-Asset Comparison



Data as of December 3rd, 2018

Sources: Federal Reserve Bank of St. Louis ; Yahoo Finance ; Blockchain.com

Value Potential: Investible Gold Market

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It is unlikely Bitcoin replaces the entire investible gold market over the next decade, but there is a reasonable chance it commands a small allocation in traditional portfolios as a complement to gold in our view.

Over the next ten years, it is likely a gold-backed digital asset gains popularity. This would eliminate many of the barriers to entry for gaining exposure to the precious metal, but does not offer the same ownership benefits that Bitcoin does. Buying a gold-backed digital asset requires a centralized entity to store that amount of gold, so a digitized version likely replicates many of today's existing options (i.e. gold-backed ETFs, etc).

Model Assumptions	
Time Horizon (Years)	10
Current BTC Price	$3,858
Bitcoin Supply in 10 Years	20,425,781
Current Gold Price ($/oz)	$1,238
Current Gold Price/Metric Ton	$39,803,00
Global Gold Supply (Tonnes)	187,200
Total Global Gold Supply	~$7.5 Trillion
% Gold Held as Private Investment	25%
Total Gold Held as Priv. Investment	~$1.9 Trillion
10-Year Growth Rate	2%

If the ~$1.9 trillion of gold used today for private investment grows at a modest 2% rate per year, the expected value of Bitcoin would be roughly $13,900 assuming a 25% chance it captures half the value of the investible gold market at the time. This would imply a nearly 14% compound annual growth rate over the next ten years.

Total Market Value Captured by BTC in 10 years (Millions)

		Market Share			
		10%	25%	50%	75%
Probability	10%	$22,707	$56,767	$113,535	$170,302
	25%	$56,767	$141,918	$283,837	$425,755
	50%	$113,535	$283,837	$567,674	$851,510
	75%	$170,302	$425,755	$851,510	$1,277,265

Price of BTC in 10 Years (USD)

		Market Share			
		10%	25%	50%	75%
Probability	10%	$1,112	$2,779	$5,558	$8,338
	25%	$2,779	$6,948	$13,896	$20,844
	50%	$5,558	$13,896	$27,792	$41,688
	75%	$8,338	$20,844	$41,688	$62,532

10-Year Compound Annual Growth Rate (CAGR)

		Market Share			
		10%	25%	50%	75%
Probability	10%	-11.7%	-3.2%	3.7%	8.0%
	25%	-3.2%	6.1%	13.7%	18.4%
	50%	3.7%	13.7%	21.8%	26.9%
	75%	8.0%	18.4%	26.9%	32.1%

Data as of December 4th, 2018
Sources: World Bank, World Gold Council

**This analysis focuses exclusively on gold held as a private investment and excludes central bank reserves, which is addressed in the next section.*

Value Potential: Central Bank Gold Reserves

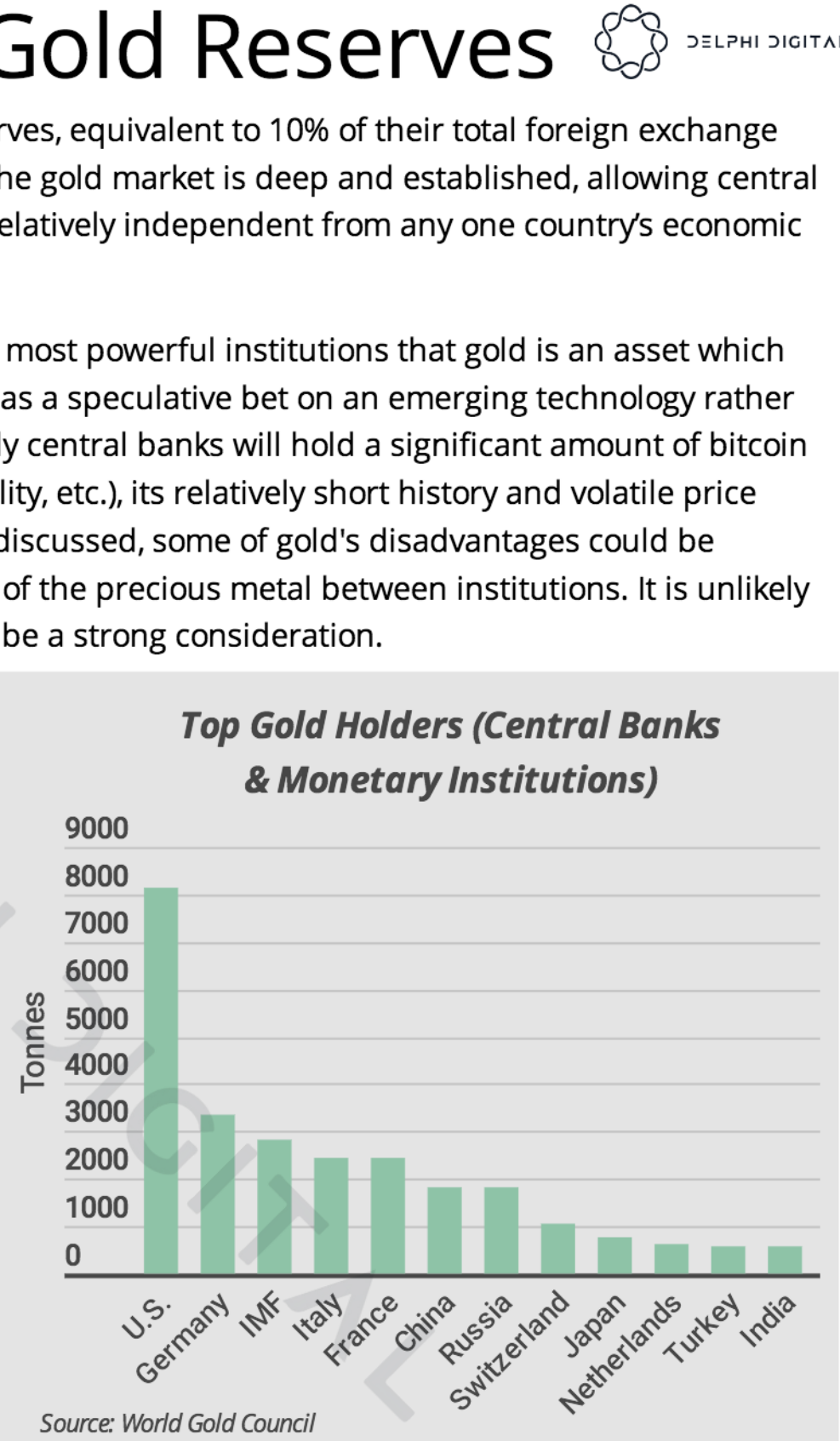
The IMF estimates global central bank sector holds around $1.4 trillion of gold reserves, equivalent to 10% of their total foreign exchange reserves. Central banks hold gold reserves for numerous reasons. The liquidity of the gold market is deep and established, allowing central banks or monetary institutions quick access to funds if emergencies arise. Gold is relatively independent from any one country's economic policies as it is not issued by any government, giving it no credit or default risk.

The kicker fueling the demand for gold is the widely accepted notion by the world's most powerful institutions that gold is an asset which retains value. Bitcoin, on the other hand, is still largely viewed by many institutions as a speculative bet on an emerging technology rather than a replacement or complement to physical gold, which is we believe it is unlikely central banks will hold a significant amount of bitcoin in the foreseeable future. While it may offer several advantages (portability, divisibility, etc.), its relatively short history and volatile price fluctuations are impediments to an established alternative like gold. As previously discussed, some of gold's disadvantages could be overcome by a digitized, gold-backed asset that allows for faster, cheaper transfers of the precious metal between institutions. It is unlikely this would solve the issue of centralization, but for central banks this may not even be a strong consideration.

Earlier this year, Ronan Manly of BullionStar surveyed dozens of the world's largest central banks to understand their primary motivations for holding gold as a reserve asset. One of the most notable responses came from the Polish central bank (Narodowy Bank Polski), which stated, "the main features which support the unprecedented role of gold at the same time constitute the rationale for holding gold within central bank's reserves. These are: lack of credit risk, independence from any country's economic policy, limited size of the resource, physical features such as durability and almost imperishability." Sounds a bit familiar.

It is important to note even if central banks wanted to dump their gold reserves in favor of a suitable alternative, there are limitations to the amounts they can sell in any given year. The Central Bank Gold Agreement, for example, signed by the ECB and several other central banks, states "signatories will continue to coordinate their gold transactions so as to avoid market disturbances." One institution liquidating a large portion of its gold reserves could spark a lot of

Top Gold Holders (Central Banks & Monetary Institutions)



Source: World Gold Council

Data as of December 4th, 2018Sources: IMF, ECB, World Gold Council

Value Potential: Central Bank Gold

There is a case to be made for central banks to hold a small portion of bitcoin in their reserves as a complement to gold if it matures into an accepted store of value. The amount held by central banks could potentially increase if a portion is also stored as foreign exchange reserves. However, this is largely dependent on whether bitcoin becomes widely viewed as an alternative reserve currency to government-issued fiat currencies. Estimating an exact dollar figure for the total value of bitcoin central banks and monetary institutions may eventually end up holding is unlikely to be accurate at this stage, which is why we use rather conservative assumptions given the projected amount of gold reserves held by central banks today.

Model Assumptions	
Time Horizon (Years)	10
Current BTC Price	$3,858
Bitcoin Supply in 10 Years	20,425,781
Current Gold Price ($/oz)	$1,238
Current Gold Price/Ton	$39,803,000
Global Gold Supply (Tonnes)	187,200
Total Global Gold Supply	~$7.5 Trillion
% Gold Held as Central Bank Reserves	18%
Total Gold Held by Central Banks	~$1.4 Trillion
10-Year Growth Rate	2%

If the ~$1.4 trillion of gold reserves held by central banks grows at a similarly modest 2% rate per year, the expected value of bitcoin would be roughly $10,000 assuming a 25% chance it captures half the total value of future gold reserves. This would imply a 10% compound annual growth rate over the next ten years.

Total Market Value Captured by BTC in 10 years (Millions)

		Market Share			
		10%	25%	50%	75%
Probability	10%	$16,379	$40,946	$81,893	$122,839
	25%	$40,946	$102,366	$204,732	$307,099
	50%	$81,893	$204,732	$409,465	$614,197
	75%	$122,839	$307,099	$614,197	$921,296

Price of BTC in 10 Years (USD)

		Market Share			
		10%	25%	50%	75%
Probability	10%	$802	$2,005	$4,009	$6,014
	25%	$2,005	$5,012	$10,023	$15,035
	50%	$4,009	$10,023	$20,046	$30,070
	75%	$6,014	$15,035	$30,070	$45,105

10-Year Compound Annual Growth Rate (CAGR)

		Market Share			
		10%	25%	50%	75%
Probability	10%	-14.5%	-6.3%	0.4%	4.5%
	25%	-6.3%	2.7%	10.0%	14.6%
	50%	0.4%	10.0%	17.9%	22.8%
	75%	4.5%	14.6%	22.8%	27.9%

Data as of December 4th, 2018
Sources: IMF, BullionStar, World Gold Council

Value Potential: Putting the Pieces Together

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The upside potential for bitcoin is immense assuming it captures even a modest portion of the total assets held in offshore bank accounts, the investible gold market, and central bank gold reserves. The most significant of these (the value held in offshore accounts) is also one of the more compelling use cases in the near- to intermediate-term. We believe the transition process of holding portions of private wealth will be gradual, but over the long-term can serve as a significant source of demand for bitcoin. As more private wealth is successfully stored in the world's largest cryptocurrency, more conservative institutions (central banks, state and local pension funds, etc.) are likely to follow suit as they become more comfortable with digital assets.

Bitcoin can serve as a store of value in a number of different scenarios. Assuming we assign a mere 10% probability bitcoin captures 25% of the total value of the aforementioned pool of assets, the expected value of BTC would be roughly $18,000. Using a ten year time horizon, this would imply a 17% compound annual growth rate (CAGR) over the next decade. If we bump up the probability from 10% to 25%, the expected value of BTC jumps to over $45,000, implying a 28% CAGR. On the other hand, a 10% probability bitcoin captures only 10% of the total asset value still results in an expected value of $7,300 per bitcoin. Given the most recent market sell-off, this more conservative scenario still renders an implied CAGR of almost 7% over the next ten years.

While we remain very constructive on the long-term outlook for bitcoin, there are many hurdles it must overcome before it can become an alternative means of storing value. Price volatility, secure custody solutions, and global regulatory uncertainty are just a few of the challenges currently suppressing demand for bitcoin. Barring any major disruptions to its network, however, over the long run we foresee bitcoin serving as a staple allocation in traditional investment portfolios, central bank reserves, and as a suitable alternative for a portion of assets held in offshore accounts.

Total Market Value Captured by BTC in 10 years (Millions)

		Market Share			
		10%	25%	50%	75%
Probability	10%	$149,287	$373,217	$746,433	$1,119,650
	25%	$373,217	$933,042	$1,866,083	$2,799,125
	50%	$746,433	$1,866,083	$3,732,167	$5,598,250
	75%	$1,119,650	$2,799,125	$5,598,250	$8,397,376

Price of BTC in 10 Years (USD)

		Market Share			
		10%	25%	50%	75%
Probability	10%	$7,309	$18,272	$36,544	$54,816
	25%	$18,272	$45,680	$91,359	$137,039
	50%	$36,544	$91,359	$182,718	$274,078
	75%	$54,816	$137,039	$274,078	$411,117

10-Year Compound Annual Growth Rate (CAGR)

		Market Share			
		10%	25%	50%	75%
Probability	10%	6.6%	16.8%	25.2%	30.4%
	25%	16.8%	28.0%	37.2%	42.9%
	50%	25.2%	37.2%	47.1%	53.2%
	75%	30.4%	42.9%	53.2%	59.5%

Inflation Rate & Supply

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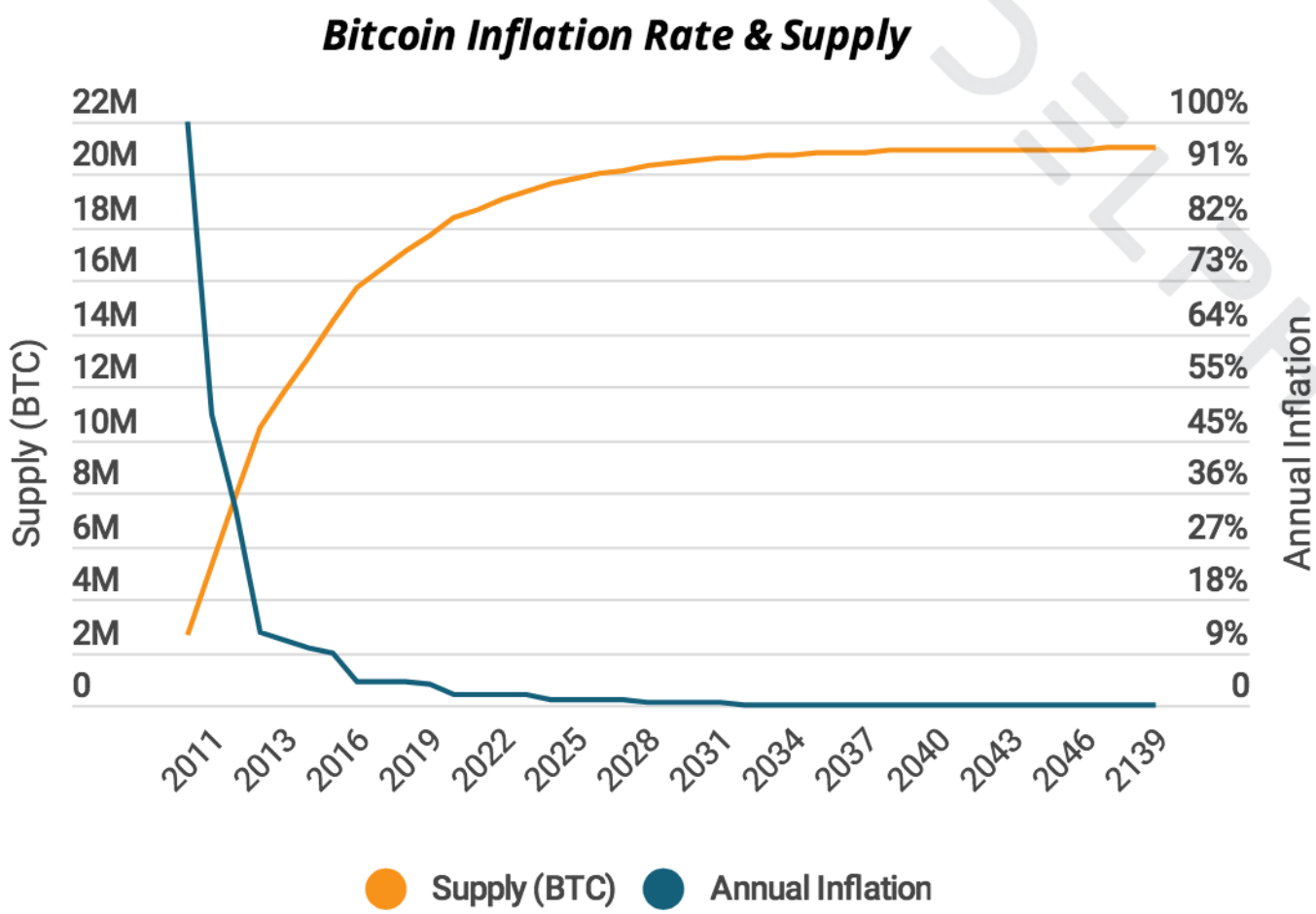
A good store of value must have scarcity. Bitcoin's disinflationary growth and finite supply make it an ideal asset for this purpose. The creation of new bitcoin is governed by a mathematical formula and the maximum supply has already been set at 21 million BTC. Depicted in the chart below, we can observe the projected inflation schedule. Bitcoin's inflation rate has been falling dramatically since its inception, and in 2018 the annualized rate was 3.85%. By 2024, Bitcoin's annual inflation will drop below 1% for the first time ever as it gradually trends towards 0 over the coming century. Periods where a heavy supply of bitcoin was regularly coming to market has already passed, especially given miners are typically some of the largest sellers (in order to fund operations). We expect future increased demand to coincide with a lack of new supply, reinforcing our long term outlook on bitcoin's potential price performance.



Key Stats	
2018 Inflation Rate	3.85%
2019 Inflation Rate	3.70%
Average Block Time	10 minutes
Current Block Reward	12.5 BTC
Projected Next Halving Date	May 2020
Next Block Halving	630,000
Next Block Reward	6.25 BTC
Total BTC Mined	17,408,800
% of BTC Already Mined**	82.9%
Blocks Per Day	~144
BTC Mined Per Day	~1,800 BTC
Blockchain Size*	~200 GB

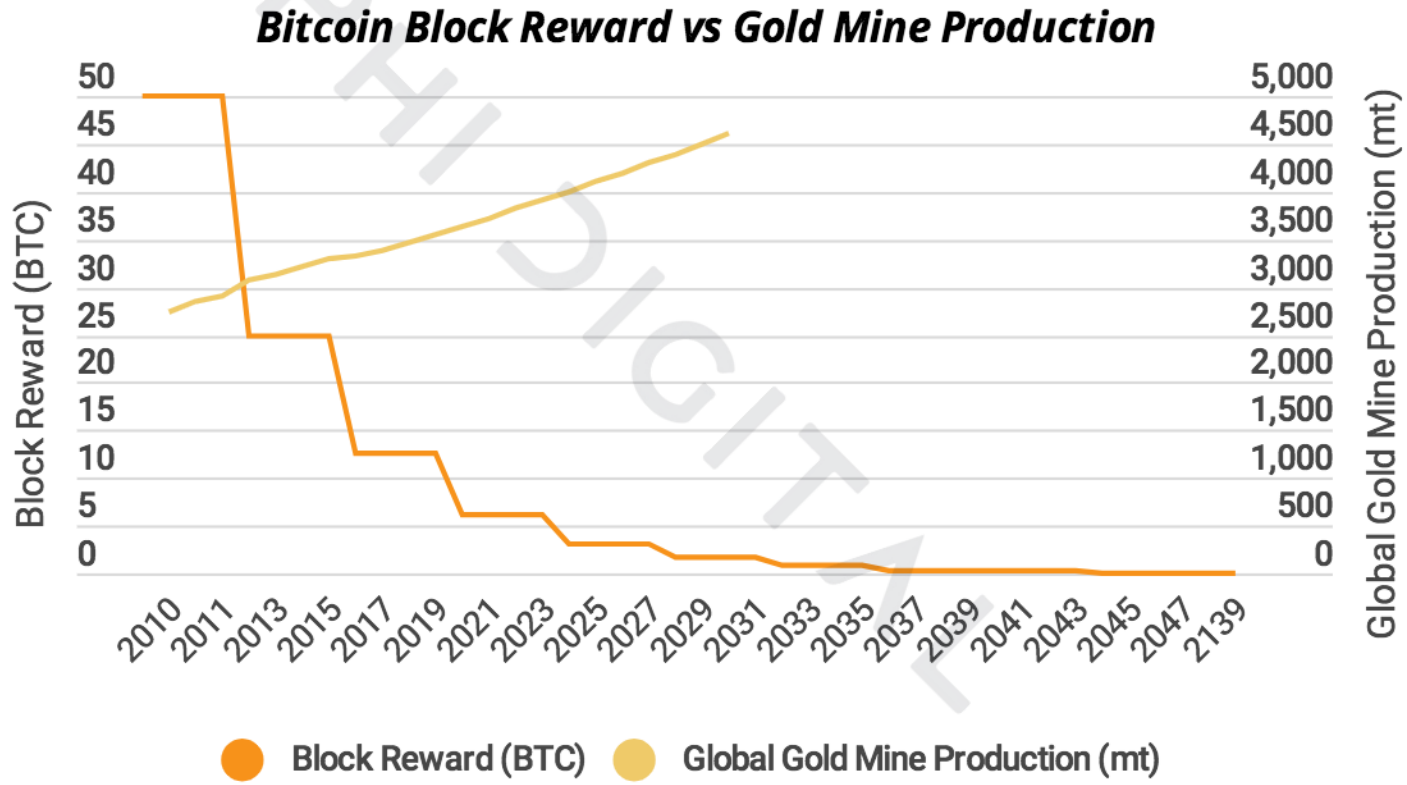
Data as of December 4th, 2018
Sources: Blockchain.com, Coin.dance

Block Reward vs. Mine Production

Now that we've established how the growth rate of Bitcoin's supply is set to slow and eventually end, let's compare this to growth in the gold supply. Global mining production for gold has averaged 3,065 tonnes annually since 2010, with a compound annual growth rate of 2.4%. By taking this average and growing it with the CAGR we've derived, the annual future supply from gold mining has been projected in the chart below. We eventually hit the upper limit in ~2031 where miners have exhausted the known below ground gold reserves that hold an estimated 54,000 tonnes. This is a simplified projection that does not take into account a variety of factors that impact mine production, and does not incorporate the discovery of future gold deposits which are likely to occur. However, this projection, when compared to Bitcoin's block reward, allows us to further illustrate Bitcoin's scarcity over the intermediate term.

It's important to note that Bitcoin's decreasing block reward also represents a risk to its durability. Without any changes, if block rewards drop too low and a robust market for on-chain fees fails to develop, the security of Bitcoin's network could weaken as the economic incentive to participate as a miner is reduced. Given that a majority of miner revenue is derived from the block reward, this is especially pronounced. In such a situation, others have proposed the need to reinstate some form of inflation, or move away from PoW mining all together. Neither idea is very palatable to staunch Bitcoin supporters and enacting either change would be incredibly difficult. It is our opinion that if necessary, the network would probably choose to move away from PoW mining rather than instate inflation. We touch on this subject more within our Key Risks & Mitigants section.

Key Stats	
Estimated Below Ground Gold Reserves	54,000 tonnes
CAGR (2010-2017)	2.4%
Average Annual Supply Mined (2010-2017)	3,065 tonnes



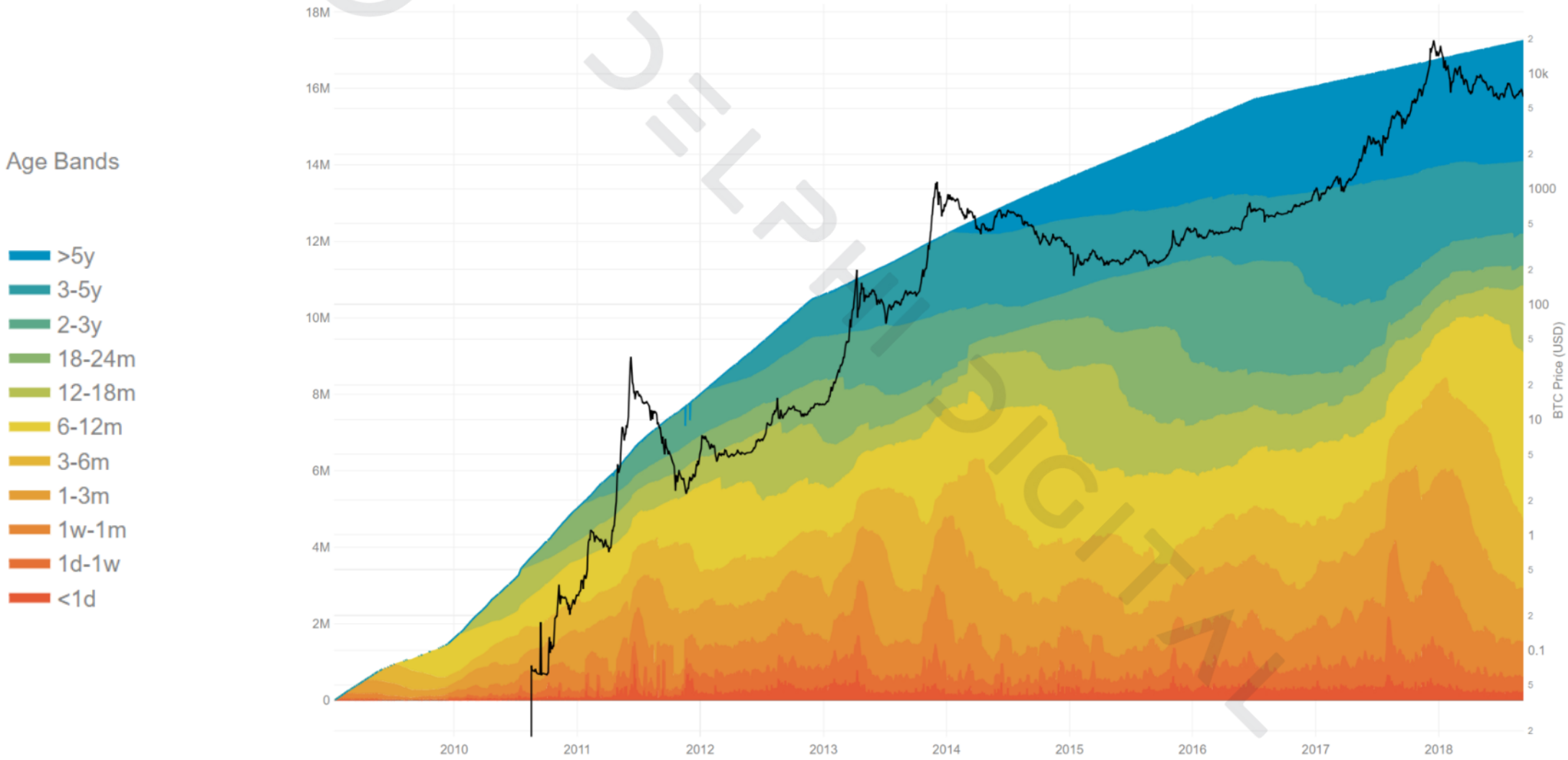
Data as of 2017

Sources: World Gold Council

UTXO Distribution

While we've outlined above how the current total supply is ~17.4 million BTC, that is not really the complete picture. By analyzing the Bitcoin UTXO age distribution, as seen below, we can observe that roughly 1/3 of the Bitcoin in circulation have not moved in at least 3 years. This can be presumed to be a combination of two things: (1) there are long term holders with a strong enough conviction in Bitcoin that they were not interested in liquidating at these historically high levels, and (2) the private keys that access these bitcoins have been lost and will remain lost indefinitely. Chainalysis completed a thorough analysis of bitcoins that are likely lost and came to an estimate ranging from 2.78-3.79 million coins. Both scenarios are positive, either reflecting strong faith in Bitcoin or an even scarcer supply than is commonly recognized.

Bitcoin UTXO Age Distribution



Data as of 2018

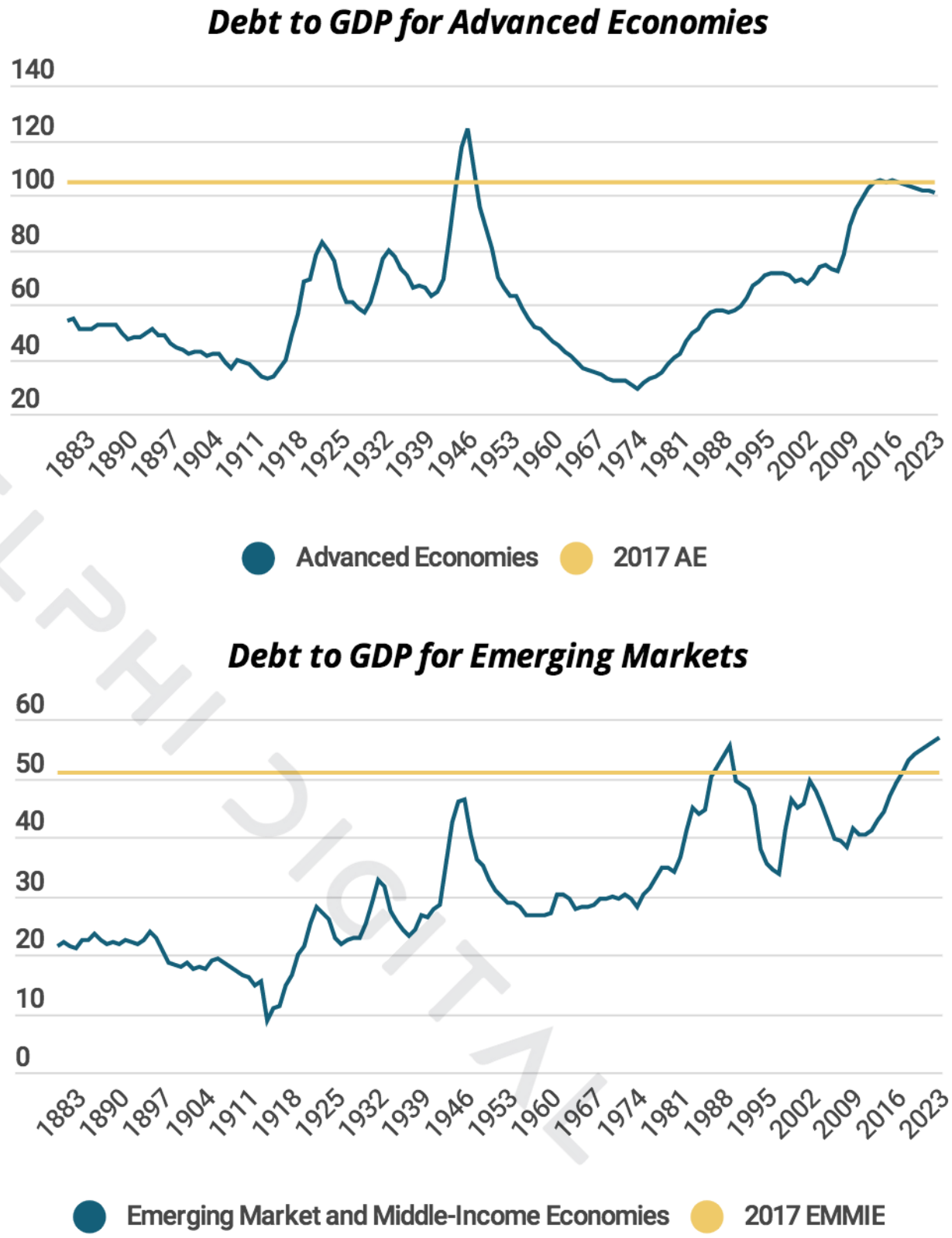
Sources: Chainalysis, Dhruv Bansal (Unchained Capital)

Global Fiscal Overview

Now that we've highlighted how Bitcoin compares to gold as a store of value its important to understand the potential this type of asset could have over the long term. In the IMF's April 2018 Fiscal Monitor, the organization issued a warning to governments due to global debt hitting an all time high of $164 trillion in 2016. Debt in advanced economies is at a level not seen since World War 2, with emerging market debt at levels last experienced during the 1980's debt crisis. In 2017, more than one-third of advanced economies had debt above 85 percent of GDP, three times more countries than in 2000.

The IMF also highlights the risk the United States runs not reigning in their debt now by stating *"lower corporate and personal income tax rates will give rise to overall deficits in excess of $1 trillion over the next three years (above 5 percent of GDP), and debt is projected to increase to 117 percent of GDP by 2023."* This could be problematic in the event of another financial crisis, weakening the efficacy of government policies deployed in response.

To quote former Vice President Dick Cheney, *"Deficit's don't matter"*. That's certainly proven true so far. However, over the long term there could be ramifications especially when total government liabilities are taken into account.



Data as of 2018

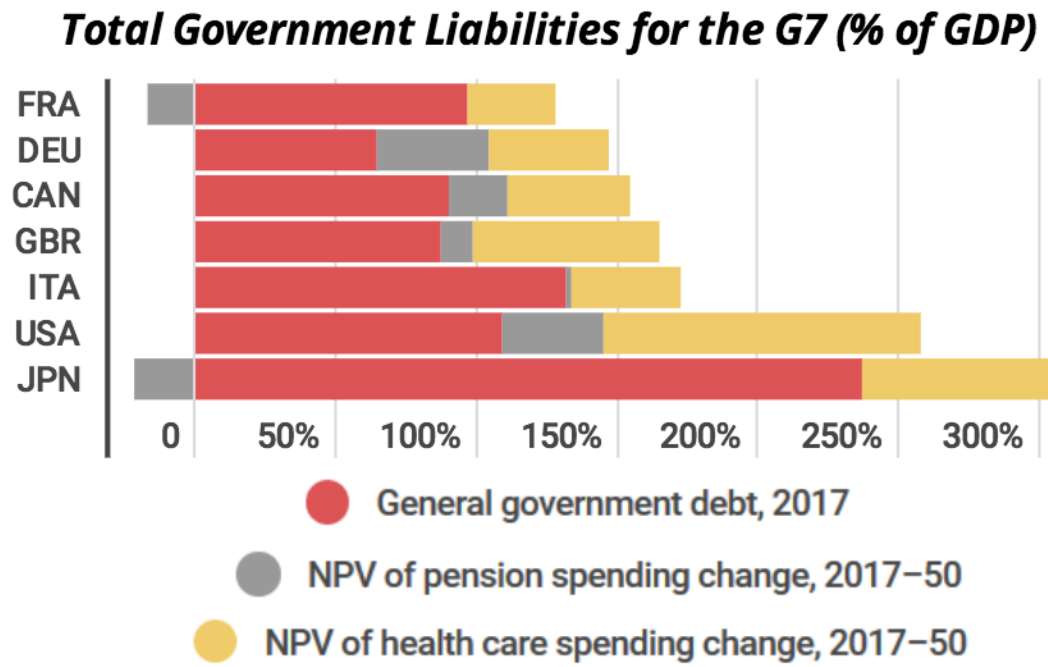
Sources: IMF Fiscal Monitor

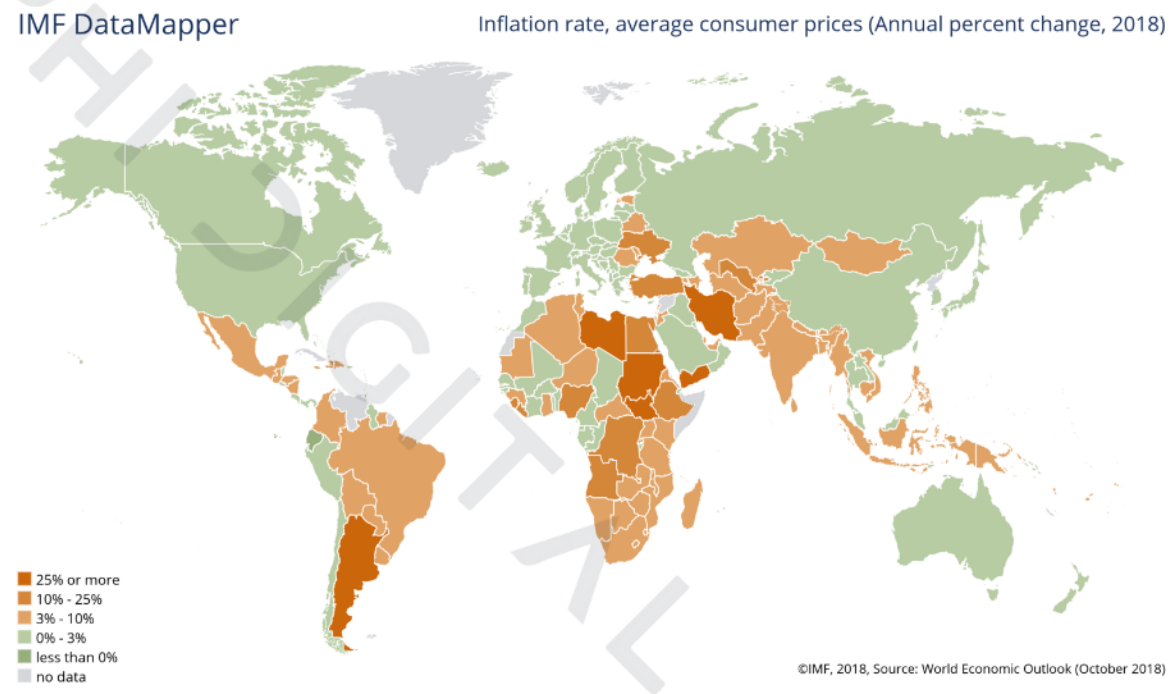
Global Fiscal Overview

As seen in the chart to the right, when assessing full government liabilities, including pension and healthcare obligations, it's clear that the debt burdens faced by many countries are more severe than it seems.

This isn't to say that the United States is on the verge of an imminent financial crisis, or that the fiscal situation won't improve over the long term. It is simply to highlight the reality that global debt levels are historically high and there are ramifications if that continues to trend up. As history has shown many times, when debt reaches unsustainable levels it typically results in a devaluation of the currency and higher inflation.

Debt can be a tool and a crutch. It can be used to stimulate economic growth, but a growing deficit can burden an economy as growth trails off. The long-term structural outlook for U.S. Dollar, for example, may be bleak if the U.S. prints money to fund its fiscal deficit. The ability to do this is the exception rather than the rule, however, as the USD is regarded as the global reserve currency. Other countries, especially those in developing markets, do not share this luxury.





Data as of 2018

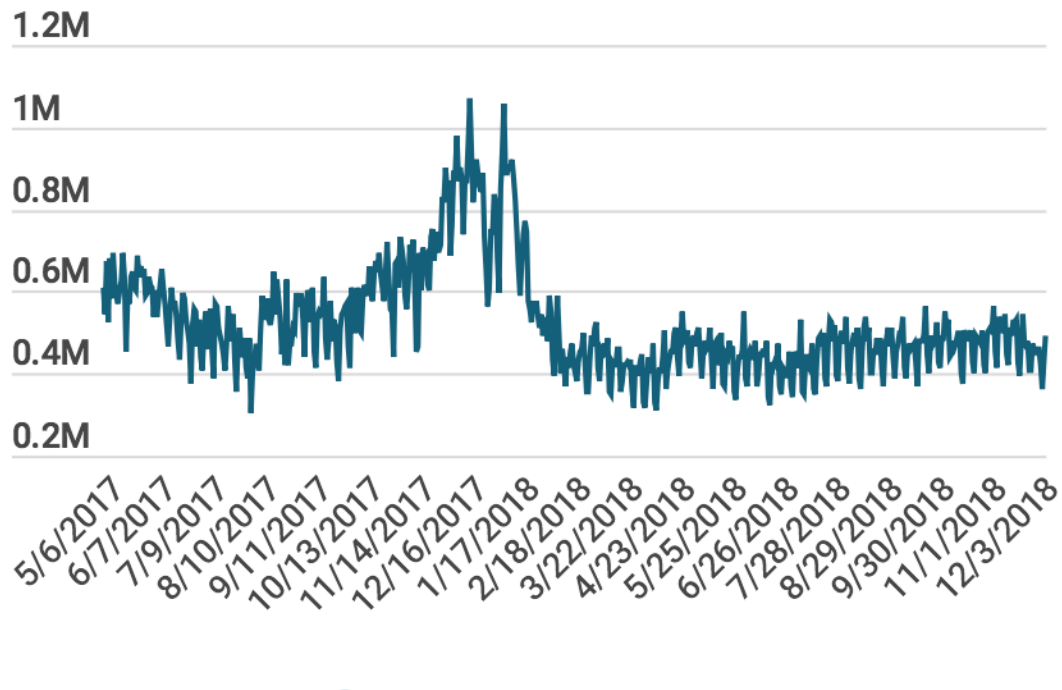
Sources: IMF Fiscal Monitor ; IMF Data Mapper

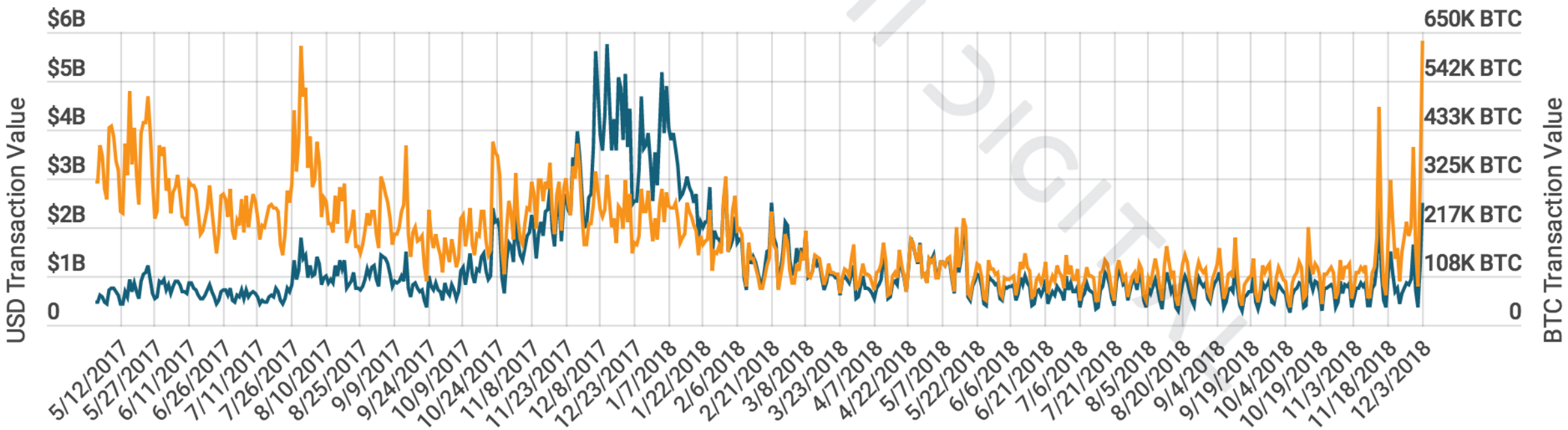
Medium of Exchange

The Road To Medium of Exchange

Bitcoin faces many headwinds for its usage as a currency. It's disinflationary nature means that a holder is less likely to spend it today because they think it will be worth more in the future. This principle is why many economists fear deflation and its effects to slow an economy. Merchant adoption will also play a large factor and be dependent on payment processing. Fortunately, there are commerce solutions now being offered by firms like Coinbase. In addition, Bitcoin faces competition from traditional fiat currencies, other cryptocurrencies, and stablecoins.

Even with these challenges, Bitcoin still has the potential to work as a payment network if scaling solutions such as Lightning Network succeed. In fact, with the eventual absence of the block reward, there will need to be a large amount of transactions to facilitate a justifiable fee market for miners. In order for Bitcoin to work as a medium of exchange, we believe it first needs to establish itself as a store of value to help reduce its volatility. Throughout this section we will highlight Bitcoin's potential strengths as a currency and where opportunities may exist in the intermediate term.





Data as of December 3rd, 2018

Sources: Blockchain.com

Emerging Market Opportunities

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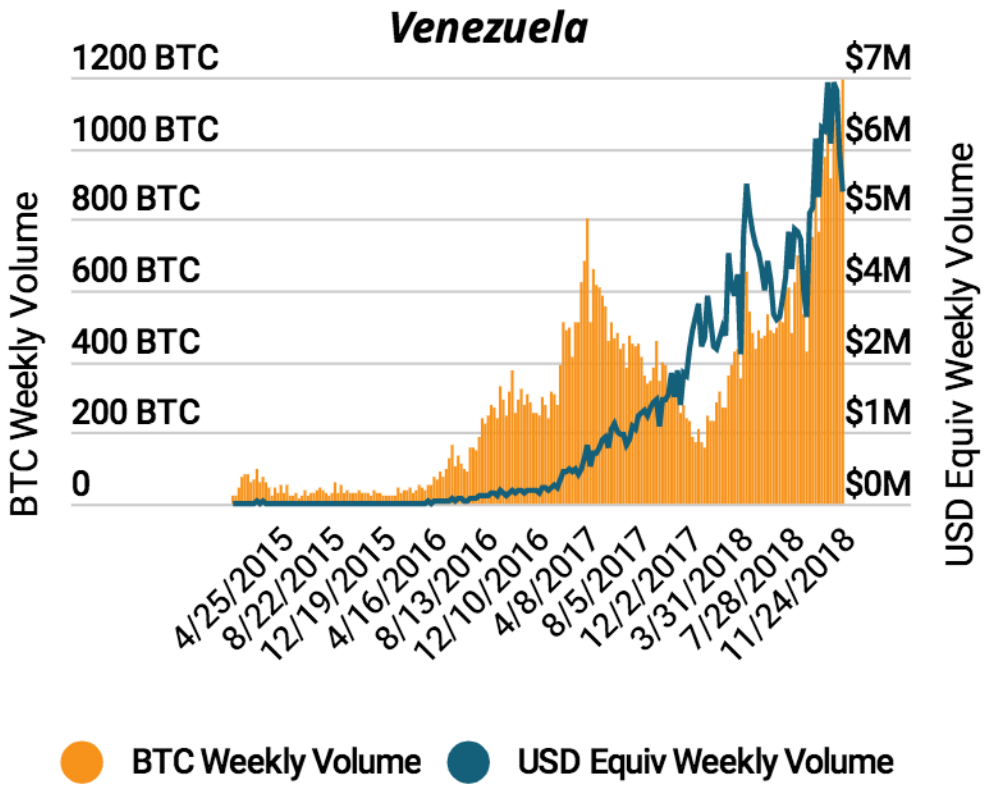
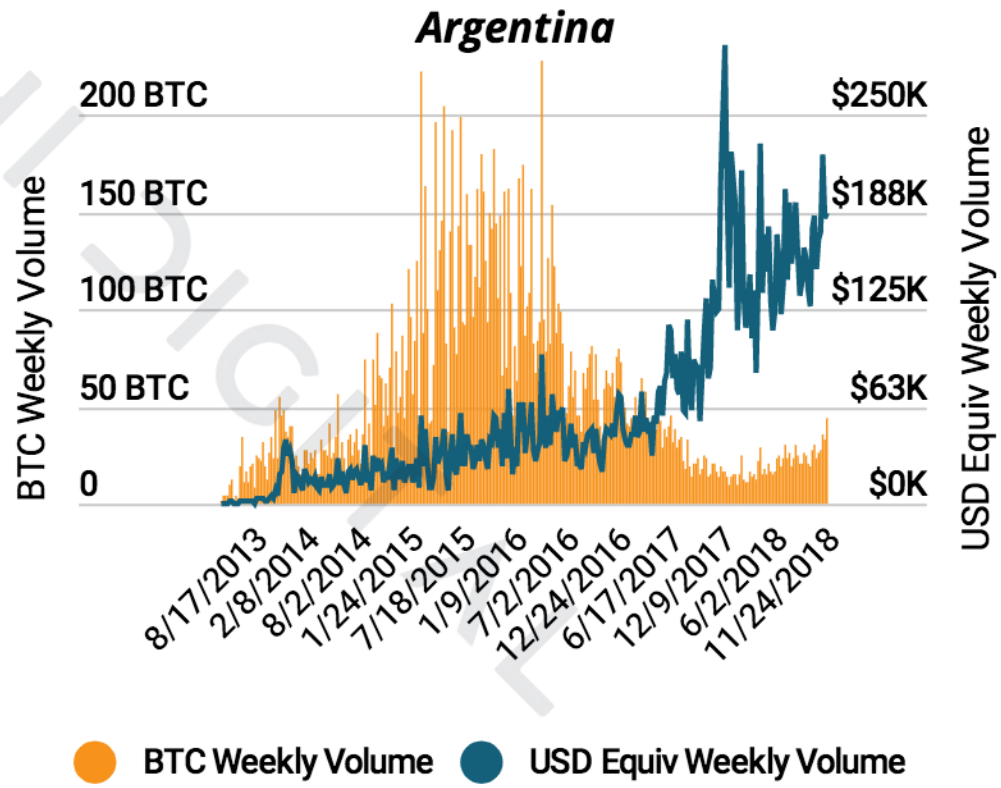
Bitcoin offers less utility as a method of payment for users in developed economies with reliable institutions and stable currency. However, in the near to intermediate term, we believe Bitcoin can offer utility to citizens in emerging markets and developing economies around the world for the following reasons.

1) As an alternative to local currencies suffering from high or hyperinflation
2) By allowing citizens to hold their wealth directly, rather than trust a local bank
3) To improve the speed and reduce transaction fees for sending remittances

In the past, when high inflation took hold in a person's country, there was little that they could do except watch as their purchasing power evaporated. Now, however, any person with internet access has the option to insulate themselves from local currency risk by switching to Bitcoin. Essentially, Bitcoin can offer a check on government power and policy while providing a vital safe haven for people from all around the world. Below, we explore this emerging markets hypothesis further by evaluating how Bitcoin has traded in countries currently suffering from high inflation. This analysis only includes data provided by LocalBitcoins, a service that facilitates OTC trading for Bitcoin in local currencies. As a result, this should be seen as an incomplete assessment of total Bitcoin trading in these countries. Even with the fall in prices throughout 2018, we've seen steady growth in USD adjusted volume over the past year. This is particularly pronounced in Venezuela, which should not be a surprise given that estimated annualized inflation for 2018 could range from 52,855% to 2,500,000% (depending on the source). It's important to highlight that volume is still low on a nominal basis, making it too early to say that Bitcoin has taken hold in a meaningful way. However, markets such as these will be important to monitor moving forward.





Data as of November 24th, 2018

Sources: Blockchain.com, IMF, LocalBitcoins & Coin.dance, Steve Hanke (John Hopkins; Cato Institute)

An Alternative To High Inflation

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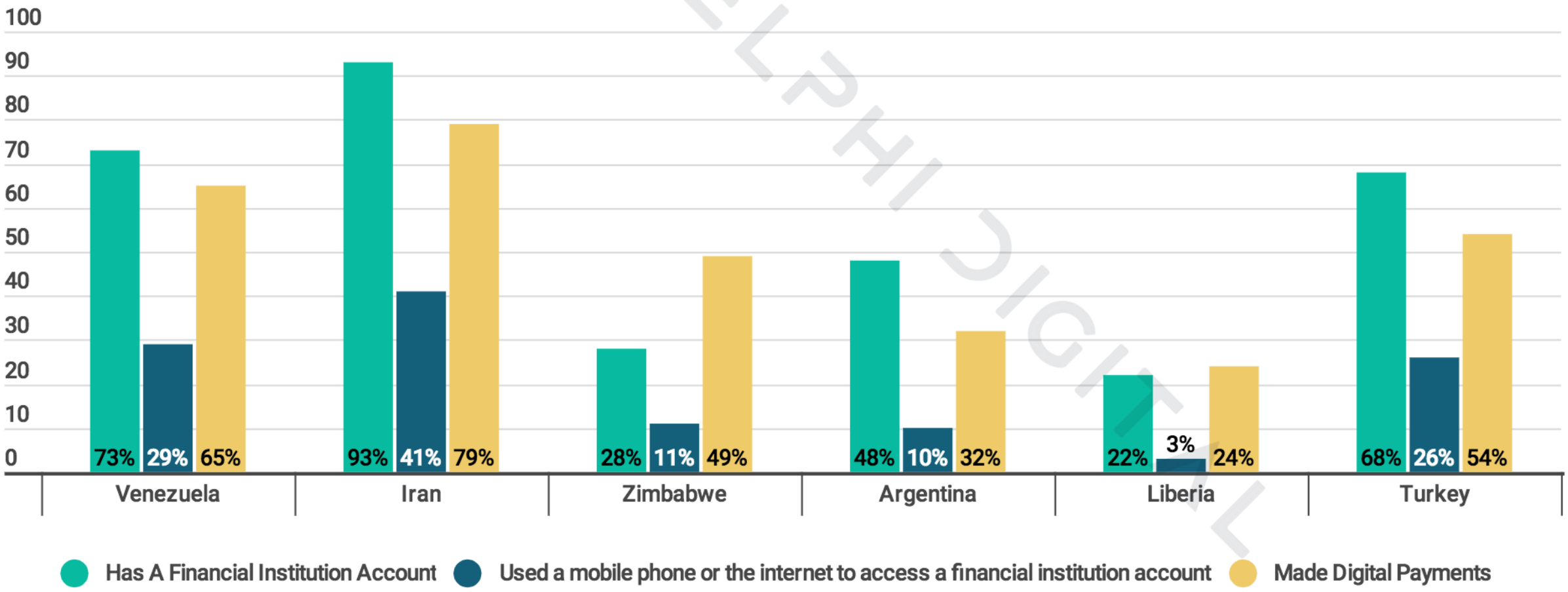
Accessibility in Countries with High Inflation

Country	Free-Market Exchange Rate	Date of Information	Hanke Annual Measured Inflation	IMF Year - End Inflation Projection	Hanke - IMF Differential
Venezuela	42,105,000 VEF/USD	11/29/2018	52,855%	2,500,000%	-2,447,145% pts
Iran	116,000 IRR/USD	11/29/2018	189%	47.8%	141% pts
Zimbabwe	4.91 "zollars"/USD	11/29/2018	173%	6.3%	167% pts
Argentina	38 ARS/USD	11/29/2018	115%	40.5%	75% pts
Liberia	161.06 LRD/USD	7/18/2018	36%	27%	9% pts
Turkey	5.22 TYR/USD	11/29/2018	35%	20%	15% pts



Data as of 2017 (unless stated otherwise)

Sources: IMF, Steve Hanke (John Hopkins; Cato Institute), World Bank Global Findex

Accessibility

Bitcoin can also help boost financial inclusion in developing economies. There are estimated to be 1.7 billion adults globally that lack a bank account, however, two-thirds of them have a mobile phone. This illustrates an important point about the proliferation of technology even in the developing world. With Bitcoin, all that's necessary is a device connected to the internet and these financially excluded residents can become their own bank and join a new financial system.

In the World Bank's Global Findex database, the most commonly cited reason for not having an account was a lack of money. Bitcoin may not be able to help with that problem, but it can address the next most common responses including accounts being too expensive, financial institutions are too far away, people lacking the necessary documentation, and a lack of trust.

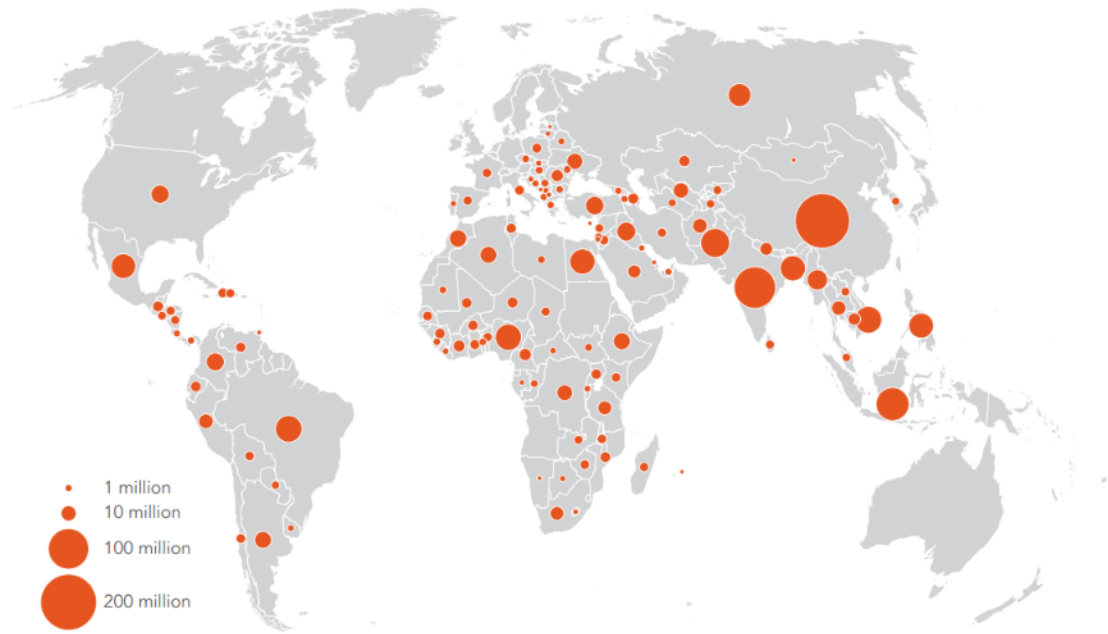
Bitcoin's censorship resistant nature plays an important role in providing these citizens with a valuable tool, and answer for their lack of trust. With Bitcoin, these people no longer need to fear that a local government, bank, or company can seize their assets. This is particularly important in countries with autocratic regimes, weak rule of law, and capital controls. While the rich have always found ways to hide money offshore and out of reach, Bitcoin can now offer similar protection to the average person around the world.

We can already see replacements for traditional bank accounts starting to take hold, such as mobile money accounts. These are electronic wallet services that allow users to hold, send, and receive money through their mobile phone. If this concept sounds familiar to Bitcoin, it should.

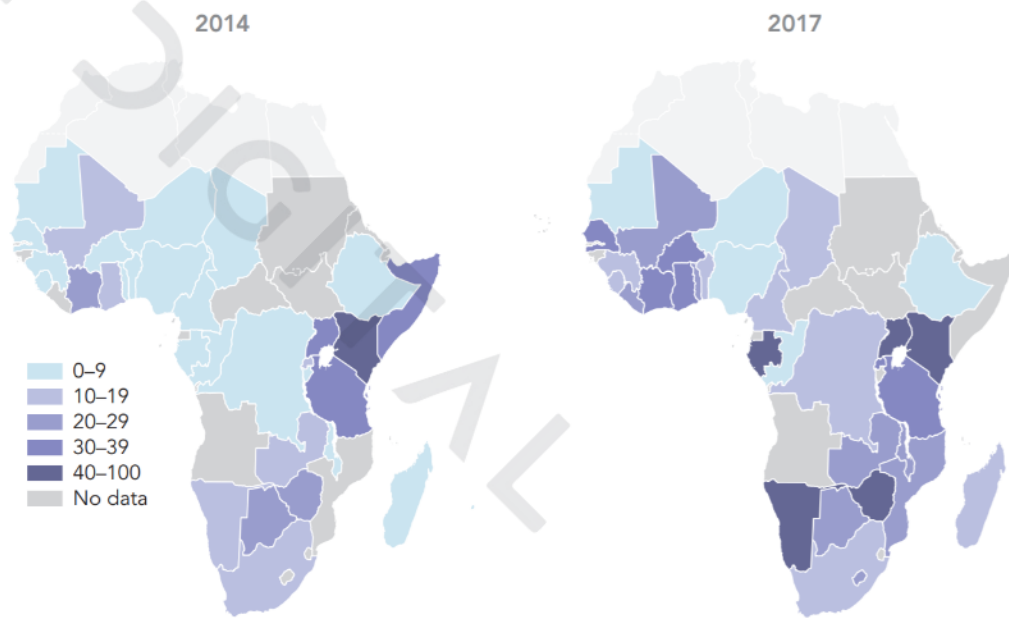
Data as of 2017

Sources: World Bank Global Findex

Adult Population Without a Bank Account That Own a Mobile Phone



Mobile Money Account Growth in Africa (% of Adult Population)



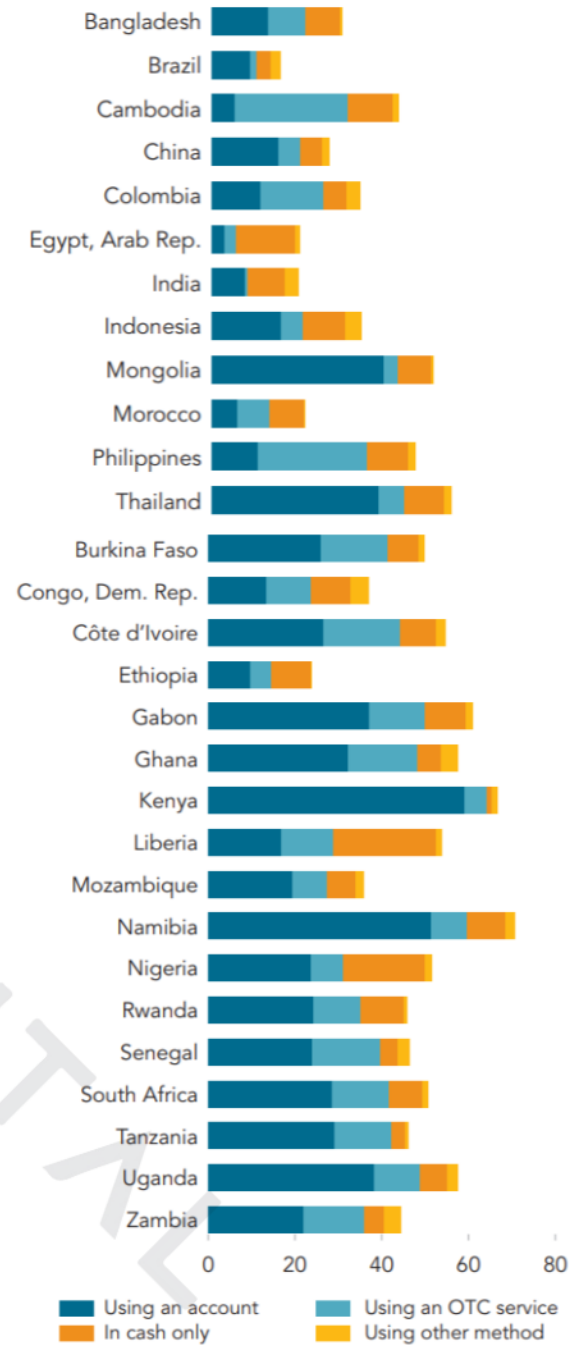
Remittances

Mobile money accounts are used for sending remittances, which is a big business globally. On average, 27% of adults in developing economies have used domestic remittances in the past year. As the chart to the right shows, a mix of remittance services are highly used in these countries. Adjusted for inflation, total global remittance volume has nearly tripled since 2000, with the current annual amount valued at ~$600 billion. While usage of these services remains high, so do the fees. The global average cost for sending a remittance is 6.94%, however, this varies by region and is typically higher for smaller amounts.

These fees impose a steep cost on the people who can least afford to pay them. Bitcoin can offer an alternative by allowing them to send money to their friends and family around the world for only a few cents. In addition, while remittances can take days to settle a Bitcoin transaction can do so in minutes.

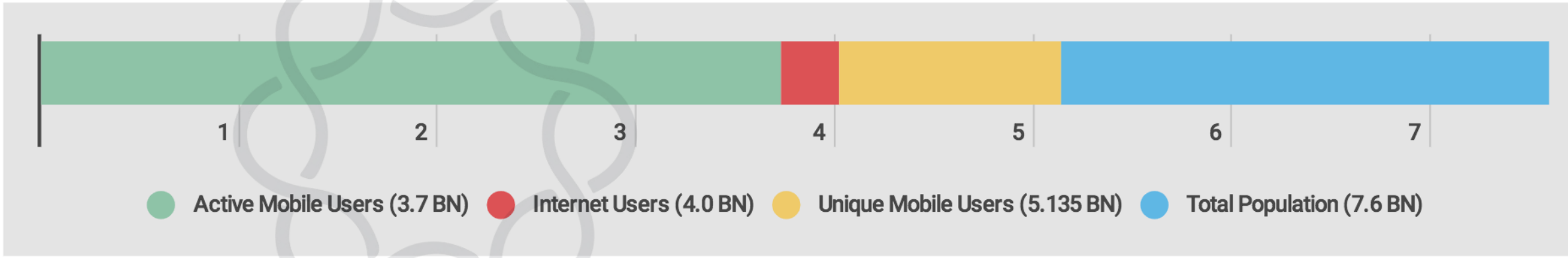
> *"Remittance costs vary considerably, but still strike us as high in most instances. Take the benchmark case of sending $200 or the equivalent. The average cost of a transfer from the US to Mexico is $8.91; from Germany to Turkey, it is $12.83; and from South Africa to Botswana, the average is a whopping $36.60"*
>
> **- Stephen Cecchetti, *American Economist***
> **and**
> **Kim Schoenholtz, *NYU Stern Professor***

% of Adults Who Have Sent or Received Remittances in the Past Year

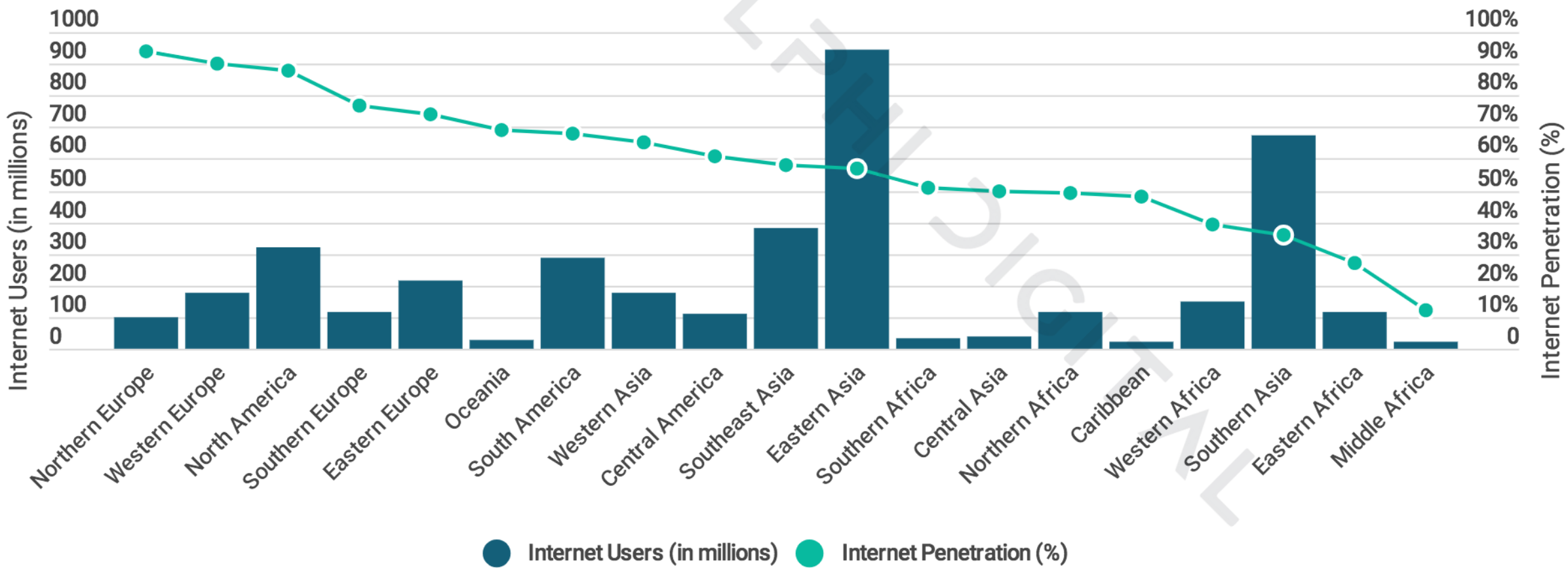


Data as of 2017
Sources: Voxeu.org, World Bank Global Findex

Barriers To Adoption



A lack of infrastructure and the need for education surrounding its use are some of the biggest impediments to Bitcoin taking root in developing economies. As seen in the chart below, internet penetration for these regions is significantly lower than their developed peers. This may be a hurdle in the near term, but we expect this margin to narrow over time as the proliferation of internet connected devices grows, giving people access to sound money globally.



Data as of 2018

Sources: Hootsuite, We Are Social

Native Currency of the Internet

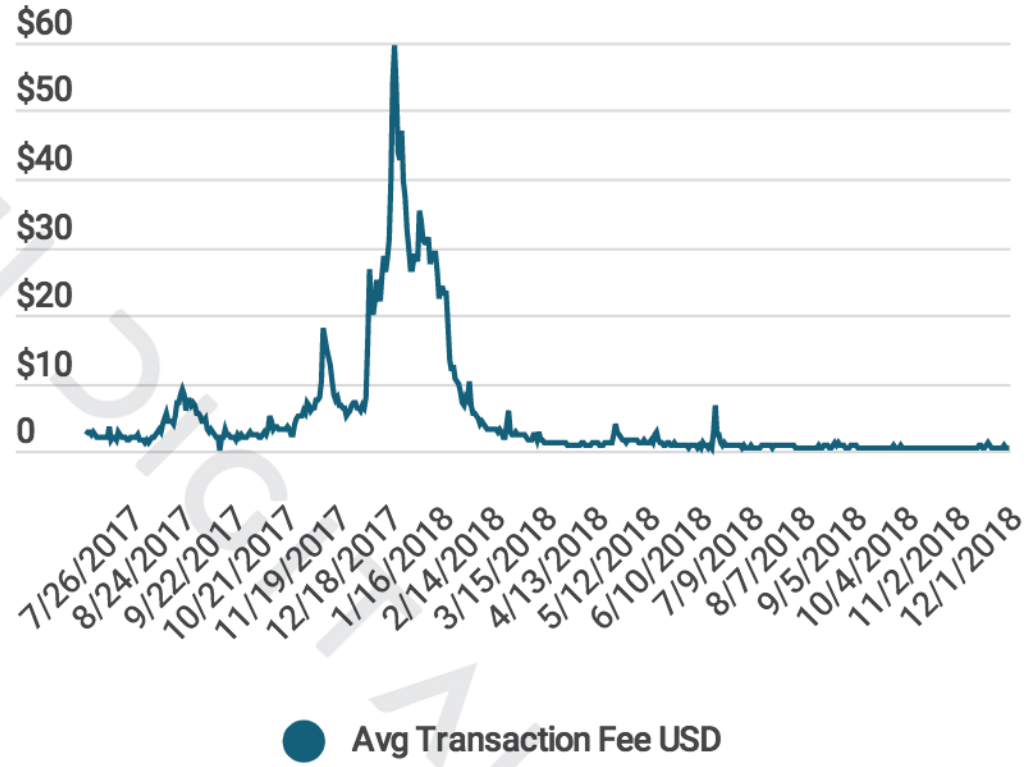
Aside from the potential opportunities we believe exist in emerging markets over the intermediate term, Bitcoin can also succeed at becoming a ubiquitous form of payment over the internet. However, as we prefaced earlier, this will not be without competition from other currencies, and would probably have to coincide with the growth of the Lightning Network and Bitcoin's acceptance as a store of value. We cover Lightning Network more within our Key Risks & Mitigants section.

If Lightning Network succeeds, it will enable Bitcoin to have nearly instant transactions and fees at potentially a fraction of a cent. This opens the door for fast micropayments where users could pay a penny to read an article or receive small tips from fans on social media. This provides unique advantages over the current web based payments infrastructure which is saddled with middle-men, delays in settlement, and high transaction fees.

While Bitcoin fees have generally stayed under a $1 in recent months, as the chart to the right clearly shows there have been spikes in the past. This was due to a surge in transaction volume coupled with Bitcoin's currently low on-chain throughput. This could have been avoided if throughput had been raised by increasing the block size, however, these growing pains were tolerated to further decentralization, avoid a hard fork, and purposely maintain a bottleneck on-chain to help a fee market develop in the future. We believe this was the right decision, and understand the important role an on-chain fee market will play in securing the network in the future once the block reward diminishes. On-chain transactions should not be confused with Lightning Network, where small transactions will happen off the main chain at a much lower cost.

Data as of December 1st, 2018
Sources: Blockchain.com

> *"The internet is going to have a native currency so let's not wait for it to happen, let's help it happen. I don't know if it will be bitcoin but I hope it will be."*
>
> **- Jack Dorsey**
> Square & Twitter CEO



Portfolio Diversification

Portfolio Diversification

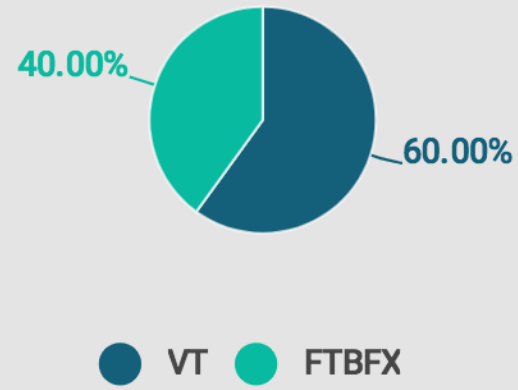
DELPHI DIGITAL

One commonly held belief is that Bitcoin will rally amid the next recession as individuals sell out of riskier assets (i.e. stocks) and pile into the world's largest cryptocurrency as a safe haven asset similar to gold. This may be true over the long run, but it is unlikely to be the case in the near-term until Bitcoin develops the level of trust necessary for investors to view it in such a context. Rather, we argue a major correction in stocks fueled by an economic downturn will more likely hurt than help the value of Bitcoin given it is still widely regarded as a speculative, high-risk asset. Bitcoin can, however, enhance traditional investment portfolios by both 1) increasing returns and 2) decreasing drawdown risk, leading to significant improvements in risk-adjusted returns. Using a classic 60-40 portfolio (60% stocks, 40% bonds) we can see how a small allocation to Bitcoin has improved risk-adjusted returns in recent years.

We use the Vanguard Total World Stock ETF and the Fidelity Total Bond Fund to represent our equity and bond allocations in a traditional 60-40 portfolio.

Portfolio 1

Ticker	Name	Allocation
VT	Vanguard Total World Stock ETF	60%
FTBFX	Fidelity Total Bond Fund	40%

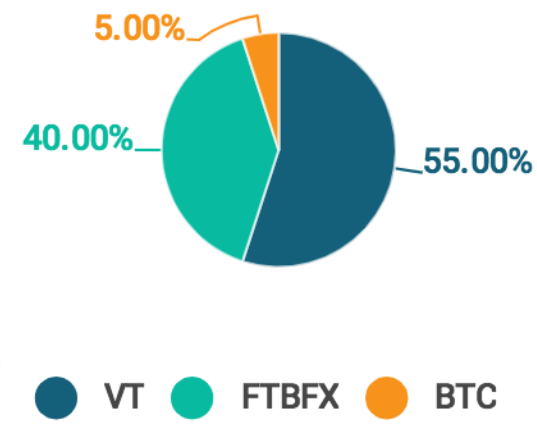


Using the same securities as our base portfolio, we add a small bitcoin allocation to analyze the different risk-return profiles at incremental levels of BTC exposure.

Portfolio 6

Ticker	Name	Allocation
VT	Vanguard Total World Stock ETF	55%
FTBFX	Fidelity Total Bond Fund	40%
BTC	Bitcoin	5%

**Portfolios correspond with diversification analysis on the following*



The results of backtesting each portfolio indicate even a small allocation (1-4%) to Bitcoin significantly enhanced the value of a traditional 60-40 portfolio over the last 3-5 years. We also expect the historical volatility of Bitcoin to decline as the broader crypto market matures.

Sources: Fidelity, Portfolio Visualizer, Vanguard

Portfolio Diversification

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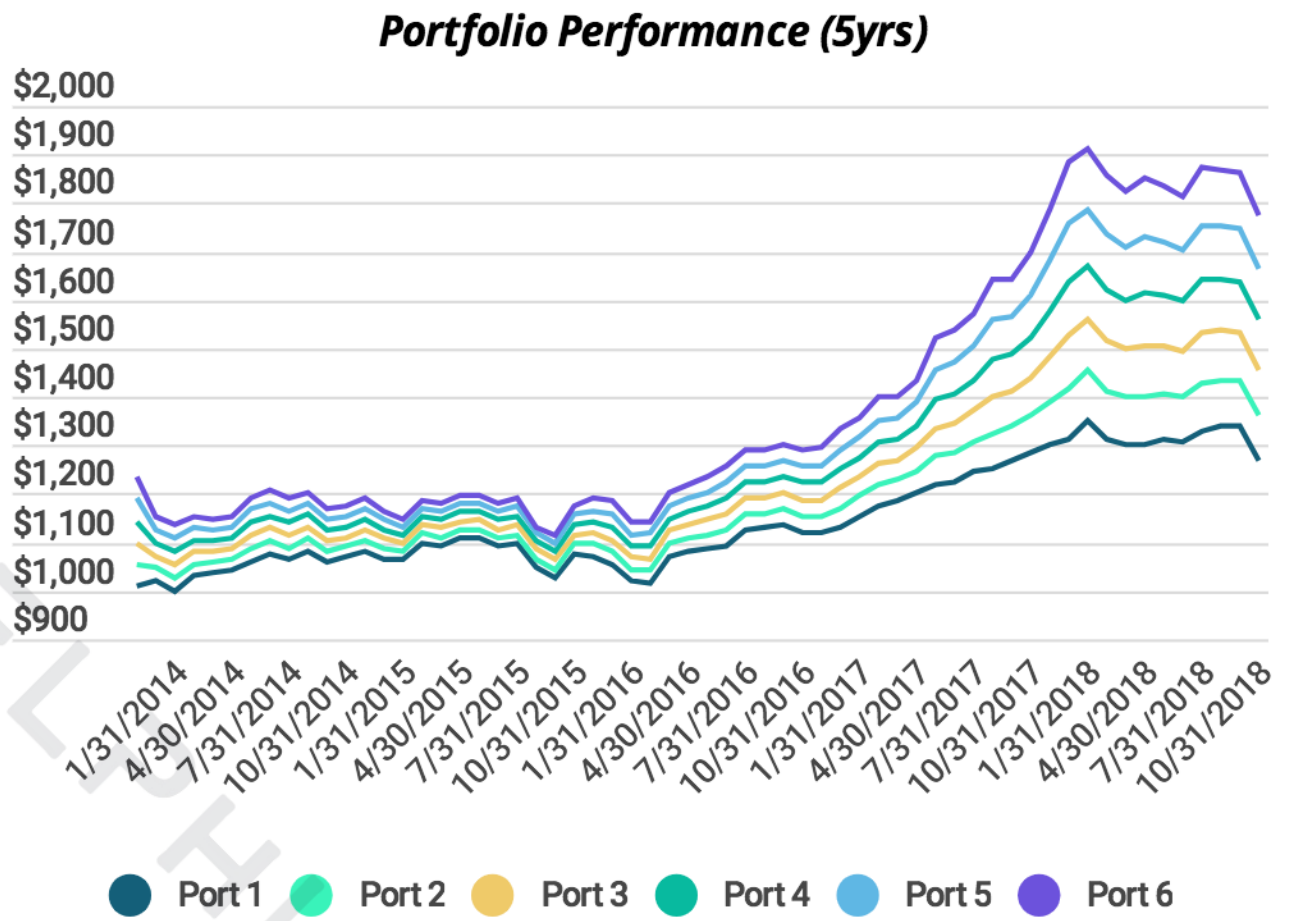
Appropriately sizing a position in Bitcoin is vital. As expected, portfolios with a higher allocation to BTC saw greater overall returns during the period. Using a simple tiered-allocation analysis, we find a portfolio with a 3% allocation to Bitcoin rendered the best Sharpe Ratio when compared to a traditional 60-40 portfolio. This allocation mix also had the smallest max drawdown, ~150-bps less than a traditional 60-40 allocation.

Granted, this analysis benefits from hindsight, as we know BTC's performance the last several years trumped all other major asset classes. But if our store-of-value thesis proves correct, traditional portfolios still stand to benefit from a small allocation to Bitcoin over the coming decade, especially as the expected returns for other risky asset classes (i.e. stocks) appear lackluster.



Portfolio #	Portfolio Allocation	CAGR	Std. Dev.	Best Year	Worst Year	Max Drawdown	Sharpe Ratio
1	60% Stocks, 40% Bonds, 0% BTC	4.89%	6.67%	16.05%	-3.34%	-8.64%	0.68
2	59% Stocks, 40% Bonds, 1% BTC	6.36%	7.15%	20.90%	-3.87%	-7.75%	0.83
3	58% Stocks, 40% Bonds, 2% BTC	7.82%	8.31%	25.87%	-4.40%	-7.26%	0.89
4	**57% Stocks, 40% Bonds, 3% BTC**	**9.27%**	**9.88%**	**30.96%**	**-4.93%**	**-7.12%**	**0.9**
5	56% Stocks, 40% Bonds, 4% BTC	10.70%	11.71%	36.18%	-5.46%	-7.86%	0.89
6	55% Stocks, 40% Bonds, 5% BTC	12.13%	13.66%	41.52%	-5.99%	-9.92%	0.87
7	50% Stocks, 40% Bonds, 10% BTC	19.10%	24.20%	70.17%	-8.64%	-18.68%	0.81

Data as of December 1st, 2018
Sources: Fidelity, Portfolio Visualizer, Vanguard

**Portfolios are rebalanced quarterly back to original allocation % from November 2013 - October 2018. This analysis does not account for management fees.*

Correlation With Stocks

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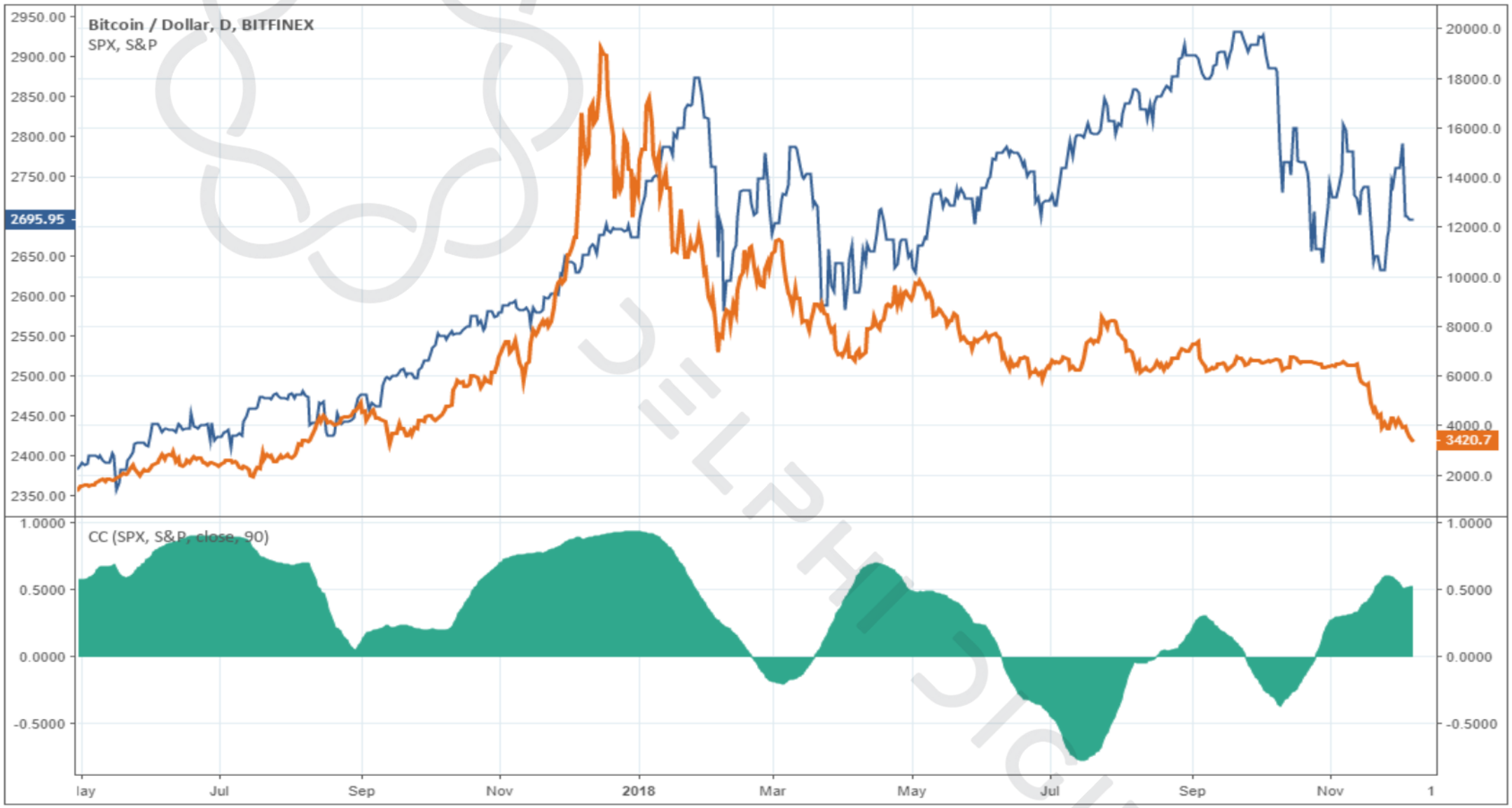
Rolling 90-Day Correlation (BTC vs. S&P 500)



Created with TradingView

Bitcoin and U.S. equities exhibited a relatively strong positive relationship for much of 2017, peaking just before stocks sold off in late January (using a 90-day rolling correlation). This relationship, however, has broken down quite drastically since Q1, but has risen sharply in recent weeks as the sell-off in risk assets has not been kind to crypto markets. We believe institutions will continue to view Bitcoin and other crypto assets as high-risk, speculative investments for the near- to-intermediate future. A rally in stocks may alleviate some selling pressure on BTC, however, especially if U.S. equities break to new highs following the S&P 500's recent double bottom.

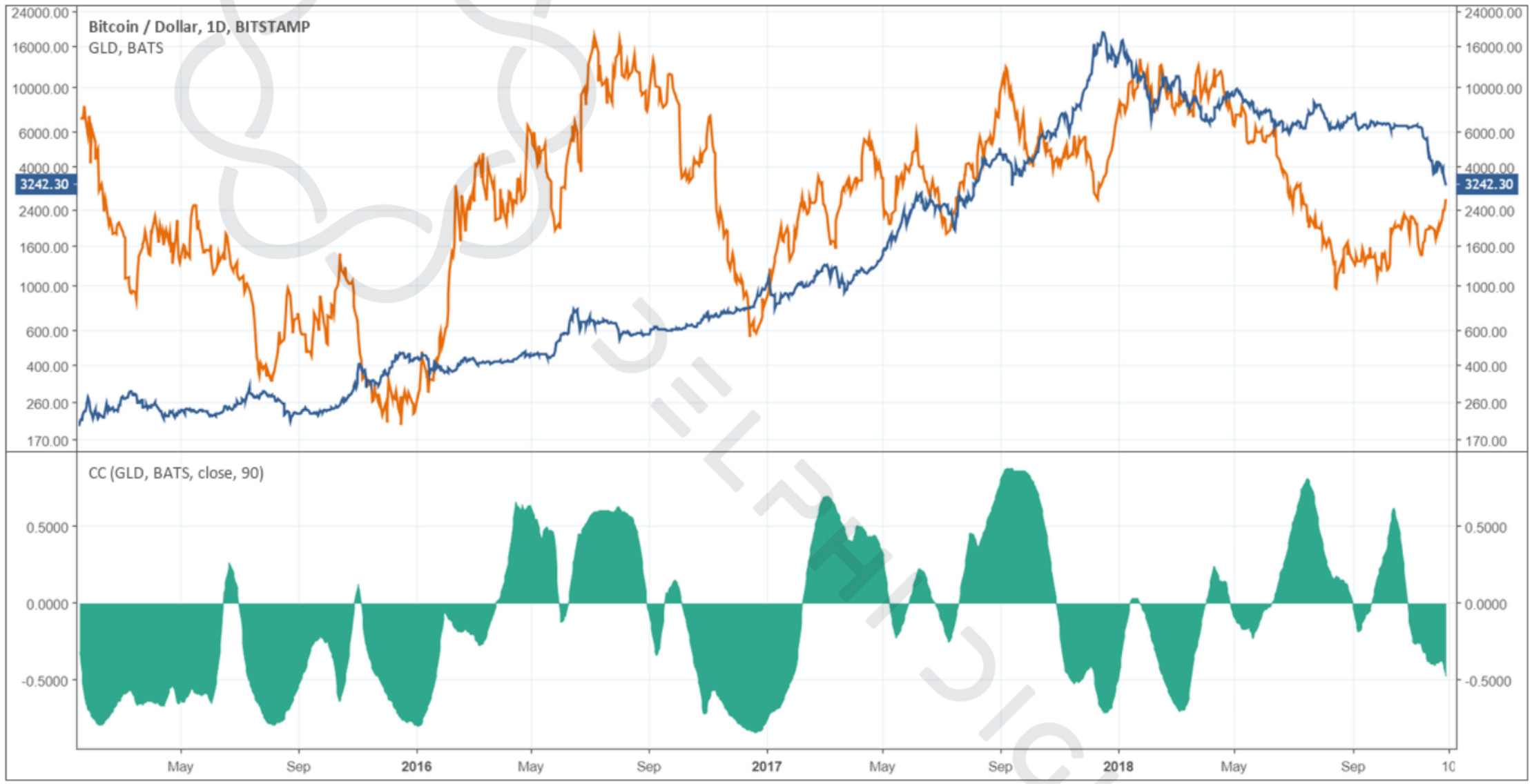
Data as of December 6th, 2018

Sources: S&P Global, Bitfinex

Correlation With Gold

DELPHI DIGITAL

Rolling 90-Day Correlation (BTC vs. SPDR Gold Shares ETF)



Bitcoin and gold do not appear to have a consistently strong correlation with one another over the last 3+ years during BTC's most recent meteoric rise. We believe this largely stems from the differences in each asset's primary investor base, as well as the perceived risk profile of BTC relative to gold. The latter still reigns king as both a hedge against inflation and a safe haven during times of economic uncertainty. As awareness and accessiblity to crypto markets grows, the risk profile of BTC may become more closely aligned with traditional market hedging instruments (i.e. gold), especially as the global economy starts to slow down the later we get in the cycle.

Data as of December 6th, 2018

Sources: State Street Global Advisors, Bittstamp

Key Risks & Mitigants

Key Risks & Mitigants

Given Bitcoin is only a decade old, it is still has many risks associated with it at this stage. While we have tried to highlight these risks throughout this report where relevant, in the next section we will focus on some key risks as well as the mitigants. Below, you can see an overview of some key risks our team identified.

Dependent on Scaling Solutions

Competition

Volatility

Hackers & Nation State Attacks

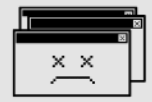
Long Term Sustainability Without Block Reward

PoW Energy Consumption

Miner Centralization

Regulatory Risk

Infrastructure Fails To Develop



Protocol Failure

Hardforks

Scaling Solutions

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Bitcoin's current scalability is limited by its low on-chain throughput, and because every full node stores an entire history of the chain and processes each transaction. Fortunately, there are plenty of scaling solutions being developed by the community. We highlight these below, and focus on Lightning Network (given it is one of the few actually live).

Lightning Network

Status: Beta Implemented March 2018
Description: Enables users to open channels with another party to transact "off-chain" until the channel is closed out (more on this on the next two pages).

Liquid Network

Liquid by Blockstream

Status: Went Live in September 2018
Description: Sidechain built on the Bitcoin network, which facilitates faster BTC transactions between businesses and individuals.

Schnorr Signatures

Schnorr

Status: Under development since 2012
Description: Replace BTC's current digital signature algorithm with a more efficient one. Allows for aggregation of multiple tx signatures into a single signature.

MAST (Merklized Abstract Syntax Tree)

Status: No final release date announced.
Description: Reduces size of smart contracts (complex scripts) & increases their privacy. Moves portion of smart contract processing & storage off-chain.

Other

Sidechains

While Liquid Network is already live, there are other sidechains currently being discussed (including: RSK, Drivechain, Mimblewimble, etc.)

Increase Block Size

This may be reintroduced in the future but we believe it is unlikely to be implemented given Bitcoin's current scaling plans.

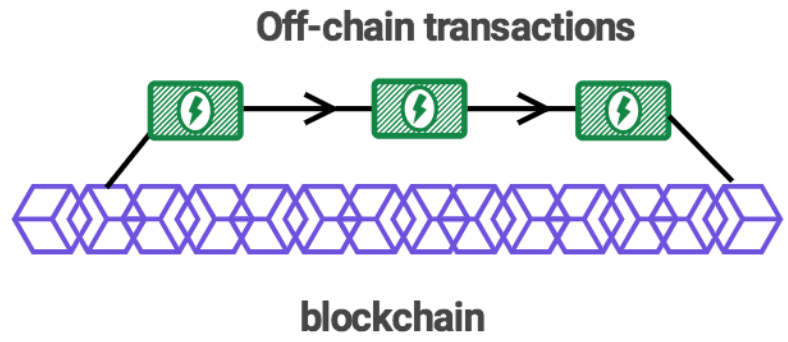
Bulletproofs & Confidential Transactions

Bulletproofs are lightweight and are geared towards improving the privacy of Bitcoin by concealing quantities of transactions, while leaving the sender and receiver's wallet addresses public. Meanwhile, Confidential Transactions would keep the amounts of BTC transactions visible only to the participants of the tx.

Data as of December 1st, 2018
Sources: Blockstream, David A. Harding, Let's Talk Bitcoin, Ian Edwards

Lightning Network

Joseph Poon and Thaddeus Dryja released the Bitcoin Lightning Network whitepaper in January of 2016. The system utilizes bi-directional payment channels that consist of multi-signature addresses to enable the instant off-chain transfer of BTC without the need of a trusted third party. With Lightning Network, there will only be two times when an on-chain transaction is really needed: (1) to open a channel and (2) to close a payment channel. Similar to Bitcoin, Lightning is open source making it free to download and allows anyone to run a node on the network.



Advantages

- Allows for micro payments
- Transactions are completed in a fraction of a second
- Lower transaction fees
- Brings a sense of privacy to Bitcoin, given not every transaction is stored on the public chain

Disadvantages

- Doesn't allow for offline payments
- Designed for small to medium-sized transactions, large transactions would probably be settled on-chain
- Miners will not collect lightning network transaction fees

On November 13th, 2018: Alex Bosworth (Infrastructure Lead at Lightning Network) shared the upgrades that the community agreed to implement.

There were a total of 30 changes that were accepted to go live with the next version of the Lightning Network. While you can view the complete list here, a few major ones:

- multi-path payments
- dual-funded channels
- hidden destinations

Data as of December 1st, 2018
Sources: 1ML

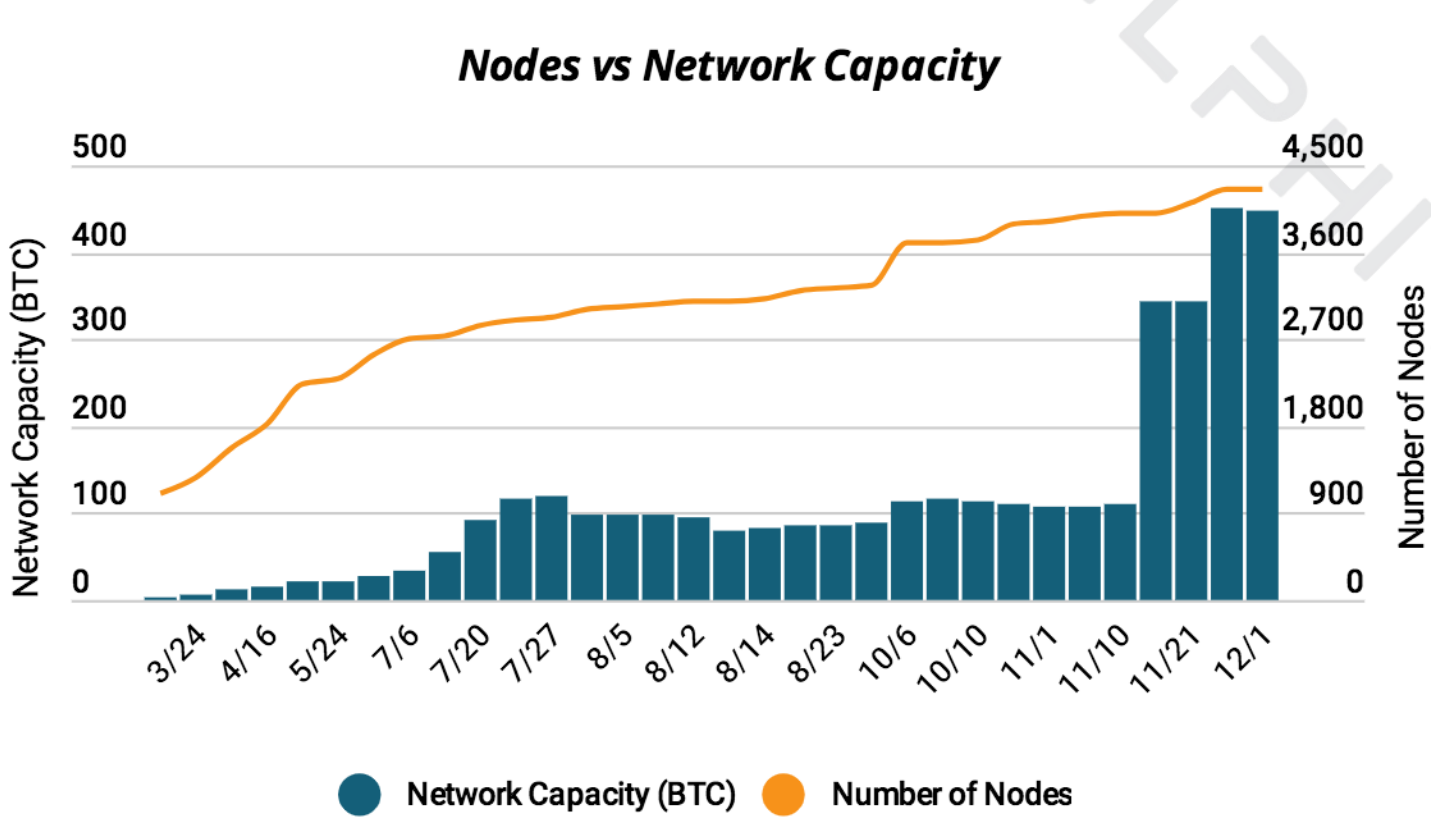
Lightning Network Statistics

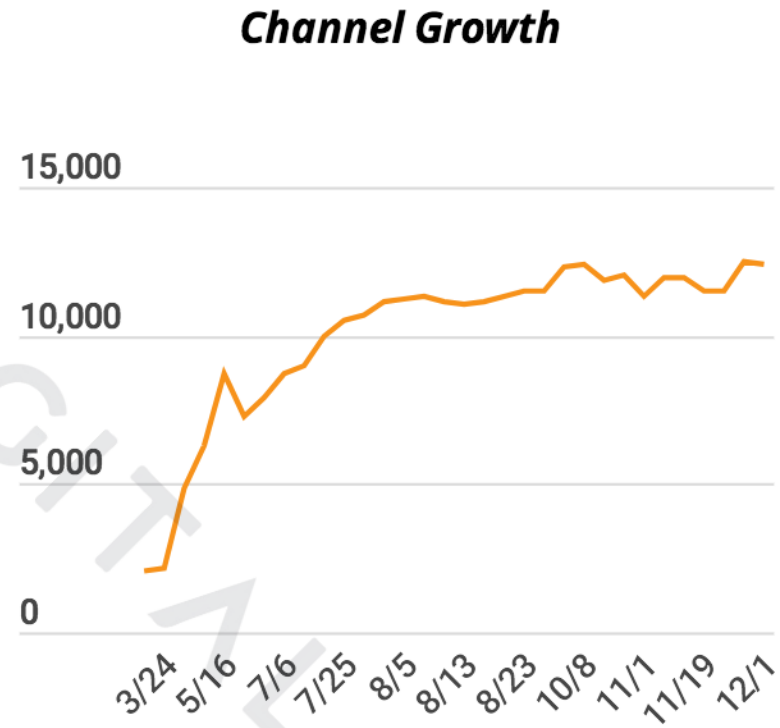
Lightning Network has seen significant growth since its beta release on Bitcoin's mainnet in March.

4,279 Nodes
+9.2% in the past 30 days

12,620 Channels
+38% in the past 30 days

450 BTC Capacity
+319% in the past 30 days





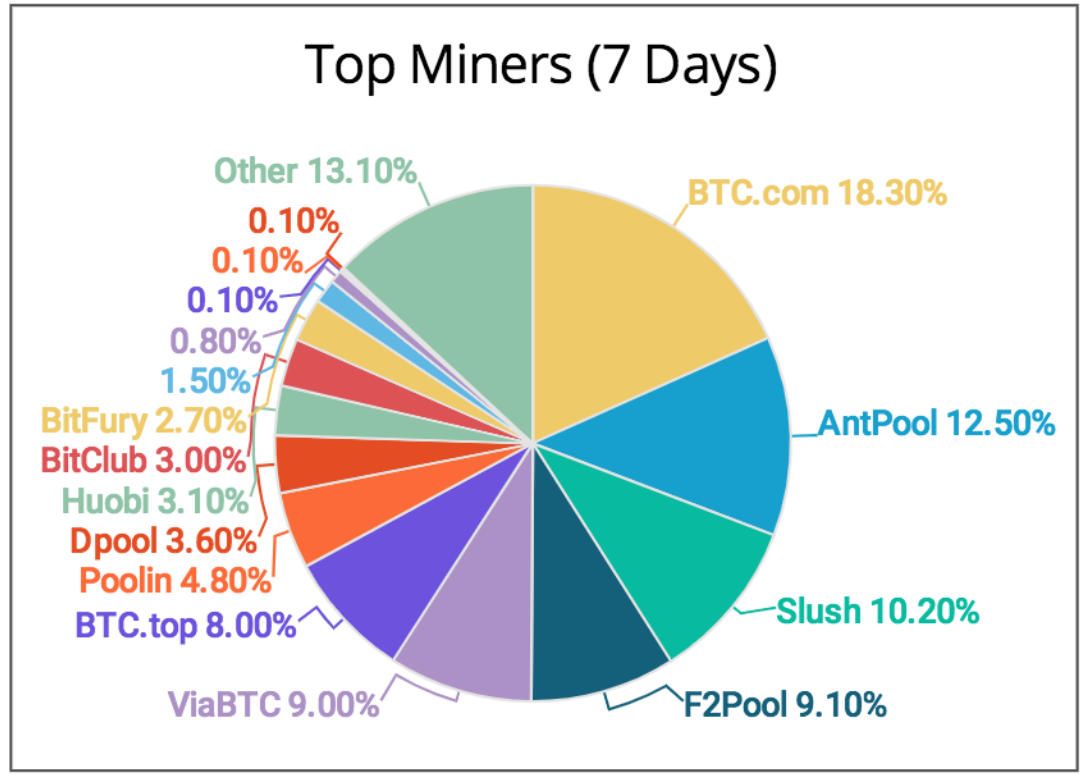
Data as of December 1st, 2018
Sources: 1ML

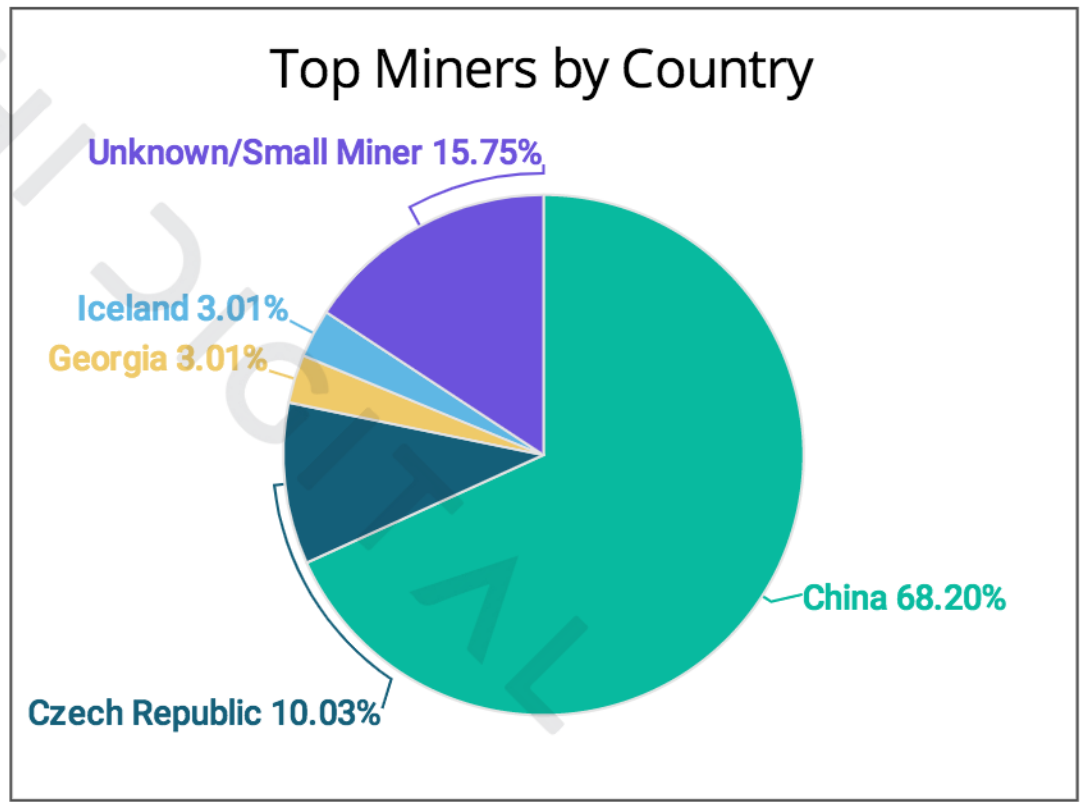
Mining Centralization

Bitcoin's decentralization enables its censorship resistant nature which is an important factor in its future potential value. Miners play an important role running the network, however, the current PoW algorithm (SHA256) benefits groups of individuals that combine their resources to create mining pools. These groups have the necessary hardware to successfully mine at a profit. As a result, mining tends to centralize into a few dominant mining pools, creating a potential threat to network security.

At first glance, the chart in the top right is more centralized than it appears for two prominent reasons. First, many of the miners are located in China, exposing the network to risks related to the Chinese government. While trading Bitcoin is restricted, the government has not banned its mining although they could take action in the future. The concentration to China is largely the result of cheap energy which is mainly derived from coal.

The second concern is the amount of control that Bitmain potentially exerts over the network. While they directly control AntPool, they are also rumored to exert influence over BTC.com, ViaBTC, and possibly others. This means that a single company, run by its founder Jihan Wu, could comprise at least ~40% of total hashrate, if not more. While Bitcoin has yet to be successfully 51% attacked, it has occurred on smaller PoW chains. While those attacks illustrate the risk that remains prevalent for Bitcoin, it is important to note these occurred on chains that had a fraction of the hashrate. Game theory, among other factors, comes into play and suggests that these mining pools would also not kill their golden goose.





Data as of December 1st, 2018
Sources: BTC.com, Coin.Dance

Protocol Failure & Bugs

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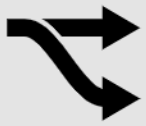
Just like any software, Bitcoin is vulnerable to software bugs and in a worst case scenario, protocol failure. Below, we highlight a few of the bugs that have been discovered within Bitcoin as well as how these were resolved.

September 2018: DDoS Attack Vulnerability

- Discovered by Bitcoin Cash developer Awemany, this vulnerability could have allowed malicious miners to artificially inflate Bitcoin's supply via a simple type of double input. Once acknowledged, Bitcoin Core Developers decided it was best to keep this bug a secret while they fixed the exploit and had time to urge miners and users to upgrade their software. Fortunately, in less than two days over half of bitcoin's mining hash rate was upgraded - meaning the attack could no longer be used.



March 2013: Two Versions

- When Bitcoin Core version 0.8 was released, it allowed for larger blocksizes than older versions could handle. Given that some of the network was still using version 0.7 or older, while other network participants had upgraded there was a chance there would be different two different ledgers going forward. Fortunately, the community pointed this out quickly and forced a hard fork back to version 0.7.

August 2010: Value Overflow Incident

- Over 184 billion bitcoins were created in a transaction within block 74638 because the code used for checking transactions would not work if the outputs were so large that they overflowed when summed. Noticed almost immediately, a code fix was put into place within 5 hours by Satoshi Nakamoto. It was implemented via a fork and the bad transaction no longer exists.

Bitcoin has benefited from having a dedicated team of experienced developers. As seen throughout its history, when there is a bug it is usually identified and patched quickly. The open source nature of the software provides transparency into the code for its users.

Sources: Bitcoin's Common Vulnerabilities and Exposures, CVE-2018-17144 Full Disclosure, Pieter Wuille, Arvind Narayanan

Regulatory Risk

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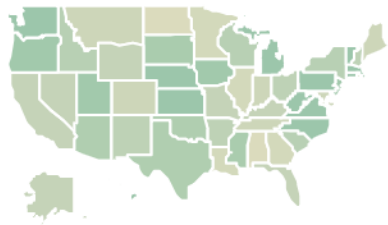
While Bitcoin's censorship resistance is an important trait, it could lead to countries enacting stricter regulations or outright bans; either due to KYC/AML concerns or fear it could weaken their local currency / capital controls. While the legal status of Bitcoin is still unclear among many areas, there are a few countries and states which have some guidelines around how they view the cryptocurrency. Below, we take a look at regulatory stances for a few major markets.

Japan

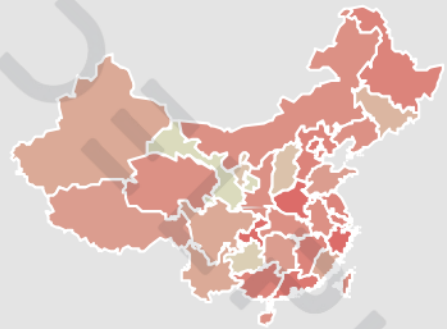
As of March 2017, Japan views Bitcoin as a form of payment. Japan is currently the biggest market for Bitcoin, with almost half of BTC's daily volume traded in the country.

USA



Recently clarified that they don't view Bitcoin as a security and instead view it as a commodity. The IRS says that Bitcoin is not a currency and defined it as property in 2014. They've also issued guidance on how it should be taxed.

China

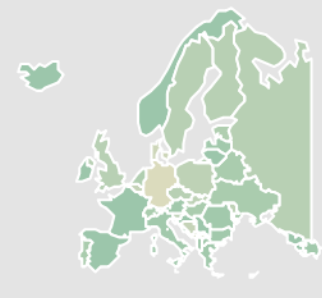


China doesn't view Bitcoin as legal tender, and trading it is currently considered illegal across the country. While their citizens are still actively mining, there are rumors that China wants to ban this as well.

South Korea

Exchanges in South Korea have been deemed legal as long as they register with South Korea's Financial Services Commission since they prohibit trading virtual currencies with anonymous accounts.

Europe



About 4% of Bitcoin's daily volume is done in Euros, and while each country has its own view on Bitcoin and cryptocurrencies - all of the countries in the Eurozone consider Bitcoin legal at the moment.

Data as of December 1st, 2018

Sources: IRS, Reuters, The Law Library of Congress

Global Legality

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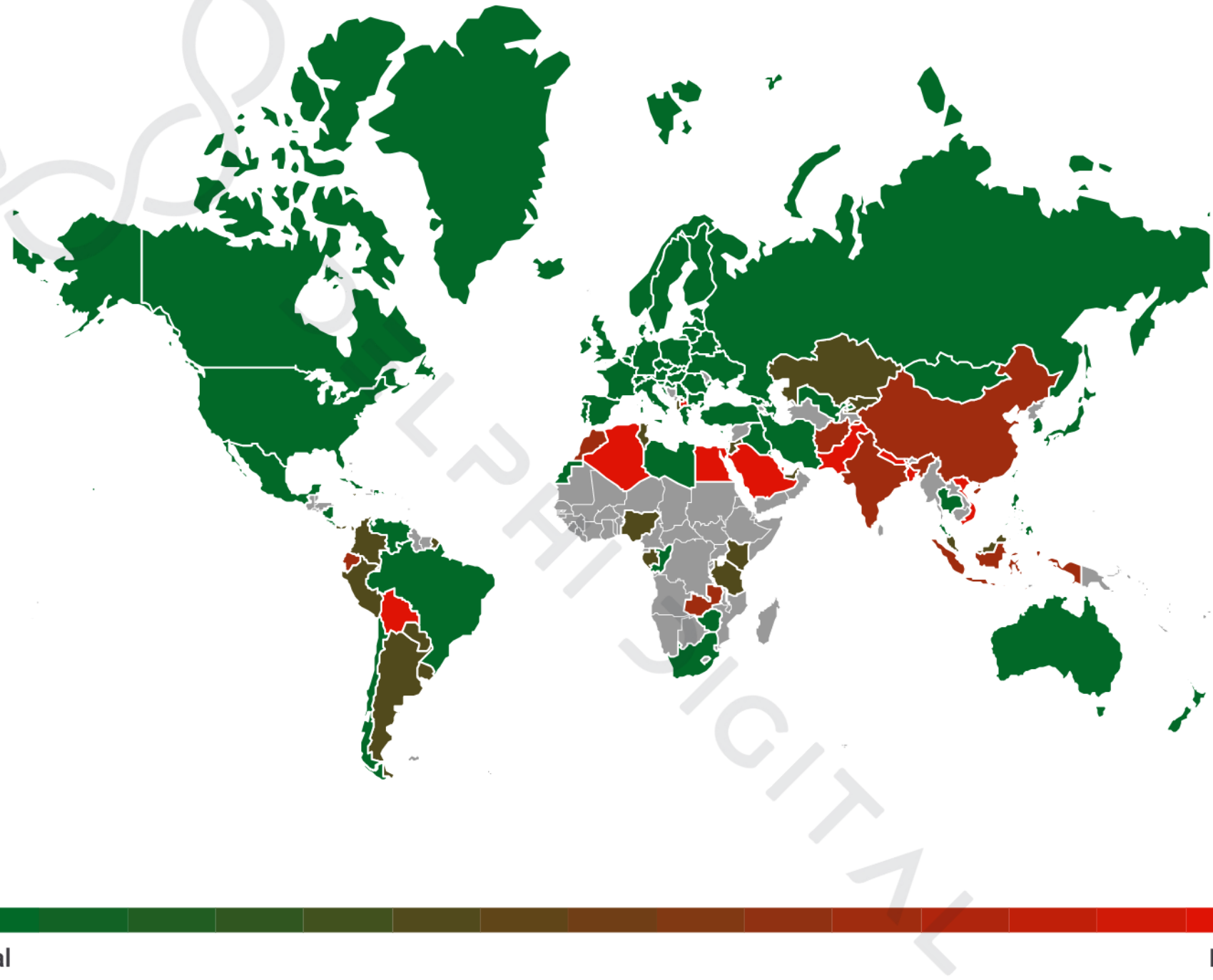
While Bitcoin is restricted in countries like China and India, it is currently deemed illegal in ten countries.

Illegal

- Algeria
- Bangladesh
- Bolivia
- Egypt
- Nepal
- Pakistan
- Qatar
- Macedonia
- Saudi Arabia
- Vietnam



Legal — Illegal

Data as of December 6th, 2018 (While some sources report that Bitcoin is illegal in Afghanistan, we were not able to confirm this and some Afghan companies use it openly)
Sources: Bitcoin.com, Coin.Dance, The Law Library of Congress

Sustainability Without Block Reward

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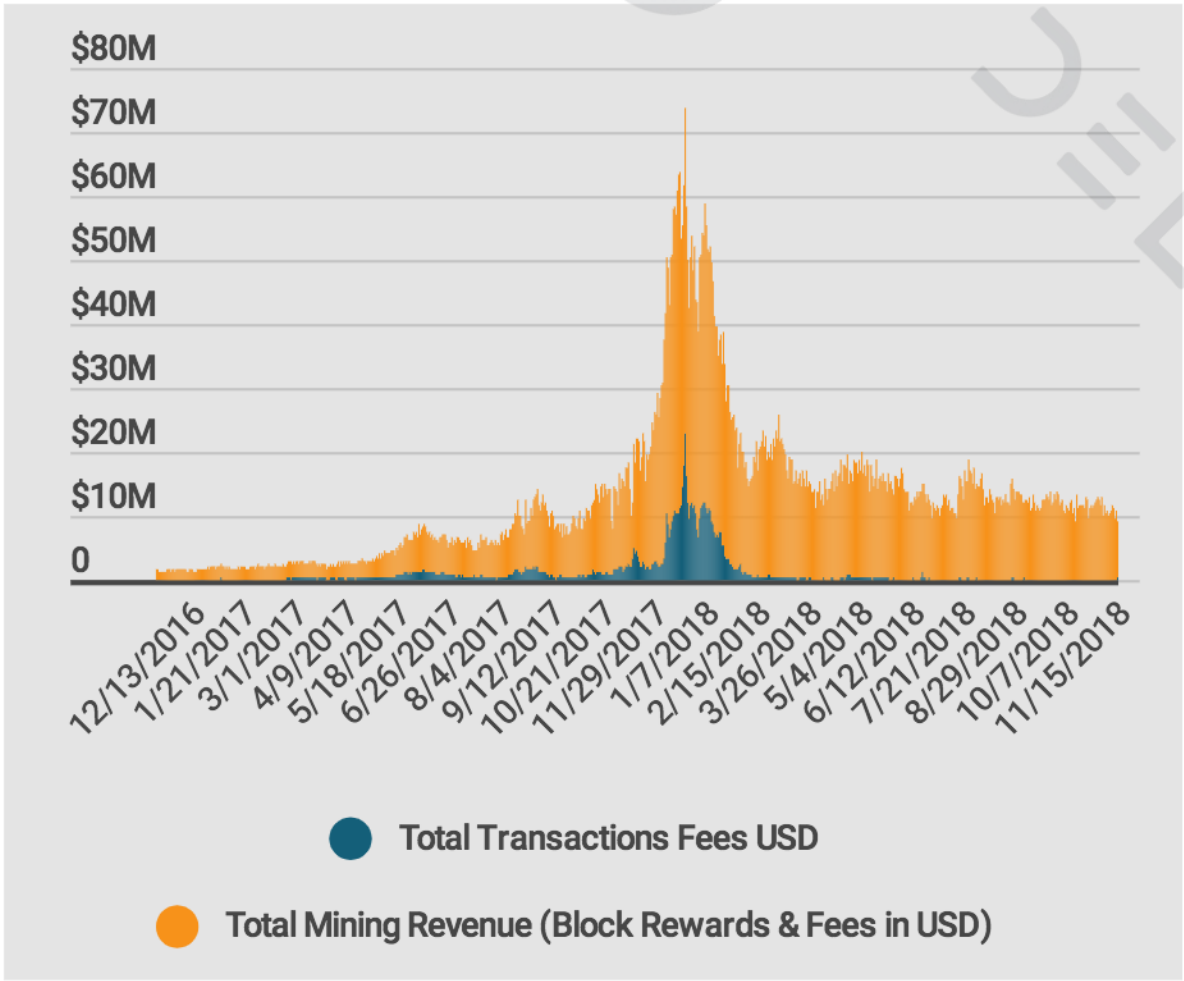
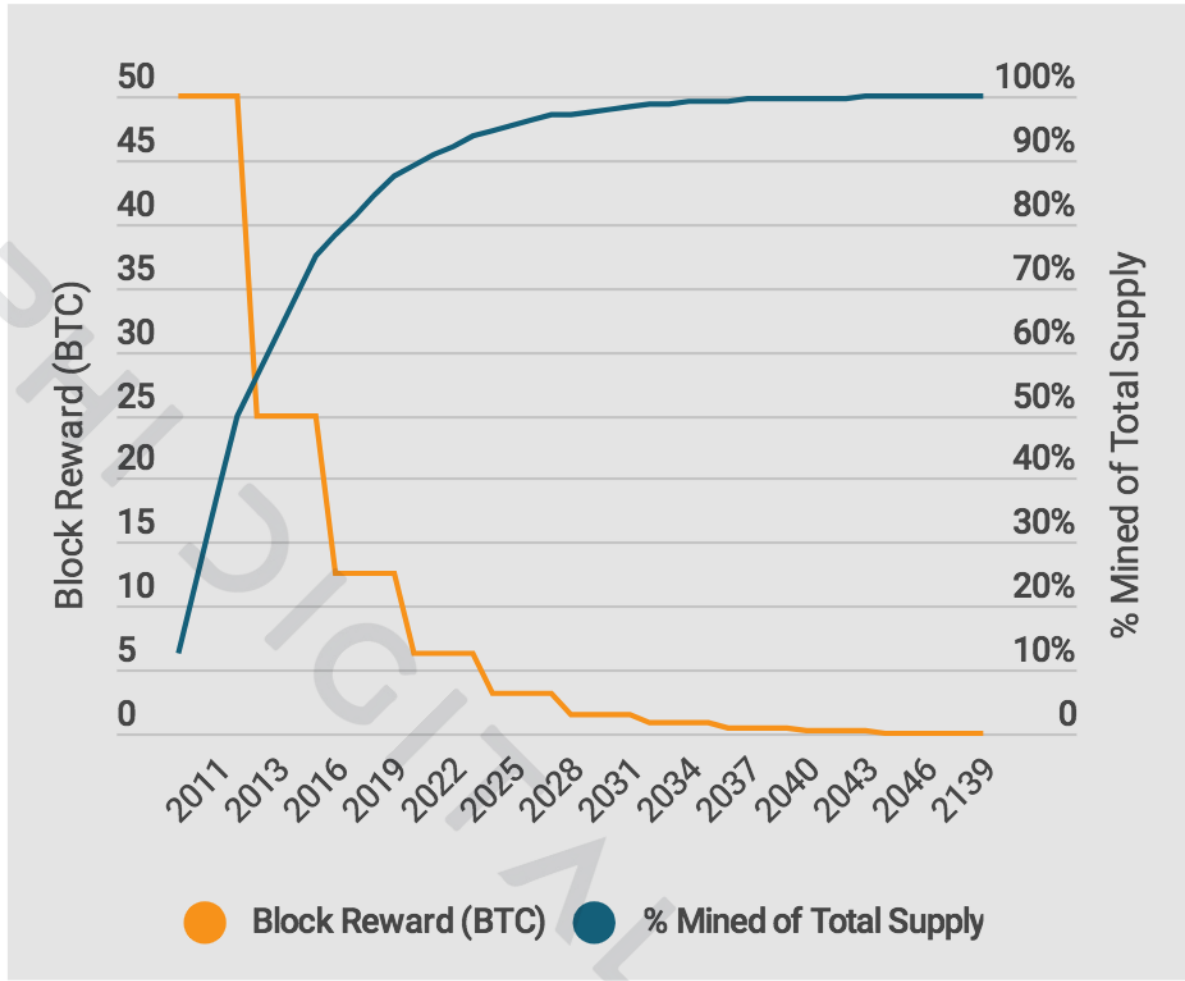
Approximately every 10 minutes a block is mined, and the successful miner is rewarded with 12.5 BTC. This block reward will eventually diminish to 0 sometime around the year 2140 due to the amount halving every four years. At a certain point, fees will have to sustain the network by providing an economic incentive for miners. As seen in the chart to the bottom left, the block reward currently makes up the vast majority of mining revenue. This risk is closely coupled with the price making it difficult to assess. While this is certainly a longer term risk it is one our team believes is important to keep an eye on.





Data as of November 15th, 2018
Sources: Blockchain.com

Other Key Risks

	Description	Mitigant
PoW Energy Consumption	While PoW has proven secure since Bitcoin's inception, it comes with a heavy electrical, and incidentally, environmental cost.	Given how big of a factor energy costs are, miners are financially incentivized to seek out the cheapest ways to mine, such as renewable energy.
Competition	If Bitcoin fails to offer a compelling thesis for investors and superior utility for users, they may stay in fiat currencies or shift to other cryptocurrencies.	While Bitcoin is relatively new compared to fiat currencies, it has strong attributes relative to its competition. (See Page 23)
Infrastructure Fails to Develop	The tools necessary to make buying, spending, and sending bitcoin seamless for an ordinary person are not created.	This is less of a concern given the investment currently flowing in to develop these tools.
Volatility	The price remains too volatile for its adoption as a store of value, or as a payment system that gains mass traction.	Bitcoin has been one of the most volatile assets in recent years, but we expect this trend to decline over time as it matures. (See Page 24)
Hardforks	Contentious hard forks can create confusion and undermine stability.	Bitcoin Core developers prefer soft forks for upgrades which make this less of a concern.

Appendix

Prominent Developers

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Bitcoin's software is open-source and built by a community of developers with extensive experience. While Satoshi Nakamoto is the original creator of Bitcoin, their involvement supposedly ended in 2010. Since then, others have taken up the responsibility and acted as the primary developers behind Bitcoin. As of December 6th, Bitcoin's GitHub had 590 contributors. Below, you can find a list of prominent developers who have worked on Bitcoin as well as links to their Github and Twitter accounts.

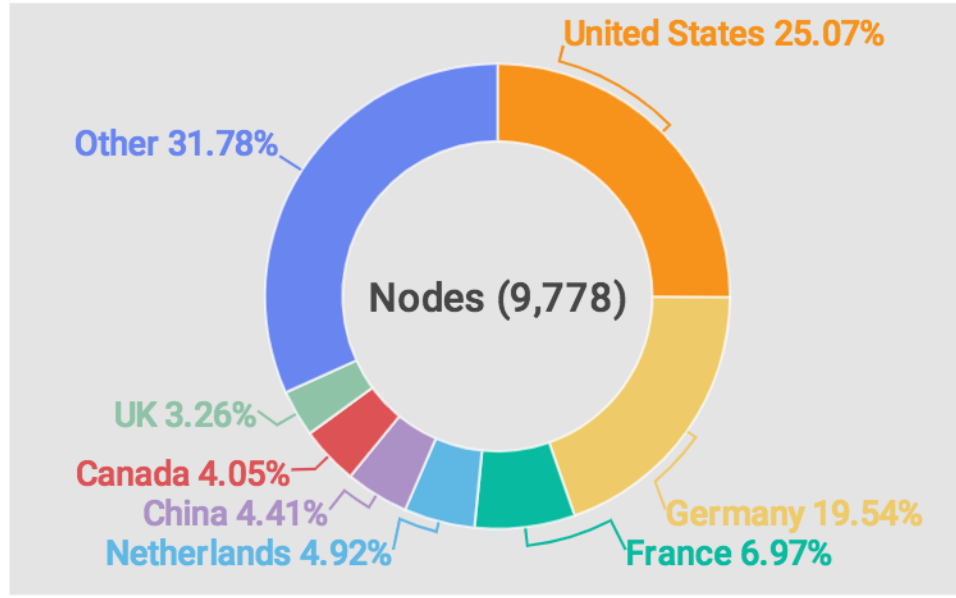
Developer	Title	Date of First Commit	Total Commits	Github	Twitter
Wladimir van der Laan	Bitcoin Core Lead Maintainer & Developer	May 2011	1,611	@laanwj	@orionwl
Pieter Wuille	Bitcoin Core Developer	March 2011	1,040	@sipa	@pwuille
Matt Corrallo	Bitcoin Core Developer	March 2011	620	@TheBlueMatt	@TheBlueMatt
Cory Fields	Bitcoin Core Developer	May 2013	574	@theuni	-
Marco Falke	Bitcoin Core Developer / Maintainer	January 2015	528	@MarcoFalke	@MarcoFalke
Gavin Andresen	Ex-Bitcoin Developer	July 2010	485	@gavinandresen	@gavinandresen
Jonas Schnelli	Bitcoin Core Developer	April 2013	466	@jonasschnelli	@_jonasschnelli_
John Newbery	Bitcoin Core Developer	September 2016	415	@jnewbery	@jfnewbery
practicalswift	Bitcoin Core Developer	January 2017	366	@practicalswift	@practicalswift
Luke Dashjr	Bitcoin Core Developer	October 2011	349	@luke-jr	@lukedashjr
Gregory Maxwell	Bitcoin Core Developer	June 2011	161	@gmaxwell	-

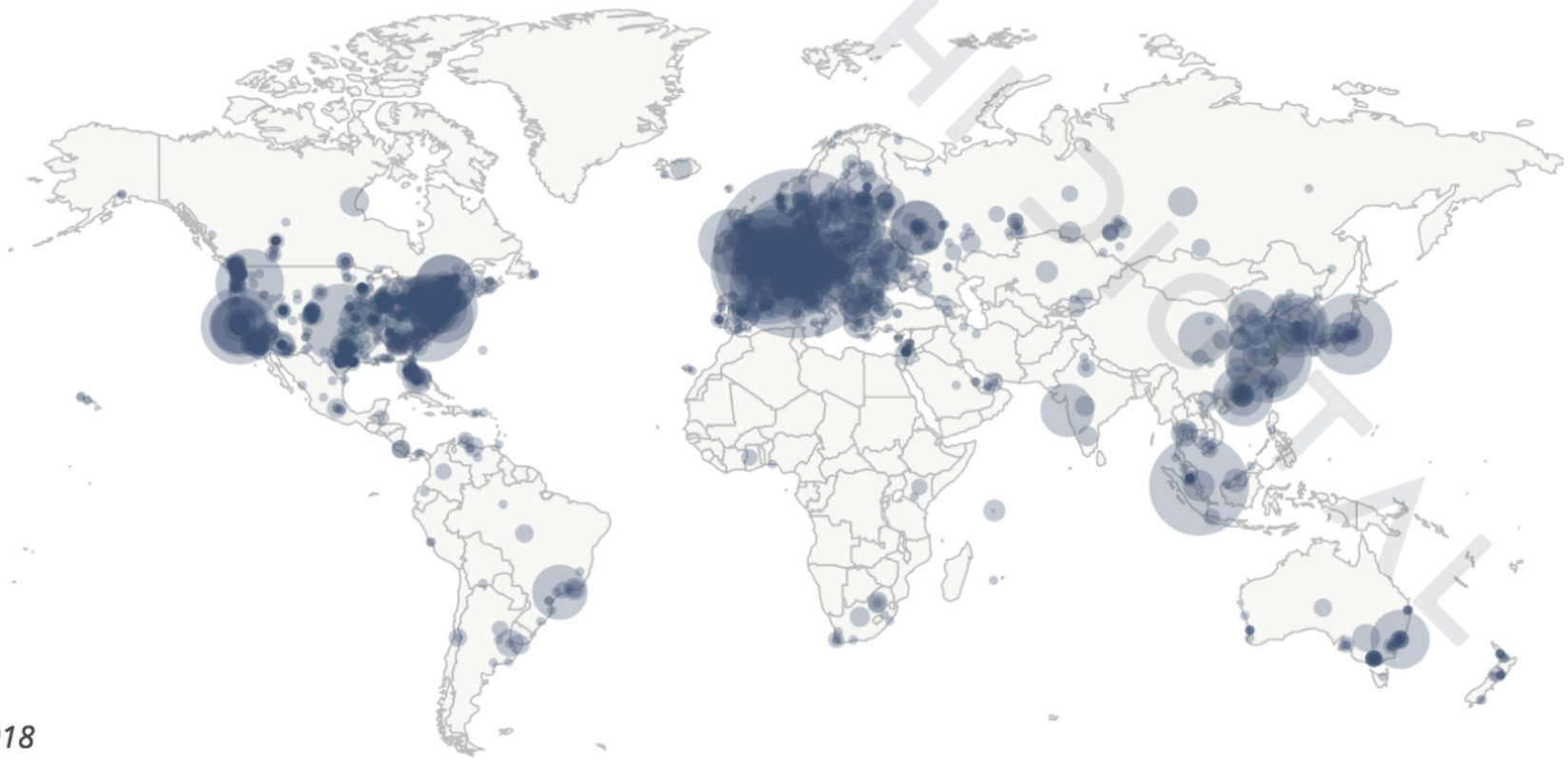
Data as of December 6th, 2018

Sources: Github

Node Distribution

Full nodes are vital to the network because they verify that all of the consensus rules are being followed and store a copy of the entire blockchain. While running a full node does not have any direct monetary incentives like mining, supporters and businesses choose to run them for benefits like privacy and to ensure that all of the rules are being followed. Full nodes also represent an important check on the power of miners. The most popular client is Bitcoin Core, which was developed by Wladimir J. van der Laan and is based on the original reference code by Satoshi Nakamoto. It was first released in January of 2009, and is the leading Bitcoin client, with over 95% of nodes currently running it. As of December 6th, ~25% of the ~10,000 active nodes come from the United States.



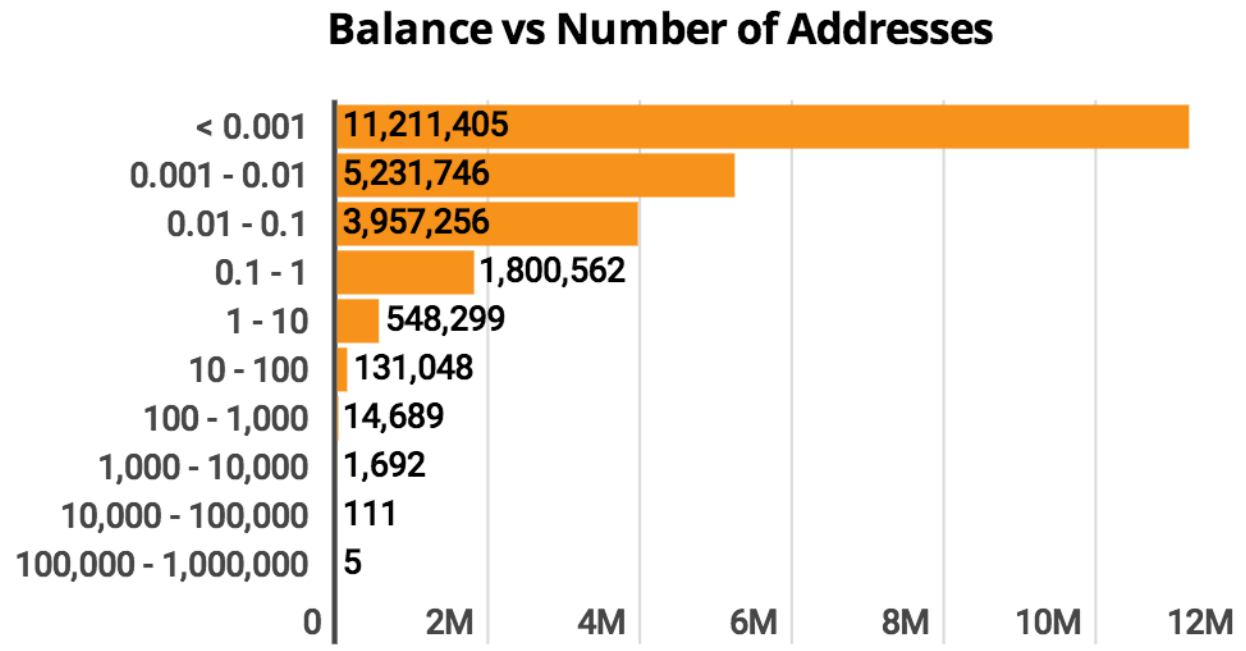


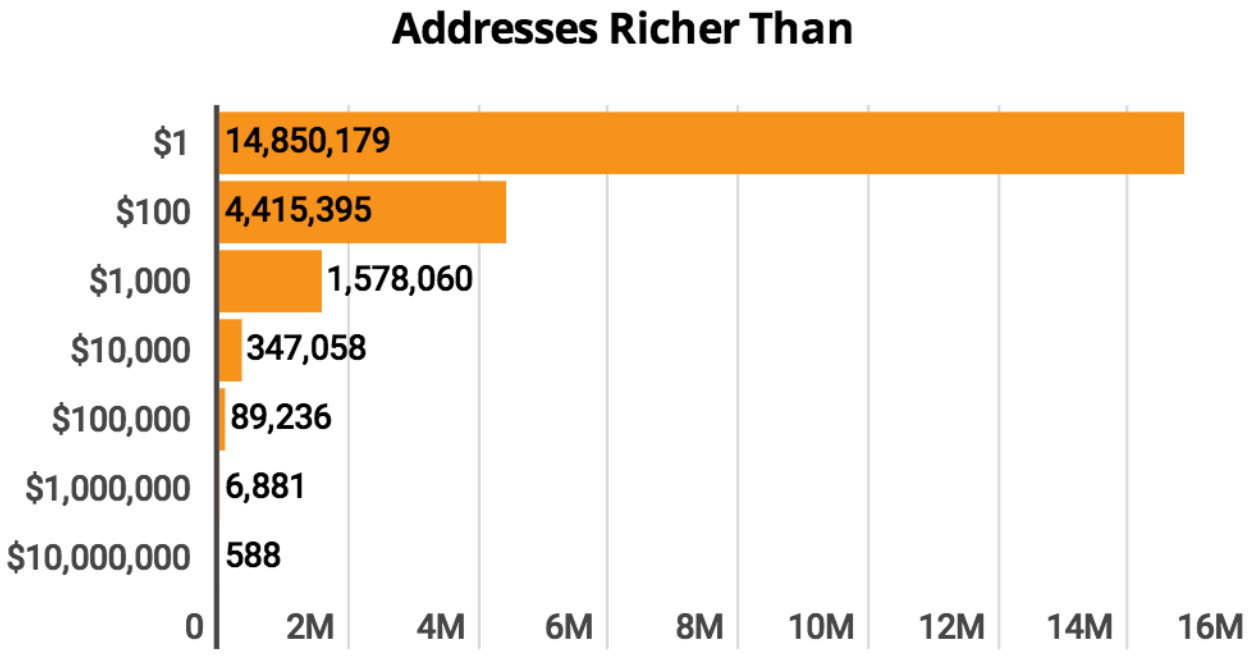
Data as of December 6th, 2018
Sources: Bitnodes, Coin.dance

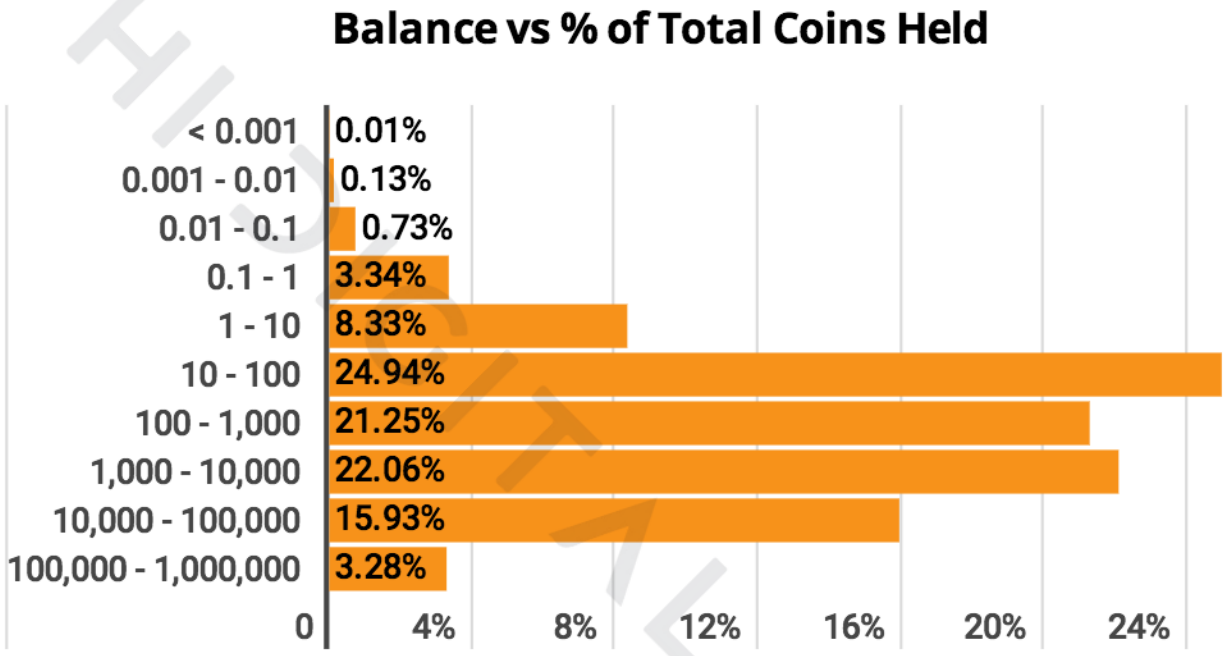
Bitcoin Distribution

There are ~22.9 million addresses holding Bitcoin. Before looking at the numbers, it's important to note that some Bitcoin holders use multiple addresses. Additionally, some of the addresses that hold a large amount of Bitcoin can be attributed to exchanges (Bitfinex, Huobi, Bitstamp, and Bittrex are four of the five with over 100,000 BTC).

Taking a look at the charts on this page, we can see that close to 50% of Bitcoin addresses have less than 0.001 BTC (which is around $3.70 as of December 5th). Additionally, only ~20% of addresses store more than $100 USD at the moment. Lastly, less than 700,000 addresses own 1 BTC or more at this time.







Data as of December 2, 2018
Sources: Bitinfocharts

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