



Abstract

Societal adoption of disruptive technologies is never a linear process – it has always followed an exponential S-Curve pattern. Bitcoin is a disruptive technology network that is quantifiably still in its early stages of adoption. In addition to examining the most pertinent Bitcoin user growth data and its historical relation to Bitcoin price, this report proposes a conceptual framework for forecasting future Bitcoin adoption in the context of past disruptive technology adoption cycles. This is not meant to serve as any type of investment advice or short-term trading tool, but simply a conceptual guide to gauge the rate of adoption.

Specifically, this report will analyze:

- 1. The characteristics of the typical exponential S-Curve adoption pattern exhibited by disruptive technologies:**
 - a. General phases of the s-curve cycle
 - b. Historical examples

- 2. Bitcoin user growth data:**
 - a. Where it places Bitcoin on the adoption S-Curve
 - b. The historical relationship between user growth & Bitcoin price
 - c. Evidence that the s-curve adoption of Bitcoin may occur even more rapidly than that of past disruptive technologies

- 3. A conceptual framework to forecast future Bitcoin growth metrics based on the s-curve model and historical rates of adoption exhibited by other disruptive technologies**

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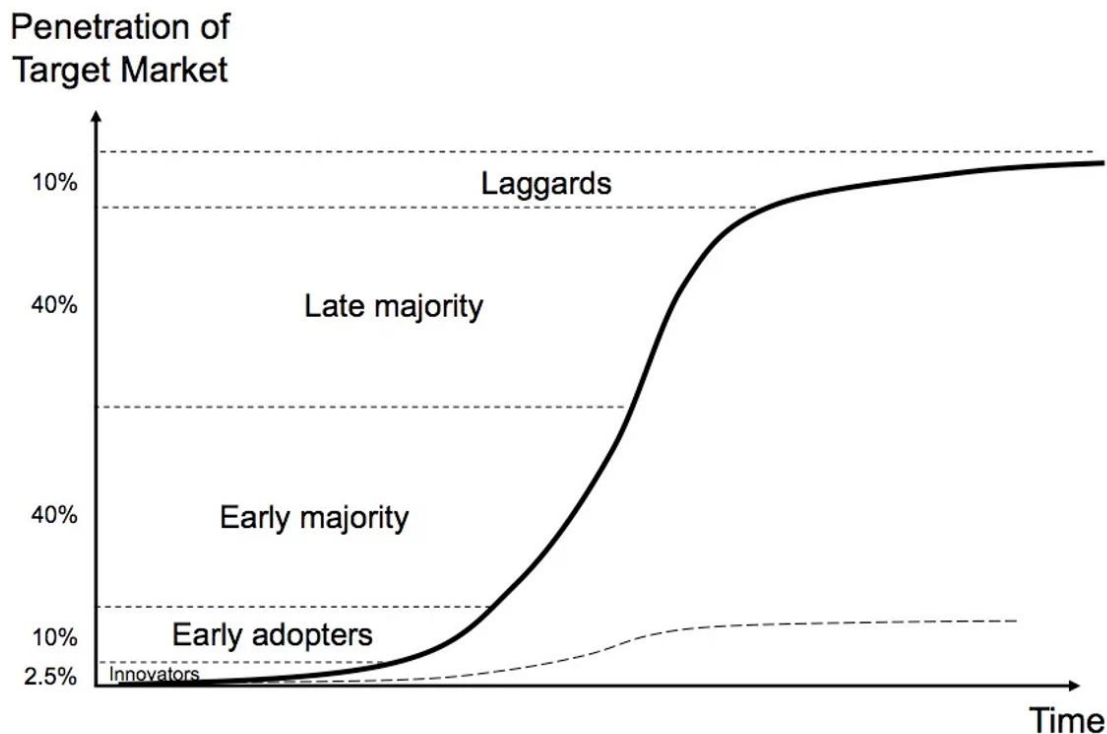
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Introduction

One of the most powerful characteristics of Bitcoin is its ideological malleability. Countless research pieces have already eloquently described the different value propositions for Bitcoin: inflationary hedge, digital payments system, a decentralized settlement network, a censorship-resistant borderless bearer asset you can take anywhere in the world by memorizing a set of words, etc. The purpose of this report is not to convince you of those value propositions, to quote the Declaration of Independence, “we hold these Truths to be self-evident.” This report proposes a conceptual framework (model) for examining Bitcoin adoption through the context of past disruptive technology adoption cycles in the hopes of more accurately forecasting future growth rates. Again, this is not meant to serve as any type of investment advice or short-term trading tool, but rather a conceptual guide to gauge the rate of adoption and glean potential future insights.

Adoption Curves

Let’s start with talking about adoption curves. Adoption curves describe the sociological life cycle of a particular technology or concept. While the technology at hand may differ, the natural human behavior and sociological dynamics repeat.



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In all technology disruptions the pace of adoption appears slow at first because a new product has minimal market penetration until it hits an inflection point and accelerates through an exponential growth phase. In the early days, a small niche group of individuals or entities have the specialized knowledge to grasp the value of the new technology. The specialization of knowledge and therefore conviction of this concentrated group of innovators provides the bedrock foundation of adoption. This

group brings the technology from zero to one¹. However, in this stage the technology is often still in its infancy and societal penetration is so low that few are even aware it exists yet. After the Innovators the next group is the Early Adopters. Oftentimes these are highly open-minded individuals who have direct or indirect connections with the innovators. Early adopters often face intense scrutiny and pushback from outsiders. As this report will describe later, the data suggests that Bitcoin adoption is in the latter half of the Early Adopters “phase.”

After the early adoption phase the technology hits the fastest acceleration of adoption; the exponential point of the “S” curve of adoption. This is where the technology begins to get widespread attention and known by most technologists around the world. Slowly, then suddenly. The late majority stage is when the technology becomes mainstream, and everyday households and individuals are aware of the concept. With this stage the technology starts to reach saturation; with the only group left to adopt being the very slow-moving laggards. Laggards tend to either be entities who are too stubborn to adopt the technology or have external restrictions (such as regulation) not allowing them to do so. Let’s look at some real-world examples of these adoption curves.

Historical Adoption Curves

All disruptive technologies follow a similar exponential s-curve pattern, but the speed of adoption has continued to accelerate over time. Newer, network-based technologies continue to be adopted much faster than the market expects. The below chart displays the adoption rates for 9 different disruptive technologies. But in order to properly compare the s-curves of different disruptions, we must first quantify the metrics used to define each technology’s “Adoption Rate.”

Adoption Rates Defined:

1. AUTOMOBILE: Percentage of US households that own an automobile.
2. RADIO: Percentage of US households that own a radio.
3. LANDLINE: Percentage of US households with a landline.
4. ELECTRIC POWER: Percentage of US households with electric power.
5. SMART PHONE: Percentage of US adults who own a smartphone.
6. TABLET: Percentage of US adults who own a tablet.
7. CELLULAR PHONE: Percentage of US households with a cellular phone.
8. INTERNET: Percentage of US households with access to the internet.
9. SOCIAL MEDIA: Percentage of US adults who use at least one social media site.²

¹ “Zero to One: Notes on Startups, or How to Build the Future.” Peter Thiel with Blake Masters

² <https://ourworldindata.org/technology-adoption>

Bitcoin's relation to those adoption curve methodologies

We believe Bitcoin adoption will reach saturation quicker than many of these technologies for the following reasons: direct monetary incentives to adopt, macro environment end game, and rails of adoption growth being the internet; and the most efficient state of informational spread on the internet ever.

Bitcoin is unique from past technology due to the direct monetary incentive of being an early consumer. Of course, for entrepreneurs there were direct and indirect monetary incentives to adopting new technologies. From a consumer perspective, past technologies had convenience/efficiency related incentives to adopt them: adopting automobiles allowed you to zoom past the horse and buggy, adopting the cell phone allowed you to make calls without being tied to a landline, adopting the internet allowed you to expand the reach of your business far beyond what any analog marketing was capable of etc. However, it is difficult to measure the direct monetary value gained by being an early consumer of some of these technologies. With Bitcoin direct financially incentivized adoption creates a game theory in which everyone's best response is to adopt Bitcoin.

Adoption of the internet and adoption of other technologies before the internet occurred on analog rails. The internet, which exponentially increases the speed of the spread of information, is the main tool in which the word about Bitcoin is spread. After all it is an asset native to the digital domain. Anybody with internet access has a countless quantity of free resources with which to educate themselves on Bitcoin. Bitcoin spreading on the internet is analogous to it traveling on a superhighway versus internet adoption spreading on a dirt path.

Data on Bitcoin User Growth

We've discussed historical adoption curves and why theoretically Bitcoin adoption should accelerate just as fast if not faster than those historical curves. Now let's look at some real data for Bitcoin's user growth to date to get an idea of where network adoption sits currently and what hints this may provide about what expectations should be for growth moving forward. The following data is derived from Glassnode, a leading blockchain data provider; therefore, the data below is reliant on their heuristics and data science capabilities. Should also be disclosed that the model in the end of the report is based upon Glassnode's on-chain user data.

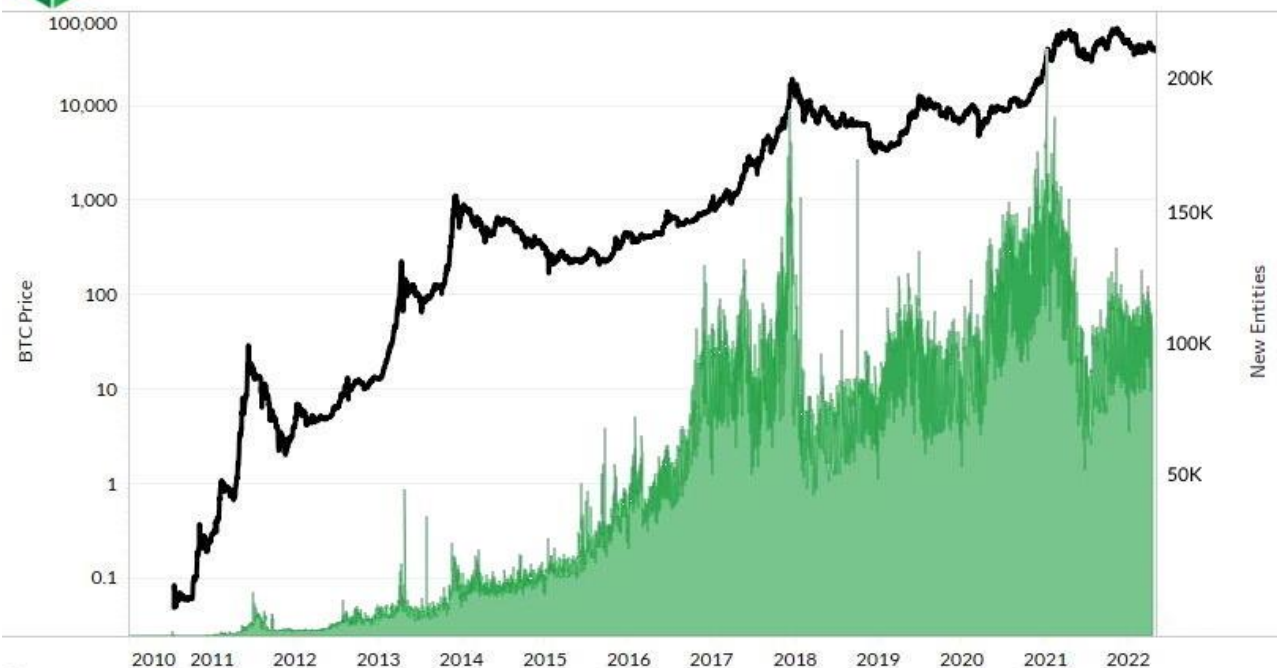
Before diving in, we would like to mention that these estimates are conservative. Why do we say this? By looking at entities on-chain we are excluding the amount of individual users that have their BTC holdings on centralized custodians or exchanges.

Entities are defined as a “cluster of addresses that are controlled by the same network entity and are estimated through advanced heuristics and Glassnode's proprietary clustering algorithms.” One entity could be a person with self-custody of their BTC, an exchange, custodian, OTC desk, lending desk, etc. With this in mind, one entity identified on-chain may actually be holding BTC for hundreds of thousands if not millions of people. This is also why the figures you hear about “90%+ of Bitcoin’s supply is held by 1% of users” is nonsense and lacks nuance; analogous to saying one traditional bank is one person when in reality it is holding funds for millions of individuals. That’s a discussion for another report. Anyway, due to this reason, these user adoption estimates shown later in the report actually undershoot the real value we suspect; but for the sake of this report, we wanted to lean on what we know best, which is on-chain data. To conclude, this data is looking at the number of unique wallets on the Bitcoin blockchain; which we believe serves as a good quantifiable proxy for the number of people who currently own Bitcoin. With that being said, we do believe this will be less true in 10+ years from now as fewer individuals interact with the base chain.

First, we look at New Entities. This is defined as, “The number of unique entities that appeared for the first time in a transaction of the native coin in the network.” We can see that from a broad perspective this only trends up over time, with large spikes during major Bitcoin bull runs. The cyclical behavior of BTC adoption thus far has gone as the following from a user growth perspective: Bull market price appreciation attracts new users on the network, heading into the bear market some of those new users stay, while non-convicted speculators get shaken out, those coins consolidate into the hands of the convicted until the process completes, and the early stages of the next bull market begins.

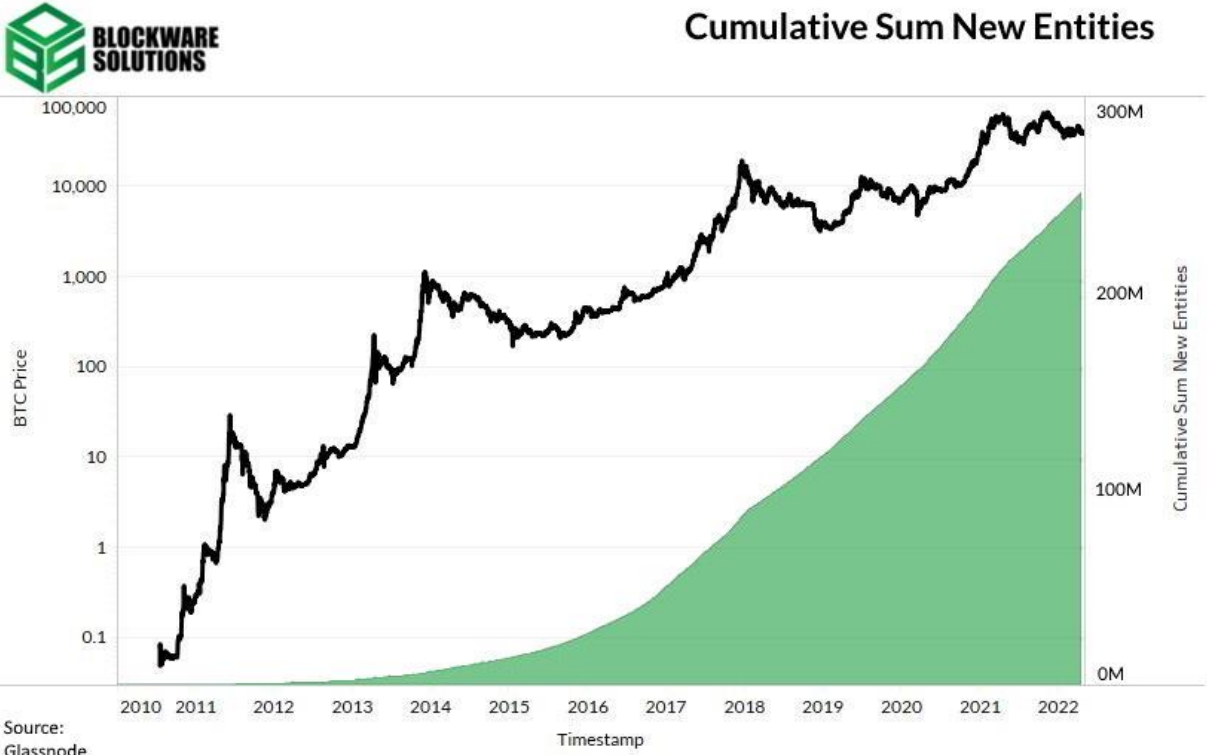


New Entities

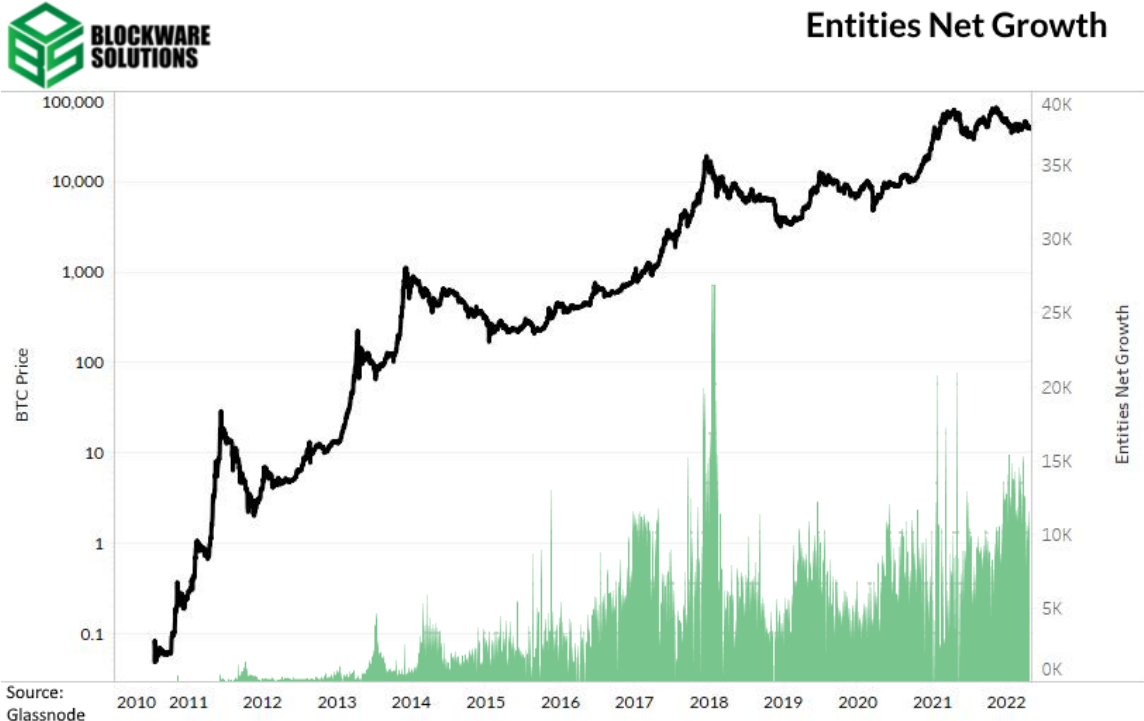


Source:
Glassnode

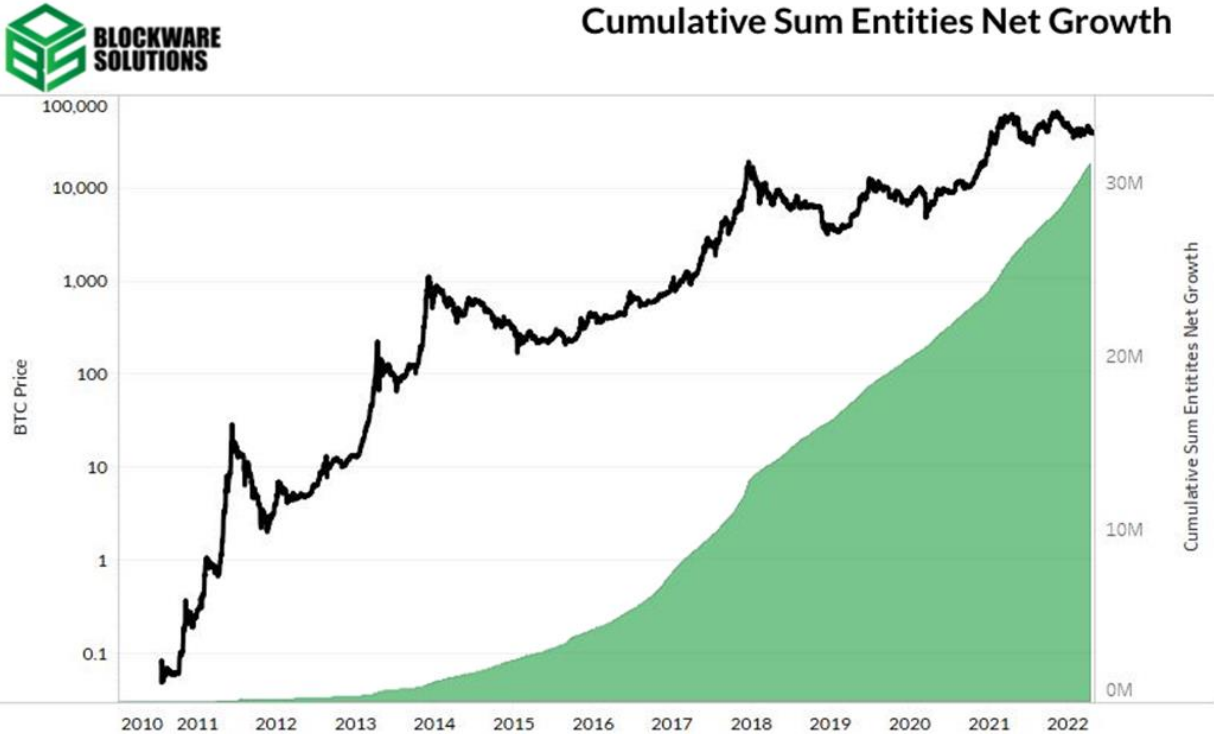
By taking a rolling cumulative sum of all new entities, we get the chart below. This is a cumulative total of all the users that have ever *been* on the Bitcoin network to date; currently sitting at a value of 253.4 million entities.



The only drawback of looking solely at new entities is the fact that the metric doesn't factor in the entities that have left the network. This is where the Net Entities Growth metric comes into play and is the reason why we decided to proceed with the adoption curve projections by using net entities growth and not new entities. Net entities growth is defined as "the difference between new entities and "disappearing" entities (entities with a zero balance that had a non-zero balance at the previous timestamp)."

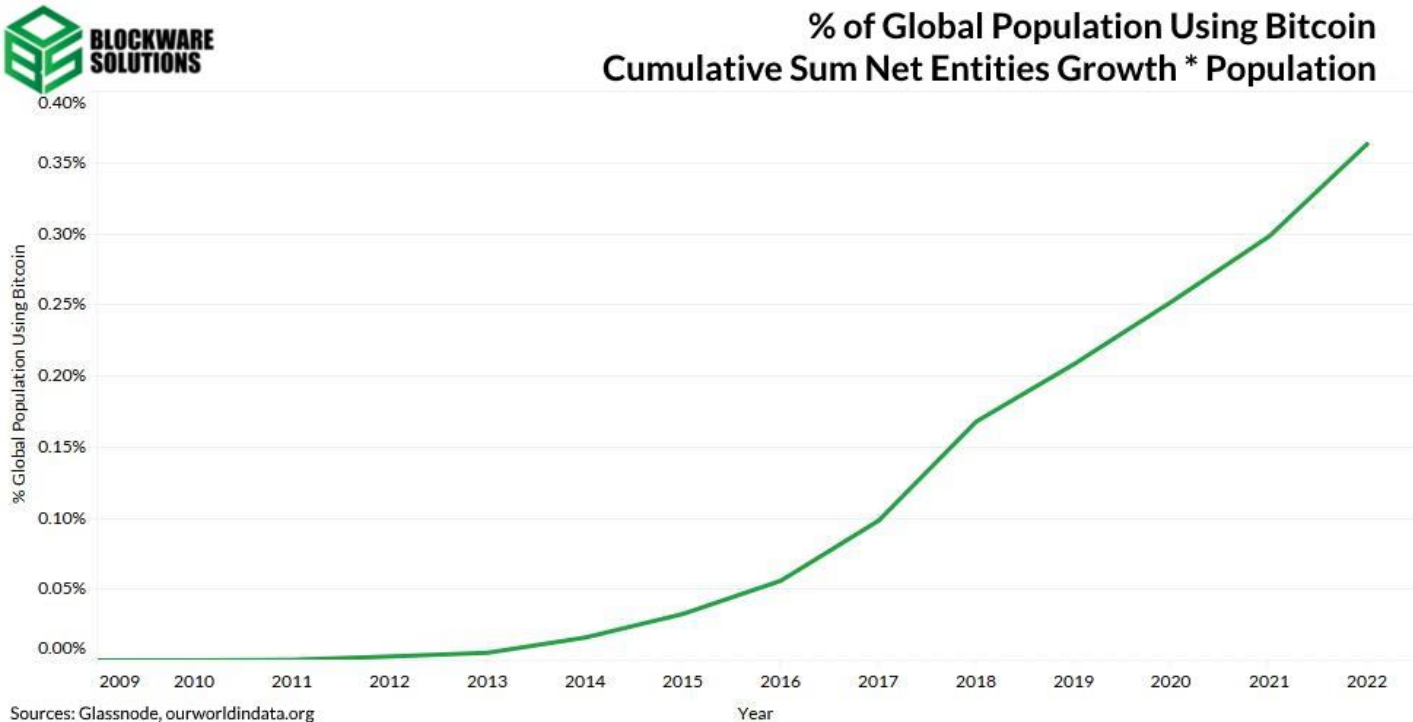


By taking a cumulative sum of entities net growth, this gives us a value of 30.8 million unique entities (users) on the network right now.



Source: Glassnode

Dividing Cumulative Sum of Net Entities Growth by Global Population (with respect to each year) gives us the percentage of the global population that has adopted bitcoin. By this estimation ~0.36% is currently using the Bitcoin network.



Sources: Glassnode, ourworldindata.org

Future Bitcoin Adoption Forecast

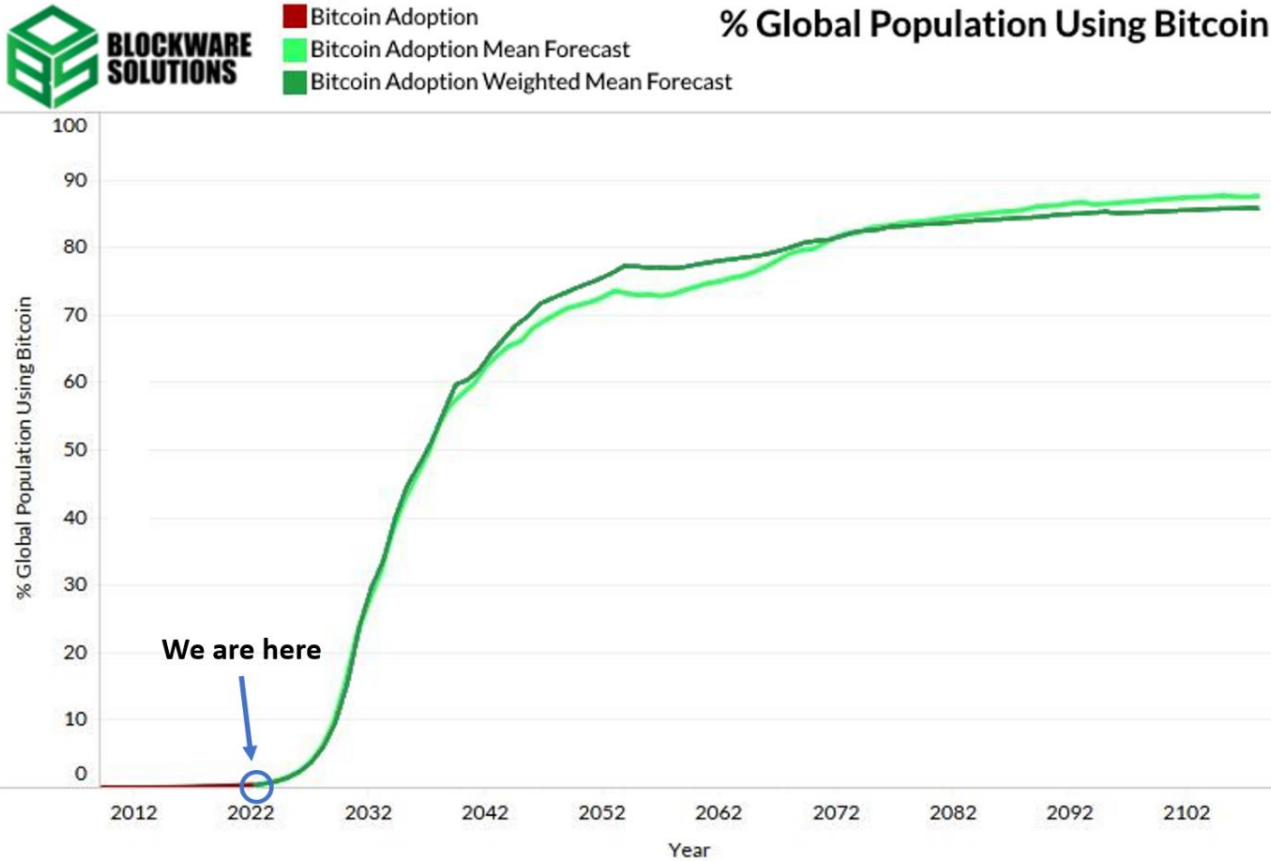
Using the previously discussed average and weighted average of historical technology adoption curves as well as the growth rate of Bitcoin adoption since 2009, we have forecasted the future adoption rate of Bitcoin. However, the first datapoint for the average and weighted average of historical adoption curves is at ~11% adoption and ~13% adoption respectively; just above the 10% threshold in which adoption shifts from “early adopters” to “early majority.” With this being said, it would be inaccurate to apply the growth rate of technologies during the hyperbolic stage of the S-Curve to Bitcoin whilst the latter is only at ~3% adoption according to the Cumulative Sum of Net Entities, and ~0.3% adoption according to the Cumulative Sum of Entities Net Growth.

To forecast the growth period from current state of adoption *up to* 10% adoption we used a 10-year compounded annual growth rate (CAGR) of Cum Sum Entities Net Growth and excluded outlier values. Next, we divide by the expected global population of each year in order to convert the raw number of entities to a percentage of the population. Again, the reason we are using this CAGR up to the 10% threshold is because the data of past technology adoption curves is unavailable before ~10% adoption.

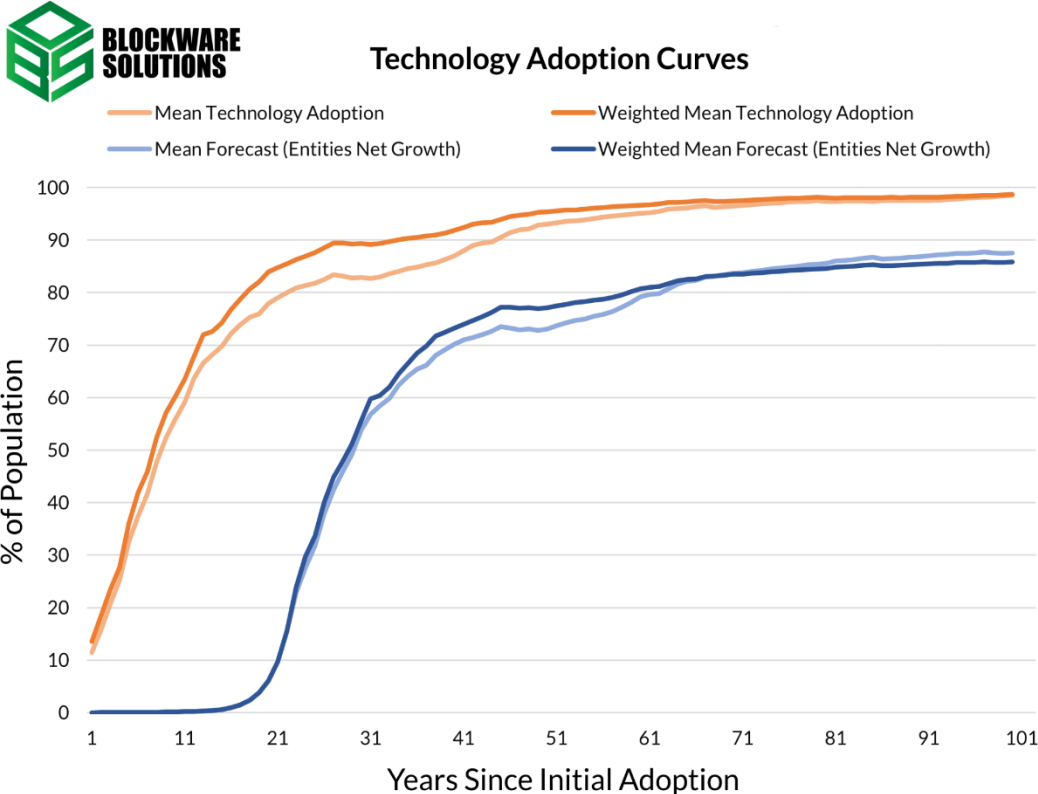
Once our forecasts reached the point in the adoption curve roughly equal to our data of past adoption curves, we can then proceed with applying the average and weighted average of these curves to our forecast. To recap: The adoption forecast up to 10% is forecasted using the CAGR of the net entities growth metric. And the adoption forecast beyond 10% is forecasted using the average/weighted average of the past adoption curves.

Using the Cumulative Sum of Net Entities Growth and its CAGR of 60% we forecast that global Bitcoin adoption will break past 10% in the year 2030. The red line represents actual Bitcoin Adoption and the Green Lines represent forecasted Bitcoin Adoption.

This is our projection for the percentage of global population that uses Bitcoin:



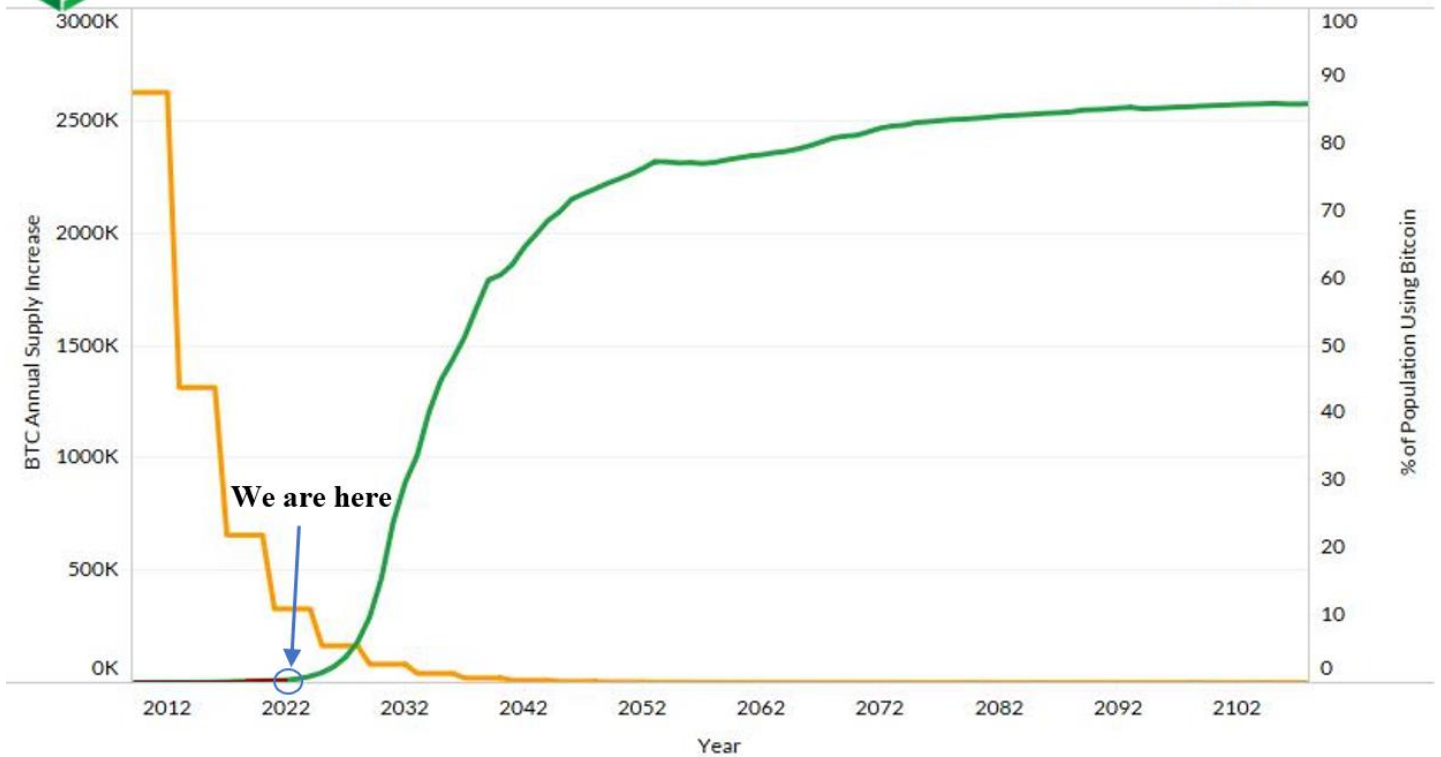
Below you can see the Bitcoin Adoption Forecasts plotted alongside the average and weighted average of past adoption curves which were used to forecast the hyperbolic stage of adoption.



Below we have the same chart, but it also includes the annual Bitcoin supply issuance. For those unfamiliar the supply schedule of Bitcoin is known and verifiable, guaranteeing a maximum supply of 21,000,000. Here we are able to juxtapose the increasing adoption of Bitcoin along with its increasingly deflationary money supply. In our eyes, this is arguably the simplest visual representing the bullish case for Bitcoin.



% of Global Population Using Bitcoin + Bitcoin Supply Issuance



CONCLUSION

As British statistician George Box said, all models are wrong, but some models are useful. This is not meant to serve as a scientific short term trading tool, but rather a conceptual guide for long term Bitcoin investors. Over time, as we get more real time user data, we can continue to improve the accuracy of the model's predictions into the future. We intend to upkeep the model every 6 months with new data for those interested. With that being said, the general trend is clear; there is a high probability that Bitcoin's global adoption will grow significantly into the future and thus so will price. Prior technological adoption curves show us that adoption occurs first slowly and then rapidly; on-chain data shows us that Bitcoin is still in the "slow" phase. Just as there is a risk to owning BTC (through volatility), there is also a risk of not owning BTC during this time period of accelerated adoption. We deeply hope you enjoyed this report.

Peer reviewers: Huge thank you to the following for peer reviewing this report/model. Without the feedback from these individuals, we couldn't have completed this project: *David Puell* On-Chain Research for Ark Invest, *Eric Wall* Chief Investment Officer at Arcane Assets, *Jason Smith* Crypto Trader/Angel Investor/Entrepreneur, *Tim Stolte* Quantitative Researcher at AMDAX Asset Management, pseudonymous quant *Nick* (@btconometrics), *Jay Gould* Entrepreneur and Investor, and *Nathan Montone* Founder and CEO of M31 Capital

Data Sources: Glassnode, <https://ourworldindata.org>, <https://ourworldindata.org/future-population-growth>,