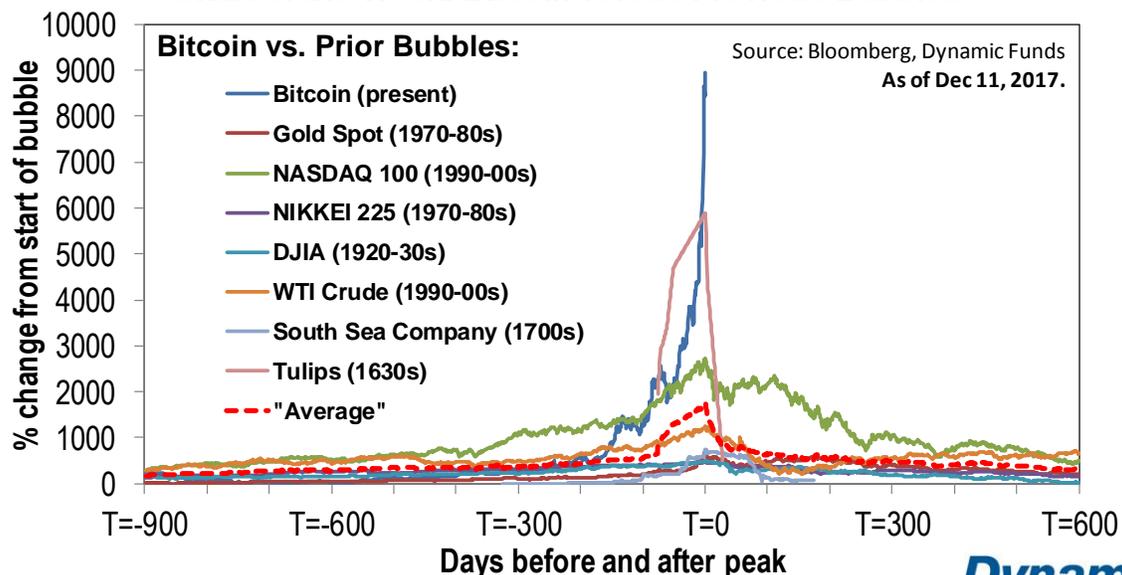December 13, 2017

Special Edition – Bitcoin!

The meteoric rise of Bitcoin has prompted us to release this unscheduled *Musings* on bubbles:

- The term "bubble" is so loosely thrown around that its popularized use has become meaningless: "FANGS are in a Bubble"; "Cannabis Stocks are High on Helium"; "The Global Bond Bubble is set to Burst".

- Our operating definition of a bubble is rooted in mathematics. An asset bubble typically exhibits a significantly faster than exponential price increase which, and this is key, is an impossibility in a world defined by finite resources.

- Bitcoin has taken on the impossibility by ascending along a price trajectory approaching the hyperbolic. Today it doubles in 31 days but a year from now doubling will take only 6 days, assuming the trajectory of the current price rise continues.

- While Bitcoin's price exhibits an unsustainable growth path, it should not be shorted. The recent CBOE listed futures are an inappropriate vehicle to sell-short the crypto-currency given that the underlying price can change by three orders of magnitude in a short period of time. Options are needed to efficiently express a negative view on Bitcoin and these do not exist.

- All asset price paths during the prior 400 years of market history look like they were stuck in neutral when compared with Bitcoin (**see Chart of the Week**). This is truly amazing. Geoffrey West's book "Scale" suggests that this bubble could bury all of its predecessors based on network effects alone.

Chart of the Week: Bitcoin versus Previous Bubbles

Bitcoin vs. Prior Bubbles:

Source: Bloomberg, Dynamic Funds
As of Dec 11, 2017.

- Bitcoin (present)
- Gold Spot (1970-80s)
- NASDAQ 100 (1990-00s)
- NIKKEI 225 (1970-80s)
- DJIA (1920-30s)
- WTI Crude (1990-00s)
- South Sea Company (1700s)
- Tulips (1630s)
- "Average"

Y-axis: % change from start of bubble (0 to 10000)
X-axis: Days before and after peak (T=-900 to T=600)

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What is a Bubble?

In finance, or in economics, there is no agreement about what constitutes a financial bubble or if it can even be recognized in real time. Here is a quote from economist and former Chairman of the Federal Reserve, Alan Greenspan:

> *"We, at the Federal Reserve...recognized that, despite our suspicions, it was very difficult to definitively identify a bubble until after the fact, that is, when its bursting confirmed its existence... "*

Definitions proposed by a few thought leaders in these professions all sound interesting but prove unhelpful in determining bubble risks in real time. As you read through these, deposit all of the references to "fundamentals" in your cerebral cortex:

- **Peter Garber**: *The definition of a bubble most often used in economics research is that part of an asset price movement that is unexplained based on what we call fundamentals.*

- **J. Barley Rosser**: *A speculative bubble exists when the price of something does a not equal its market fundamentals for some period of time for reasons other than random shocks. Fundamentals are usually argued to be a long-term equilibrium consistent with a general equilibrium.*

- **Jeremy Siegel**: *...a period of rising (or falling) prices in an asset market can be described as a bubble (or negative bubble) at time t if it can be shown that the realized return of the asset over a given future time period, that time period defined by the duration of the asset, can be shown to be inconsistent i.e., more than two standard deviations from the expected return, given the historical risk and return characteristics of that asset at time t.*

Many ideas embedded in these definitions are circular. Even abstracting from that, one still needs to determine the intrinsic value of an asset in order to gauge how far the current market price has deviated from its fundamental benchmark. This is an incredibly difficult task loaded with subjectivity, as anyone with experience in constructing a dividend discount or similar valuation model will attest to.

Main Street's "Bubble"

Most financial authors and investors feel that an asset price bubble is associated with a "really steep" or a "really fast" price trajectory. People colloquially refer to a bubble as one in which the price of an asset "has gone exponential".
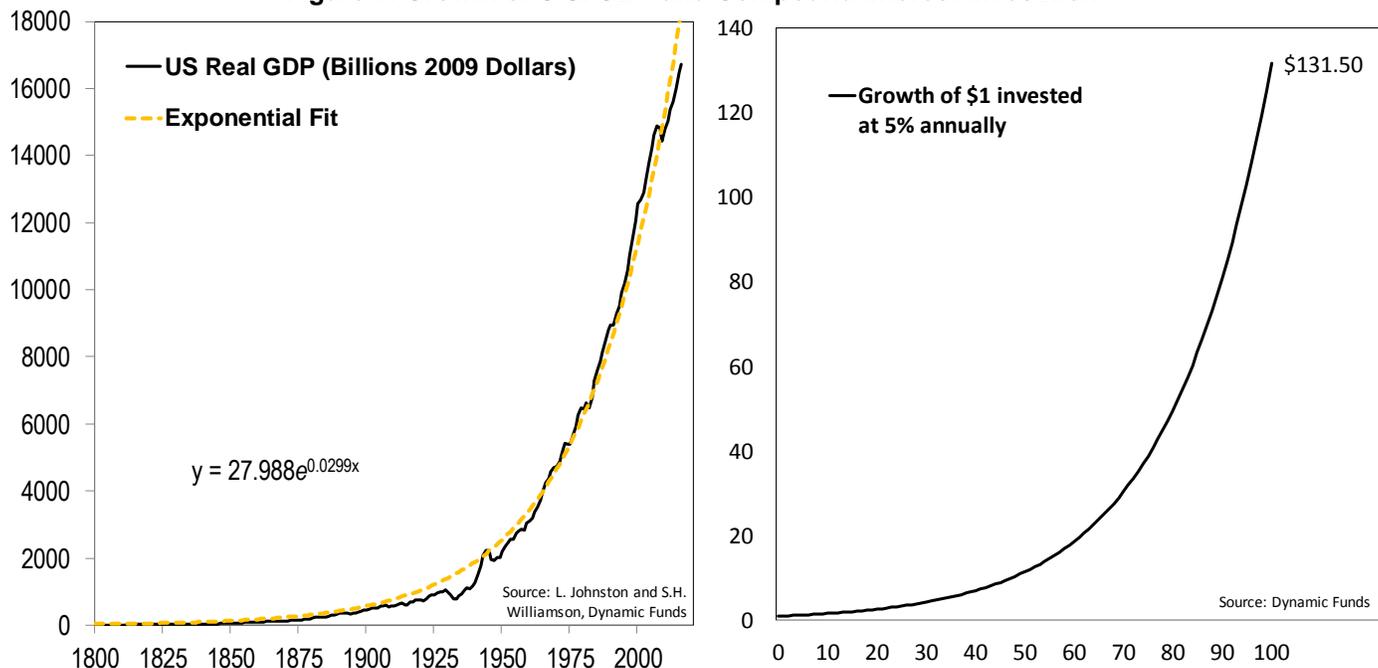
Exponential price trajectories are impressive. These occur when the rate of change of a given variable is proportional to the variable's current value. Would you like for me to give you $1 million in 30 days or to give you, at the end of 30 days, a penny whose value doubles each day? The penny follows an exponential growth path and would provide you with $10.7 million at the end of thirty days. Obviously, take the penny whose value doubles each day!

As impressive as exponentials are, they represent much of what we see in our daily financial and economic lives. For example, the U.S. economy has grown exponentially, at a rate of about 3%, since the 1800s (Figure 1, LHS). We provide another example of a hypothetical vehicle earning a compound annual interest rate of 5% through time (Figure 1, RHS). It is no wonder why Albert Einstein has said "Compound interest is the eighth wonder of the world. He who understands it, earns it. He who doesn't, pays it".

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Once the exponential growth rate, like the 3% bogey for the U.S. economy, is figured out it is easy to determine how long it will take to double its size using the simple "rule of 72". Said differently, on the current trajectory the size of the U.S. economy will double every (72/3) ~24 years. An asset which grows at a compound annual rate of 5% doubles in value every 14.4 years.

Exponential paths are impressive, but they are not bubble paths.

Figure 1: Growth of U.S. GDP and Compound Interest Investment

US Real GDP (Billions 2009 Dollars)
Exponential Fit

$y = 27.988e^{0.0299x}$

Source: L. Johnston and S.H. Williamson, Dynamic Funds

Growth of $1 invested at 5% annually

$131.50

Source: Dynamic Funds

Towards an Operational Definition of Bubble

Observers with the sense of non-linearity and scaling, dynamics which govern social networks like those covered in Geoffrey West's book "Scale", seem to have gotten closer to a practical definition of an asset price bubble.

A couple of examples are offered by the following people:

- **Charles Kindleberger**: *A bubble may be defined loosely as a sharp rise in the price of an asset or a range of assets in a continuous process, with the initial rise generating expectations of further rises and attracting new buyers.*

- **Robert Shiller**: *...a situation in which news of price increases spurs investor enthusiasm which spreads by psychological contagion from person to person, in the process amplifying stories that might justify the price increase...*

The idea of a positive feedback loop is the key building block for financial bubble mathematics, in our opinion. An initial innovation – be it tulips, the internet, or blockchain – creates a burst of wealth for a few, and in a short time the social epidemic spreads to create demand where there was none: Higher prices create the demand to generate even higher prices.

# Bitcoin and Hyper-Exponential Asset Price Paths

We have already informed you as to how powerful, but common, an exponential growth path is in the world we live in. GDP, computing power, and your savings account all follow exponential growth through time. Bubbles seem very different.

We have examined the pricing dynamics of the Tulip Mania, the South Sea Bubble, and numerous other financial bubbles throughout history. The one common element shared by all is a much faster than exponential price increase. Take the late 1970s gold price, as one example, which had started to rise at a faster pace than exponential or even double exponential pace (Figure 2, LHS). It was not long after breaching the double-exponential threshold that the price uptrend broke.

The main idea is that variables in the real world expanding at a faster than exponential pace of growth are unsustainable. Why? To grow at a hyper-exponential pace requires an unlimited, ever increasing, and eventually infinite supply of resources at some finite point in the future to sustain it. This is an impossibility.

With this in mind, the price of Bitcoin has moved above an exponential and even a double-exponential pace (Figure 2, RHS). This, like all other paths before it, is unsustainable. When it breaks is anyone's guess. But it has approached the stage of criticality – one where even minute negative shifts can lead to explosive negative responses.

Figure 2: Gold and Bitcoin Exhibit Faster Than Exponential Paths
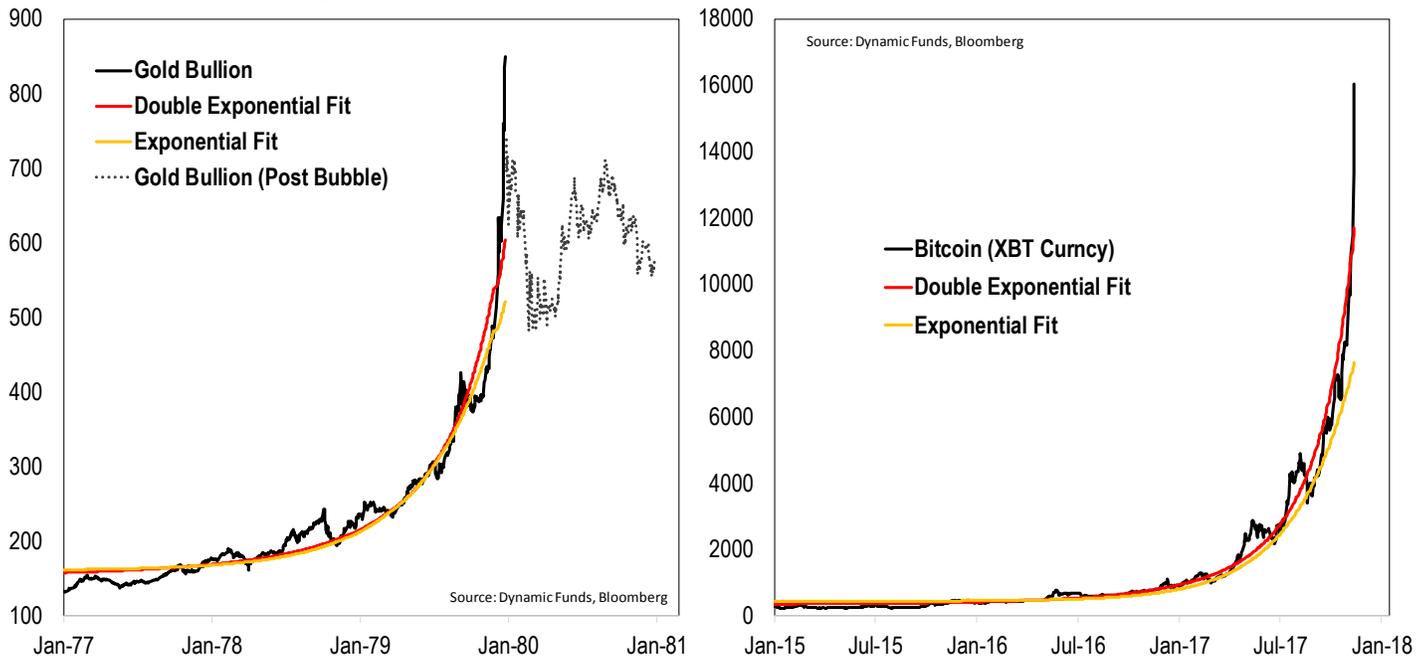
Bottom line: Bitcoin is a bubble based on the fact that it's price is tracking a hyper-exponential curve. Short it? Absolutely not. It could climb to $500k before $5k and futures are not the way to short-sell an asset like this. One needs an options market. It is now the most dangerous asset on earth, in our opinion.

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