A simple macroeconomic model of bitcoin

Joseph C Wang Bitquant Research Laboratories
joequant@gmail.com

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Abstract

This working paper presents a simple model for the macroeconomic behavior of bitcoin based on the economic equation of exchange. According to this model, the value of bitcoin is determined largely by the willingness of bitcoin holders to save bitcoin and not by its transactional use. This model therefore predicts that increased use of bitcoin will not cause its value to rise, but that the value of bitcoin in terms of fiat currency will be almost solely determined by the willingness of bitcoin holders to pull bitcoin out of circulation. This model suggests that bitcoin will not fall victim to a liquidity trap as suggested by some economists.

I. Introduction

In this working paper, we present a model for the valuation of bitcoin based on simple macroeconomic arguments. We caution that our model is intended primarily to stimulate discussion and that the truth of this model or any economic model will be determined by empirical observation of the bitcoin market.

II. Macroeconomics of Bitcoin

We begin our money with the equation of exchange where

$$M \cdot V = P \cdot Q \tag{1}$$

where

- M is the nominal amount of money
- V is the velocity of money
- P is the price level
- Q is the index of real expenditures

We now modify the equation in order to take into account the unique aspects of bitcoin. First we express all of our quantities in units of fiat currency. By expressing all of our quantities in terms of fiat currency, we can set the P to 1. Since we are expressing all quantities in units of fiat currency, the value for M is now the value of bitcoin as measured in fiat currency units.

We next expand the quantity M in terms of the number of bitcoin in circulation n_b and the price of a single bitcoin p_b. The number of bitcoin in circulation is externally determined and slowing and predictable varying, whereas the price of a single bitcoin will fluctuate. Substituting $M = n_b p_b$ we and rearranging we get.

$$p_b = \frac{Q}{n_b V} \tag{2}$$

We note that n_b is an externally determined and slowing changing variable. The main determinant of the price of bitcoin is the interaction between the level of bitcoin usage and the velocity of bitcoin.

At this point we have made no assumptions concerning the dynamics of bitcoin. We shall now add some dynamical assumptions concerning the relationship between the number of bitcoin expended Q and the velocity of an individual bitcoin V.

We decompose the velocity of bitcoin into a portion that is saved and portion that is transacted. We denote the likelihood that a invidid-

ual bitcoin is saved by l_s and the likelihood that a bitcoin is transacted as l_t. These two variables will sum to 1. These portions have a corresponding set of velocities v_s being the velocity of a saved bitcoin and v_t being the velocity of a transacted bitcoin.

We now make several claims about the dynamics of bitcoin. Because $v_t \gg v_s$ we claim that we can set the velocity of saved bitcoins to 0. We further claim that the velocity of transacted bitcoins can be modeled as a linear function of Q. We therefore have the following expression for the total velocity of bitcoin.

$$V = l_t \alpha_t Q \tag{3}$$

.

Substituting back into the original equation we see that

$$p_b = \frac{1}{l_t \alpha_t} \tag{4}$$

.

We claim that α_t will remain roughly constant over time. That leaves only one term which impacts the price of bitcoin, which is the l_t the likelihood that a given bitcoin will be transacted rathr than saved.

III. Implications of our model

Our model makes very strong claims concerning the price of bitcoins. In particular, it states that the price of bitcoin is determined almost solely by the likelihood that a given bitcoin will be saved. If a user uses bitcoin for transaction purposes then this has no impact on the value of bitcoin, while the value of bitcoin rises a given bitcoin is more likely to be saved rather than transacted.

This model seems to agree with the changes in bitcoin pricing in 2013. The two events that caused bitcoin prices to increase were the Cyprus banking crisis in April 2013 and the rise of mainland Chinese bitcoin exchanges in October 2013. Both these events increased the likelihood that a given bitcoin would be saved rather than transacted which increased the price of bitcoin. We note that the main drivers for bitcoin prices have been news reports concerning the convertibility of bitcoin, and that news reports concerning the increasing usage of bitcoin has made very little impact on its price.

We also note that bitcoin has is prone to sudden changes in price due to news events but that the price of bitcoin after a sudden shock has returned to stable levels. Our model explains this phenomenon by asserting that although shocks can cause a sudden change in the price of bitcoin, to the extent that it does not cause a change in how likely a bitcoin is saved or transacted, it will not cause a change in the long-run price level of bitcoin.

Our model also makes predictions concerning the future price of bitcoin. If our model is correct, then we should expect that increased usage of bitcoin should manifest itself in larger volumes rather than increased prices. Prices in bitcoin would only be effected by events which increase or decrease the likelihood that a given bitcoin would be saved rather than transacted.

Some economists, notably Paul Krugman, are pessimistic about the viability of bitcoin as a medium of exchange, because they believe that bitcoin will fall into a liquidity trap caused by the fixed supply of bitcoin Krugman [2013]. Krugman claims that as the price of bitcoin rises, the amount of bitcoin in circulation will decrease thereby increasing the price, ultimately creating a situation in which bitcoin is completely hoarded. This effect has been observed in scrip economies such as the Capital Hill Babysitting Co-op Krugman [1997].

However, our model provides a mechanism by which bitcoin can avoid a liquidity trap and explains why bitcoin has not experienced such a trap. The mechanism which we claim this will occur involves the interaction between bitcoin and fiat currency. As the price of bitcoin rises, we claim that people will be more likely to spend their bitcoin rather than fiat currency, which will decrease saved bitcoin thereby cause bitcoin prices to fall. Conversely a fall in the price of bitcoin will increase the likelihood that people will save bitcoin as they will be more likely to spend fiat, and this will cause bitcoin

prices to rise. Our models claims that long-run increases or decreases in the price of bitcoin will not influenced by the transactional use of bitcoin but rather by external factors which change the likelihood that a given bitcoin will be saved.

Krugman's belief that bitcoin is destined for a liquidity trap ignores the fact that bitcoin exists within an fiat-based economy, and that the ease of convertibility to and from fiat prevents a liquidity trap that exists when convertibility is difficult.

IV. Conclusion

We caution that the correctness of the model will be determined by future empirical observations of the bitcoin market. However, we hope to illustrate that the behavior of bitcoin can be modelled using basic economic principles, and we hope that this working paper will stimulate research and discussion in this area.

References

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