SWISSREX MODEL PROVES NON-LINEARITY OF STOCK TO FLOW MODEL

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In this report we provide a formal derivation of the SwissRex Model for Bitcoin and prove the non-linearity of the Stock to Flow Model. More than one predictor variable is needed for a realistic specification; nominal variables such as global broad money supply and Bitcoin velocity should be added to avoid distortions. The SwissRex Model results in a fair Bitcoin value of around $25'000 at the end of 2020.

Formal Derivation of the Stock to Flow Model

When we talk about the Stock to Flow Model below, we refer to the **logarithmic form** given by PlanB.[1]

Our analysis starts with two quantity identities which state that the supply of money always corresponds to the demand for money.

supply of money	≡	demand for money	
(1) M x V	≡	T	global quantity equation
(2) $P_{Bitcoin}$ x $M_{Bitcoin}$ x $V_{Bitcoin}$	≡	$T_{Bitcoin}$	Bitcoin quantity equation

M = money supply
V = velocity
T = transaction volume
P = price
Unit of account = USD

$T_{Bitcoin} = bT$

b = Bitcoin adoption or percentage of Bitcoin to global transaction volume

Reshaping the quantity equation for Bitcoin results in

(3) $MC_{Bitcoin} = P_{Bitcoin}$ x $M_{Bitcoin} = \dfrac{bT}{V_{Bitcoin}}$

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[1] https://medium.com/@100trillionUSD/modeling-bitcoins-value-with-scarcity-91fa0fc03e25

MC = market capitalization

and in its logarithmic form

(4) $\ln MC_{Bitcoin} = \ln b + \ln T - \ln V_{Bitcoin}$

If global transaction volume (T) and Bitcoin velocity ($V_{Bitcoin}$) are given, this equation transforms into

(5) $\ln MC_{Bitcoin} = a + \ln b$ $\quad\quad\quad\quad\quad\quad$ $a = \ln T - \ln V_{Bitcoin}$

and specifying b as

(6) $b = d + S2F^c$ $\quad\quad\quad\quad\quad\quad$ S2F = Stock to Flow[2]

finally results in the famous **Stock to Flow Model introduced by PlanB:**

(7) $MC_{Bitcoin} = e + c \ln S2F$ $\quad\quad\quad\quad$ $e = a + \ln d$	

In his regression analysis PlanB received the following values for the parameters:
e = 14.6
c = 3.3

This equation gives you extreme predicted values for Bitcoin:[3]

Year	BTC price prediction
2020	100'000 $
2024	1'300'000 $
2028	18'000'000 $

Critical Discussion of the Stock to Flow Model

Our analysis shows that the Stock to Flow model by PlanB is incorrectly specified and leads to unrealistic price predictions. Our main criticisms are:

1. **Linearity**:

The model assumes a linear relationship between Stock to Flow (S2F) and the market capitalization of Bitcoin ($MC_{Bitcoin}$), which, as described above, implies

(6) $b = d + S2F^c$

But, b is the percentage of Bitcoin to global transaction volume and therefore, the value of b can be a

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[2] Please refer to Crypto Research #7 for an explanation of Stock to Flow.
[3] We used newer data for Bitcoin supply growth, https://plot.ly/~BashCo/5.embed

maximum of 100%. Using equation (6), b will exceed 100% after a certain point in time, which is not possible. Hence, the correct specification of b must be an exponential function:

(8) b = f exp (kS2F^c)

The Stock to Flow ends in a singularity, when the block reward or the flow disappears around the year 2140 (division by 0). To avoid this, we use the reciprocal of Stock to Flow, which is the Bitcoin supply growth g:

(9) b = f exp (kg^c) $\qquad\qquad\qquad g = \frac{1}{S2F}$

2. **Simple regression**:

As shown above, PlanB's model implicitly assumes global transaction volume (T) and Bitcoin velocity ($V_{Bitcoin}$) to be constant, which is obviously not the case. If the model contains only one variable (S2F) an overlap of a linear (lnT - lnV) and an exponential part (b) is measured simultaneously. The linear part could dominate and pretend a linear Stock to Flow relationship.[4] Therefore, it is important to include all three variables in the specification of the model.

SwissRex Model

The SwissRex Model remedies these shortcomings.

Inserting equation (9) into (4) results in

(9) $\ln MC_{Bitcoin} = \ln (f \exp (kg^c)) + \ln T - \ln V_{Bitcoin}$

and using equation (1) to substitute transaction volume (T) with global broad money (MV)

(10) $\ln MC_{Bitcoin} = \ln f + kg^c + \ln (MV) - \ln V_{Bitcoin}$

We call this equation the **SwissRex Model**.

The SwissRex Model uses three inputs:

i)   Adoption rate (b)   =   f(Bitcoin supply growth)   =   f(S2F)
ii)   Global broad money (MV)
iii)   Bitcoin velocity ($V_{Bitcoin}$)

If global broad money and Bitcoin velocity are kept constant the SwissRex Model ends in the **Capped Stock to Flow Model**.

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[4] This is the case, when inflationary effects kick in.

When the block reward or Bitcoin supply growth (g) disappears around the year 2140, equation (9) translates into:

$$\ln MC_{Bitcoin} = \ln f + \ln (T) - \ln V_{Bitcoin} \qquad\qquad \text{or,}$$

$$MC_{Bitcoin} = P_{Bitcoin} \text{ x } M_{Bitcoin} = \frac{fT}{V_{Bitcoin}}$$

The parameter f is the maximum allowed value for b. If f = 1, then all transactions worldwide are executed in Bitcoin. The SwissRex model no longer ends in a singularity in the year 2140.

Regression Analysis of the SwissRex Model

We performed a first rough statistical analysis of the SwissRex Model:

$$\boxed{\ln MC_{Bitcoin} = \ln f + k \, g\char`\^c + \ln (MV) - \ln V_{Bitcoin}}$$

Data:

Bitcoin market cap:	https://github.com/100trillionUSD/bitcoin
Bitcoin supply growth:	https://plot.ly/~BashCo/5.embed
Bitcoin transaction volume:	coinmetrics
Data range:	September 2010 – November 2019[5]

<u>Assumptions:</u>

MV = world money supply M1: 95 trillion in the year 2017[6]

M1 supply growth = 10% a year

$$V_{Bitcoin} = \frac{T_{Bitcoin}}{MC_{Bitcoin}}$$

The regression was solved by using Excel and minimizing the mean squared error (MSE).

<u>Regression results</u>:

f = 0.64   k = -14.4   c = 0.42

Fit		SwissRex Model	Stock to Flow Model by PlanB
R^2	MC	64%	61%
R^2	ln (MC)	90%	92%

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[5] Bitcoin velocity is a critical factor and figures are heavily distorted before September 2010.

[6] http://money.visualcapitalist.com

Both models fit about the same[7], but the price targets of the SwissRex model are much more modest:[8]

Year	SwissRex Model	Stock to Flow Model by PlanB
2020	25`000 USD	100`000 USD
2024	70`000 USD	1`300`000 USD
2028	170`000 USD	18`000`000 USD

According to the SwissRex Model, Bitcoin adoption will be 64% of global transaction in the year 2140 (f = 0.64).

Chart 1: Bitcoin market capitalization: regression results and predictions

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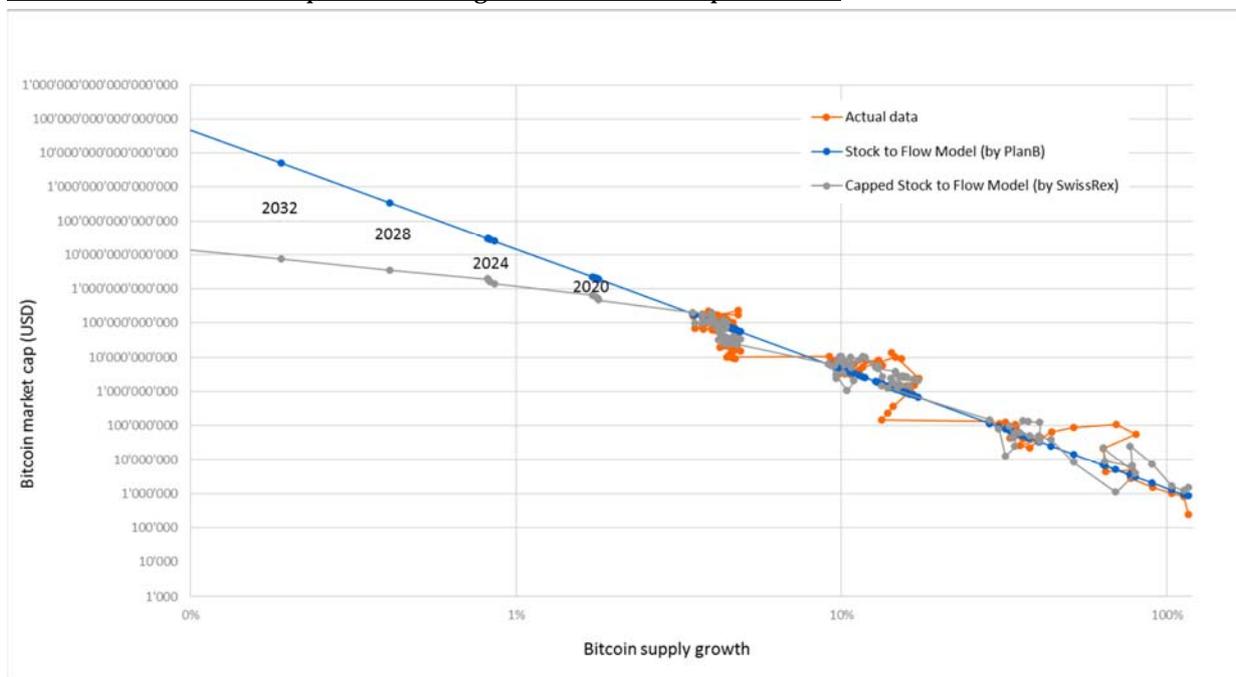
[7] We leave it to others to test the regression results in more depth.
[8] Price targets are fair values. Actual prices could significantly deviate from the targets in the short- and medium term.

Chart 2: Bitcoin price: regression results and predictions
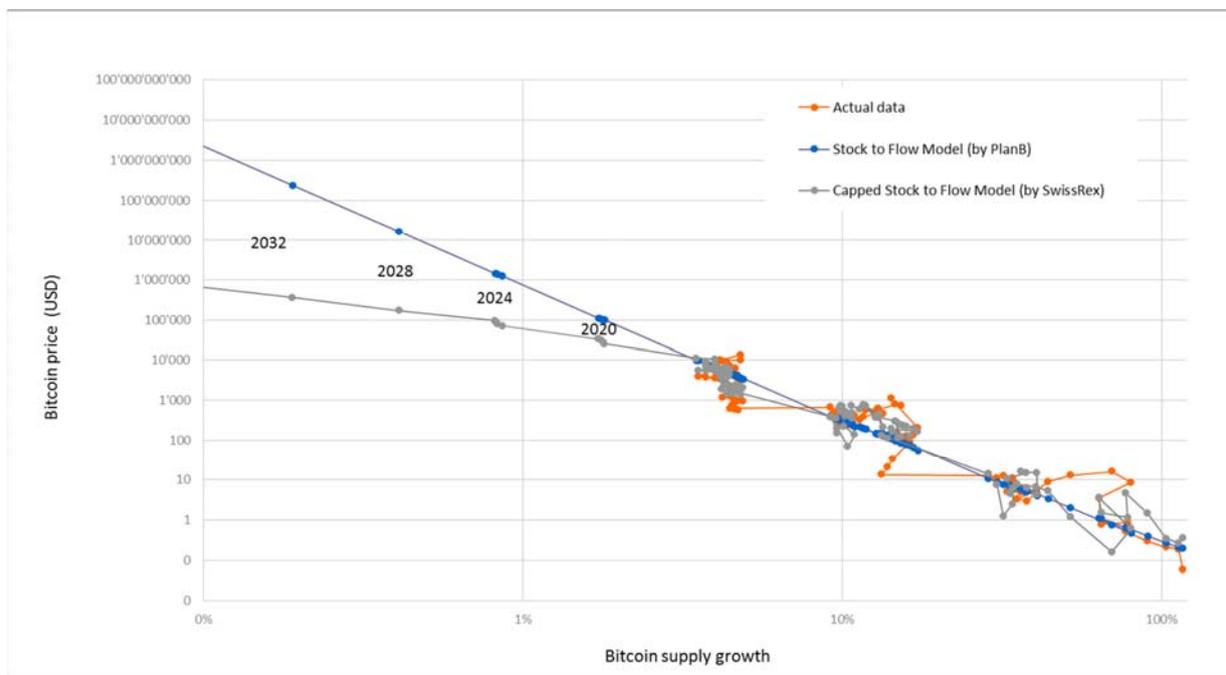
Chart 3: Bitcoin adoption (b): regression results and predictions
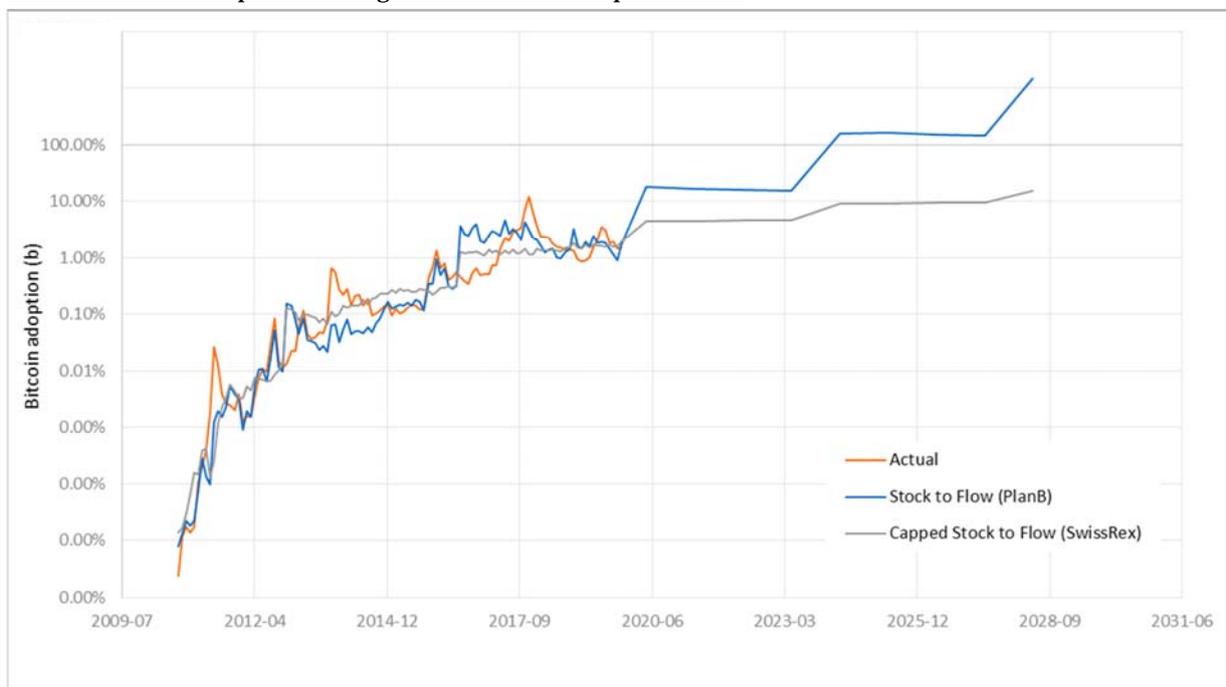
According to PlanB`s model:

1.)   adoption overshoots 100% from year 2024 on, which is impossible.
3.)   adoption is more volatile.
2.)   adoption decreases between the halvings.

This is all a result of mixing monetary and Stock to Flow effects.

Monetary effects

Price predictions by PlanB`s Stock to Flow Model could only become reality if **monetary effects** kick in. This is evident if equation (10) is transformed:

$$\ln MC_{Bitcoin} = \ln b + \ln (MV) - \ln V_{Bitcoin} = \ln b + \ln M + \ln (V/V_{Bitcoin})$$

Inflated money supply (M) coupled with hyperinflationary effects (higher $V/V_{Bitcoin}$) could catapult the Bitcoin price. But that cannot be attributed to Stock to Flow.

Chart 4 shows the predicted Bitcoin adoption (b), if global money supply growth tripled to 30% per year from now on. In that case, PlanB`s model would be valid up until 2024, assuming a 100% global adoption of Bitcoin. But, the strange behaviour of a decreasing adoption between the halvings would be even more pronounced and shows the misspecification.

Chart 4: Bitcoin adoption (b): regression results and predictions given 30% future money supply growth
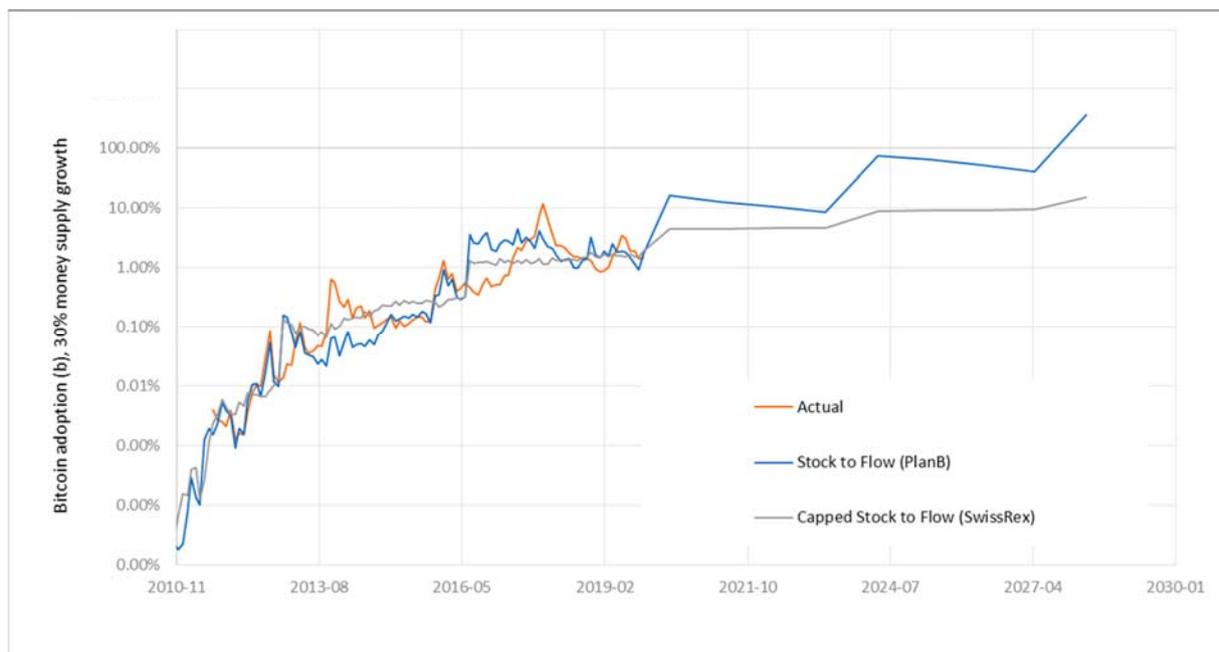
Conclusion

Based on economic theory, **we have proved that the Stock to Flow Model must be capped** and can only explain part of the Bitcoin price. The Stock to Flow model is all about the division of the cake, whereas macroeconomic variables define the size of the cake. As a result of the proof we derived the specification of the **SwissRex Model for the valuation of Bitcoin**. The SwissRex Model consists of three parts: i) adoption rate of Bitcoin, ii) global broad money supply and iii) Bitcoin velocity. The adoption rate solely depends on the Bitcoin supply growth or the Stock to Flow ratio. At the end of 2020 a fair Bitcoin value of 25`000 USD results.