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My Answers

Finance: Question One

Bitcoin Stock-to-Flow model: The SF model traditionally is used to measure abundance and predict the value of commodities used as a store of value. A good example is a precious metal like Gold. It is practically the ratio of the current supply(stock) of the resource to the amount produced per annum(flow). The model wasn't applied to bitcoin until recently when PlanB, a Dutch trader published a paper applying the model to bitcoin. This model treats bitcoin as traditional commodities like gold. Now the Bitcoin Stock-to-Flow Model is the ratio of the total amount of bitcoin that exists (BTC 18.5m) to total supplied/mined in a year. Mathematically:

$$SF = \frac{Q(Quantity)}{Q(Quantity)/T(time)} = T(Time)$$

Bitcoin has its current supply at 18.5million BTC and annual supply at approx. 0.7million BTC/year, applying the formula above with these figures to calculate the SF of bitcoin, we get 26Years.

According to PlanB, high Stock-to-Flow indicates low supply or scarcity which in turn drives the bitcoin value in USD up. It also indicates that the commodity will retain its value for a long period.

Failure of Stock-to-Flow Model: The usefulness of any model is entirely dependent on the wideness of its assumptions and the extent to which these assumptions correspond to reality. The Bitcoin stock-to-flow model popularized by PlanB assumes that the value of a store of value like bitcoin is solely dependent on scarcity which in reality is not the case. There are other factors involved in determining the value of BTC.

Sandford's University's professor Paul Pleifderer put it this way "An initial evaluation of a model should begin with a critical look at the model's theoretical assumptions… Imagine an asset pricing model based on the assumption that there is no uncertainty about any asset's returns… No serious person would suggest that predictions of the model be subjected to further empirical testing before rejecting it. The model can be rejected on the basis that a critical assumption is contradicted by what is known".

The model is based on assumption that the USD market cap of gold is a direct function of its supply rate or SF. This however is not true given that the value of Gold in the last 115 years ($60billion to $9trillion) has no known direct relationship with its SF (60). This simply tells us that SF is not the driver of price and that there are other factors that drive price/value that is not accounted for by SF.

In bitcoin, going by the SF model, given relatively stable SF value for a resource like bitcoin, the market price would be stable or at least be within a reasonably acceptable range. However, bitcoin is notorious for high volatility and sharp moves. This wasn't and cannot be accounted for by SF.

Also going by the SF model, when Q(quantity)/year in our equation above becomes zero, that is when there is no more bitcoin to mine, the value or price of bitcoin will become infinity. This we know can't to be in practice.

In conclusion, I think the SF model is an extremely simple model that should only be used for theoretical purposes.

Finance Question Two

I will answer this question by using the Black-Scholes model/formula as follows:

$$C = SN(x_1) - KN(x_2) - - - -eqtn(1)$$

Where $K = Be^{-rt} - - - - - eqtn(1.1)$

Also

$$x_1 = \frac{ln\, {}^{S}/_{B}}{6\sqrt{t}} + \frac{1}{2}6\sqrt{t} - - - eqtn(2)$$

$$x_2 = \frac{ln\, {}^{S}/_{B}}{6\sqrt{t}} - \frac{1}{2}6\sqrt{t} - - - eqtn(2.1)$$

Before I proceed, let us define terms;

C = Call Option Price: Our unknown

S = Current Stock Price: 40dollars

B = Strike price: 45dollars

r = Risk Free Price: 3% (0.03)

t = Time to Maturity: 4months(1/3yr)

N = A Normal Distribution or Gaussian Distribution

Ϭ = Standard Deviation: 40% (0.4)

Now let's proceed!

$$x_1 = \frac{ln\ {}^{40}/_{44.5522}}{6\ \sqrt{0.33}} + \frac{1}{2}\text{x}(0.4)\ \sqrt{0.333}$$

$x_1\ =\ \frac{-0.10778}{0.2309} + 0.115701 =\ -0.35108$

Following a similar approach for x_2 we obtain

$$x_2 =\ -0.5821843$$

Also, from equation 1.1 we have that

$$K = Be^{-rt} = 45xe^{-0.03x^1/_3} = 44.55224$$

Having solved for all the parameters, we can now go ahead and find our Black-Scholes price by substituting for these parameters obtained so far into equation 1:

$$C = 40\ x\ N(-0.35108\ ) -\ 44.55224\ x\ N(-0.5821843\ ) - - - eqtn(4)$$

Now let us compute the values of N(x):

N(x) is known as the Gaussian Normal distribution equation and defined as

$N(x) =\ \frac{1}{6\ \text{x}\sqrt{2u}}e^{\frac{1}{2}(\frac{x-u}{6})^2}$ − − − −eqtn (4)

Now applying equation 3 by substituting for the two values of 'X' we obtain

$$N(x_1) = \frac{1}{6 \text{ x} \sqrt{2u}} e^{\frac{1}{2}(\frac{x_1 - u}{6})^2}$$

$$N(-0.3512442) = \frac{1}{0.4 \text{ x} \sqrt{2(3.14159)}} e^{\frac{1}{2}(\frac{-0.3512442 - 0.7}{0.4})^2} = N(x_1) = 0.55452$$

Similarly, $N(x_2) = 0.26470$

Finally, we substitute these values of N(x) into equation 3

$$C = 40 \; x \; 0.55452 - 44.55224 \; x \; 0.26470 = \$10.38$$

Computer Science Question One

There are two major ways one can find the Fibonacci of a number: recursive and iterative method.

The problems with recursive method are:

1. Time Complexity: this is the total time required for an algorithm or program to execute. The time complexity or time taken by calculating Fibonacci is O(2^n) or exponential.
2. Space Complexity: this is simply the amount of memory an algorithm needs to run or while running. The space required by recursive Fibonacci is directly proportional to the maximum depth of the recursion tree O(N).

Iterative method, is a better way to find Fibonacci of a number.

Computer Science Question Two

Please check the .cpp file attached.

Mathematics Question

$$Y = \sqrt{(x+2)^2 + 25} + \sqrt{(x+6)^2 + 121}$$

But $Y = y(1) + y(2) - - - - - eqtn(1)$

Where;

$y(1) = \sqrt{(x+2)^2 + 25}$ and $y(2) = \sqrt{(x+6)^2 + 121} - eqtn(2a\ and\ 2b)$

Solving the first part:

$y(1) = \sqrt{(x+2)^2 + 25},$

now let $U = (x+2)^2 - - - eqtn(3)$

so that eqtn. (2a) becomes $y(1) = \sqrt{U + 25}\ - - - eqtn(3.1,$

Therefore $y(1) = (U+25)^{\frac{1}{2}}$ ➔ $\frac{dy(1)}{dU} = \frac{1}{2}(U+25)^{\frac{-1}{2}} - - - eqtn(4)$

So that we now have:

$$\frac{dy(1)}{dx} = \frac{dU}{dx}\ x\ \frac{dy(1)}{dU} = 2(x+6)x\ \frac{1}{2}(U+25)^{\frac{1}{2}} =$$

$$\frac{dy(1)}{dU} = \frac{(\boldsymbol{x+6})}{(\boldsymbol{U+25})^{-1/2}} = \frac{\boldsymbol{x+6}}{\sqrt{(\boldsymbol{x+6})^2 + \boldsymbol{25}}} - - - \boldsymbol{eqtn(4.1)}$$

Second Part:

The second part y(2) similarly and we would get

$$\frac{\boldsymbol{x-6}}{\sqrt{(\boldsymbol{x-6})^2 + \boldsymbol{121}}} - - - - \boldsymbol{eqtn(5)}$$

Now solving further by merging first and second part, we proceed as follows,

Because $\frac{dY}{dx} = 0 - - - eqtn(6)$

we now using eqtn. (6) we have:

$$\frac{dY}{dx} = \frac{(x+6)}{\sqrt{(x+6)^{25}+25}} + \frac{(x-6)}{\sqrt{(x-6)^2+121}} = 0 - -eqtn(6.1)$$

Now taking the LCM of both sides, we have that;

$$\frac{(x+6)x\sqrt{(x-6)^2+121} + (x-6)x\sqrt{(x+6)^2+25}}{\sqrt{(x+6)^2+25}\ x\ \sqrt{(x-6)^2+121}} = 0 - -eqtn(7)$$

Multiplying both sides of equation 7 by the denominator we have

$$(x+6)\ x\sqrt{(x-6)^2+121} + (x-6)\ x\sqrt{(x\ +\ 6)^2+25} = 0 - eqtn(7.1)$$

Taking the multipliers outside of the square-roots into the square-roots, we have

$$0 = \sqrt{(x-6)^2 x(x\ +\ 6)^2 + 121(x\ +\ 6)^2} + \sqrt{(x-\ 6)^2 x(x\ +\ 6)^2 + 25(x-\ 6)^2} - -eqtn(7.2)$$

$$\sqrt{(x-6)^2 x(x\ +\ 6)^2 + 121(x\ +\ 6)^2} = -\sqrt{(x-\ 6)^2 x(x\ +\ 6)^2 + 25(x-\ 6)^2} - eqtn(7.3)$$

Raising both sides of equation 7.2 to power 2, and cancelling out the common terms, we have;

$121(x\ +\ 6)^2 = 25(x-\ 6)^2 - - - eqtn(7.4)$

$= 121(x^{\ 2} + 12x + 36) = 25(x^2 + -12x + 36) - - - -eqtn(7.6)$

Multiplying through and subtracting left side from the right side

$$96x^{\ 2} + 1752x + 3456 = 0 - - - eqtn(8.0)$$

Finally, we ended up with a quadratic equation (8.0) which we can proceed to solve using the so-called almighty formula:

$$\frac{-b \pm \sqrt{b^2-4ac}}{2a} = x - -eqtn(9)$$

Applying equation 9 to solve equation 8, let’s proceed:

$$\frac{-73 \pm \sqrt{73 - 4(4)(144)}}{2(4)} = x = \frac{-73 \pm \sqrt{3025}}{8} = \frac{-73 \ \pm 55}{8}$$

For $\frac{-73+55}{8}$ we have that $x = -\frac{9}{4}\ or -2.25$

For $\frac{-73-55}{8}$ we have that $x = -\frac{125}{8}\ or -16$

Therefore, for minimum y we will have to test these two values of x into the equation

$$Y = \sqrt{(x+2)^2 + 25} + \sqrt{(x+6)^2 + 121}$$

For x = -2.25:

$Y = \sqrt{(2.25+2)^2 + 25} + \sqrt{(2.25+6)^2 + 121}$ = 20

For x = -16:

$Y = \sqrt{(2.25+2)^2 + 25} + \sqrt{(2.25+6)^2 + 121}$ = 35.7771

Therefore, the minimum value of x for which
$Y = \sqrt{(x+2)^2 + 25} + \sqrt{(x+6)^2 + 121}$ is X= -2.25

QED. Also, there is an alternative way to solve this question with which the person solving can avoid solving a quadratic equation. That method boils down to linear algebraic equation.