Problem Chosen	2022 MCM/ICM Summary Sheet	Team Control Number
C		2228334

Given two data sets of daily Bitcoin and Gold price, this paper attempts to develop a trading strategy. Here is the summary answering the questions:

- Using the model and strategy, the 1000 USD in 9/10/2016 will worth 104700 USD.
- The model is sensitive to transaction costs; however, we can adapt easily (to be discussed later).

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A. Model and Strategy

1. On the day i, calculate two values $B10$ and $B30$, which are the average of the bitcoin price of the previous 10 days (day $i-9$ to i) and 30 days, respectively.

2. Similarly, calculate $G30$ and $G50$ for each day i, which are the average of gold price of the previous 30 days and 50 days which trading are allowed (where data are available).

3. On the day i that $B10$ starts exceeding $B30$, it indicates that it is a good time to buy bitcoin. To be clear, on day $i-1$, $B10 < B30$, but on day i, $B10 \geq B30$. On the day $B30$ starts exceeding $B10$, we would sell bitcoin.

4. Similarly, we buy gold when $G30$ starts exceeding $G50$; we sell gold when $G50$ starts exceeding $G30$.

5. Now, each day can be marked with the actions needed: Buy/sell Bitcoin/Gold, or no action.

6. If a day is marked with both Sell bitcoin and Sell gold, we trade both to coins.

7. If a day is with Sell Gold, there will be two options: if we are buying Bitcoin (in the portfolio $B \neq 0$), then we sell all Gold to buy Bitcoin. If we are not buying Bitcoin ($B = 0$), we sell all Gold and leave it as coins.

8. We do the same thing for days that are marked with Sell Bitcoin. There is one difference; that is when we are buying Gold, yet the current day does not allow trading, we just trade it into coins and leave it there.

9. If a day is marked with Buy Gold, there will be two possibilities: if we are not buying Bitcoin ($B = 0$), we take all the coins to buy Gold. However, if we are buying Bitcoin, we would sell a portion of Bitcoin to buy Gold. The portion is defined as:

$$\frac{a}{a+b} \cdot \alpha,$$

   where a, b are the change ("the growth") in Gold and Bitcoin price. We take $\alpha = 0.7$.

   a, b can be calculated as the sum of price in the last $t = 5$ days (i.e. from day $i-4$ to i) divided by the sum of the previous 5 days (i.e. from day $i-9$ to $i-5$), with a for Gold and b for Bitcoin.

10. We do it similarly for the day marked with Buy Bitcoin; however, when we are buying Gold but the current day does not allow Gold transaction, we will not buy Bitcoin.

B. Assumption

Before talking about how we decide to choose this model, we want to go over some assumptions we made.

- It is clear that the price on the last day $9/10/2021$ cannot be the only factor to determine if a model is good or not. Instead, we determine how good a model is by two factors: the average worth of the portfolio and the maximum worth of the portfolio.

  For each day, there are new values $currB$ and $currG$, which are the price of Bitcoin and Gold on that day. If that day does not allow Gold transaction, we take $currG$ to be the closet day before that allows gold transaction. The portfolio value everyday can be calculated as:

  $$coin + B \cdot currB + G \cdot currG.$$

  The average and the maximum of those values are the factor to evaluate the model. For our model, the average is around 34300 USD, and the maximum is around 122500 USD.

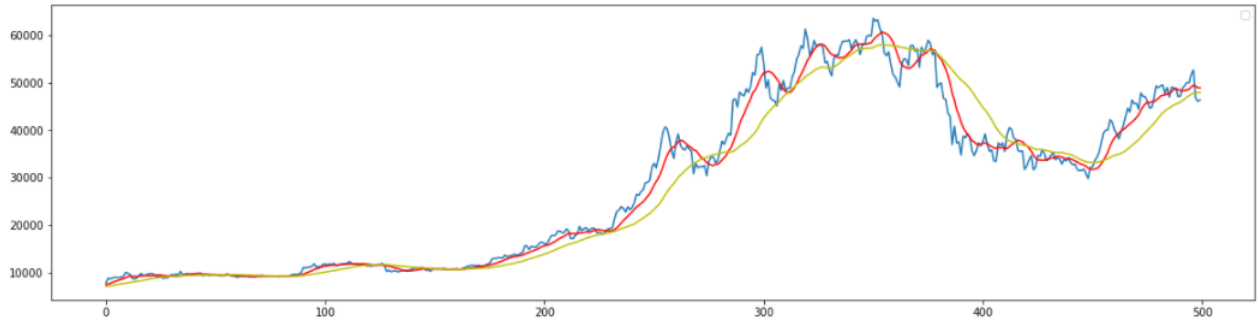
C. Discussion

This section attempts to explain how we develop our model. We mark the number corresponding to the steps in part A (Number n here will attempt to explain the point n in part A).

1. We believe taking the average will help smooth the price curve. The change in each day affect the curve less, but if we take the average of too many days before, the trend will not be as "up-to-date" as before.

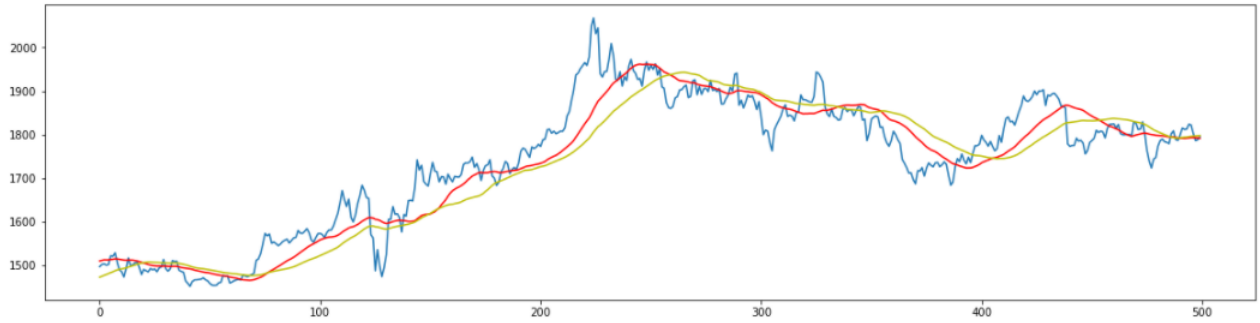
2. The idea of taking the average is to smoother the line and reveal the actual trend of it. Therefore, although we are missing some values, what we need is the trend of price, so it is justified to care only about the values on the days where transactions are allowed.

3. As mentioned, if we take the average of a smaller number of days, the information is more up-to-date. If $B10$ starts exceeding $B30$, it shows that the price is increasing. We should buy it as its price will increase in the future and generate profit.



This is the graph of the actual Bitcoin price (blue), $B10$ (red), $B30$ (yellow).

4. The same idea works for Gold, and because we are looking for the overall trend only, it is justified to use the data that has some values missing.



This is the graph of the actual Gold price (blue), $G30$ (red), $G50$ (yellow).

* Note: we first work on single value only (either Bitcoin or Gold), with the assumption that the profit will be linearly proportional to the initial money spent. We see that $B10, B30, G30, G50$ works the best for our data.

5. Note that the marking only based on the past prices.

6. No comment needed.

7. No comment needed.

8. We personally think it would be better to wait for the day when gold transaction is allowed to trade those coins for Gold. Yet, it is much harder to implement that in the code so we were not able to evaluate that.

9. It is clear that if one asset is increasing much faster than the other, we should invest more on that, which justifies the $\frac{a}{a+b}$ part. The α here is used to accommodate the transaction cost. When we trade one asset to another (different than coins), the money spent will be affected by both Gold and Bitcoin transaction cost.

   We ran the model multiple times and observed that it would work best when $\alpha = 0.7$ and $t = 5$.

10. Again, we think it would be better to wait until the next day when gold transaction are allowed to consider buying Bitcoin, yet we were not able to test it.

D. Limitation

Those are some limitation of the model that we would like to address.

- Some of the constant involved in the model $\alpha, t, \cdots$ were determined based only on trial-and-error; we did not find the math underneath those.
- The model did not account for the days when they are marked both with Buy Bitcoin and Buy Gold. Here, the money spent only be affected one and not two transaction costs; therefore, we would need a different α. For our data, no day was marked as that, so we cannot evaluate which works the best.