

✓ Cryptocurrency Momentum and Reversal

by Aviral Sharma

Paper Introduction

In the paper Cryptocurrency Momentum and Reversal, author Victoria Dobrynskaya studies the effects of different sorting and holding periods on the portfolio for cryptocurrencies. She studies the 2000 biggest crypto-currencies (with a market-cap above **\$1 Million**) during the **2014-2020** time-period. Momentum is the tendency of a financial asset with high recent returns to continue to generate high returns in the future, while reversal is the opposite. She concluded by saying that momentum turns into reversal if we expand the sorting period and keep the holding period short or if we expand the holding period and keep the sorting period short or if we expand both.

Data and Methodology

Data

The author focused on the time period 2014-2020 and got the data from www.coinmarketcap.com. The time period at the time the paper was written was considered to cover the entire crypto-currency history

The site had information from more than 200 exchanges and contained the daily prices. The data contains the following information:

| Symbol Date Open High Low Close Volume Market Cap Time Open Time High Time Low Time Close

Preprocessing

There was quite some preprocessing done on the data:

1. Only coins with market-cap above **\$1 Million** were extracted

2. We add the week number and the year based on the Time Open
3. The daily data was transformed into weekly frequency
4. The weekly returns were then calculated
5. The returns are extremely volatile so they were winsorized at the **0.005%** level

Methodology and Strategies Implemented

She implemented the J/K methodology where the coins are sorted by their previous cumulative returns over J weeks (ascending order).

The first 30% with the lowest returns form the loser portfolio and the top 30% form the winner portfolio.

Then she creates a winner minus loser (WML) portfolio which gets rebalanced after holding it for K weeks. The author initially considered a set of J/1 cryptocurrency reversal strategies. The sort period J varied between 1 and 104 weeks. She concluded that strategies with sort periods of 1-4 weeks yielded positive average returns which was evidence of short-term momentum effect.

In the winner-minus-loser portfolio, the author takes a long position on winners and a short positions on losers

She then considered 144 J/K strategies where both sort periods and holding periods varied between 1 and 12 weeks. The short-term momentum effect was observed on sorting and holding horizons below 1 month and longer-term reversals effect was observed on horizon beyond 1 month. This was different from stock market where short-term momentum is commonly observed on horizons below 1 year which pointed to the fast metabolism of crypto-currencies.

The author then also goes on to test winners and losers separately because some crypto currencies may be difficult to short and hence the strategies may not be fully implementable in practice.

So, she analyzed the performance of 'past winners' and 'past losers' separately as long-only portfolios. She noticed that winner portfolios yielded roughly the same positive average returns irrespective of the sorting and holding periods however the performance of loser portfolios varied significantly depending on the horizon.

She concluded by saying that taking a long position in the past-losers generated a very high return in the long run and could be considered an attractive, long only strategy.

Hypothesis

The author brings out attention to three main hypothesis in this paper, which are:

1. She argues that a significant, but rather small, momentum effect occurs on short horizons up to 2-4 weeks for holding periods
2. These effects then turn into a significant and economically large reversal effect on longer horizons, up to 2 years.
3. She also argues that momentum turns into reversal if the sorting/holding period is expanded.
4. She concludes that a long-winner portfolio returns yielded roughly the same positive average returns irrespective of the sorting and holding periods however the performance of loser portfolios varied significantly depending on the horizon.

She achieves this by analysing the cross-sectional momentum (or reversal). The cryptocurrencies are sorted by their trailing returns into winner and loser portfolios, the winner-minus-loser (WML) portfolio is held for some time and regularly rebalanced. A positive average return on the WML portfolio is evidence of momentum, whereas a negative return is evidence of reversal.

Let us look at all the hypothesis in a little bit more depth:

Hypothesis 1

In this hypothesis, the author demonstrates that when the sorting/holding periods are low ($J, K \in [1, 4]$), we get positive returns from our portfolio and then it starts decreasing until week 4 after which the returns become negative. This indicates that initially, when the holding/sorting periods are relatively low, the winners are the driving force behind the portfolio returns.

Hypothesis 2

As the holding/sorting period increases, we notice that the returns start becoming negative and start stabilizing around the -4 quantity which is near the 2 year mark. This makes sense because as the sorting/holding periods are expanded the WML portfolio would generate negative results as over a long period, the prices of assets can increase or decrease a lot and the positions we have (long or short) can lead to different results because of this. The main drivers of the reversal effect are 'past loser' cryptocurrencies.

Hypothesis 3

She argued that momentum turns into reversal if the sorting/holding period is expanded. We are dealing with a highly volatile market of cryptocurrency. If we choose winners and losers on big holding/sorting periods, the chances of the prices falling or rises increases drastically and this can have an adverse effect on the short and long positions. Perhaps the losers that were chosen and shorted, had a price increase because of the long holding periods which would lead to tremendous loss.

Hypothesis 4

She created two separate portfolios: winners and losers where she took a long position. The winner portfolio more or less had a similar result for different permutation combinations for sorting and holding horizons, while the loser portfolio generated high returns depending on the horizon. The loser portfolio giving high return makes sense as we are betting that the price of the losers will rise and there is a high possibility that it will depending on when we exit our positions

Tests for these Hypothesis

We will be testing out the hypothesis by doing the following:

1. We will mine the data from **coinmarket.com**
2. We will apply the same pre-processing
3. We will apply the same J/K methodology for picking winners and losers
4. We will create the winner-minus-loser portfolio and track the returns
5. We shall plot the results and see if we can replicate the same results

Summary (Precis Format)

Author Victoria Dobrynskaya in her paper Cryptocurrency Momentum and Reversal argues that the switching of momentum in reversal for crypto-currency occurs approximately after 1 month which is quicker compared to equity market and points towards faster metabolism of crypto-currencies. Victoria supports her claim by introducing her strategy for collecting data which includes collecting historical data for the top 2000 cryptocurrencies with market cap above \$1 Million between 2014 and 2020 and how she plans to trade using the J/K strategy

Victoria explains how she will sort the returns of the coins for J weeks and divide them into two categories: Winners (bottom 30%) and Losers (top 30%). She will then create a winner minus loser portfolio and hold it for K weeks. She will then expose it to other crypto-currency risk factors. 2. She establishes a relationship between J sorting and K holding time period by trying out different permutation and combinations in order to find which pair has the greatest/smallest momentum or reversal. She also then regresses each portfolio's returns to factors such as Market betas, Upside betas and Size Factor

She concluded that a significant, but rather small, momentum effect occurs on short horizons up to 2-4 weeks, which turns into a significant and economically large reversal effect on longer horizons, up to 2 years and momentum turns into reversal if the sorting/holding period is expanded

Literature Review

There are two main papers that I looked at apart from this paper:

1. Jegadeesh and Titman (1993)
2. Grobys and Sapkota (2019)

Jegadeesh and Titman (1993)

This paper explained the J/K Methodology in a little more in depth. According to them, the strategy was:

Every month, at time t , securities are organized from lowest to highest according to their return performance over the previous J months. Using these ordered rankings, ten portfolios are created, each containing an equal weight of stocks from each decile range. The portfolio comprising the highest-performing decile is labeled the "winners" portfolio, while the one with the lowest-performing decile is designated as the "losers" portfolio. The investment strategy implemented each month involves purchasing the stocks in the winners portfolio and selling those in the losers portfolio, and maintaining these positions for a duration of K months.

While the paper was focused on stocks, the same principle is being applied in my replication project. I didn't focus much on the results and conclusions in this paper as we are dealing with an entirely different market

Grobys and Sapkota (2019)

This paper focused on trying to find the presence of momentum in crypto-currencies. They also downloaded data from coinmarketcap.com, however they had an additional filter : they only included coins that had a proof of work mechanism. Their methodology was :

The study utilizes the portfolio classification technique established by Fama and French in 2008, categorizing all cryptocurrencies by their cumulative past returns in ascending order into quintiles. The first quintile, labeled as the "loser" quintile, comprises the lowest 20% of equal-weighted cryptocurrencies based on the least cumulative returns from month $t - 12$ to $t - 2$. In contrast, the fifth quintile, the "winner" quintile, contains the top 20% based on the highest cumulative returns for the same period. These portfolios are then held for a period of one month subsequent to their creation.

This research did not find any evidence of significant momentum payoffs in the cryptocurrency market.

Implementation Resources

I have used the following python packages:

1. Pandas
2. Numpy
3. matplotlib

This replication work did not require any machine learning libraries

✓ Replication

My assumptions

My job is to replicate the process and the rest of the paper will be focusing on that. But before we get on that, there are a couple of things which I want to bring forward:

The author never explained her investing strategies: how was she buying her positions and closing her positions when rebalancing had to happen at the end of the K holding period. What does she do if she incurs a loss or loses her initial investment. In the entire paper, she just says that in a winner-minus-loser portfolio, she longed the winners and shorted the losers.

Another thing to note is that we have no idea till when in 2020 did the author gather the data for. And we know that in 2020 there was great fluctuation in the crypto-market which will have direct impact on the portfolio returns.

So I have assumed the following things:

1. At the end of holding period, when it is time to rebalance, I completely close all the positions and then open new positions
2. A lot of cryptocurrencies tend to rug, that is, it was a scam and the price simply falls to zero and there is simply no liquidity left to complete any orders. When this happens, on exchanges, the price is shown as 0 and then delisted after sometime. When a crypto-currency is associated with a scam and is a rug, all positions usually end up becoming losers since there is no way to close them. Both long and short positions become useless. The author does not talk about this scenario or how she handles it. As a result, I am just going to assume that the positions become useless.
3. We do not know how she is investing. Is she reinvesting her profits or if she incurs a loss, does she invest more to come back to the original investing amount. It is tough to replicate that without actually knowing what the author is doing. So I followed the following strategy:
 1. I take out all the profits and if there is a loss and investment strategy goes below the initial amount, I add the difference to come back to the original amount
4. I am considering the entire 2014 to 2020 time period.
5. The author simply mentions that after sorting the coins based on the cumulative return, she takes the top 30% as losers and bottom 30% as winners. But she does not mention how she is investing her original amount into these. What fraction of the amount goes to the winner portfolio and the loser portfolio. So I calculated the total marketcap of losers and winners and added them together and considered that the universal market cap (this excludes the coins which were neither winner nor losers) and used this universal market cap to calculate the individual weights.

6. Looking back J weeks: the author didn't specify what she did when there were not J weeks to look back. For example, if $J = 30$ and we are starting at 01/01/2014, we cannot look back 30 weeks. So I only started implementing this strategy when I had enough days to look back to calculate the winners and losers.
7. Weekly Rebalancing: It is difficult to rebalance weights when you have open positions. So I simply closed those shorts/longs. The quantity is the difference between the initial quantity and the final quantity.

My Strategy

1. Firstly, I extracted data from coinmarketcap using a scraper. After that, I preprocessed the data and converted the daily data into weekly format.
2. Post that, I created a lookup function which would return the winners and losers based on the cumulative return of previous J weeks. I only considered these winners and losers as my universe.
3. Once I have the winners and losers, I calculate the individual weights of the assets. I always invest the same quantity which is \$1000.
4. I put more into the investing fund anytime it drops below \$1000 so as to maintain uniformity.

Replication of Returns of J/1 strategies

Process

I had the start date (Week 1, Year 2014) and the end date (Week 53, Year 2020). From here:

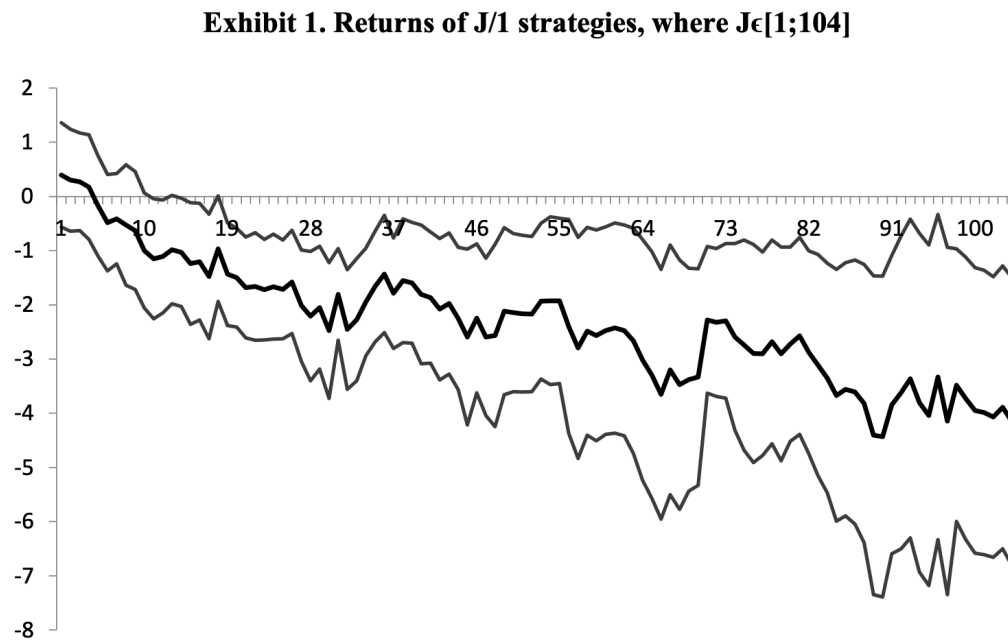
1. I simply looked back J weeks as I moved from start date to end date, got the winners and losers after calculating the cumulative returns
2. Based on the weights, I bought specific quantities of each coin. I entered a long position for winners and a short position for losers.

3. I closed the positions after one week as that was the holding period and then calculated the profits post exiting the current positions.
4. I repeated this process for different values of J

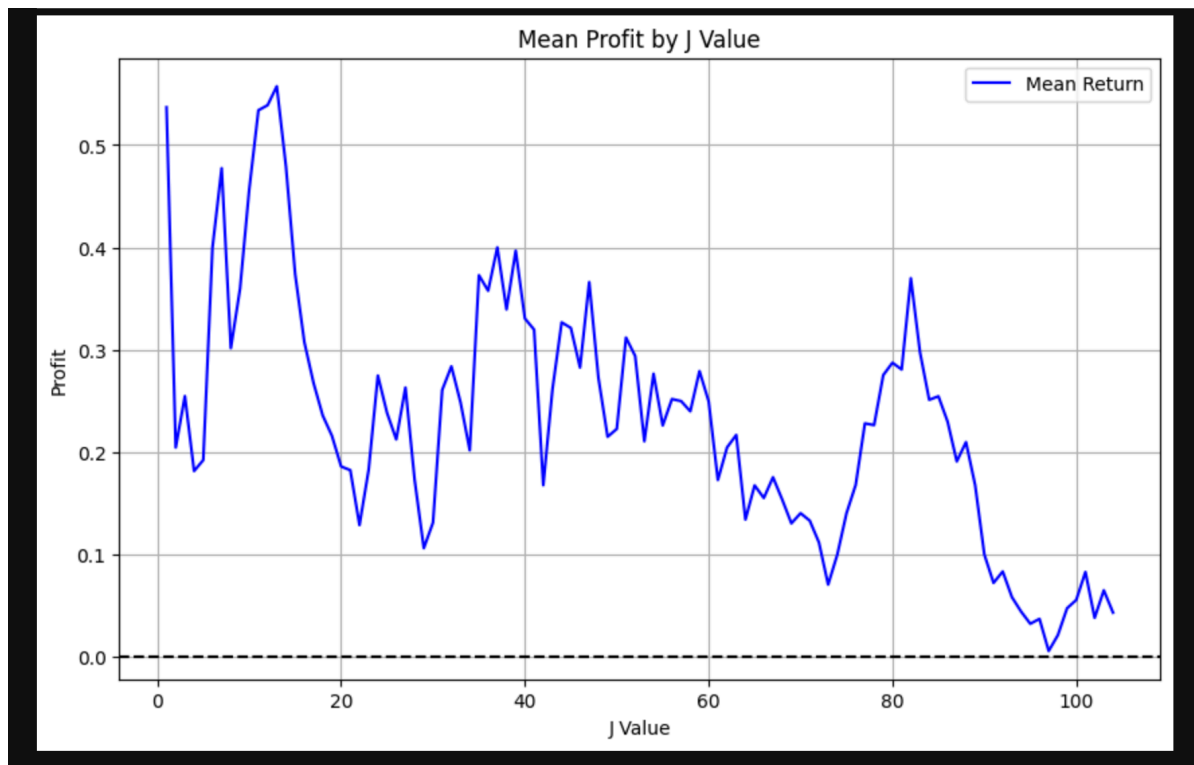
In order to store data, I used Pandas dataframe which had information about the quantity, the price and the weight which I was referencing constantly

Results

This the graph of the paper:



This was my result:



The result validates hypothesis 1 to some degree and I will explain how:

1. She argues that a significant, but rather small, momentum effect occurs on short horizons up to 2-4 weeks for holding periods. Through our replication we see that after a certain point, the returns of our portfolio start decreasing which points to a change in price (reversal) happening. We will not get the exact graph as the paper because it was tough to figure out how the author was trying to invest, but we are still able to see the hypothesis in another format

Notes

1. My strategy does not have a negative return while the author's strategy does. This simply boils down to what her investing strategy was and how she was dealing with her profits and loss. I assumed that getting a -3 return is simply not possible as that would mean losing 3x your initial investment which we do not have. It is possible that the author recreated a leveraging environment. Our investing strategy was safe hence we never had negative returns

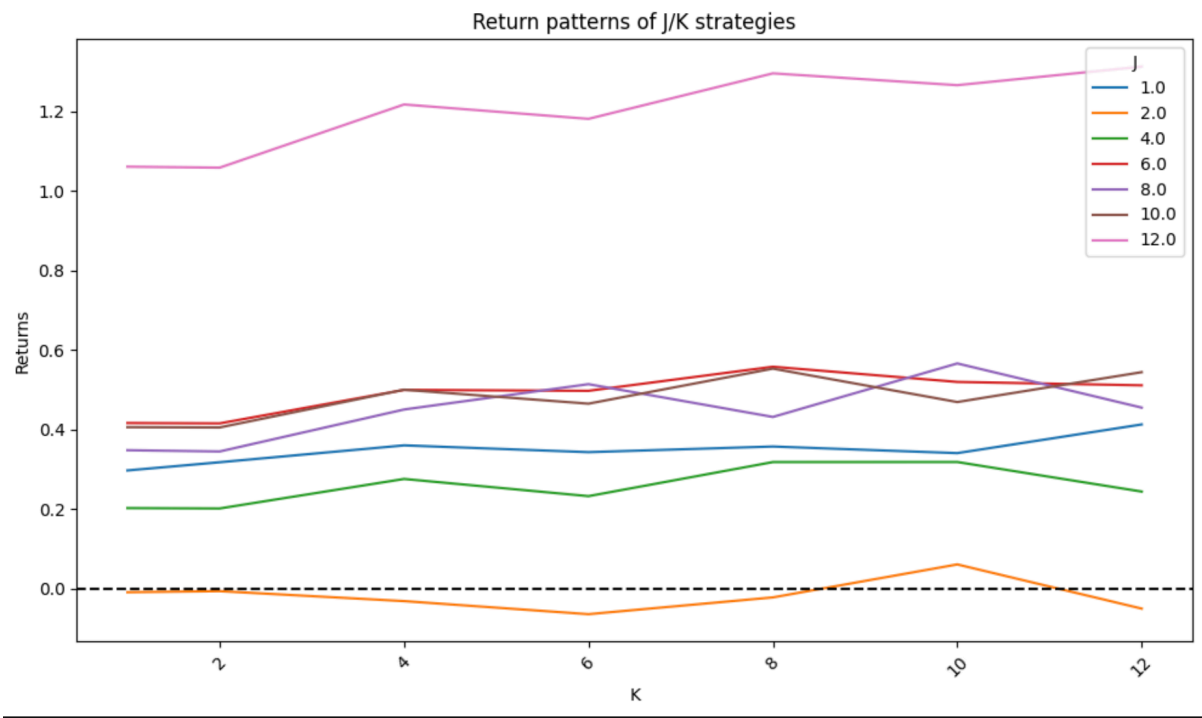
Replication of Average returns on J/K strategies with weekly rebalancing

Process

The process isn't really that different from the strategy mentioned above. There is just one additional step: I iterate over different values of J and K together.

Results

My graph looks like this:



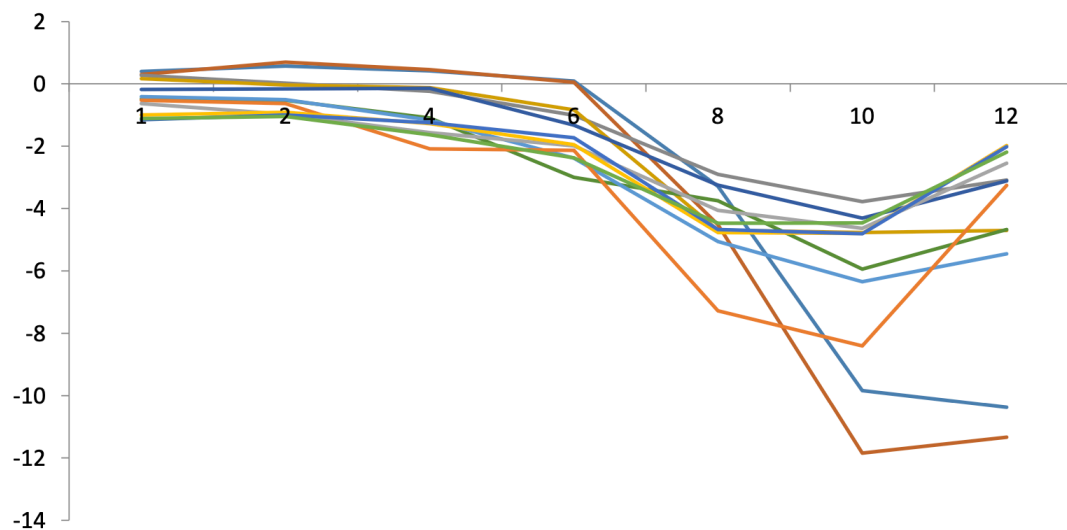
The exhibit plots returns of J/K winner-minus-loser strategies, where cryptocurrencies are sorted by returns over J previous weeks and held for K subsequent weeks, weekly rebalanced. J and K vary from 1 to 12. Each line represents strategies with varying K for each level of J.

J\K	1	2	4	6	8	10	12
1	0.297458	0.318080	0.360501	0.343439	0.357663	0.340996	0.413086
2	-0.008628	-0.005948	-0.031030	-0.063852	-0.021705	0.061240	-0.049884
4	0.202791	0.201883	0.276093	0.232841	0.318544	0.318673	0.244366

J\K	1	2	4	6	8	10	12
6	0.416665	0.415792	0.500004	0.497646	0.558184	0.519991	0.511470
8	0.348316	0.345157	0.450685	0.514378	0.431946	0.566482	0.455340
10	0.406278	0.405542	0.500383	0.465343	0.553441	0.469430	0.544564
12	1.061094	1.058638	1.217482	1.181357	1.295736	1.265951	1.312615

My results are a bit different from the author's. The author's results for this strategy is:

Exhibit 2. Return patterns of J/K strategies



According to the author the best return combination was J=2, K=2. But for me, it was J=12, K=12 which actually makes more sense because when you are longing and shorting such volatile assets, the possibility of it being a succesful trade is much higher (especially when you do not have stop losses etc). Another interesting trend which was also present in the authors result is, as K increases, the returns slightly increase as well.

Replication of Winners and Losers, Seperately

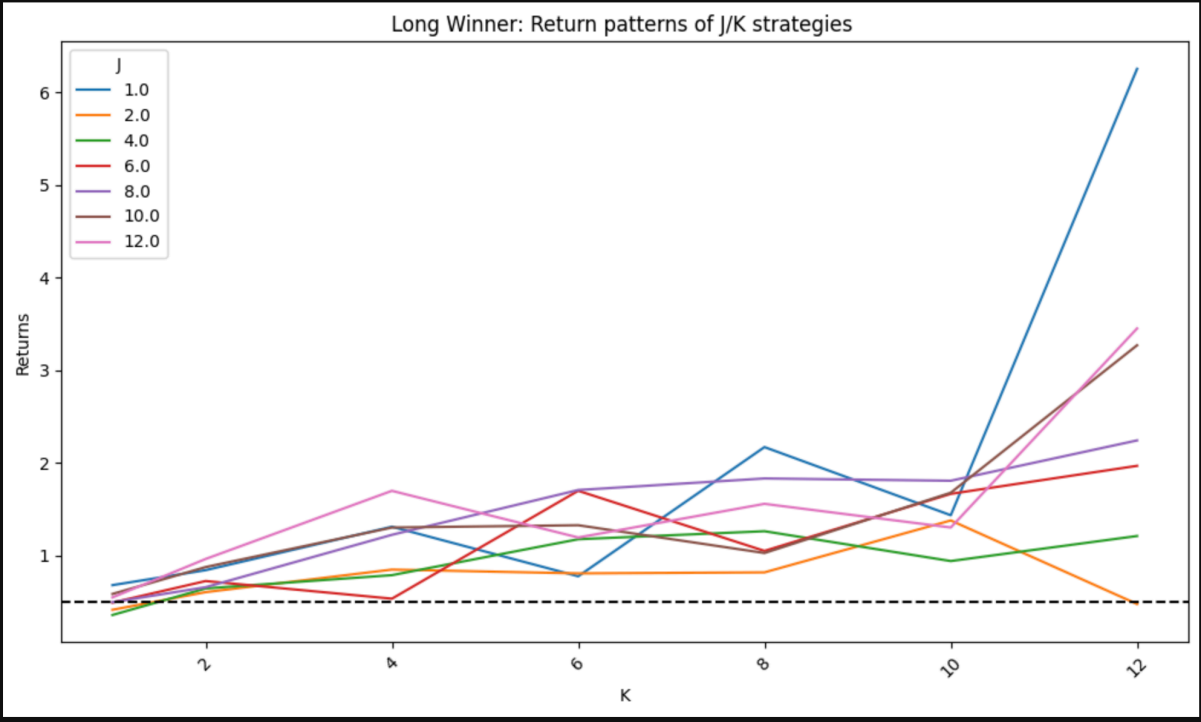
I am now longing winners and losers seperately :

Results

Winners

This table shows the returns for just Winner Portfolio

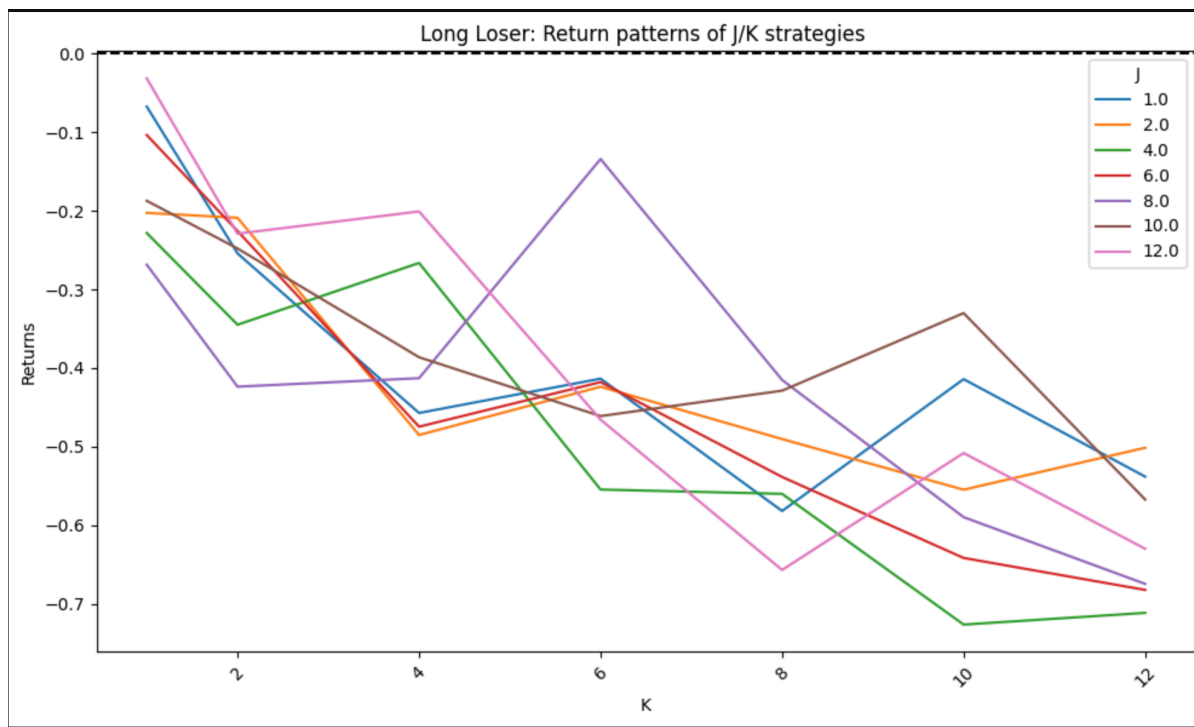
J\K	1	2	4	6	8	10	12
1	0.680892	0.842520	1.311666	0.776505	2.171832	1.436003	6.256467
2	0.414844	0.605193	0.848749	0.807878	0.818819	1.379618	0.476968
4	0.358575	0.645018	0.788575	1.176678	1.263426	0.941075	1.211542
6	0.492452	0.725188	0.534645	1.699981	1.050411	1.666926	1.969434
8	0.496523	0.658581	1.224592	1.708256	1.833050	1.808383	2.243926
10	0.585631	0.876039	1.303016	1.327989	1.027876	1.679040	3.271431
12	0.548422	0.963465	1.699589	1.195487	1.558980	1.303421	3.453169



Losers

This table shows the returns for just Loser Portfolio

J\K	1	2	4	6	8	10	12
1	-0.067360	-0.254141	-0.457164	-0.413522	-0.581831	-0.414109	-0.538131
2.0	-0.202584	-0.208856	-0.485157	-0.423772	-0.490322	-0.554781	-0.501413
4.0	-0.228228	-0.344854	-0.266286	-0.554583	-0.560045	-0.726392	-0.711482
6.0	-0.103571	-0.225678	-0.474600	-0.417892	-0.538564	-0.641622	-0.682260
8.0	-0.268555	-0.423633	-0.412916	-0.134006	-0.415146	-0.589709	-0.674620
10.0	-0.187221	-0.247907	-0.386246	-0.461114	-0.428775	-0.330076	-0.567256
12.0	-0.031582	-0.229018	-0.200757	-0.465623	-0.656856	-0.508143	-0.629942



The returns from the paper are as follows:

Table 3. Returns on past winner and past loser portfolios

Past winners								
JK	1	2	4	6	8	10	12	
1	2.28	2.14	2.17	2.15	2.26	2.63	3.37	
2	2.12	2.16	2.64	2.50	2.43	2.46	2.38	
4	2.14	2.04	2.76	2.61	2.51	2.33	2.02	
6	1.75	1.95	2.06	2.13	2.06	1.74	1.74	
8	2.09	2.09	2.13	2.12	1.79	1.75	2.04	
10	2.00	1.91	2.08	1.81	1.65	1.83	2.12	
12	1.59	1.57	1.59	1.54	1.71	1.73	1.91	
Past losers								
JK	1	2	4	6	8	10	12	
1	1.89	1.57	1.75	2.06	5.54	12.46	13.75	
2	1.82	1.46	2.18	2.45	6.94	14.30	13.71	
4	1.97	2.07	2.88	3.44	7.20	7.09	6.71	
6	2.23	2.48	3.16	5.12	5.81	7.68	6.41	
8	2.62	2.72	4.21	4.26	9.07	10.15	5.29	
10	3.00	2.82	3.35	3.75	6.41	6.63	4.10	
12	2.69	2.61	3.22	3.91	6.17	6.19	4.10	

The table reports average annualized returns (in absolute values) of J/K past winner and past loser strategies, separately, where cryptocurrencies are sorted by returns over J previous weeks and held for K subsequent weeks, weekly rebalanced. J and K vary from 1 to 12. All returns are highly significant, t-statistics are not reported.

Notes

Let us now compare the results:

The results are very different. According to the paper,

the winner portfolios yield roughly the same positive average returns irrespective of the sorting and holding horizons. The average returns of all loser portfolios are also positive in line with return reversal. However, the performance of the loser portfolios varies significantly depending on the horizon. The average returns are increasing with increasing

Summary of my Replication Project

1. For J/1 Strategies, as the lookback window increases, our returns decrease as well. So there is a direct ***negative correlation*** between the return and J for $K = 1$.
2. For J/K Strategies, our returns show that as K is increased, the returns also increase with (12,12) being the most profitable combination.
3. In case of winners and losers separately, the winner portfolio generates great returns while longing losers returns losses. In this case as well, increasing K increases the profit/loss as the larger holding period allows more price changes. In this case for winners, keeping $J = 1$ had the best results which means that longing for winners based on shorter historical data is better

✓ Expansion

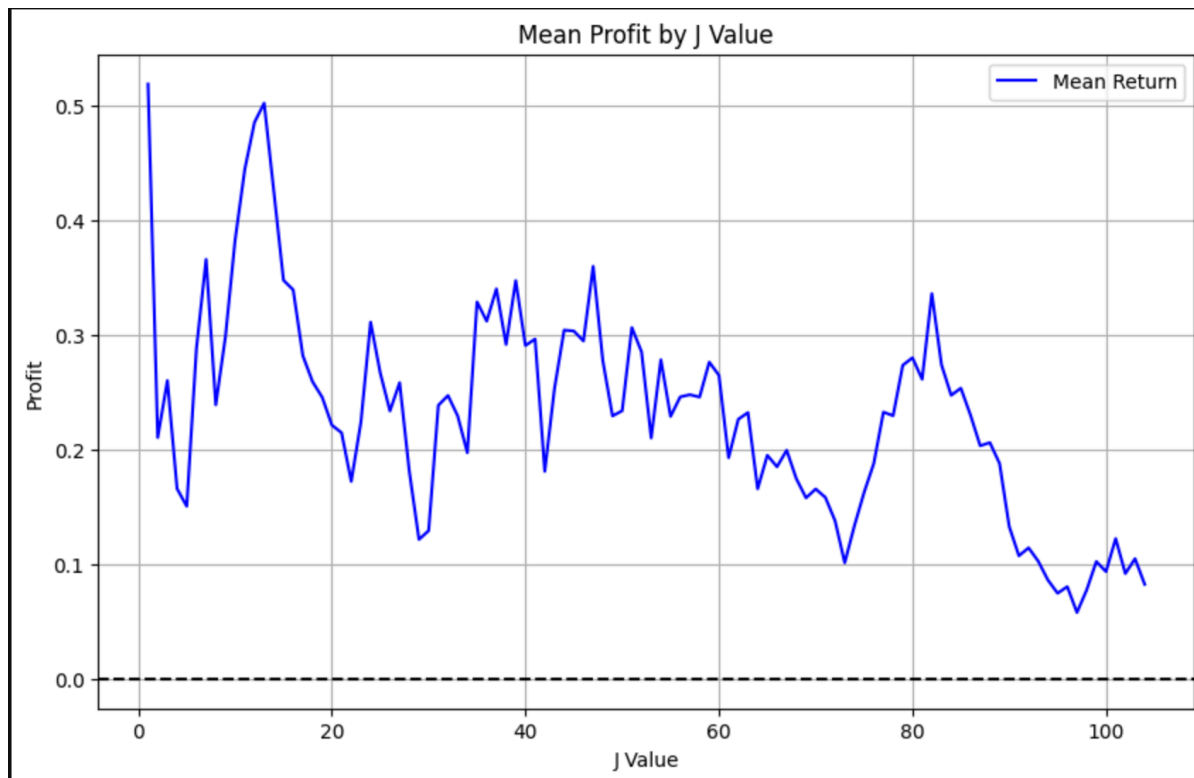
I also wanted to expand on the paper. The paper only considered the time period 2014-2020. I want to extend the time period to 2023. I am curious about the results because during this extended time period, there were two major crypto-currency bubble burts along with the pandemic where everyone was getting a check from the government and a recession. So I want to know if all these factors had an effect on the trend or not.

Not only will we have additional price data (3 additional years), we will also have access to higher number of coins to look at.

Expansion: Returns of J/1 strategies

Results

The graph looks like:



Notes

The graph is pretty similar to our replicated strategy, the only thing different is it has a slightly higher return when J is large.

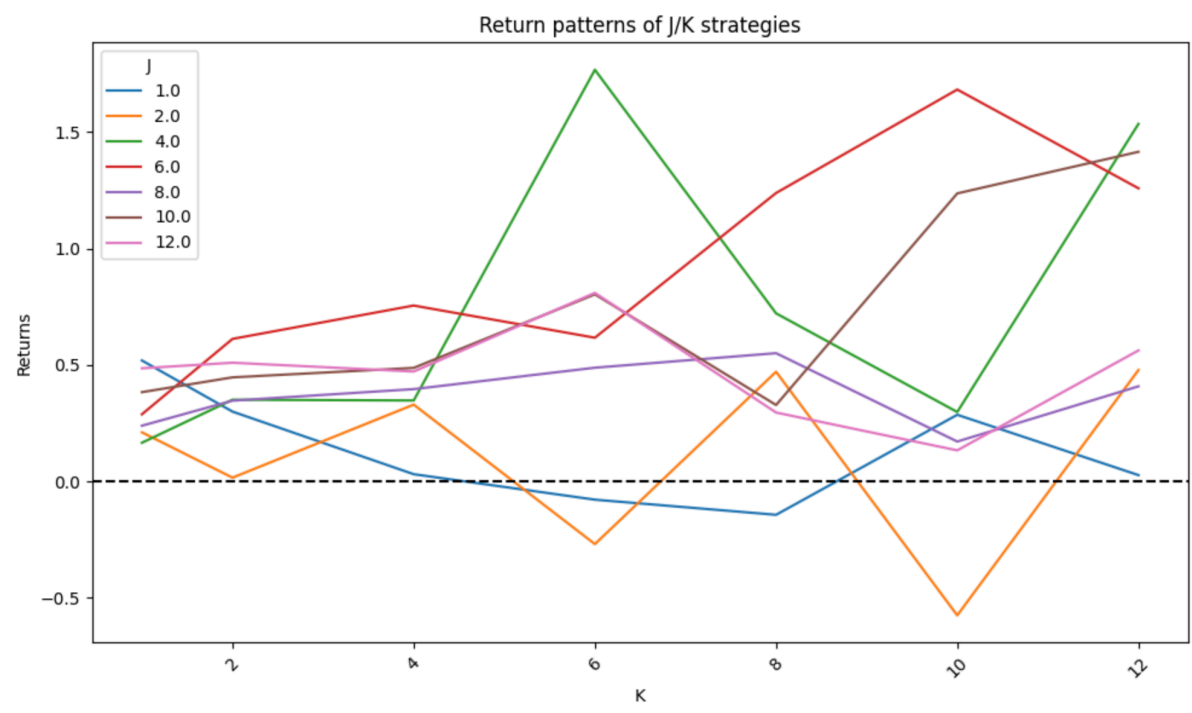
✓ Expansion: Replication of J/K Strategies

Results

This table shows the returns for different J and K values

J\K	1	2	4	6	8	10	12
1	0.519021	0.299514	0.030715	-0.078648	-0.143637	0.285887	0.026820
2.0	0.210493	0.015864	0.329562	-0.269414	0.470586	-0.575412	0.477996
4.0	0.165791	0.350568	0.347310	1.767538	0.721546	0.297766	1.534991

J\K	1	2	4	6	8	10	12
6.0	0.288070	0.611754	0.755091	0.616809	1.238336	1.682698	1.258578
8.0	0.239032	0.346519	0.396027	0.488028	0.550515	0.170961	0.408150
10.0	0.383066	0.446650	0.487226	0.803216	0.327921	1.236551	1.415265
12.0	0.485561	0.509489	0.471718	0.809292	0.295564	0.133103	0.562207



There is no trend on this expansion. Its just a very noisy graph. I think this could be because:

1. Influx of lots of coins some of which were scam
2. Crypto-bubble burts
3. Pandemic

This is what I had assumed should have happened in the case of J/1 Strategies

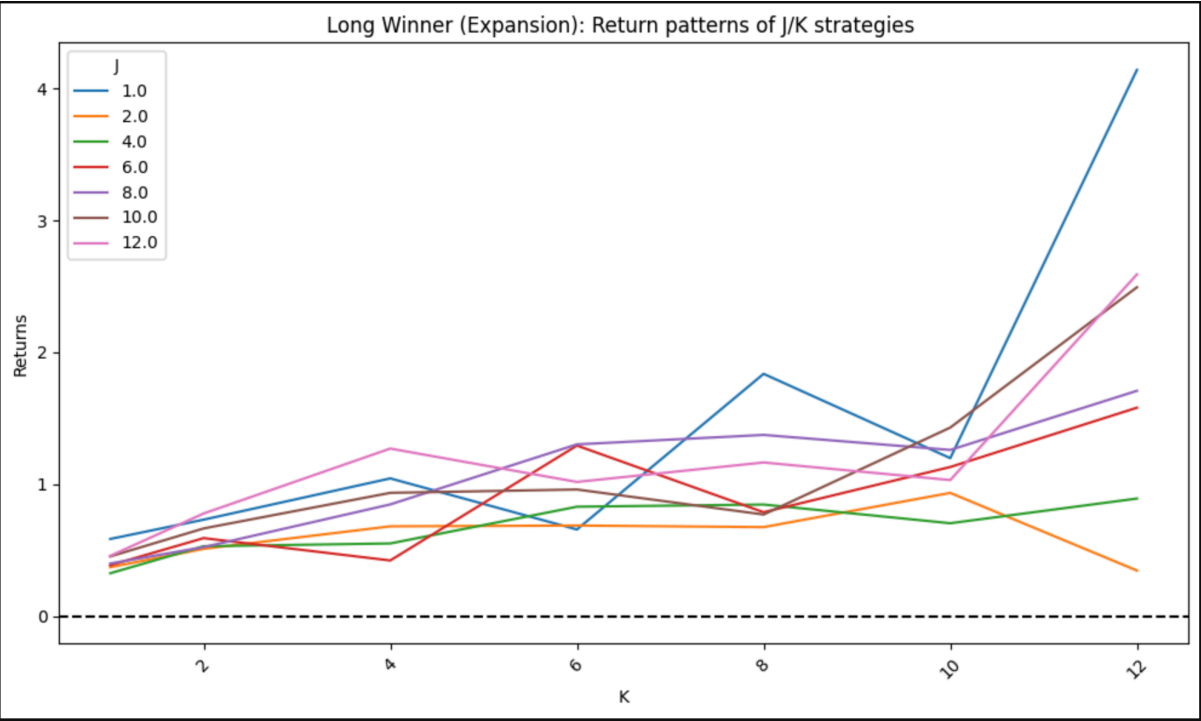
Expansion: Replication of Winners and Losers, Seperately

Results

Winners

This table shows the returns for just Winner Portfolio

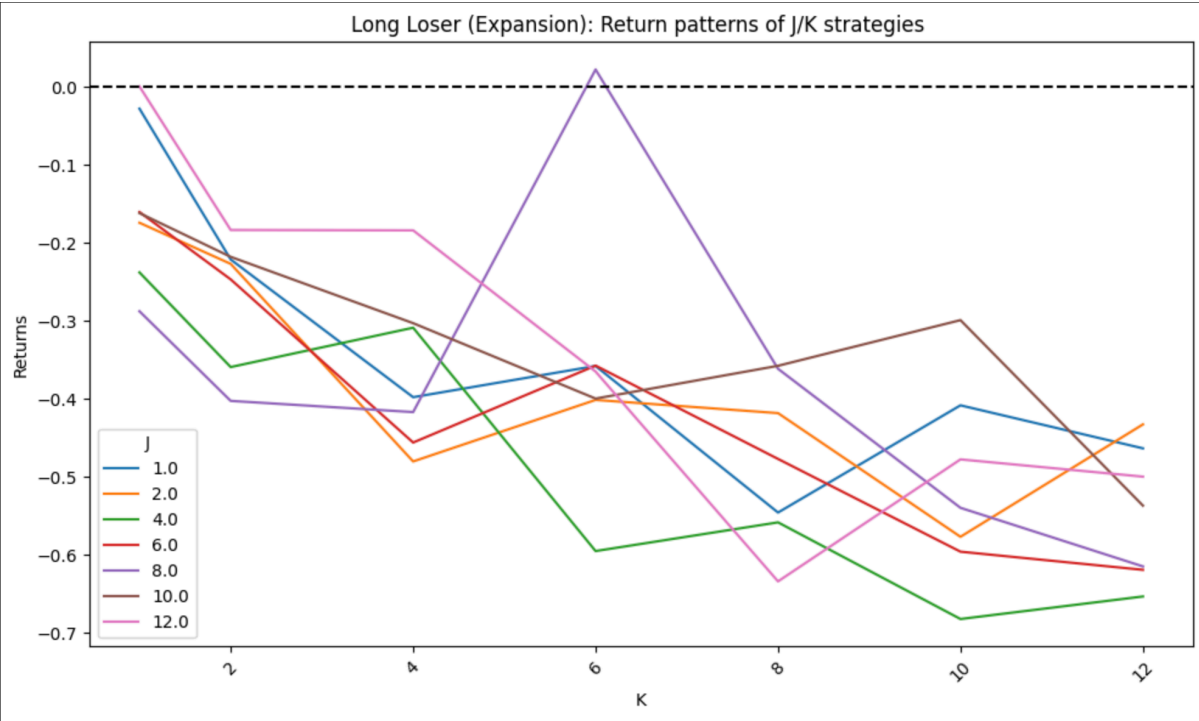
J\K	1	2	4	6	8	10	12
1	0.586151	0.732397	1.045006	0.657991	1.837027	1.198404	4.139395
2.0	0.372577	0.511362	0.681839	0.687989	0.675894	0.935163	0.347008
4.0	0.326462	0.531172	0.552179	0.830497	0.846984	0.705340	0.892217
6.0	0.387214	0.592535	0.423284	1.293716	0.788853	1.131391	1.580389
8.0	0.400096	0.524490	0.847985	1.302771	1.374441	1.260551	1.708508
10.0	0.453912	0.665877	0.935547	0.960946	0.771529	1.430135	2.492796
12.0	0.458190	0.779082	1.270911	1.018159	1.165738	1.032560	2.590385



Even in the expansion, the winner follows the same trend. As K increases, the returns are also increasing

Losers

J\K	1	2	4	6	8	10	12
1	-0.028076	-0.221256	-0.397683	-0.357680	-0.545422	-0.408090	-0.463188
2.0	-0.174224	-0.226886	-0.479965	-0.401159	-0.418062	-0.576488	-0.432517
4.0	-0.237845	-0.359069	-0.308662	-0.594772	-0.558000	-0.681815	-0.652950
6.0	-0.160498	-0.246770	-0.455752	-0.357217	-0.476750	-0.595560	-0.618802
8.0	-0.287630	-0.402394	-0.416742	0.022131	-0.361277	-0.539379	-0.614437
10.0	-0.161845	-0.217887	-0.302847	-0.399462	-0.357443	-0.298941	-0.536541
12.0	0.000408	-0.183476	-0.183954	-0.364845	-0.633602	-0.477326	-0.499448



The trend is the same for losers. It gives negative returns and the losses increase as holding period increases

Future Opportunities

There is definitely a lot of different things that can be done:

1. We have just been in a way backtesting data. What we can do next is create a trading bot that actually implements this strategy in realtime. This would also require us to generate signals and metrics. We can then tune the strategy based on the results we are getting
2. Currently, the investing strategy did not involve any stop losses etc. Another opportunity is to integrate this into the strategy so as to make it more robust and minimize further losses.
3. We are also currently not using other stuff like volatility etc. We could also use that for longing and shorting the assets (Ex: Call and Put Options)
4. Work with different percentages of losers and winners. Instead of using 30%, we can try 10%, 20% etc

✓ Conclusion

Overall I feel that there were big differences in the results of my replication project and the actual project. A lot of the differences can be explained by the assumptions I made earlier.

In J/1 strategies, there is definitely a reversal which can be seen as our returns decrease. It would have been more visible if our investment strategy was different.

If we invest in winners and losers separately, the winner portfolio generates good returns while the loser portfolio causes loss.

In J/K strategies, (12,12) combination had the best results and the returns were increasing as holding period increased.

I personally feel that the paper did manage to capture the principal correctly. The only place which I am not confident about is how the returns were calculated, how did they tackle certain situations (such as coins being delisted, scams) and how were coins being shorted or longed.

1 Start coding or generate with AI.

