The Role of Cryptocurrencies in Investor Portfolios - Mark Kritzman
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[MALE RESPONDENT]
[Other comments:]

Well, thanks a lot, Michael. It's really nice to see your smiling face. I thank all of you for tuning in.
I'm going to talk about how cryptocurrencies might fit into a portfolio. This is work that I've done jointly with my State Street colleagues, Megan Czanonis, Baykan Pamir and Dave Turkington. I'll start by giving a brief overview. Then I'll describe 3 methodologies that we use to analyze the role of cryptocurrencies in a portfolio, and then I'll sum up. I think everybody is well aware of the fact that cryptocurrencies are pretty widely used by speculators, mainly retail investors as well as hedge funds for the purpose of speculation. Even some large institutional investors are now starting to include cryptocurrencies in their portfolios, which actually at least to me is a bit surprising given their volatility, given the fact that they're not backed by any country, and also given the fact that the ownership of cryptos is very, very highly concentrated and opaque. I think the reason that is floating around out there about why people think it might make sense to allocate part of their portfolios to cryptocurrencies is that they might offer favorable diversification properties or serve as a hedge against crises - much like people use gold to do or, say, a safe haven currency like the Swiss franc. The problem is that diversification is a very complicated topic.

First of all, the average correlation doesn't tell you much about an asset's diversification potential because investors care about how an asset diversifies when their portfolio's main growth engine is doing poorly, not when it's doing well. So we need to impose that condition, and the other issue is that investors are probably more concerned about how an asset diversifies over the duration of their investment horizon rather than from day to day or month to month. I want to see if I can tackle those issues. The first thing I want to talk about is conditional correlations. This is something that I think my colleague, Will Kinlaw, will be talking about a little bit more later on. What we want to know is; how do cryptocurrencies protect from poor equity market performance? The problem is that if we estimate correlations from a subsample, those estimates are going to be biased.
Especially they’re going to be biased downward if we cut off the right side of the distribution. In other words, if we ignore when stocks for example are doing very well and we just look at that part of the sample when stocks are doing poorly. So there's this bias that we need to control for. The way we do that is we have the full sample correlation, and assuming normality we simulate, given the means and covariances, what the correlation should be for this partial sample. The sample would be for example when stock returns are below some threshold. So we simulate how that correlation changes assuming normality. Then what we do is we look at the empirical full sample correlation and then look at the actual - the empirical - partial sample correlation and we have these two differences. We have the difference that applies to the situation of normality. Then we have the difference that applies to the actual empirical reality. We look at the difference in those differences to determine the extent to which cryptocurrencies, for example, offer more or less diversification than the full sample correlations would suggest. So let me show you some results. Well, first of all before the results let me just illustrate this concept a little bit. On the left we have a scatter plot of the returns of, say, cryptos and stocks for the full sample. What I've just been describing is the fact that we want to truncate it at some threshold for stock returns when stock returns are doing badly. Under those conditions how are cryptos diversifying the portfolio? So we're interested in that part of the scatter plot that you see in the right panel that's just to the left of that threshold. You can see just by looking at this exhibit that if you get rid of the upper right side of the distribution that the correlations are going to be very different for that partial sample than they are for the full sample, they'll be lower because you're eliminating these opposing extremes. So the opposing extremes, obviously we have a very high correlation. If you get rid of one of the opposing extremes then the correlation is going to go down just as an artefact of correlation mathematics. That's what we're going to correct for. Here what you see, this is going to show you the correlations of 3 asset classes. It's going to be treasury bonds, gold and cryptocurrencies all with stocks. The top row shows you the full sample correlations. Even without doing the conditioning you can see right off the bat that cryptocurrencies do not compare favourably to treasury bonds or to gold. Then what you see in the second line is again assuming normality with the same means and covariances, the change in the correlation just is a consequence of the mathematics. Then what you see is the actual empirical outcome for when stock returns are losing money. That's less than 0 per cent and then the empirical minus the
normal, so what you’d like to see; you’d like to see those numbers negative. You see that for treasury bonds and you see that slightly for gold, but cryptos are moving in the wrong direction, so what's the bottom line here? That first of all cryptos don’t offer… If you look at the full sample, that suggests that cryptocurrencies do not offer as much protection and diversification as treasury bonds or gold. Then when you condition it to focus just on the subsample when stocks are losing money, it's even worse whereas treasury bonds and gold improve a little bit versus the full sample. Cryptos starting out very unfavourably get even worse when you condition negative returns. So let me just show you based on the same concept; let me give you some more results. What we have here are correlations for daily returns and monthly returns where we're conditioning on different thresholds for stocks. We’re looking at when stocks are returning less than 0, 1 standard deviation below average and 2 standard deviations below average. So if you look at the right, the right corresponds to that final row; the difference in differences that I showed you before. What you see here again, it's pretty much the same story; that the correlation profile of cryptocurrencies conditioned on poor stock returns is even worse than what the full sample correlation suggests. The full sample correlations are not nearly as favourable as what you see with treasury bonds or gold. The bottom line here is that if you think cryptocurrencies are going to offer protection against poor stock market performance at a high frequency - by high frequency I mean daily or monthly - that's just not been the case empirically. There's no evidence to support that; in fact the evidence suggests quite the opposite. What we show in this table is the exact same analysis, but this time we're looking at thresholds where stocks do well. What we want here is unification, not diversification. We want high correlations rather than low correlations. What we do see is that cryptocurrencies in some cases do offer decent upside unification, but the results are not quite uniform. In this case we want to see positive differences rather than negative differences. With cryptocurrencies, especially at the monthly interval, it's a mixed story. Anyway I guess again the bottom line is for investors with short horizons, there's no evidence that cryptocurrencies offer protection or meaningful unification on the upside. Let me now talk about this other issue I mentioned at the outset, which is that investors probably care more about performance over the duration of their horizon rather than from day to day or month to month. The problem here is:
unlike what most people believe, correlations differ drastically depending on whether you estimate them from monthly returns or annual returns or 3-year returns. You can see this on the right; you can see this is the correlation of cryptocurrencies with stocks. What you see is that there's just this massive difference in the correlation depending on whether you measure the correlation from monthly, annual or 3-year returns. Dave Turkington is going to get into this in much more detail a little later on. What you might think is that: if I care about 3-year outcomes what I'll do is I'll just measure the correlation from 3-year returns because I want to have as reliable result as possible. Perhaps I should use independent 3-year periods to estimate the correlation. There's a couple problems with that approach. First of all, if you're using independent 3-year observations the start date is going to matter a lot. You can get a very different outcome depending on what day you actually start your 3-year interval. Then the other problem is that these correlations, they vary through time quite dramatically. So you might think instead: maybe I should just use overlapping 3-year periods. That helps mitigate the start date problem but you still have this time variation, so what we need to do is introduce a new measure of correlation called a single period correlation. This correlation actually measures the extent to which assets move synchronously, the cumulative returns move synchronously over the horizon or drift apart over the horizon. That's really what we care about for people who focus on a longer horizon than just a month, for example. So let me show you what it looks like. I don't think I want to dwell too much on this formula other than to say: those expressions you see in the parentheses are just Z-scores. What we're looking at is: if you have 2 assets, X and Y, what's the Z score for exit for the 5-year returns versus the average of 5-year returns divided by the 5-year standard deviation? So a typical Z-score, and what this does is it tells us how the assets - as I said, how their cumulative returns are correlated over the duration of the investment horizon. It's actually mathematically related to the correlation that we're used to, which is the Pearson correlation. Let me just give you a little illustration here. The way it works is: if the two assets' Z scores are the same, then the single period correlation will equal 1. If they're both positive but not the same then it will be somewhere between 0 and 1. If the Z scores are opposite each other, then the single period correlation will be minus 1 and if they have different signs and different magnitudes, then it'll be somewhere between minus 1 and 0. Again the key thing to remember here is that the single period correlation is a correlation of the cumulative return over an investment horizon. It captures the extent to which, say, cryptocurrencies and stocks
move synchronously over, say, a 3-year horizon or drift apart over that 3-year horizon. So this is actually what we want to be able to forecast. We first show these single period correlations for cryptos and stocks for a monthly horizon. I guess the key takeaway here is that it varies like crazy through time. There’s no pattern here. The dotted line you see there is the Pearson correlation, so it's the correlation of monthly returns over the entire sample. Each of those bars is the single period correlation for the months. This shows the single period correlations of cryptos and stocks for a yearly horizon. This is a little bit more interesting. Again you see the Pearson correlation is the dotted line, and you can see that these correlations tend to cluster for several years at a time. Again there’s still quite a bit of time variation. Then finally we have the single period correlation for 3-year intervals. Here, there’s quite a distinct pattern in that the stocks and cryptocurrencies move together over 3-year intervals all the way up until about the middle of 2017. Then since then they've bounced around with the last 3-year period ending in December of 2020 that was significantly negative. I guess what you can take away from this is that you can't really just look at the history and infer what’s going to happen in the next period. But this is the correlation that you want to predict. The final thing I want to talk about, and I think the methodology that gives us the most insight into the effect of cryptocurrencies on portfolios, is a technique called full-scale optimisation. This is a very flexible and robust alternative to mean variance optimisation. The way this works is that we have a return sample of the assets that we want to include in our portfolio. So you can just imagine a matrix where the columns are the different asset classes and the rows are the, say, monthly returns of those asset classes. We have every single return; we're not summarising the sample by computing means or standard deviations or correlations, or even considering higher moments such as skewness and kurtosis. Those are all going to be captured in this particular procedure. So you have in your mind this matrix of returns where the columns again are the assets and the rows are the months. It could be days, it could be years but let's just assume for the moment that they're months. Then over on the right, after you have let's say stocks, treasury bonds, gold and cryptocurrencies, and then the next column over you put in this formula here. This is a formula that reflects the investor's preferences. In mean variance that assumes quadratic utility - not literally - but it assumes that you can approximate preferences with just mean
and variance. It's a fairly simple description - perhaps unrealistic description - of investor preferences. What we want to do, because this methodology allows us to do this, is capture more nuances in investor preferences. We actually need to be able to do that because in order to justify exposure to cryptocurrencies we're going to have to come up with a pretty complicated utility function. What this utility function assumes is that there's a kink; that investors have a threshold, and below that threshold they are super-averse to losses below that threshold. Then they're less averse to losses to the right of that threshold and then there's another inflection point which is a jump. We refer to that as a lottery preference so we need a kink and a lottery preference to justify allocation of cryptocurrencies. I apologise; you're looking at this formula and it's not going to make any sense to you, but let me just show you a picture instead. You see to the left of that kink, at the left kink there's very high aversion to losses. To the right of that kink up to the jump there's much more normal loss aversion. Then that jump, you see that gives us a lottery preference so what that means is that for investors who would be very happy if the price of a crypto jumped by 20 per cent, that would be we'd locate that jump at the 20 per cent one. Here it's at 50 per cent. The way it works then is, again reconsidering this matrix with the returns in the utility function, what we do is we start out with some allocation. Then based on that allocation for each row, and given this utility function, we calculate utility. We do that row by row by row and we add it up and we store it, and then we substitute another asset allocation. We go through the same process and we get the utilities for every month, given that utility function and all those returns. We sum it and store that and we do that a few 100,000 times and then what we do is we just rank the utilities and the one with the highest utility is the optimal portfolio. So that's what's called full scale optimisation. What's so nice about it is that it allows us to capture every single feature of the data. In addition to that it allows us to consider a description of investor preferences that is pretty nuanced, as you can see in this exhibit. Let me just show you some results here. This shows you what the allocation to cryptocurrencies would be for different expected returns for cryptocurrencies and different lottery preferences. What we see is that unless the expected return of cryptocurrencies is greater than 20 per cent you wouldn't allocate anything to cryptocurrencies even with some lottery preference. When it gets to 30 per cent then you'll allocate a tiny bit. To the extent that the lottery preference is low, it would be a little bit more. What this shows, let me just summarise because I see I'm running out of time and people are staring at me: the summary
is that a lottery preference for returns above 20 per cent supports some exposure to cryptocurrencies even if they're not expected to generate a positive return. With a lottery preference, though, investors require cryptocurrencies to return at least 30 per cent of support in allocation to them that's without a lottery preference. In general and as expected, an optimal allocation of cryptocurrencies falls with increases in the lottery threshold and rises with increases in the expected return. I think I'll just stop here and respond to any questions that might arise.

Mark, thank you. The reason people were staring - because that was very insightful as always - and maybe some of them had bitcoin portfolios! Let's see what questions the audience have. Thanks again, Mark. Let's just dive straight into the questions. First one here: how much history is there for cryptocurrency returns? Is there any concern that there might be regime changes in the short history that you have?

Yes, that is actually a great question and had I not run out of time, I would have talked about that. So the history is short; I think it's about 9 years of daily returns. So I think rather than draw firm conclusions from the specific results that I've presented here, what I'd rather impart is how to think about the role of cryptocurrencies in a portfolio; that we can't just rely on the conventional full sample correlation if we expect to understand what kind of protection it's got to offer when stocks are doing badly; that we need to use more advanced tools. The sample, really in my judgment it's too short and the sample's entirely bitcoin because that's where most of the data are. As cryptocurrencies evolve - and it may be the case as they're embraced more widely that they'll become more stable so that the required return won't be as high. Yes, that's a great point and I guess the bottom line is that there's no evidence yet that cryptocurrencies offer a hedge against crises or offer protection against, say, downside equity returns. But what happens going forward? Who knows.
I think this is a related question and one probably close to your heart, to some extent: it seemed to take FC many years to be accepted as an asset class. Do you think that cryptocurrencies are at the start of a similar and potentially long journey?

I think they may evolve to merit consideration as an asset class, but I think the way they are created has to change. I think there may have to be some kind of sovereign backing for them to be taken seriously by institutional investors. What I will say, though, is that I think other asset classes will be digitised. I think that's really the most important thing that's going to happen with this technology, with the blockchain technology.

We're right back to the digital asset video we showed right at the start of the conference, I think, with that. Then a technical question here on the full scale optimisation: did you use a modified search algo when you were doing the full scale optimisation?

You all out there know me! I have co-authors who do these.

I know.

The algorithms that we use are based on a genetic search algorithm. I think in this case, I don't know.

Mark, I've got Will and Dave on after this so I can ask them; how about that?

Yes. I was telling them that I would just pass on these questions to them, since they know more about this stuff than I do.

Then there are a couple of other questions here about: have you looked at other cryptocurrencies other than bitcoin, or tested models with a diversified crypto basket? I think you've partially answered that already but why don't we just talk about that for a second?
Yes, we didn't, but the research that I've seen shows that these other cryptocurrencies are super-highly correlated with bitcoin. So I don't think you'd get much diversification across different cryptocurrencies. I don't think you'd get a much different answer in the total portfolio context.

Well, the one thing I can tell you, Mark, is this is incredibly topical. I'm just approving the questions now and throwing them up there so that the audience can see them. Unfortunately we don't have time for all of them, but obviously that means that this isn't going anywhere any time soon. Thank you again for that. That was great and I'm sure we're going to be answering questions about crypto at these conferences in many years to come. Thanks again, Mark.

[END OF TRANSCRIPT]