Rodrigo:	**00:01:03**	Oh, he's muted.
Adam:	**00:01:05**	Oh no, I was unmuted
Rodrigo:	**00:01:08**	You're ready to go.
Adam:	**00:01:09**	Yeah, that's so true. Ladies and gentlemen, welcome to the stage the lovely Matt Hollenbach from *"Breaking the Market"*. Put your hands together. So I don't know if you guys missed it but Matt proposed the drinking game. Matt, do you remember the rules?
Matt:	**00:01:28**	I do. It was a bit of a joke. I think if I try and follow that I'll be, run out of alcohol at my house within a couple hours. But the rules were one drink for *'geometric'*, two drinks for *'rebalancing'*, three drinks for *'ergodicity'*, and then if you feel like being aggressive, go ahead and go 2.7 times that for the full Kelly experience.
Rodrigo:	**00:01:49**	Yes, I like it that.
Adam:	**00:01:50**	I like it.
Mike:	**00:01:52**	Ladies and gentlemen, this is how nerds party.
Rodrigo:	**00:01:57**	This is even better than the Dungeons and Dragons party you guys have every Wednesday.
Matt:	**00:02:03**	What did you say Adam 2.7?
Adam:	**00:02:05**	Yeah. Did you just leave a margin of safety on that one?
Matt:	**00:02:08**	No, I didn't. I went all the way on that.
Adam:	**00:02:10**	That's full Kelly.
Matt:	**00:02:12**	Right. 2.7.
Adam:	**00:02:13**	Got you. That is aggressive. No wonder you're a little bit gun shy. What are you drinking?
Matt:	**00:02:19**	I'm drinking Smithwick's, I had a leftover from St. Patrick's Day. So I got to keep going with it. Matches the beard too.
Adam:	**00:02:27**	And it's ready. What are you drinking Mike?
Mike:	**00:02:29**	I'm having a Swell. I'm trying to use up some of these kids drinks my kids left here.

Adam:	00:02:36	Okay, nice. Rodrigo, what's going on?
Rodrigo:	00:02:38	I got a little bit of gin tonic to switch it up.
Adam:	00:02:42	Okay. I'm going to say a few words about this beer, which is called Freestyle by Cayman Brewery and it's only three grams carbs, 90 calories, it's light beer. So I was just thinking if we're going to play this…
Rodrigo:	00:02:55	Do you mean our sponsor?
Adam:	00:02:56	Yeah, I know. We should be. We should be soliciting some sponsorship dollars from Cay Brew I think. But in the meantime, it's just a really good beer. Anyways, welcome Matt. We're really excited to have you on.
Matt:	00:03:10	I'm excited to be here too. This is fun.
Adam:	00:03:12	Matt and I were chatting earlier in the week about just how much a lot of our thinking overlaps. Obviously, it's not perfect overlap, but there's just a lot of common themes. And so we were pumped to get Matt back on. Matt was on a podcast, when was that? About a year ago now. Maybe a little less?
Matt:	00:03:32	It was June, June or May. I think it was June.
Adam:	00:03:35	Okay. So what...
Matt:	00:03:37	Times were blurred last year as to what a year actually is.
Adam:	00:03:39	That was true. I think at that point you had written maybe a dozen, or maybe less articles in your series on the theme of the concept you're *calling'geometric rebalancing'*. And so we tried to cover a lot of the concepts there. And I know that your thinking has evolved even further since then. So looking forward to bringing everyone up to date on your thinking and maybe trying to try to close the loop a little bit on some of the more nuanced differences between some of the ways that we have traditionally thought about the problem and some of the strategies that we run and the strategy that you've been running successfully, for a while. So maybe I think it'd be helpful if you can introduce yourself and give us your background which is a little unusual for somebody who's now thought of as a novel thinker in finance, and then bring us up to date in terms of your journey.
Matt:	00:04:38	Okay, sure.
Mike:	00:04:39	Before we do that, none of this is advice. And if you're going to try and get advice, don't get it from the four people having beers on Friday happy hour.

Matt:	00:04:52	Especially the second half of this, right?
Mike:	00:04:55	Well, this is when it gets good is about 60 minutes from now. So all right, let on with the fodder then we'll get us to the exciting stuff.

Backgrounder

Matt:	00:05:06	I am mechanical engineer by degree and background, I've spent my entire career doing engineering, designing buildings and facilities and then helping people manage and maintain them and now I manage a team of people that does that. So my background is not from engineering, I have a pretty strong math background, and of course engineering problem solving type background, and I've been interested in investing for a long time, really got more into it around the financial crisis back in 2008. Just intrigued by the problem of how to invest and how to grow your wealth, and just kept studying and researching and trying to learn more and more about it, and I've poked away learning as much as I can originally. I think a bit like you Adam I thought maybe people could predict these things or have an idea on the future and after enough time of seeing people not be very good at a lot of that generally speaking, even people that were right for a couple years, all of a sudden become very wrong for a few years, I became a little disillusioned with that. I started paying a lot more attention to just randomness and how that works and how you should understand randomness and if there's anything to gain from doing so.

I came to the conclusion that I think you...thanks. I came to the conclusion that you can gain a little bit from randomness if you're paying attention to what you're doing and monitoring where the markets are. So I came up with a strategy that seemed to work pretty well and decided to create a blog to tell the world about it and talk about it, it's called *breakingthemarket.com*, where I describe the strategy and then I describe the concepts of viewing the market around the idea of geometric growth and that the market is... |
Adam:	00:06:53	That they're geometric. You've got a pretty good job of playing along here.
Mike:	00:06:57	I heard it, I just ignored it.
Matt:	00:07:03	So the blog, it took a little while like most blogs do but I got a little bit of traction and people started paying attention to some things that I was saying and then it blew up from there and so I got a little bit of a following, it's not as big as a lot of people on FinTwit, but and I've had a lot of people reach out to me and the ideas and concepts I've talked about seem to do fairly well. So I decided through COVID and sticking at home last year that I wanted to try and push it to a further direction so I went out and decided to start a company called *Pronghorn Analytics* to figure

out how to implement this for other people. Implement these strategies and similar and still take the concept of geometric balancing to another level.

Adam: 00:07:55 Okay, well don't leave us hanging. What is this concept of geometric rebalancing and how do you think it differs from...would you map it in the sphere of more familiar type of strategies and then how does it differ from those that are maybe proximate to it in conceptual space.

Geometric Rebalancing

Matt: 00:08:13 The idea of geometric rebalancing is that the whole goal of investing is to maximize long term growth and if you look at it from a compound growth rate perspective, foundationally you can get too aggressive, you can lever too high you can own assets that are too volatile and the interesting idea is that if you size a bet properly it has a really strong impact on how it does in the long term. That it's not just picking the right asset you really need to size the assets that you pick properly, and then when you do that in a portfolio form, that of course drives down the volatility of the whole portfolio but, if you size the assets within that portfolio, you can put yourself in a position to maximize growth. And if you rebalance that portfolio as much as you can theoretically, you have to worry about costs, then you're picking up a rebalancing premium, that is drinking I guess.

Mike: 00:09:20 I'm going to be getting the later ones and you're going to hate me for it.

Matt: 00:09:25 The general idea is that you need to be constantly focused on rebalancing as often as you can or as often as feasible, and constantly trying to adapt the portfolio to the right position to reap that gain. So if we're thinking from a traditional finance framework, there's the geometric frontier which is like the efficient frontier, but it's cut off on the right because you don't go past the peak. And my view is that you need to be somewhere on that geometric frontier, potentially down into cash, there's plenty of times that even owning cash itself is useful. And you would be, you'd want to pick a point somewhere on that frontier and constantly adjust your portfolio back to that position. I think one place that I do differ from a lot of people is I view the market is... a lot of people realize the market changes frequently.

But I think that your portfolio should very much be willing to track and adjust quickly to the way that the market moves, which is if the market does start getting very volatile within a few days, your portfolio should pull back fairly quickly, as opposed to just sit back and wait for it to go through. It may be a bad idea in the short term, it may be a bad idea on that time, but if we're thinking about it over the long term, if we're thinking about it for compounding growth, year over year, decades out, in the long run you're better off doing that and trying to monitor where you are in the portfolio setting and maximize return. There's some similarities to risk parity and what I believe, I think I believe you should be slightly

more aggressive than the standard risk parity concept, but I guess that's some of the view.

Adam: 00:11:19 So you mean be more aggressive in terms of having a view on expected returns, having some model to pass.

Matt: 00:11:29 Yes, I do agree. I do believe that. But I also believe that you should probably be a little bit more aggressive. So a risk parity portfolio, conceptually is the tangency portfolio, the maximum Sharpe ratio portfolio. And I think obviously, if you're using leverage, that's generally the right place to go after. But this is one of the reasons I attacked the blog the way I did. I think a lot of people talk about Kelly and maximizing geometric growth, and they instantly think that means I go straight to the maximum Sharpe ratio portfolio and leverage it up to a certain amount. And that's true, but at the same time, not everyone is going to use leverage. Not everybody can use leverage in their investing world and what they're focusing on. And so I actually started the blog just talking purely about finding the maximum geometric growth rate without using leverage, without worrying about that, just if you've got stocks and bonds how would you mix them? Just those two, no borrowing of anything, just make them the best return you can. And that to me is still a maximizing geometric growth perspective. And the really interesting thing about just limiting yourself and kicking leverage out of the equation is when you do that, you still get a better product from a return perspective and a drawdown perspective and a standard deviation perspective, when you look in the back tests, than you would if you just held like the S&P 500, or just held things.

And so this is where I guess when people sometimes say Kelly is the idea of maximizing geometric growth is too dangerous. That's true if you're willing to leverage through the roof. If you look at just maximizing that stuff, theoretically you should be willing to go short everything you own too. You should be able to do the opposite, not just with cash, but shorting the assets you have. And yeah, if you start taking it to that perspective, it's crazy. But if you limit the amount that you're willing to borrow, then you don't necessarily get too crazy with it. So my point was, is I think that to your point, I think sometimes people just think go to the maximum Sharpe ratio of portfolio, and be done with it. And I think there's a lot of value in thinking about where the rest of the curve comes up and rolls over and peaks for people that even aren't using leverage. And then it's worthwhile to maybe you go a little bit more risk for a little bit more reward, maybe it's not the maximum Sharpe ratio, but you still get extremely good rebalancing benefit, if you're paying attention to it.

Adam: 00:13:49 So I just want to unpack some of those. Because I think at the moment, the conversation is at the level of, if you've read through a meaningful amount of your blog, and I think it's worth diving one level deeper and what are the

underlying mechanics, what is being traded here? What does the portfolio look like from week to week? So conceptually I think, and again feel free to step in. You're focusing in on two separate things. One is the idea that traditional finance focuses on the efficient frontier which is a one period model, and it doesn't account for the effect of compounding, and that actually has a very meaningful impact. And if you maximize for the arithmetic mean return as the efficient frontier would have you do, then you will actually not get the optimal compound return over time. So the idea is, let's focus on the geometric frontier because those are the actual compound returns that you will generate over time.

Mike:	00:15:01	You guys aren't playing the game anymore? There's been like three geometrics.
Adam:	00:15:06	That's true.
Rodrigo:	00:15:07	We're just going to sit back and drink.
Adam:	00:15:09	Exactly. It's just to incentivise people to talk. The person who's talking doesn't have to drink.
Mike:	00:15:15	Sure. Are you just trying to shut us up?
Rodrigo:	00:15:18	Let's just take it back because there's been a bunch of questions. I want to hear the second level. What are you trading and how are you constructing?
Adam:	00:15:29	Interrupted me midstream. That's one theme. The second theme is that diversification and rebalancing premium, and the way I think you've approached this is more from a permanent portfolio type of perspective, where you've got stocks, treasury bonds, gold, and cash, in theory in the portfolio that you are reallocating to in order to maximize the expected compound rate of return. And that compound rate of return will be a function of both the expected return from those underlying markets and you have a model that you use to forecast returns for those three markets, and how effectively you harvest this rebalancing premium over time. Just this premium that mathematically emerges from rebalancing optimally back to diversified portfolios over time. So did I miss anything there, and Rodrigo did you then want to take it another level deeper?
Rodrigo:	00:16:36	No, I just wanted him to say the words that came out of your mouth, but let's rehear it from him.
Matt:	00:16:41	No, I'll go over that again. Thank you, because sometimes I can step on my own tongue when I try and talk about this and explain it to people, since I don't really have a deep background in trying to do that. I only trade three assets and then cash, which I still think should be considered an asset actually, but it's stocks, long term United States government treasury bonds, and gold. And the main reason I

picked those three is because they're generally uncorrelated to each other. So they don't seem to...one will go up and the other one will go down, one will go up, the other one won't move. And when we talked about the rebalancing premium, you really can't extract any rebalancing premium if the assets are moving together. You need them moving against each other or in different ways.

And the problem with most of the assets in the investing world is that they move with each other a lot, especially in crisis all correlations go to one, which isn't totally true, but it's true for so many assets that it feels that way. So I've kept this very simple, just with those three assets and cash, to focus on extracting the rebalancing premium as best as I can from those assets. I firmly believe if you're really good and you have plenty of data and skill and prediction capabilities and understanding what's going on with the market in terms of volatility in correlation, you can go well beyond that. But for myself and the amount of time I have to give into it, I felt sticking to those core assets was the important part. And as Adam said, that's the foundation of the permanent portfolio. My portfolio is a bit like that, but it's dynamic in that if you look at the permanent portfolio certainly over the last 40 years or so, it's lagged a lot of other portfolios because it's got a lot of cash sitting in it, and it's generally compared to what most people would consider, it's underweight stocks and equities.

And my view is that you go out and you monitor the correlations and the standard deviation in the market, what's going on between these three assets. Historically, you're never going to get them dead on, but correlation and volatility tends to cluster. High correlation, high volatility, they happen together. So if you see volatility start spiking, it's likely that it's going to continue to stay high for a little while, it's not likely to just dive right back down. And so if you know that, you can then take the properties of the portfolio and combine it together in a way that will maximize the rebalancing game. And I don't know if there's an easy way to visit the, verbally describe the math behind how you do that. But essentially, I'll monitor what's going on in the volatilities and the correlations in the market and when you see things start changing, then the portfolio weights will move.

So a really easy example is if stocks are normal and everything's as is but then stock volatility goes way up, then likely the stock levels in the portfolio will come down because a volatile asset like that is less likely to produce long term compound growth and geometric return unless there's something else, unless there's a reason to believe that the returns have shot up and gone higher. And I think some of what you were talking about is that, my view of returns is that they're not very predictable and they're certainly not predictable in the very short term. But I do think that there's some metrics out there, I've presented one thing I've talked about on my blog was just the CAPE Ratio and then how over 10 years generally speaking, the P/E ratios can give a general idea of where the values of stocks will be a decade out. And I try and use things like that, long term views for

return projections just in. So because of that, when the volatility spikes, my returns generally don't believe that the volatility spike mean stocks are about to go higher, it generally means that the stocks are about to roll over. And the same thing with bonds and the same thing with gold.

Adam: 00:21:02 So I guess that would be one interesting thing to explore as a slight difference from traditional risk parity, where with the dynamic risk parity approach, when volatility spikes on the one hand, in the numerator because, depending on how you're constructing the risk parity portfolio, but let's assume that you're really just trying to maximize diversification. So when you're maximizing diversification, you're assuming that expected return is proportional to the volatility of each asset, twice as volatile as, two times the expected excess return is another asset, that's half as volatile. But at the same time, you're trying to minimize portfolio volatility. So you've got this push and pull, the expected return is going up, volatility is going up, return is going up for that asset. Expected returns are going up because expected return is proportional to volatility. But also, you're trying to minimize exposure to that on the portfolio level, because you're trying to minimize portfolio volatility.

Whereas, I think on your hand, volatility is going up and therefore, from a geometric rebalancing standpoint you've got this driver to reduce exposure, because it's at the margin increasing portfolio volatility, but because of your expected return model, perhaps, that buffers it, Because typically markets, mostly for equities, volatility expansion usually leads to or is coincident with a drop in prices. And so, a drop in prices may from a CAPE standpoint, make stocks have a slightly higher expected return. And that buffers a little bit the amount that you reduce the total exposure to that market. So risk parity and geometric balancing actually have similar directional dynamics but for slightly different reasons.

Matt: 00:23:06 Right, yeah. And so that's a good point. I actually like thinking about that for bonds a little bit better just because the bonds it's very crystal clear. And that if rates go up, bond prices go down, but rates are higher. So now, the belief is, actually you're going to get paid more. So if we look at these last three months in the market, the rates on long term treasury bonds have risen quite a bit, and everybody was talking about three months ago, what's the point of having bonds in your portfolio, but now they're nearly a percent higher, I think in return than they were a while ago. So now bonds, they look a little more favorable. So you respond to that by actually giving them a little bit more expected return in the portfolio a little bit more weight, even though of course their volatility has been pretty high over the stretch too. So, bonds had fallen down a little bit, in my view not as much as I would have liked, but they fell down some, but now you can see that they've got a little bit higher expected return. So there's like a buffer that says, I only go so low because you can actually start getting a little bit of yield here, or when stocks, you're actually going to start getting a little bit earnings that are higher.

So in a way, it's a little bit that way. But to me, the biggest difference between risk parity and my portfolio, when things are funny, when things are volatile, my portfolio looks a lot like risk parity, it will go into a very similar structure. I think the big differences is, I guess a pretty good recent example would be like maybe late in 2017 when volatility in the market goes way down, my portfolio really went into it aggressively. Went into stocks aggressively. And the reason is because it didn't really, until stock prices started going up and earnings started coming down, it didn't take the drop in volatility as a signal that returns were any lower, because the P/E ratio hadn't started to reset itself by falling downward. And so in general markets, compared to risk parity, I'm more willing to hold aggressive stock type assets.

Mike: 00:25:12   Is that built into your models, that valuation metric, that fundamental valuation metric? Or is it built in there from...

Matt: 00:25:18   With the earnings?

Mike: 00:25:20   Yeah. Your comments on earnings. Is that built in somehow that it would know, or is it the expected return that you're putting in for the via CAPE? Like, how is that or is that just an example?

Matt: 00:25:32   So what I talked about in the blog was, and this I do a little bit more complicated things in this, than what I try to do normally, but the blog, the simplest concept was, it's the earnings ratio of in this case, the S&P 500, because that's what I'm trading, and then plus what I call the half the volatility or half the variance of stocks which is about four to four and a half percent. And that is in the neighbourhood of what I believe is going to be the arithmetic return for stocks going through the future.

Adam: 00:26:08   Walk us through that. It took me a couple of passes to really grasp. So you've got an expected return. Is it that you're generating an expected geometric return and then you're adding half the variance to get to the arithmetic return, and you're using that to create the geometric frontier?

Matt: 00:26:33   Yeah, the thinking is, one of the things about modern financial theory and portfolio theory that I think is a little bit off. Sorry, the stock market is a collection of stocks and the portfolio nature of the stock market is just going to make it act a little different than individual stocks themselves. So essentially, what I'm trying to do is I'm trying to say, okay, all the individual stocks, let's average out what their return is. And if the P/E ratio of the individual stocks is, I'm saying that nearly are going to be generally around where the individual stocks are going to trend to, then their

own arithmetic return must be half as much as the geometric returns, since the arithmetic return is half the variance over the geometric return.

I first came up with this concept thinking about bonds because bonds, the general long term return of bonds is best estimated as the yield on the bond. And so what's the yield on a stock? It could be the dividend yield, but in some ways also, it's probably, I think it's more appropriate that it's the earnings yield.

Adam:	00:27:52	Okay, but why are you adding back half the variance though?

Matt:	00:27:57	Because if the stock is going to trend somewhat towards its P/E ratio over multiple years, over a decade, then that return is not the arithmetic return over the next day or the next week. That's the geometric return because it's your long term gain. So if your return is 5% per year for the next 10 years, that's actually much closer to being a geometric return than it is to be in an arithmetic return. So if I took that and I just took the return stream, like say on a weekly basis over that timeframe, and I went back and arithmetically averaged all the weekly returns and then blew them, and then extrapolated them back out to an annual return, they would be roughly half the variance above the P/E ratio.

Adam:	00:28:46	I see. So you're saying the earnings yield is, let's assume that the prices stay constant and your only return is the compounded return of the dividends that are produced from the earnings?

Matt:	00:29:03	Yeah, you could take that concept to the dividend, but I guess I'm saying you're going to get your dividend stream and then the price will go up a little bit by the leftover part that's being reinvested in the company, that's returned back.

Adam:	00:29:17	But your assertion generally is that the expected compound return is what is imputed from the earnings price ratio, and therefore you need to add half the variance to get to the expected arithmetic return to put it into your optimizer.

Matt:	00:29:34	Correct.

Ergodicity

Adam:	00:29:35	I got you. Which I think actually leads to, and Mike and Rod, I'm not sure actually if you're familiar with this particular thesis that Matt has, but I'm looking forward to him running through it. So just take this concept of the equity risk premium as a function of basically a rebalancing premium among the stocks in the index, and just walk us through this. Because I think this is a really novel thesis that'd be great to pull some threads on.

Matt:	00:30:10	So this thesis, in a way, I didn't actually come up with the original concept of this. It came from ergodicity which is...
Mike:	00:30:18	Great. Here we go. I've been drinking voluntarily, just because we hadn't said any of the words before.
Matt:	00:30:28	I said a few, I'm trying to hold back, we got a long way to go.
Mike:	00:30:32	No, I agree. Thank you.
Rodrigo:	00:30:34	It gets better for at least us, as time goes by.
Matt:	00:30:40	So Ole Peters, who's the proponent, and I guess the one that came up with a lot of these ideas with ergodicity and how they affect economics, he came up with the idea that the stock market should be stochastically efficient and that it should be trying to match its optimal leverage. And long story short, his point is that the return on the market, the return premium on the market over the risk free rate should match the variance of the market. And if it does that then there's no reason whatsoever for anybody to leverage anything, because that means any more leverage actually hurts your compound growth rate and you would never hold cash, because holding cash hurts your compound growth rate. So it theoretically has a little bit of a stability to it. And that the market should work into that general direction, and there's no benefit to picking either other side, if that's where the market finds its price return.
		At the time, I thought it was an exceptionally novel idea. Having read a little bit more and having some people on Twitter point some things out to me, it's actually extremely similar with some of the stuff that mainstream economics have talked about. Bill Sharpe had nearly the exact same formula in some of his papers as well. But I had done enough work, working through the concept I just talked about of individual stocks and how they play out. But I knew in the back of my head that at least large cap stocks, over the last 80 years or so had a standard deviation of about 28%.
Rodrigo:	00:32:22	28?
Matt:	00:32:24	That's 28%. I'm basing this around stocks in the Dow Jones.
Adam:	00:32:28	This is the individual stocks in the Dow, not the standard deviation of the index.
Matt:	00:32:34	Just look at the individual stocks, just look at the individual stocks.
Rodrigo:	00:32:37	The average standard deviation of those stocks.

Matt:	00:32:43	Correct. And then the return premium of those stocks inside the Dow is about 8%. So the variance, 28% squared is 8%. I mean, they match up almost perfectly. Interestingly, gold does the exact same thing. Gold is also over 70. I think I did it over seventy years. The variance of gold matches up perfectly with its risk premium over that timeframe. I didn't do it over seventy years, I took it back to 71 or whenever they broke the gold window. I apologize. Which, is that a coincidence? I don't know. It's surprising that it works out that perfectly for individual stocks to line up that well. And then there's an actual conscious reason as to an individual stock perspective, if the market is trying to be efficient on an individual stock perspective you can give a reason for why stocks would try and move towards their optimal leverage.
		Now, I'm sure Adam's going to explain that there's all sorts of problems with that across a wide range of stocks but holistically, it's interesting that it seems to work.
Adam:	00:33:55	One thing that stands out without getting into some of the faults with CAPM. Going back to the fact that Sharpe originally identified a lot of these structures back in the 60s is, we're missing the risk free rate. Like if the risk free rate is 3 or 4%?
Matt:	00:34:17	No, I said it's the premium. Well, it's the premium. So the variance equals the premium over the risk free rate.
Adam:	00:34:22	No, I hear you, but the risk free rate is 4%. So you get 4% for free and then you get 4% on top. So the question is, is the risk premium 4% or 8%? Because if you take all the stocks together on individual Dow stocks, they all have an average vol of 28%. And therefore, the implied premium is 8% per, we observe 8% in total return. But some fraction of that is also the risk free rate so some of its missing. At the index level it does add up.
Matt:	00:35:05	What I'm saying is that the risk free rate is four and the arithmetic return is 12. So the premium is eight on the stocks.
Adam:	00:35:20	The total return is 12, okay. Ironically at the index level, it kind of works a little better, or maybe the same actually because the, at the index level the vol is 20%, the variance is 4% and the equity risk premium is 4% on a global level. If you look at Dimson-Staunton- Marsh, their Credit Suisse Annual Yearbook they break down the equity premium across a wide variety of global markets and the global market of all stocks and it's about 4.1% since 1900 and the vol is about 20%. That is also an interesting and consistent data point.
Matt:	00:36:10	Is that premium geometric premium or, because the one thing I find interesting about the risk premium and the equity premium is there's no standard way to report it.

Adam:	00:36:19	That's a really good question.
Matt:	00:36:20	People report a lot of different things. When I said 8%, I was talking arithmetic premium not geometric premium.
Adam:	00:36:26	Got you. That makes more sense then. And yeah, it's a 4% geometric premium.
Matt:	00:36:34	And that lines up then I guess. So that would line up with more of the stuff that I found.
Adam:	00:36:41	Again, if expected return is a function of variance then it's also a function of vol and therefore doesn't that argue in favor of using vol as a proxy for expected return?
Matt:	00:36:59	Are you talking about, back to like the risk parity concept?
Adam:	00:37:03	Yeah.
Matt:	00:37:05	So the thing is though from a portfolio perspective, the volume of portfolio it's a function of the volatility of the stocks and the correlation of those stocks to each other, and so it becomes a lot more complicated if the S&P 500 return is supposed to be efficient on those fronts.
Adam:	00:37:31	Yeah. I mean there's no evidence that the S&P 500 is remotely efficient.
Matt:	00:37:37	This is one of the things that I find interesting when people, and I realized that a lot of people attacked this concept on Twitter. Other people think it's great and I'm not trying to say it solves all problems in the world. I think it's just a very interesting concept that when you look at the data for large cap stocks, it plays out that way and if gold does it too which I find, once again it could be coincidence but it's interesting that it does that as well. But, I actually forgot where I was going. I'm saying too geometric too much.
Adam:	00:38:12	All good.
Mike:	00:38:15	Did you just say he was saying geometric too much?
Adam:	00:38:18	That could be.
Mike:	00:38:20	Geometric said, oh make it three.

Bitcoin

Adam:	00:38:22	So here's the first Bitcoin question, I'm surprised it took this long. We're 38 minutes in, so well done folks. I'm sure everyone wants to know why are we not including Bitcoin in your geometric rebalancing portfolio, for the crowd.
Matt:	00:38:41	I get that question every week probably by somebody through some channel. There's a lot of reason to do so. When I wrote my post actually on why I use stocks, bonds and gold, I put on there Bitcoin on paper looks perfect, like it's uncorrelated to all those, it has an enormous amount of volatility which is really what you actually want. When you're trying to harness the rebalancing premium you want volatility, you don't really want to run from it, you're perfectly happy to have uncorrelated or negatively correlated volatility. So the volatility of Bitcoin is a wonderful thing, the fact it's uncorrelated is a wonderful thing. My two biggest reasons it's not in my portfolio right now is, one, the data is not very deep. So it's been around for 12 years at this point, 11 years, not terribly long, and I have no idea how to project what its expected returns are going to be. I don't really have a good foundation...
Rodrigo:	00:39:44	The latest asset admin is it at 100X by the next two years.
Adam:	00:39:49	Not advice.
Matt:	00:39:53	So that makes it very difficult.
Mike:	00:39:54	If that then just buy Bitcoin.
Matt:	00:39:59	Clearly, if you're willing to ride some stuff...
Rodrigo:	00:40:01	Laser eyes.
Adam:	00:40:03	Don't forget to add half the variance.
Matt:	00:40:08	No, the arithmetic return of Bitcoin is through the roof. It's insane. But I don't know how to project what it's going to do in the future. And there's a part of me that thinks that I should just predict it flat or nothing or even slightly down and figure out how to blend it in there. The other side of the fence and I think this is improving a little bit, is that the transaction costs, they're a lot more than just buying the S&P 500 ETF. And when you are rebalancing you have to be really conscious of this. I mean, if you tried to run the strategy I try and run 30, 40 years ago, you would have gotten eaten up by transaction costs, paying commissions or paying the friction in the market, the friction's come way down over the last 20 years, which means it's possible to really go after for just everyday investors, it's much more possible to go after rebalancing techniques. Whereas this wouldn't

have been a thing in the past. And Bitcoin still seems to have a decent amount of friction in it to me.

And to do it properly, you got to be able to move in and out. I can't just take it from one account and move it to like a Coinbase account. I need to rebalance the whole thing right then. So you need something within like the middle part of the financial market and there's only a couple things right now that really fit into that. But I know Canada's got some ETFs now, and I've been meaning to look into those a little bit more to see how they look and if it looks more plausible.

Mike: 00:41:30 So, obviously that the Bitcoin potentially in a front digital gold on one of the asset classes in the portfolio that you're considering. Do you have concerns in other ways, for example, are you just using US stocks? Are you incorporating stocks from the emerging markets or found no interest in that? Because the sort of correlation if you will, it just seems to me that there are a couple of other...

Adam: 00:41:55 Exactly, instead of just S&P.

Home Country Bias

Matt: 00:41:59 No, you're right about the lack of global equities, is a flaw in what I'm doing. I'm way too home country biased and I would very much like to get more international exposure on there. The problem with it, and the way I try and build a portfolio, is that it's very difficult to accurately put things in there that have a high correlation to something else. And certainly in crisis, it's very common for developed markets, where most equity markets in the world have become very correlated with American stocks. And so to kind of have both of them there, because when that happens, then your portfolio allocations are very dependent on whatever your expected return is. Whereas if you have a negatively correlated stock, or negative correlated assets, the expected return will move the portfolio allocations, but it doesn't move them from 20% to 100%, just because you're off by 1% on your projection of the future returns, it'll keep it much tighter.

But with foreign equities they become, when they're very correlated it can be very touchy. I've run models with it, I've taken developed markets and put them in as a fourth asset and run them through and it just gets awful twitchy when it comes to back and forth. So the alternative to that is obviously, I think what Adam said, just not using the S&P 500, using a global index itself. And that's something I'm thinking about doing. The one thing I do like about being purely American is that I think the correlation between the US treasury bonds and the US based stocks is much easier to understand I guess. And when they go negative, I feel like they're more likely to hold that way because it's purely US centric assets.

Mike:	00:43:53	Well, structurally, right? Structurally speaking, you're talking about the US economy with a global currency, but a Fed that is thinking about those US stocks and a business cycle that impacts the US. So there is a fundamental structural underlying that would link that, and then gold is the third asset as the 'distressed I want out of this particular stock and bond world'. And so structurally, there's some choices there that make potentially some of the impacts greater possibly, in the way that geometric rebalancing is occurring. Aside from that, it sounds like there's some turnover.

And so in my mind, when we think about sort of these, even using a geometric return and you're putting some fundamentals, you would have this efficient frontier that wouldn't seem to move around a lot as I walked through it with you. And yet it sounds like there are some pretty big swings in allocations. And so I'm kind of curious as to what's driving that because it's probably not the return expectations from a long term perspective. So is it the covariance matrix that's imparting that, like what pieces of the puzzle are imparting these, what seemed to be large implied or implied large? You haven't said how big the swings are, but it trades a bit. It's got to have liquidity. So these are all leading me to this conclusion. So if I'm wrong there that it doesn't trade a lot, then that's fine. |
Matt:	00:45:22	No, it does trade a lot. The turnover is around 400% a year. It's mostly just trading small levels. It doesn't, when like the bottom fell out of the market last March, it did move pretty aggressively. It could have sold off and gone from let's say, a 60% stock portfolio down to, I'm making this up but maybe 30% in a week and a half, which I think is a pretty aggressive move.
Adam:	00:45:56	That's a good standard disclaimer, we're making this up.
Mike:	00:46:00	Everything is made up for illustrative...
Matt:	00:46:03	Don't go look it, it's all on the blog. Anybody wants to go see what, I've got it published there. Don't go poke me. I know it only went to 35%, Matt you're lying.
Mike:	00:46:12	And then you re-lever quite quickly or you reinvest quite quickly as... It seems to me vol is a...
Matt:	00:46:19	Vol is a huge one. I mean, correlation can do it too. And I honestly think correlation will make the portfolio snap faster, especially when correlations shoot up towards one. Like if you're thinking from the geometric frontier perspective, one correlation sheet or is one, the nose of the Markowitz bullet shrinks in and when it does that, like the efficient Sharpe portfolio becomes...
Adam:	00:46:45	It's the second order effect.

Matt:	**00:46:47**	Yeah, it dives in real fast. And so it can torque the portfolio really quickly. And it does it much faster when correlations go to one on assets, than it does on others. Like if I had a set of assets that I thought were negatively correlated, then say we thought stocks and bonds were negatively correlated. And then it spent a week where they were moving perfectly in sync with one another, the portfolio will move very quickly. It's very convex, that relationship. That's the fastest way it'll move. And it can move pretty substantially, quickly. I'm a big believer of being able to react somewhat quick. I was really surprised when I got into really reading about how other people did stuff and I saw that people were taking decade long estimations of variance and things like that for their models. And I was like, what exactly does 10 years ago have to do with what's going to happen over the next month?
		To me, the standard deviation has its own standard deviation, like, you've got your volatility, but there's a volatility of volatility, and you have to be prepared to adapt to that. And if you're not, you're going to be wrong constantly when the market actually does explode. And you're never going to get it right when things are collapsing around you. So if you're taking data that's 10 years old into your model.
Mike:	**00:48:03**	Is this just a vol timing strategy?
Rodrigo:	**00:48:05**	Ani, would you mind sharing the screen?
Matt:	**00:48:07**	A vol timing strategy? I mean, there's aspects to that of it.
Rodrigo:	**00:48:14**	By the way, watch this here. Here are the historical changes.
Matt:	**00:48:19**	Oh, there we go. Okay. Thank you. It is related to the timing of vol, but it's more complicated than that because, the correlations I said we'll move it to. And as we talked earlier, when the market does fall and the P/E ratios come down, or where bonds fall in price, so yields go up, it'll adjust to try and recapture the fact that they theoretically are going to provide a little bit more return in the future. So I don't think it's purely a vol timing strategy.
Rodrigo:	**00:48:55**	Yeah, we can see here that's aggressive on the, in March, for example, your equity position went down as much as down to 13%.
Matt:	**00:49:06**	Yeah, it got real tight about a year ago. That's almost a year ago to the day, I think it is.
Rodrigo:	**00:49:13**	We went from 60 then 13 and now where are we at around 52% and zero cash.
Adam:	**00:49:25**	Welcome to Mike Harris, who's coming on strong here in the comment section. The gall of Mike to come in halfway through or three quarters of the way through

and then start lobbing questions like, 'is geometric return an unbiased estimator of future returns'? I mean, Mike, how about a couple of softballs before you come for the jugular, dude? I mean, we weren't making any strong assertions about the geometric return being an unbiased estimator.

Matt: 00:49:57 Yeah. Is he trying to say that past geometric return predicts future geometric return?

Adam: 00:50:01 I don't know, I think that might be, that was implied.

Matt: 00:50:05 I don't think that's what I was trying to say.

Adam: 00:50:09 No. I want to also offer something because you mentioned adding extra assets to the portfolio that sometimes become highly correlated with other assets, ends up being a problem. And so, one way to manage that which we have found to be extremely successful is where you have assets that all belong to the same kind of cluster. Let's say you've got US equities, ... equities and emerging market equities. And then you've got 10 year treasuries and 30 year treasuries and gold and commodities, this as an example. So you basically have to kind of three clusters. You got an equity cluster, you've got a bond cluster, and you've got a inflation cluster like a commodity cluster. So you just draw all cluster-wise combinations. So one portfolio is emerging markets, 10 year treasuries and commodities. What is the optimal geometric return portfolio? Okay, set that aside. The next is ... equities 30 year treasuries and commodities. Optimize, that's the optimal portfolio. You take all combinations, or if you have a much larger set of markets, you take a representative sample like a stratified sample of them, but for this case, you can actually take all combinations because it's small, and then just average all of those optimal portfolios, and that'll allows you to avoid that.

Matt: 00:51:37 So you're just ensembling them together then, how you've created them?

Adam: 00:51:41 Yeah.

Rodrigo: 00:51:41 Basically adding up all the portfolio's equal weight, rather than having to choose one asset class over the other and then the next rebalancing you choose the other class, the other highly correlated asset class over the other, these large shifts in portfolios. Once you do this, where you're creating unique portfolios for the unique asset classes in those unique clusters and using them all, you get to include them all without the noise.

Matt: 00:52:09 I like that. That's good.

Adam: 00:52:11 In a previous life we did a lot of work in portfolio optimization.

Matt:	00:52:16	Yeah, I understand. I'm going to have to dig into that a lot more. I will say, I started trying to run ensembles, not trying, I am running ensembles, now. And a lot of that is partially because of things you've talked about, Cory Hoffstein talked about. When I first heard those concepts I thought they were ridiculous. I was like, no, you pick the best one. Why in the world are you going to try and pick a second best one or compromise yourself? That makes no sense. And I did this knowing full well about geometric growth and rebalancing and why you rebalanced assets to each other. And I heard you guys talking, I think it was on Meb Faber's podcast and I was like, these guys are smart but this part's ridiculous. But then, it occurred to me, I was like, well, if I can rebalance assets, why can't I rebalance strategies? There's nothing different about them technically when you get down to it, and then when you look into it's spectacular, and so I that's good. I like that.
		You can have portfolios, instead of changing the parameters of the portfolio, you can change the asset in there and it does the same thing.
Rodrigo:	00:53:15	Can I just take it back? I wanted to understand. You have an estimate for equities. When you said gold, it's a great diversifier, and that Bitcoin you can't really put a pin on what the valuation is, how do you put a pin on the valuation of gold? Aside from the variance being equal to the long term return?
Adam:	00:53:39	I told him you weren't going to go there Rodrigo.
Rodrigo:	00:53:42	Oh my God, I missed the chat.

Gold and the Schelling Point

Matt:	00:53:47	So gold is extremely hard to predict. Gold is in my opinion, it's hard to predict on correlations, it's hard to predict on the returns and the variance as well. My prediction for gold is based around the money supply, and the growth of how the money supply moves forward. Once again it's not short term, it can be way off but the thought process is over long term, it's going to be reasonably close. So if you see the money supply growing at 7% a year, the return of gold maybe should be a little bit lower than that, because the gold supply itself is growing so it's a supply/demand imbalance situation and that's how I try and handle it. But gold is a tough nut to crack because it...
Rodrigo:	00:54:38	Just to be clear, you got an X amount of supply plus excess mining on a yearly basis, whatever that ends up being one, 2%.
Matt:	00:54:47	Yeah. On the minus side. So like if the money supply is growing at like 8% a year and you're mining 2% a year then the return should be around 6% a year, somewhere.

Mike:	**00:55:00**	So, we've grown the money supply a lot, like a lot, so how is that fed through the model?
Adam:	**00:55:06**	High powered money, low powered money.
Mike:	**00:55:11**	M2's up 15%, I don't know.
Matt:	**00:55:16**	Is it really up that much?
Mike:	**00:55:17**	No, it's something like that, all of the add up of the Stimulus Plan.
Matt:	**00:55:23**	Yeah, it's a tough question isn't it that, what is the money supply. You got MZM, M1, M2. I thought it was really interesting the whole issue of what happened last year and how wealth moved from like M1 to M2 and the calculation factors of which fell into which bucket, based off what congress said. I generally lean towards M2 because I think it, because it includes everything it doesn't seem to affect it that much, affect it as much but it's not an easy question to answer, I agree with you on that and I probably don't have an answer better than most people. I don't take it over, it's not it's not that I'm going to say that well money supply went up 15% this month so gold's going to go up 15% a month, It's looking over a much longer term, just like theoretically the whole CAPE Ratio idea, the 10 year bond idea, that's not like a next month return, it's theoretically 10 years in the future. I'm not just looking at the money supply growth over the last couple months.
Mike:	**00:56:25**	We're going to have this 'pig in the python' as you go through that, which may have the lag effect to take effect when it's realized, obviously it's happened, and gold has gone nowhere but down. So obviously the short term is totally random as it should be, and the longer term is that that's the force that will drive gold price, maybe also Bitcoin price to include that one in there with your gold.
Rodrigo:	**00:56:56**	I think one of the arguments for gold is the fact that it's broadly distributed, it is used by the major sovereign banks, we understand hundreds of years of behavioral history around it, and certain characteristics if not 1000s exactly, and so there's certain network effects that we can count that have existed for centuries that we can count on, that non-correlation that we need from a rebalancing premium perspective but further it seems to hold its value as inflation becomes a thing, or the growth of money supply becomes a thing right.
Matt:	**00:57:39**	Yeah, the fact that it's been around forever is... I mean you've only got a decade of Bitcoin but I've got a century.
Rodrigo:	**00:57:47**	And Bitcoin broadly distributed yet right, it in the hands of...

Matt:	00:57:49	And I think that matters because the largest financial institutions in the world love gold. Maybe that will happen to Bitcoin and if it does it'll probably go through the roof, but it's been the foundation of a lot of the monetary system for so long. It may dwindle off, I don't know, but just the fact that it's... I saw someone say that gold is the Schelling point of monetary system, it's been there for so long that people just instantly think of it as being in the middle of the financial world and it's probably not going to disappear.
Adam:	00:58:26	What is the Schelling point?
Matt:	00:58:28	I think it's Schelling, I could have got that wrong but if you just tell someone to think of something what would they think of? I don't know much about Toronto or where you guys are but, there's usually like a landmark, so if you were to say like meet me at 12 o'clock at this location but you never told the person location. I live outside Washington DC. If you did that in Washington DC, there's only a couple places people are going to come to their mind, they're kind of going to go Washington Monument and maybe that's a decent choice, like stairs to the Capitol, there's only a couple places that you would think, he's probably going to think there, she's probably going to think this too, and so those points are like the Schelling Points in people's minds, they're the ones that just gravitate to just in the default and so, I've seen people say gold has got that position in people's heads, like it's just something that people gravitate to.
Adam:	00:59:22	That makes sense by the way we're totally stealing that, we're going to be using that, you going to hear that in every podcast.
Matt:	00:59:27	I may have said that once on the blog somewhere, I don't know. If I haven't, I've thought about it.
Rodrigo:	00:59:34	Something's going to take over the...wait...we used the three body problem five times a podcast for like 10 podcasts in a row, so I think this one will be a good thing to take over that.

Margin of Safety

Adam:	00:59:47	The Schelling Point is the three body problem of Riffs, exactly. I don't want to let you go before talking about this idea which I really like as a student of robust optimization, I really like the way that you talk about margin of safety in the context of examining the slope of the geometric frontier and what that sort of point of diminishing marginal utility, and how to think about that. I know that's a bit of a technical detail but if we can try and explore it I think it'd be really interesting.

Matt:	**01:00:23**	I would like to try and pull it up on my screen and share it if I can figure out how to use this computer.
Mike:	**01:00:29**	You're doing great so far, I mean using a computer.
Matt:	**01:00:32**	Thank you, I haven't been typing at the same time so, which one should I...
Adam:	**01:00:41**	In the meantime Ani, while you bring that up, or just define what the Schelling Point was, if you can put that up and let everybody know what it is.
Matt:	**01:00:52**	Was I way off? There we go.
Rodrigo:	**01:00:54**	In theory a focal point or a Shelling Point is a solution that people tend to choose by default in the absence of communication. The concept was introduced by the American economist Thomas Schelling.
Adam:	**01:01:02**	I bet it's Thomas Schelling, running out of space.
Matt:	**01:01:12**	Alright, how do I share my screen? There it is, it'll come up in a sec.
Adam:	**01:01:26**	For those listening through audio he's showing a picture of Elle McPherson with nothing on but a gun holster.
Matt:	**01:01:36**	All right.
Mike:	**01:01:37**	I've never been happier.
Adam:	**01:01:41**	I just totally dated myself didn't I? Like, terribly.
Rodrigo:	**01:01:43**	Yeah, who is that person? I have no idea what you're talking about.
Matt:	**01:01:47**	This is a blog post I wrote called *'The Factor of Safety'*. When you look at a geometric frontier, I don't know if I have got a picture of that but, geometric frontiers they slope upwards like we see here, and then they roll over, and they look exactly like a stress strain curve for an engineering material, like a beam on a structure, or beam on a bridge and when you look at the maximum geometric return...
Adam:	**01:02:22**	Hold on, I think it's useful to actually go into what is stress versus strain.
Matt:	**01:02:27**	Okay, you're going to really make me remember some of my deep engineering stuff, aren't you?
Adam:	**01:02:30**	No, if it's a pain then never mind but...

| Matt: | 01:02:32 | No, it's fine. Stress is, I've got it on here actually I think, stress is the amount of force or, it's force over area so that the amount of force that's on the part and strain is how much it's deflecting, and so as things go with an engineering part as they go, more and more force is put on the part, the part deflects further and further and further, until it gets to a point that it will starts deflecting and bending and rolling over. That's where it actually yields or bends before that it roughly holds its shape, but then it keeps bending and then it gets to a point where it actually starts, you have to get into a lot of deep engineering stuff to understand why it technically rolls over like this, but it comes to a point that if you put any more stress and strain on top of the system, the system will roll over and break and so you never want to get anywhere near that point because if you do start getting past this point the whole system will end up collapsing on itself and that's where you get failures inside the engineering system.

So when engineers deal with this because it's extremely hard to understand what causes these kind of, where these limits are that you can you can obviously do a lot of testing in the field to figure out what the stress and strain is of metals or plastics, and model this but that's all the lab, the real world parts that are made they have defects in them they may they may have voids inside of them, necessarily they're not going to work exactly like you get in the lab and you also don't know the kind of forces that you're going to put on them, you look at cars for bridges a while ago, actually I think cars are roughly the same weight as they used to be, but the load people can put on stuff can change through the years this use changes. So you want to stay away from stressing things too much and so when you look...so this is the geometric frontier and it's roughly the same shape as I said, and so from an engineering perspective we try and stay away from this point, and you generally do it by part way, so you'd say like you have a factor of safety of two so you would move halfway, you would take your stress and you would cut it in half and then pick a point back there, but you pick your factor of safety based off of what you know about the properties. This is one thing that's interesting is that, like airplane design you really don't want to be too safe, you want to be safe but too much safety just makes the plane too heavy and so it's becomes harder to fly. So airplanes have extremely high tolerances in how they're made, because they have high tolerances they can have lower factors of safety, but places that don't have high tolerances have to have much higher factors of safety because you don't know what's happening. I think I'm going to change screens here. So that's kind of the concept of when you talk about a Kelly point... |
|---|---|---|
| Adam: | 01:06:01 | We keep talking about Kelly, maybe you want to just explain the basic concept of Kelly sizing. So Kelly, really understands without understanding what maximized … is. It's probably missed. |

Matt:	01:06:25	So, Kelly sizing to me is just about maximizing geometric growth. if you go back and read the actual original work it's really about like one off coin flip kind of games and how do you only bet like 5% of your bankroll on this horse. So it's got a very yes/no kind of view to do it, but to me it's about maximizing geometric growth. The easiest thing to say if you have like one share of the S&P 500, the optimum place to leverage it is probably to leverage it up to two, so you'd borrow money and I want two, but let's say that the volatility is really high on the S&P 500, and you think the return is still low then that way you would actually hold 50% cash and then the S&P 500 and that position, if you rebalance that position creates the longest long term maximum gain. It's also a play on the whole Shannon's Demon concept of, there's a certain size to your bet that maximizes your growth.

And so, when you do it in a multi asset portfolio, it's a little bit more complicated in that you've got a lot of different moving parts but it's still effectively about this point here, this point at the top of the geometric return, is the portfolio that provides, the rebalance at that point provides the absolute most long term growth rates you can get. It may have a lot of volatility but it's the most growth you can get. So this whole geometric frontier is actually a frontier of slope, so that the peak has got zero slope, what it means is taking on more risk more standard deviation you get no more return for it, you get no more long term return. So at the peak there's no point in getting riskier, like that's as risky as you should ever be. And then you back, and you work your way down from that on lower slopes.

Most people when they talk about like a Half-Kelly Portfolio, they just simply take the standard deviation and cut it in half, of whatever the peak Kelly standard deviation is, so like the chart we have on the screen it's about 18% so a Half-Kelly Portfolio they would take to take the 9%. But to me essentially the whole Kelly concept is a trade off between the return you get from a geometric return to your next value of standard deviation next value of risk that you're going to get, so it's essentially about a slope rate. A change, a change in that relationship. When people talk about Kelly purely from a leveraging perspective it's a very slow constant curve that slowly rolls over. It's technically a parabola, which is why the Half-Kelly concept of cutting your volatility in half works, because that's actually the point, that's half the slope that you were to begin with. But if you're dealing with something that isn't levered in that way and you've constrained yourself in other methods, to me that the whole concept is about, how much more risk are you willing to take for this amount of geometric turn. The Kelly Portfolio is just the peak of that, it's just effectively saying that's the most you ever want to take. There's no reason to take any more risk.

Now, in real life people not everybody wants to take that much risk because maybe you're retired and you're going be pulling money out of your portfolio and the draw downs at that level are going to be potentially dangerous because if you draw down too much you won't be able to achieve your future growth. So for each person maybe that risk return rate isn't right, but the Kelly point is essentially saying nobody should really go past this point, and then everybody else makes an evaluation where, how far you push up the curve. And so that's where, when I when I talk about geometric balancing my point is this is the peak and your point that you should be rebalancing on is somewhere in here. Now, if you're going to use leverage you should be picking this portfolio and moving out but the...

Rodrigo: **01:10:24**   For those listeners, what we're looking at is basically an efficient frontier where as you go up the efficient frontier you get the maximum Sharpe portfolio and if you're not going to use leverage you're going to go up the equity market, the efficient frontier more towards the peak of that slope which is the Kelly, the full Kelly. And the change in expected return which is on the y-axis between the maximum Sharpe portfolio and the maximum Kelly actually is quite small, so we're looking at 5.5% return and what is that 6.5, so the meat of it is actually the beginning part of the slope between the Sharpe ratio and I guess a five percentage point standard deviation. The reason that maybe Half-Kelly is good enough is because you're not crushing returns in order to reduce that volatility. At least that's what I'm seeing there in this chart.

Matt: **01:11:34**   Right, and let me come down a little. I have a few charts in here showing different types of markets, these are just made up.

Adam: **01:11:45**   But this is critical because the point is that Half-Kelly is arbitrary because you don't know the shape of the curve.

Matt: **01:11:55**   So Half-Kelly is sometimes not that good, sometimes it could be crazy aggressive, sometimes it could be foolishly safe, like it makes no sense. From my perspective my slow path Kelly perspective, this is actually a very...

Mike: **01:12:13**   The Half-Kelly's a Schelling point.

Matt: **01:12:17**   That's true, it actually probably is, but I just don't think it's always right.

Mike: **01:12:23**   Yeah, I think that's...it's not right but it's just a heuristic that we use. Anyway, keep going.

Matt: **01:12:30**   So from like a slope perspective here, this would be the Kelly peak here and if you have Kelly just based off volatility you'd be holding a little bit of cash, you'd be kind of in here, but if you pay attention to it as a risk/ return perspective the Half-

Kelly position should be a little bit more aggressive than the tangency point, if you're from a risk return perspective, that's really where your trade off matches, and then this is a pretty tame market here, and so here we're just a little bit past this. From here this Half-Kelly point, because the market's tame, and this is just stocks and bonds by the way for anybody wondering what this is, it's just a very simple stock/bond portfolio. From here that the actual fully own 100% stocks is not even peaked, and so the Half-Kelly point here is not remotely halfway, because halfway is putting you back here with a little bit of cash but the risk/return trade-off is still quite good, so what's the point of holding cash at that point because you might as well be aggressive in that kind of market. I don't really know why that was...that's roughly the same picture.

And then here, this is a really bent over market, it's bent over because the volatility is very high in stocks at the time, the stock market. So here the Half-Kelly Point's actually closer to what you would consider Half-Kelly, but it drove it way off into a lot of cash, and so this is a little bit of the way I think about this is that, I think a lot of people traditionally just pick the tangency point which is, risk parity can do what we're looking at right here too, where it can hold, decide to hold cash. But to me, the risk/return trade-off is vital to understand it and sometimes some of the other traditional methods don't really pay attention to the risk/return trade off inside the portfolio selection. I think it actually happens more often with people just being too scared that the market is actually fine, and they go Half-Kelly but you can, you can push it up much higher.

Adam:	01:14:32	So just to make sure I understand and try and crystallize it for people listening, I think this pertains specifically to the unleveraged problem, that in the levered case, Half-Kelly is the equivalent to where the slope is half of the slope...
Matt:	01:15:01	When you are leveraging that's correct, this is assuming you're leveraging the correct portfolio obviously. We all like to believe that that's true but that's also probably technically never true but...
Adam:	01:15:10	Totally, so this is only the unlevered case where you're actually going further out the frontier. One thing I did want to highlight actually, just if you can go back up to the top where you were showing the initial chart there because I think it's interesting to know, like look at the diminishing marginal return between the maximum Sharpe ratio portfolio and the optimal Kelly portfolio in this plot, you're taking on an enormous amount of excess volatility for an extremely small amount of marginal return, whereas if you can get over your leverage aversion, your expected return at the same level of risk maybe as much as 50 or 60% higher. So in this case levering the most efficient portfolio is vastly superior to trying to push out to even Half-Kelly here, or the point of half way of diminishing marginal utility on the slope between the max Sharpe portfolio and optimal Kelly.

Matt:	01:16:22	Right. This is an extremely good portfolio to leverage. Some of the other ones I showed it's not much benefit just more equity, but this one would be very...
Rodrigo:	01:16:31	What are the differences between these all stocks and bonds but a different time periods, is that what it is?
Matt:	01:16:36	I actually may have picked them on dates but I don't think I published them. They're theoretically just different types of markets and I think they are based off of a real market that existed, but at least my view of a real market that had existed obviously, what the standard deviation was at the time is up for interpretation but.
Rodrigo:	01:16:54	Understood.
Adam:	01:16:56	The other thing is basically that Half-Kelly is a ludicrous heuristic for an unlevered portfolio because it's not actually doing what you think it's doing, because it's designed for the levered portfolio and if you're...
Matt:	01:17:17	If Half-Kelly in the traditional sense is that. I think if you use Half-Kelly in the concept of half the slope, where you are halfway along the slope, I think it's fine because it's effectively just acknowledging it's all about a trade-off of risk and return. So you're just saying I'd like half the trade off, I might get half of it to go away. But to just pick the half volatility thing you could be making horrible mistakes if you're not, if you're doing it on an unleveraged portfolio.
Adam:	01:17:43	So you need to understand the shape of the frontier in order to understand where the optimal trade-off is, and that's not typically something that people are contemplating and I think it's a really valuable insight and I think you explained it really well in your blog posts.
Matt:	01:18:01	And to tie back to the margin of safety point, because we don't really know what the volatilities are, we're guessing, we don't really know what the correlations are, we're guessing, we don't know what the returns are, we're guessing. Just like in the material we kind of think we know because of past testing what the strength of this material is, but the beam has been made by somebody and it may have been nicked or it may just not be pure. Engineers will pick and they'll say well I'm not going to go to the peak, I'm not going to design this for the exact numbers that I calculate, I'm going to say I'm going to design it for less. So it's the same kind of concept of, instead of saying I'm going to go to the edge, you say okay I'm going to go to 50%, so a Half- Kelly portfolio is like saying you're designing a bridge with a margin of safety of two. You're saying I know that there's errors in this so I'm not going to get near that and I'm going to buffer that off, and that's kind of the way I view the margin of safety aspect of this.

Rodrigo:	01:18:54	Is there a particular, the margin of safety part is that a particular number? Like what is that? Is it a heuristic?

Matt:	01:19:02	So actually, it depends on how accurate you believe your estimates are. Theoretically it's zero if you have wonderfully good pictures of the future, but if you, so it depends on how close you are to having an idea of what's going on. If you have really good pictures of the future you can get more aggressive just like airplane designers have really tight tolerances on their parts, so they can actually have a much lower set factor safety and keep the weight of the plane down. Honestly and that part to me is pristinely useful even for leveraged portfolios because if you have a really sloppy view of what the future standard deviation and return are going to be, you're crazy to take leverage in any kind of quantity because you just don't know, like that factor of safety needs to be through the roof. But if you have a really good idea and if you have a method that gets it in the neighbourhood and contemplates catastrophic failure because it's not just accuracy, it's the consequences of that accuracy, you can be a lot more aggressive with leverage in my view. I'm probably way too conservative leverage than I should be.

Rodrigo:	01:20:04	Well, this ties into a question from Mike Harris. The problem with Kelly was always over what period to measure mean return variance? It does make a difference. So have you put any thought into that?

Measuring Mean Return Variance

| Matt: | 01:20:22 | Well, yeah, I have, quite a bit. So the return side of the house, I acknowledge that my returns are kind of what they should be over 10 years therefore, they're terrible over the short term. So that has to be taken into consideration as to how safe I am staying away from the peak. On the variance side, I think because the markets change fast, like I said, if you're taking data from 10 years ago and your variance prediction it's probably actually hurting you. You're better off having much shorter terms. This was very rudimentary, but I did kind of a chart just showing if this was coin flips, how fast does it take before you get something that's reasonable? How much data do you really need in a coin flip world? I think it was a coin flip world, but it was definitely a pure random world. How much data do you need before you get something kind of in the ballpark on standard deviation and correlation. I think I said it was somewhere between 30 and 60 data points and now it's not a great number, but you had then, have to weigh that accuracy against the accuracy of how much the market moves, like how much is tomorrow going to be? Let me close this down. You don't need this up anymore. Can you stop sharing the screen or I can do it.

You have to weigh the benefit of having more data to make just a statistical accuracy more accurate versus the fact that the market is changing. And it's not |
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like it was a year ago. And so how do you trade that off? You're giving up statistical accuracy for recency that the fact that the market's moving around, and that's a very tough problem, I agree. But I personally think a lot of stuff that's looked at the stuff in the past, is used very long term data there. And therefore, they're very wrong. When the market goes crazy, they're still thinking the market's tame, because they're pulling stuff from a long time ago. Whereas if you can shrink it down, you start getting some stuff in there and you start getting a more accurate opinion of what the future is going to be from a … correlation perspective. I really think the idea that you're wrong always is really important. Like, you have to know everything we're putting in this model is wrong, like none of it's right. It's all just guesses. Therefore, you have to decide how much do you want to be wrong and where, and once you realize that it becomes okay to maybe shorten timeframes down a little bit, knowing that you're just trading off one error for another, and you just try to keep them balanced.

Adam: 01:22:41 What is the relative consequences of different types of error? Dave Nadig asks, 'doesn't using these securities with convexity embedded solve some of the leverage aversion problem'. So I guess the idea here is, instead of using leverage at options, because it gives you non-recourse leverage, and gives you convexity in the form of gamma. And I think there's something to that, though. Now you're managing, instead of managing just vega risk, you're managing vega risk plus convexity risk. So the modelling gets a lot more complicated.

Matt: 01:23:20 The math is not overly hard. Obviously, I'm an engineer, so I had a decent math background, maybe, compared to the normal population. But when the return streams are symmetrical, this isn't overly hard to figure out to me, when you start skewing this stuff especially to the level of options, it takes a lot of math, and I don't have the capability of doing that. Maybe someday but not now.

Rodrigo: 01:23:48 Probably …, quite accessible what you've created. And once you start dealing in the options world, you're managing the vega's and the gamma's and you're going to have to delta hedge, but it's a lot more complicated. A lot more data points. It's not easy to back test. So yeah, there's probably somebody willing to invest the time and energy in doing that, there's definitely something there. Just a matter of where we're at right now with a simple rebalancing portfolio.

Matt: 01:24:17 I 100% believe that people know options well and understand the concepts that I'm talking about on here, can use them to their benefit. I just know that the math would be very complicated to figure that kind of stuff out.

Rodrigo: 01:24:28 Just buy some triple bowls and just be done with it. Doesn't that maximize geometric return.

Matt: 01:24:36 Not the triple ones.

Adam:	01:24:38	I also think the other thing that gets missed is that the use of options in order to get convexity you need to be long the options, and being long options means you've got carry in this case negative carry, so you're constantly needing to manage what tenor of options, and if you roll them more frequently to maximize the rebalancing premium, you've got a much higher negative carry. So there's lots of, you've got at least two unknowns, unless you want to go into some of the more obscure Greeks. So I personally look at some of these option based strategies and some of these ETFs and think there's a lot of built in assumptions there, and there's a lot of path dependencies. And actually, we got to get, I had a really interesting chat with Corey on Thursday afternoon about just some of the less well understood intricacies of just rebalancing a fairly, like standard option portfolio as part of a product. There's lots and lots of path dependencies and rebalancing error and all kinds of stuff in there. So sounds good in theory, extraordinarily impractical in practice I think. Poor Corey, so I'm not dragging you in man, I'm giving you credit for having good insight.

So, I think we covered, what are you working on at the moment? Is there anything that you're sort of got your eye on is something that's... because I think you've done a really good job of digging into some of the fundamental sacred cows of finance, and showing that the emperor has no clothes. So what are you digging into at the moment, if anything that you find interesting? |
Matt:	01:26:41	Okay, a lot. I'm bad in that I start a lot of posts and then I just let them sit for a while because I feel like I somewhat understand them. And then I realize maybe I don't.
Adam:	1:26:49	I do the same thing.
Matt:	01:26:50	Then I got to finish them. I'm like, alright, this is good but it needs like five hours of editing and I don't want to do that. So it sits for another month. So there's a lot of things out there, I've been working on something on the business cycle and why it goes up and down. I think it's actually related. This is surprising. I don't have any drink left but to the geometric growth of companies and...
Mike:	01:27:15	Me either, I've downed two.
Matt:	01:27:18	Yeah, to optimal leverage. It's a hard concept to talk to over in words I think. But that's one of the things just about why the market's got cycles and if you look at a chart, why it goes up and down, up and down, up and down over time. I'm working on one to talk about long/ short investing and from a pure coin flip example. So just the math of...that one's kind of interesting in that you can have a long side that looks perfect and it works geometrically. You can have a short side that works perfect and works geometrically. But when you combine them together, it blows up and it will actually lose money over time. And the math behind why that plays

out. That's it. I'm not a long/short investor but to me that's really interesting in that like, you have two things that work perfectly unto themselves when you try and pair them together because you're technically leveraging the whole thing. It won't work and it will lose money over time.

Mike: 01:28:09   It's Shannon's Angel.

Matt: 01:28:12   Yeah. So to fix that you have to pay attention to the correlation.

Mike: 01:28:16   That was pretty good man.

Rodrigo: 01:28:21   I smiled. I just didn't want to interrupt Matt. I thought it was fantastic Mike. Keep going, buddy.

Matt: 01:28:27   All right. Sorry. I appreciate your jokes Mike. But yeah, I think those are the two big ones. I don't know. I'm doing a lot of research on the side too, of just ways to improve correlation. I enjoyed your guys talk on commodities last week which got me a little bit more into poking into how do I put a commodity leg into this portfolio and is it worth it? And so, that's some of the stuff I'm trying to research to figure out how to improve. I'm going to have to figure out how to do your foreign equities ensemble thing now too, but.

Adam: 01:29:06   Rodrigo is reminding us of the time.

Rodrigo: 01:29:10   I just want to keep everybody on time baby.

Adam: 01:29:12   That's right, exactly. Well, I think that's a natural place to break. Unless, Matt, you've got anything else you're just dying to cover here today?

Matt: 01:29:24   No, I don't think so. I think we've done good. Hour and a half flew by pretty quick.

Adam: 01:29:29   Yeah, I agree.

Rodrigo: 01:29:30   Yeah. And that's you're *breakingthemarket.com*, all this stuff that we've talked about all the graphics came straight from that website. So for those of you who didn't get a chance to, to watch it, definitely go there, look up the concepts and it's pretty robust and thorough.

Adam: 01:29:45   It's really cool. And I know Matt, you put together a course for me.

Matt: 01:29:49   I did. I'm going to publish that soon.

Matt: 01:29:54   Adam and I talked a week ago and I went through and I clustered the blog posts into topics kind of like the foundational entry level stuff and then getting a little

deeper into certain different directions. I'm just trying to make it pretty before I hit it so it's not just a bunch of words and get some pictures with it, but I'm going to post something on there for people that are trying to learn these concepts and get into it, where to start. Generally, I think that the progression of the blog itself was generally in that path but there are a few places where I looped back on myself, I got anxious and jumped ahead to talk about something else interesting.

Adam: 01:30:26   The big challenge honestly with the way that the blog is organized is just that you've got your weekly rebalance things in between, so that sort of pages and pages of that so...

Matt: 01:30:35   That's done, I'm not doing that anymore since I automated the whole thing and that's what Rod pulled up there, it's perfectly automated now and I'll just chime in when things are interesting enough that it's worth me talking about what's going on in the world.

Adam: 01:30:49   Yeah, anyways I think that that's something to look forward to. Someone asked for any book recommendations you might have.

Matt: 01:30:54   *Fortune's Formula* is great.

Rodrigo: 01:30:57   Yeah, that's one of my favorite books of all time.

Matt: 01:31:02   That one's good because it's got enough math in it to keep it interesting and tell you what's going on but it's also got a lot of really interesting stories, gambling and intrigue and the mafia. It's not boring at all.

Mike: 01:31:14   As I recall they kind of do a chapter of quant finance, a chapter of degenerate gambling, back to quant finance.

Rodrigo: 01:31:25   Between Samuelson and who was it? Samuelson and it was that hedge fund manager, have a feature in the book.

Mike: 01:31:35   Yeah, Thorpe.

Rodrigo: 01:31:39   It was Thorpe and Samuelson back and forth between Kelly and the utility curve, right?

Matt: 01:31:45   Yeah, that's an interesting section. I'm going to write about that, I'm planning on writing about that too. I think that's a big reason why the stuff I talk about on the blog isn't really well known or talked through because Samuelson was totally against it, and he was probably the most popular economist in the world, and when you get somebody that levels writing a one syllable report telling you you're effectively an idiot.

Rodrigo:	01:32:10	I don't know, you're applying his utility function to the fact that you're not using 100% Kelly and levering up. I think that's the perspective that he was trying to impose on, the idea that Kelly is the only thing for everybody and Thorpe saying that anybody is not using it is an idiot. I think they both have good points, as always I think you found a happy medium.
Matt:	01:32:36	You will say, hey Adam, are you...
Rodrigo:	01:32:45	He's muted again.
Mike:	01:32:48	Adam are you talking? You're muted.
Adam:	01:32:53	Sorry, thank Adam for chiming in, and he's the actual *Lead King* of our nerdy section of Fintwit I think. So Adam appreciate that. Okay, let's wrap it. I actually have to take someone to a swim meet and this was absolutely fantastic super fun Matt.
Matt:	01:33:17	Thanks guys, I really appreciate you guys letting me on.
Rodrigo:	01:33:19	Yeah, thanks Matt.
Mike:	01:33:20	Great having you on.
Adam:	01:33:21	Yeah, it's been awesome. All right, thanks guys enjoy your weekends and thanks everyone for joining us. Please hit the like button.
Mike:	01:33:28	Smash the like button and drop a review.
Adam:	01:33:31	Exactly. What else do we do? Follow or click the follow button or whatever it is, you're better at this than I am. How do you do this?
Rodrigo:	01:33:39	If people listen to our *Master Class* I think it's the thing we're most proud of recently.
Matt:	01:33:45	Yeah that's great by the way. I'm not all the way through that yet but your episodes got a little longer, as you get longer, got into it. But that first seven of those are awesome.
Adam:	01:33:55	Brilliant, thank you.
Rodrigo:	01:33:58	Thanks man, appreciate it. Alright gentlemen, have a fantastic weekend.
Mike:	01:34:05	See you gents later.