



Epsilon Theory

THE FIVE THINGS THAT MATTER #1 | BY RUSTY GUINN

# Whom Fortune Favors, Continued



**Fook:** There really is an answer?

**Deep Thought:** Yes. There really is one.

**Fook:** Oh!

**Lunkwill:** Can you tell us what it is?

**Deep Thought:** Yes. Though I don't think you're going to like it.

**Fook:** Doesn't matter! We must know it!

**Deep Thought:** You're really not going to like it!

**Fook:** Tell us!

**Deep Thought:** Alright. The answer to the ultimate question...of Life, the Universe, and Everything...is...  
42. I checked it thoroughly. It would have been simpler, of course, to have known what the actual question was.

— Douglas Adams, *Hitchhiker's Guide to the Galaxy*

**As investors, our process is usually to start from the answer and work our way back to the question. Unfortunately, the answers we are provided are usually pre-baked products, vehicle types or persistent industry conventions, which means that the answers we get when we actually focus on the questions that matter may be counterintuitive and jarring. The entire point of developing a personal code for investing is knowing which questions matter and ought to be asked first, before a single product, vehicle or style box gets thrown into the mix.**

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The purpose you undertake is dangerous.' Why, that's certain. 'Tis dangerous to take a cold, to sleep, to drink; but I tell you, my lord fool, out of this nettle, danger, we pluck this flower, safety.

— William Shakespeare, *Henry IV, Part 1, Act 2, Scene 3, Hotspur*

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**Thomasina:** When you stir your rice pudding, Septimus, the spoonful of jam spreads itself round making red trails like the picture of a meteor in my astronomical atlas. But if you stir backwards, the jam will not come together again. Indeed, the pudding does not notice and continues to turn pink just as before. Do you think this is odd?

**Septimus:** No.

**Thomasina:** Well, I do. You cannot stir things apart.

**Septimus:** No more you can, time must needs run backward, and since it will not, we must stir our way onward mixing as we go, disorder out of disorder into disorder until pink is complete, unchanging and unchangeable, and we are done with it forever. This is known as free will or self-determination.

**Thomasina:** Septimus, do you think God is a Newtonian?

**Septimus:** An Etonian? Almost certainly, I'm afraid. We must ask your brother to make it his first enquiry.

**Thomasina:** No, Septimus, a Newtonian. Septimus! Am I the first person to have thought of this?

**Septimus:** No.

**Thomasina:** I have not said yet.

**Septimus:** "If everything from the furthest planet to the smallest atom of our brain acts according to Newton's law of motion, what becomes of free will?"

**Thomasina:** No.

**Septimus:** God's will.

**Thomasina:** No

**Septimus:** Sin.

**Thomasina (derisively):** No!

**Septimus:** Very well.

**Thomasina:** If you could stop every atom in its position and direction, and if your mind could comprehend all the actions thus suspended, then if you were really, really good at algebra you could write the formula for all the future; and although nobody can be so clever as to do it, the formula must exist just as if one could.

**Septimus (after a pause):** Yes. Yes, as far as I know, you are the first person to have thought of this.

— Tom Stoppard, *Arcadia*, (1993)

**On this most important question of risk, we and our advisors often default to approaches which rely on the expectation that the past and present give us profound and utterly reliable insights into what we ought to expect going forward. As a result, we end up with portfolios and, more importantly, portfolio construction frameworks which don't respect the way in which capital actually grows over time and can't adapt to changing environments. That's not good enough.**

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Most of these notes tend to stand on their own, but this one (being a Part 2) borrows a lot from the thinking in [Part 1](#). If you're going to get the most out of this note, I recommend you start there. But if you're pressed for time or just lazy, I wanted you to take away two basic ideas:

- That the risk decision dominates all other decisions you make.
- That the risk decision is not exactly the same as the asset class decision.

## Children of a Lazier God

Before I dive into the weeds on those ideas, however, I want to tell you about a dream I have. It's a recurring dream. In this dream, I have discovered the secret to making the most possible money with the least possible effort.

Hey, I never said it was a unique dream.

It is, however, a unique investing case. Imagine for a moment that we had perfect omniscience into returns, but also that we were profoundly lazy — a sort of Jeffersonian version of God. We live in a world of stocks, bonds and commodities, and we want to set a fixed proportion of our wealth to invest in each of those assets. We want to hold that portfolio for 50+ years, sit on a beach watching dolphins or whatever it is people do on beach vacations, and maximize our returns. What do we hold? The portfolio only needs to satisfy one explicit and one implicit objective. The explicit objective is to maximize how much money we have at the end of the period. The implicit objective is the small matter of not going bankrupt in the process.

This rather curious portfolio is noteworthy for another reason, too: it is a static and rather cheeky case of an optimal portfolio under the Kelly Criterion. Named after John Kelly, Jr., a Bell Labs researcher in the 1950s, the eponymous criterion was formally proposed in 1956 before being expanded and given its name by Edward O. Thorp in the 1960s. As applied by Thorp and many others, the Kelly Criterion is a mechanism for translating assessments about risk and edge into both trading and betting decisions.

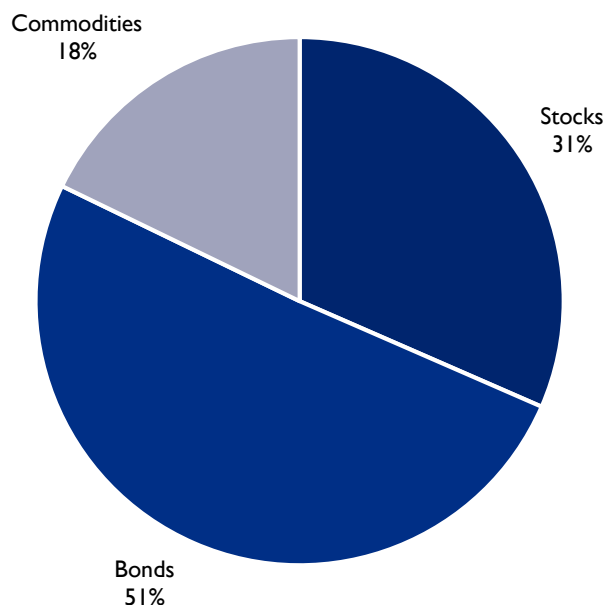
Thorp himself has written several must-reads for any investor. *Beat the Dealer*, *Beat the Market* and *A Man for All Markets* are all on my team's mandatory reading list. His story and that of the Kelly Criterion were updated and expanded in William Poundstone's similarly excellent 2005 book, *Fortune's Formula: The Untold Story of the Scientific Betting System that Beat the Casinos and Wall Street*. The criterion itself has long been part of the parlance of the professional and would-be professional gambler, and has also been the subject of various finance papers for the better part of 60 years. For the less prone to the twin vices of gambling and authoring finance papers, Kelly translates those assessments about risk and edge into position sizes. In other words, it's a guide to sizing bets. The objective is to maximize the geometric growth rate of your bankroll — or the expected value of your final bankroll — but with zero probability of going broke along the way. It is popular because it is simple and because, when applied to games with known payoffs, it works.

When we moonlight as non-deities and seek to determine how much we ought to bet/invest, Kelly requires knowing only three facts: the size of your bankroll, your odds of winning and the payout of a winning and losing bet. For the simplest kind of friendly bet, where a wager of \$1 wins \$1, the calculation is simple: Kelly says that you should bet the difference between your odds of winning and your odds of losing. If you have a 55-to-45 edge against your friend, you should bet 10% of your bankroll. Your expected compounded return of doing so is provably optimal once you have bet against him enough to prove out the stated edge — although should you manage to reach this point, you are a provably suboptimal friend.

Most of the finance papers that apply this thinking to markets have focused on individual trades that look more or less like bets we'd make at a casino. These are usually things with at least a kinda-sorta knowable payoff and a discrete event where that payoff is determined: a single hand of blackjack, an exercise of an option, or a predicted corporate action taking place (or not taking place). It's a lot harder to get your head around what "bet" we're making and what "edge" we have when we, say, buy an S&P 500 ETF instead of holding cash. Unless you really are omniscient or carry around a copy of *Grays Sports Almanac*, you're going to find estimating the range of potential outcomes for an investment or portfolio of investments pretty tricky. Not that it stops anyone from trying.

Since I don't want to assume that any of us is quite so good at algebra as to write the formula for all the future, at a minimum what I'm trying to do is get us to think about risk unanchored to the arbitrarily determined characteristics and traits of asset classes. In other words, I want to establish an outside bound on the amount of risk a person could theoretically take in a portfolio if his only goal was maximizing return. Doing that requires us to think in geometric space, which is just a fancy way of saying that we want to know how the realization of returns over time ends up differing from a more abstract return assumption. It's easy enough to get a feel for this yourself by opening Excel and calculating what the return would be if your portfolio went up 5% in one year and down 5% in the next (works for any such pair of numbers). Your simple average will always be zero, but your geometric mean will always be less than zero, by an increasing amount as the volatility increases.

So, if we knew exactly what stocks, bond and commodities would do between 1961 and 2016, what portfolio would we have bought? The blend of assets if we went *Full Kelly* would have looked like this:



Source: Salient 2017. For illustrative purposes only.

Only there's a catch. Yes, we would have bought this portfolio, but we would have bought it *more than six times*. With perfect information about odds and payoffs, the optimal bet would have been to buy a portfolio with **634%** (!) exposure, consisting of \$2.00 in stocks, \$3.21 in bonds and \$1.13 in commodities for every dollar in capital we had. After all was said and done, if we looked back on the annualized volatility of this portfolio over those 50 years, what would we have found? What was the answer to life, the universe and everything?

44. Sorry, Deep Thought, you were off by two.

Perhaps the only characteristic of this portfolio more prominent than its rather remarkable level of exposure and leverage, is its hale and hearty annualized volatility of **44.1%**. This result means if all you cared about was having the most money over a 50+ year period that ended last year, you would have bought a portfolio of stocks, bonds and commodities that had annualized volatility of **44.1%**, roughly three times the long-term average for most equity markets,<sup>1</sup> and probably five times that of the typical HNW investor's portfolio.

And before you go running off to tell my lovely, charming, well-dressed and distressingly unsusceptible-to-flattery compliance officer that I told you to buy a 44% volatility super-portfolio,

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<sup>1</sup> Back in 1989, [Grauer and Hakansson](#) undertook a somewhat similar analysis on a finite, pre-determined set of weightings among different assets with directionally similar results. Over most windows the optimal backward-looking levered portfolio tends to come out with a mid-30s level of annualized volatility.

allow me to acknowledge that this requires some... uh... qualification. Most of these qualifications are pretty self-explanatory, since the whole exercise isn't intended to tell you what you should buy going forward, or even the right amount of risk for you. This portfolio, this leverage and that level of risk worked over the last 50 years. Would they be optimal over the next 50?

*Of course not.* In real life, we're not omniscient. Whereas a skilled card counter can estimate his mathematical edge fairly readily, it's a lot harder for those of us in markets who are deciding what our asset allocation ought to look like. Largely for this reason, even Thorp himself advised betting "half-Kelly" or less, whether at the blackjack table or in the market. When asked why, Thorp told Jack Schwager in *Hedge Fund Market Wizards*, "We are not able to calculate exact probabilities... there are things that are going on that are not part of one's knowledge at the time that affect the probabilities. So you need to scale back to a certain extent."

Said another way, going Full Kelly on a presumption of precise certainty about outcomes in markets is a surefire way to over-bet, potentially leading to a complete loss of capital. Now, scaling back is easy if we are starting from an explicit calculation of our edge as in a game of blackjack. It's not as easy to think about scaling down to, say, a Half Kelly portfolio. There is, however, another fascinating (but intuitive) feature of the Kelly Optimal Portfolio that allows us to scale back this portfolio in a way that may be more familiar: the Kelly Optimal Portfolio can be generalized as the highest return case of a set of portfolios generating geometric returns that are most efficient relative to the risk they take.<sup>2</sup>

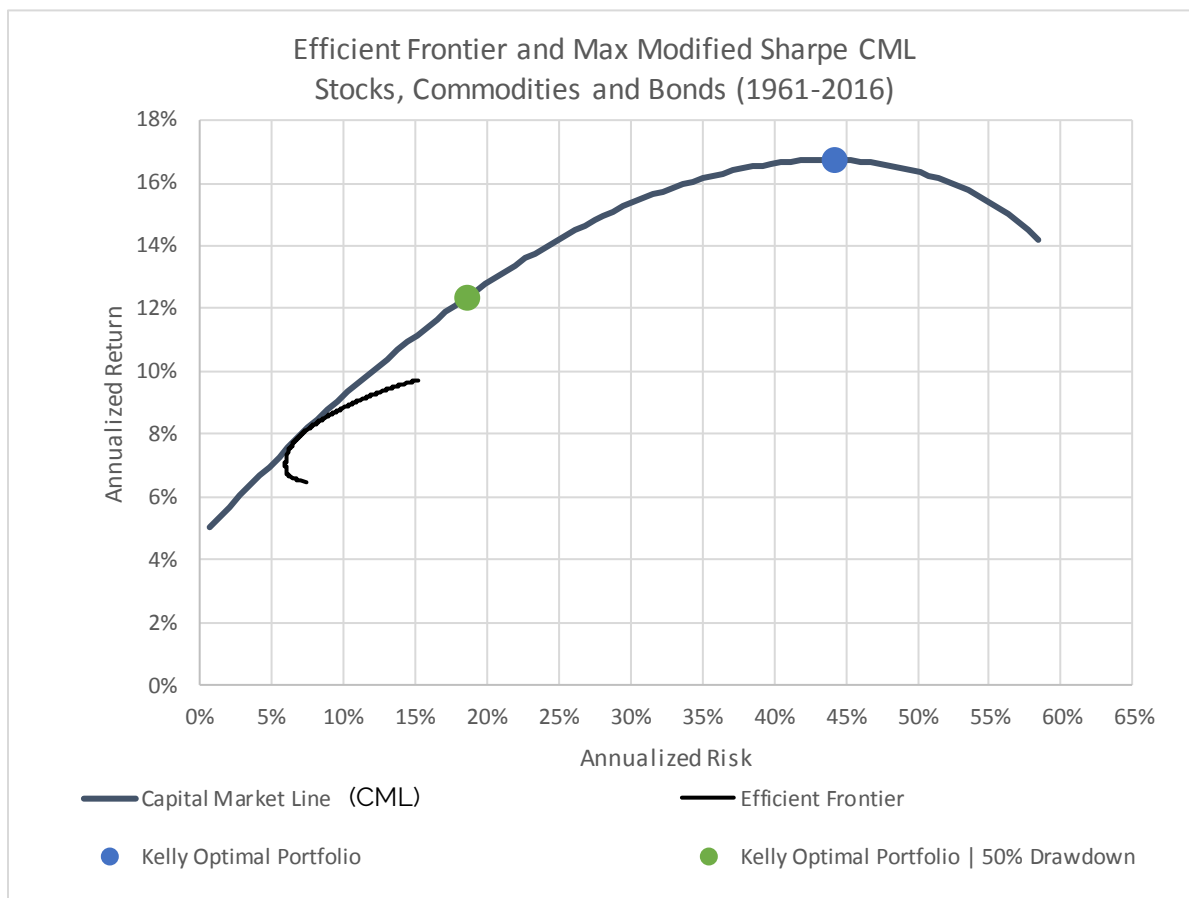
This may sound familiar. In a way, it's very much like a presentation of Markowitz's efficient frontier. Markowitz plots the portfolios that generate the most return for a given unit of risk, but his is a single-period calculation. It isn't a *geometric* approach like Kelly, but rather reflects a return expectation that doesn't incorporate how volatility and non-linearities impact the path and the resulting compound return. There have been a variety of academic pieces over the years covering the application of geometric returns to this framework, but most have focused on either identifying a single optimal geometric portfolio or on utility. [Bernstein and Wilkinson](#) went a bit further, developing a geometric efficient frontier.

All of these analyses are instructive and useful to the investor who wants to take path into account, but because the efficient frontier is heavily constrained by the assumed constraint on leverage, it's not as useful for us. What we want is to take the most efficient portfolio in *geometric terms*, and take up or down the risk of that portfolio to reflect our tolerance for capital loss. In other words, we want a geometric capital market line. The intuitive outcome of doing this is that we can plot the highest point on this line as the Full Kelly portfolio. The second, and perhaps more satisfying outcome, is that we can retrospectively identify that scaling back from Full Kelly just looks like delevering on this geometric capital market line.

The below figure plots each of these items, including a Half Kelly portfolio that defines ruin as any scenario in the path in which losses exceed 50%, rather than full bankruptcy. The Half Kelly portfolio delivers the highest total return over this period without ever experiencing a drawdown of 50%.

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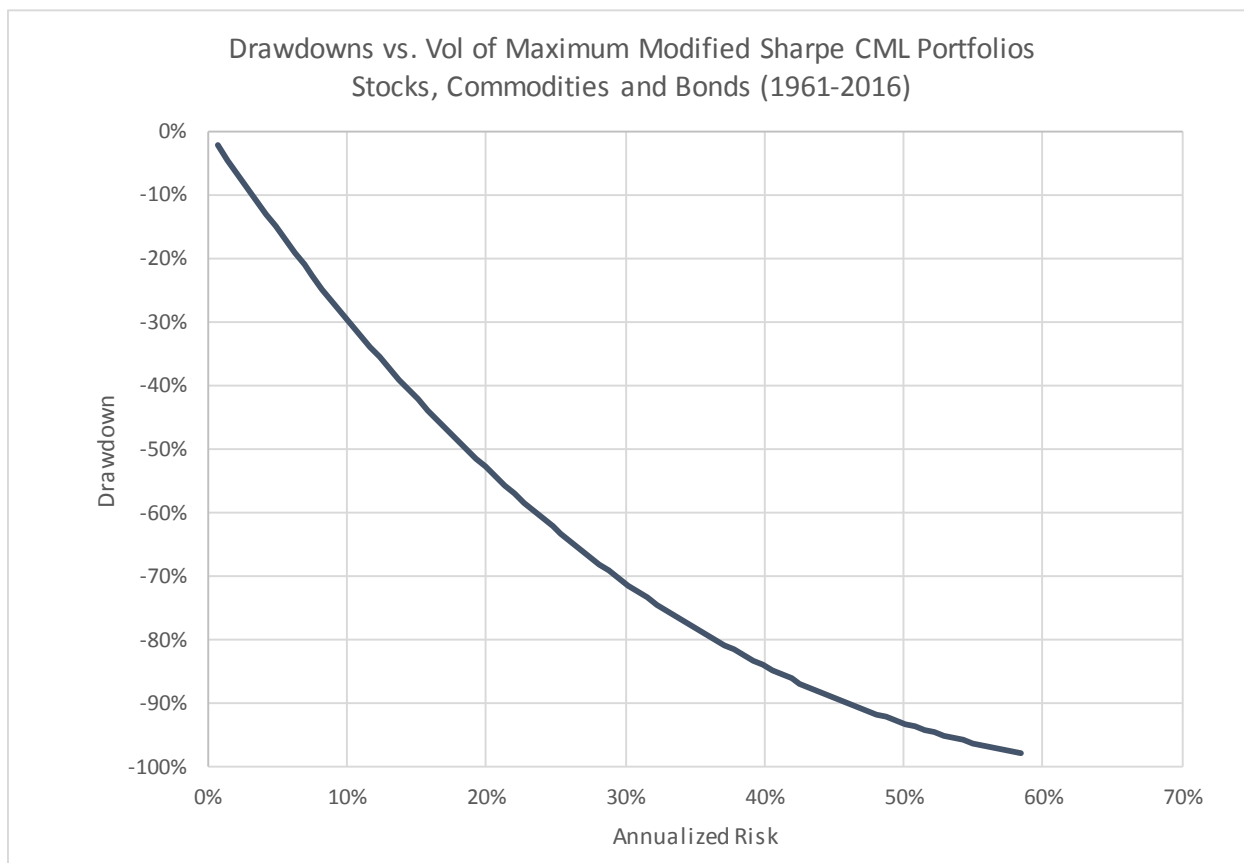
<sup>2</sup> For this and the other exhibits and simulations presented here, I'm very grateful to my brilliant colleague and our head of quantitative strategies at Salient, Dr. Roberto Croce.



Source: Salient, as of December 31, 2016. For illustrative purposes only.

When we de-lever from the Full Kelly to Half Kelly portfolio, we drop from a terrifying 44% annualized volatility number (which experiences an 80% drawdown at one point) to 18.5%, closer to — but still materially higher — in risk than most aggressive portfolios available from financial advisors or institutional investors.

This can be thought of in drawdown space as well for investors or advisors who have difficulty thinking in more arcane volatility terms. The below exhibit maps annualized volatility to maximum loss of capital over the analysis period. As mentioned, the 50% maximum drawdown portfolio historically looks like about 18.5% in volatility units.



Source: Salient, as of December 31, 2016. For illustrative purposes only.

For many investors, their true risk tolerance and investment horizon makes this whole discussion irrelevant. Traditional methods of thinking about risk and return are probably serving more conservative investors quite well. And there are some realities that anyone thinking about taking more risk needs to come to terms with, a lot of which I'm going to talk about in a moment — there's a reason we wanted to talk about this in geometric terms, and it's all about risk. But for those with a 30, 40 or 50-year horizon, for the permanent institutions with limited cash flow needs, it's reasonable to ask the question: is the amount of risk in the S&P 500 Index or in a blend of that with the Bloomberg Barclays Aggregate Bond Index the right amount of risk to take? Or can we be taking more? Should we be taking more?

Did you think that was rhetorical? Nope.

**Many investors can – and if they are acting as fiduciaries probably ought to – take more risk.**

### If every hedge fund manager jumped off a bridge...

This may not be a message you hear every day, but I'm not telling you anything novel. Don't just *listen* to what your advisors, fund managers and institutional peers are telling you. They're as motivated and influenced by [career risk concerns](#) as the rest of us. Instead, look at what they're doing.

The next time you have a conversation with a sophisticated money manager you work with, ask them where they typically put their money. Yes, many of them will invest alongside you because that is



right and appropriate (and also expected of them). But many more, when they are being honest, will tell you that they have a personal account or an internal-only strategy operated for staff, that operates at a significantly higher level of risk than almost anything they offer to clients. Vehicles with 20%, 25% or even 30% volatility are not uncommon. Yes, some of this is hubris, but some of it is also the realization on the part of professional investors that maximizing portfolio returns — if that is indeed your objective — can only be done if we strip back the conventions that tell us that the natural amount of risk in an unlevered investment in broad asset classes is always the right amount of risk.

Same thing with the widely admired investors, entrepreneurs and business operators. The individual stocks that represent their wealth are risky in a way that dwarfs most of what we would be willing to tolerate in individual portfolios. We explain it away with the notion that they are very skilled, or that they have control over the outcomes of the company — which may be true in doses — but in reality, they are typically equally subject to many of the uncontrollable whims that drive broader macroeconomic and financial market outcomes.

Then observe your institutional peers who are [increasing their allocations to private equity and private real estate](#). They're not just increasing because hedge funds have had lower absolute returns in a strong equity environment, although that *is* one very stupid reason why this is happening. It's also happening because institutions are increasingly aware that they have limited alternatives to meet their target returns. While few will admit it explicitly, they use private equity because it's the easiest way to lever their portfolios in a way that won't look like leverage. In a true sense of uncertainty or portfolio level risk, when the risk of private portfolios is appropriately accounted for, I believe *many* pools of institutional capital are taking risk well beyond that of traditional equity benchmarks.

**Many of the investors we all respect the most are already taking more risk than they let on, but explain it away because it's not considered "right thinking."**

## To Whom Much is Given

When we make the decision to take more risk, however, our tools and frameworks for managing uncertainty must occupy more of the stage. This isn't only about our inability to build accurate forecasts, or even our inability to build *mostly* accurate stochastic frameworks based on return and volatility, like the Monte Carlo simulations many of us build for clients to simulate their growth in wealth over time. It's also because the kinds of portfolios that a Full Kelly framework will lead you to are usually *pretty risky*. Their risk constraint is avoiding complete bankruptcy, and that's not a very high bar. The things we have to do to capture such a high level of risk and return also usually disproportionately increase our exposure to big, unpredictable events. If you increase the risk of a portfolio by 20%, most of the ways you would do so will increase the exposure to these kinds of events by *a lot more than 20%*.

Taken together, all these things create that famous gap between our realized experience and what we expected going in. This is because most financial and economic models assume that the world is ergodic. **And it ain't.** I know that's a ten-dollar word, but it's important. My favorite explanation of ergodicity comes from Nassim Nicholas Taleb, who claims to have stolen it from mathematician Yakov Sinai, who in turns claims to have stolen it from Israel Gelfand:

*Suppose you want to buy a pair of shoes and you live in a house that has a shoe store. There are two different strategies: one is that you go to the store in your house every day to check out the shoes and eventually you find the best pair; another is to take your car and to spend a whole day searching for footwear all over town to find a place where they have the best shoes and you buy them immediately. The system is ergodic if the result of these two strategies is the same.*

There are infinite examples of investors making this mistake. My mind wanders to the fund manager who offers up the fashionable but not-very-practical "permanent loss of capital" definition of risk, a stupid definition that is the last refuge of the fund manager with lousy long-term performance. "Sure, it's down 65%, but that's a non-permanent impairment!" Invariably, the PM will grumble and call this a 7-standard deviation event because he assumed a world of ergodicity. Because of the impact of a loss like this on the path of our wealth, we'll now have to vastly exceed the average expected return we put in our scenario models in Excel just to break even on it.



"It's not a permanent impairment of capital!"

It *matters* what path our portfolios follow through time. It *matters* that our big gains and losses may come all at once. It *matters* to how we should bet and it *matters* to how we invest. You cannot stir things apart!

So if you've decided to take risk as an investor, how do we avoid this pitfall? Consider again the case of the entrepreneur.

The entrepreneur's portfolio is concentrated, which means that much of his risk has not been diversified away. A lot of that is going to be reflected in the risk and return measures we would use if we were to plot him on the efficient frontier. That doesn't necessarily mean his risk of ruin will appear high, and his analysis might, in fact, inform the entrepreneur that he ought to borrow and hold this business as his sole investment. He's done the work, performed business plan SWOT analyses, competitor analyses, etc., and concluded that he has a pretty good grasp of what his range of outcomes and risks look like.

In an ergodic world, this makes us feel all warm and fuzzy, and we give ourselves due diligence gold stars for asking all the right questions. In a non-ergodic world, the guy **dies using his own product**. A competitor comes out of nowhere with a product that immediately **invalidates his business model**. A **bigger player** in a related industry decides they want to dominate his industry, too. And these are just

your usual tail events, not even caused the complexity of a system we can't understand but by sheer happenstance. For the entrepreneur, all sorts of non-tail events over time may materially and permanently change any probabilistic assessment going forward. How do we address this?

**The first line of defense as we take more risk must be diversification.** After all, there is a reason why the Kelly Portfolios distribute the risk fairly evenly across the constituent asset classes.<sup>3</sup>

Even that isn't enough. Consider also the case of the leveraged investor in multiple investments with some measure of diversification, for example a risk parity investor, Berkshire Hathaway,<sup>4</sup> or the guy who went Full Kelly per our earlier example, but without the whole perfect information thing. This investor has taken the opposite approach, which is to diversify heavily across different asset classes and/or company investments. His return expectation is driven not so much by his ability to create an outcome but by the exploitation of diversification. As he increases his leverage, his sensitivity to the correctness of his point-in-time probabilistic estimates of risk, return and correlations between his holdings will increase as well. In an ergodic world, this is fine and dandy. In a non-ergodic world, while he has largely mitigated the risk of idiosyncratic tails, he is relying on relationships which are based on a complex system and human behaviors that can change rapidly.

**Thus, the second line of defense as we take more risk must be adaptive investing.** Sometimes the only answer to a complex system is not to play the game, or at least to play less of it. Frameworks which adapt to changing relationships between markets and changing levels of risk are critical. But even they can only do so much.

**Liquidity, leverage and concentration limits are your rearguard.** These three things are also the only three ways you'll be able to take more risk than asset classes give you. They are also the three horsemen of the apocalypse. They must be monitored and tightly managed if you want to have an investment program that takes more risk.

It's not my intent to end on a fearful note, because that isn't the point *at all*. More than asset class selection, more than diversification, more than fees, more than any source of alpha you believe in, nothing will matter to your portfolio and the returns it generates more than risk. And the more you take, the more it must occupy your attention. That doesn't mean that we as investors ought to cover in fear.

On the contrary, my friends, fortune favors the bold.

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<sup>3</sup> And that reason isn't just "we're at the end of a 30-year bond rally," if you're thinking about being *that guy*.

<sup>4</sup> One suspects Mr. Buffett would be less than thrilled by the company we're assigning him, but to misquote Milton Friedman, we are all levered derivatives users now.

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