

Foreword by Nassim Nicholas Taleb

SAFE HAVEN



Investing for
Financial Storms

Mark Spitznagel

WILEY

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INVESTING FOR FINANCIAL
STORMS

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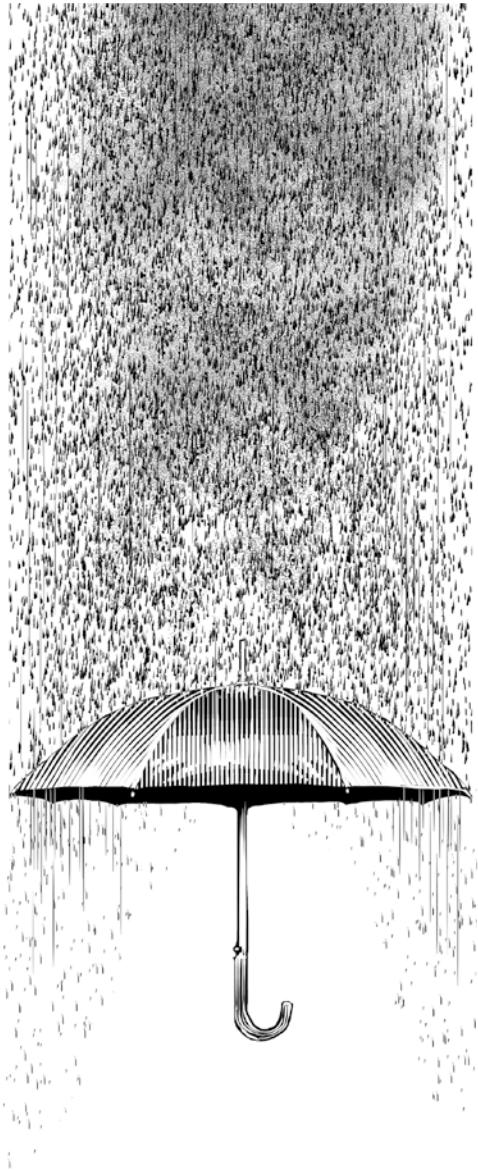
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*I was burned out from exhaustion, buried in the hail
Poisoned in the bushes an' blown out on the trail
Hunted like a crocodile, ravaged in the corn
“Come in,” she said, “I’ll give ya shelter from the storm”*

Bob Dylan

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Foreword

Nassim Nicholas Taleb

SANTA MARINA

In my ancestral village in the Northern Levant, on top of a hill, stands a church dedicated to Santa Marina. Marina is a local saint, though, characteristically, some other traditions claim her—such as Bithynia or other Anatolian provinces of the Eastern Roman Empire.

Marina grew up in a wealthy family, in the fifth century of our era. After the death of her mother, her father decided to turn his back on civil existence and embrace a life of monasticism. His aim was to spend the rest of his life in a cell carved in the rocks, in the Connubium (Qannubin) valley, at the base of Mount Lebanon, about eight miles from my village. Marina insisted on joining him and faked being a boy, Marinos.

About a decade later, after the death of her father, a visiting Roman soldier impregnated the daughter of a local innkeeper and instructed her to accuse the defenseless father Marinos of having committed the deed. The innkeeper's daughter and her family complied, fearing retaliation by the Roman soldiers.

Marina took the blame—yet she did not need a tough litigator to prove her innocence. She refrained from revealing her biological gender, to remain true to her monkhood identity

and what she perceived to be the holiness of her mission. So Marina was forced to raise the child, and to make penitence for an act she never committed, she lived for a decade the life of a beggar outside the walls of the monastery.

Marina faced daily contempt from her peers and the local community. Yet she stood firm, never giving into the temptation to reveal the truth.

After she died prematurely, her gender was revealed during the purification rituals. The iniquity of the accusers was exposed posthumously, and she was venerated into Greek Orthodox sainthood.

The story of Hagia Marina shows us another variety of heroism. It is one thing to commit spontaneous grandiose acts of courage, risk one's life for the sake of a grand cause, become a hero in battle, drink the hemlock for the sake of the philosophical death, become a martyr by standing tall while being maimed by lions in the Roman Coliseum. But it is much, much harder to persevere with no promise of vindication, while living the daily grind of humiliation by one's peers. Acute pain goes away; dull pain is vastly harder to bear, and vastly more heroic.

SPITZ

I have known Mark Spitznagel for long enough (more than two decades) to remember that he was once, briefly, a vegetarian, perhaps after reading Herman Hesse's *Siddhartha* in which the protagonist claims: "I can think, I can wait, I can fast." My suggestion to follow the Greek Orthodox fast, where one is vegan two-thirds of the year (and aggressively carnivore on the other third, mostly Sundays and holidays), failed to convince. It seemed too much of a compromise.

He finds ways to furtively inflict his musical tastes on his coworkers (Mahler, mainly, with performances by von Karajan)

and in the early days, as in a ritual, the conversations used to start and end with Karl Popper and central (Black Swan) asymmetries in the scientific method. There is this insistence that we are not in the business of trading, but partaking of an intellectual enterprise, that is, both applying proper inference and probability theory to the business world and, without any modesty, improving these fields according to feedback from markets. And there is all this German terminology, such as *Gedankenexperiment*. I suspect that there was a nonrandom geography of origin for the authors and topics that have invade the office: prewar Vienna and its *Weltanschauung*.

Spitz has always been hardheaded; perhaps a good excuse is that it came with a remarkable clarity of mind. I must reveal that while I am far more diplomatic and less obstinate in person than I am in print, he is the exact reverse, though he hides it remarkably well to outsiders, say journalists and other suckers. He even managed to fool the author Malcolm Gladwell, who covered us in the *New Yorker*, into thinking that he would be one breaking up a fight at a bar while I would be one to initiate it.

The atmosphere of the office has been playfully unique. Visitors are usually confused by the sprawl of mathematical equations on the board, thinking our main edge is only mathematical. No. Both Mark and I were pit traders before doing quantitative stuff. While our work has been based on detecting mathematical flaws in existing finance models, our edge has been linked to having been in the pit and understanding the centrality of calibration, fine-tuning, execution, orderflow, and transaction costs.

Remarkably, people who have skin in the game, that is, self-made successful people with their own money at risk (say a retired textile importer or a former shopping center developer), get it right away. On the other hand the neither-this-nor-that MBA in finance with year-end evaluation filed by the personnel department needs a helping hand—they can neither connect to

the intuitions nor to the mathematics. At the time when I met Mark, we both were at the intersection of pit trading and novel branches of probability theory (such as Extreme Value Theory), an intersection that at the time (and still, presently) included no more than two persons.

MUTUA MULI

Now what was the dominant idea to emerge?

There are activities with remove payoff and no feedback that are ignored by the common crowd.

With the associated corollary:

Never underestimate the effect of absence of feedback on the unconscious behavior and choices of people.

Mark kept using the example of someone playing piano for a long time with no improvement (that is, hardly capable of performing Chopsticks) yet persevering; then, suddenly, one day, impeccably playing Chopin or Rachmaninoff.

No, it is not related to modern psychology. Psychologists discuss the notion of *deferred payoff* and the inability to delay one's gratification as a hindrance. They hold that people who prefer a dollar now versus two in the future will eventually fare poorly in the course of life. But this is not at all what Spitz's idea is about, since you do not know whether there might be a payoff at the end of the line, and, furthermore, psychologists are shoddy scientists, wrong almost all the time about almost all the things they discuss. The idea that delayed gratification confers some socioeconomic advantage to those who defer was eventually debunked. The real world is a bit different. Under uncertainty, you must consider taking what you can now, since the person offering you two dollars in one year versus one today might be bankrupt then (or serving a jail sentence).

So what this idea is about isn't delayed gratification, but the ability to operate *without* external gratification—or rather,

with random gratification. Have the fortitude to live without promises.

Hence the second corollary:

Things that are good but don't look good must have some edge.

The latter point allows she or he who is perseverant and mentally equipped to do the right thing with an endless reservoir of suckers.

Never underestimate people's need to look good in the eyes of others. Scientists and artists, in order to cope with the absence of gratification, had to create such a thing as prizes and prestige journals. These are designed to satisfy the needs of the nonheroics to look good on the occasion. It does not matter if your idea is eventually proved right; there are intermediary steps in between that can be won. So "research" will be eventually gamed into some brand of nonresearch that looks cosmetically like research. You publish in a "prestige" journal and you are done, even if the full idea never materializes in the future. The game creates citation rings and clubs in fields like academic finance and economics (with no tangible feedback) where one can BS endlessly and collect accolades by peers.

For instance, the theory of portfolio construction (or the associated "risk parity") à la Markowitz requires correlations between assets to be both known and nonrandom. You remove these assumptions and you have no case for portfolio construction (not counting other, vastly more severe flaws, such as ergodicity, discussed in this book). Yet one must have no knowledge of the existence of computer screens and no access to data to avoid noticing that correlations are, if anything, not fixed, changing randomly. People's only excuse for using these models is that other people are using these models.

And you end up with individuals who know practically nothing, but with huge résumés (a few have Nobel Prizes). These citation rings or circular support groups were called *mutua muli* by the ancients: the association of mutually respecting mules.

COST-EFFECTIVE RISK MITIGATION

Most financial and business returns come from rare events—what happens in ordinary times is hardly relevant for the total. Financial models have done just the opposite. A fund miscalled Long Term Capital Management that blew up in 1998 was representative of such decorated *mutua mali* misunderstanding. The Nobel-decorated academics proved in a single month the fake-ness of their models. Practically everyone in the 1980s, particularly after the crash of 1987, must have known it was quackery. However, most if not all financial analysts exhibit the clarity of mind of a New York sewer after a long weekend, which explains how the *mutua mali* can take hold of an entire industry.

Indeed the investment world is populated by analysts who, while using patently wrong mathematics, managed to look good and cosmetically sophisticated but eventually harm their clients in the long run. Why? Because, simply, it is OPM (other people's money) they are risking while the returns are theirs—again, absence of *skin in the game*.

Steady returns (continuous ratification) comes along with hiding tail risks. Banks lost more money in two episodes, 1982 and 2008, than they made in the history of banking—but managers are still rich. They claimed that the standard models were showing low risk when they were sitting on barrels of dynamite—so we needed to destroy these models as tools of deception.

This risk transfer is visible in all business activities: corporations end up obeying the financial analyst dictum to avoid tail insurance: in their eyes, a company that can withstand storms can be inferior to one that is fragile to the next slight downturn or rise in interest rates, if the latter's earning per share exceed the former's by a fraction of a penny!

So the tools of modern finance helped create a “rent-seeking” class of people whose interest diverged from those of their clients—and ones who get eventually bailed out by taxpayers.

While the financial rent seekers were clearly the enemies of society, we found actually worse enemies: the imitators.

For, at Universa, Spitz built a structure that tail-hedged portfolios, hence insulated him from the need for delayed random gratification. As introduced (and *formulated*) in *Safe Haven*, risk mitigation needs to be “cost-effective” (i.e., it should raise your wealth), and to do that it needs to mitigate the risks that matter, not the risks that don’t.

It was the birth of *tail risk hedging* as an investable asset class. Tail risk hedging removed the effect of the nasty Black Swan on portfolios; cost-effective tail risk hedging obliterated all the other forms of risk mitigation. Accordingly, the idea grew on people and a new category was born. This led to a legion of imitators—those very same *mutua muli* persons who had previously been fooled by modern finance tools, finding a new thing to sell.

Universa proved the following: not only is there no substitute to tail risk hedging, but, when it comes to tail risk hedging, simply—as per the boast in the Porsche advertisement—there is *no* substitute.

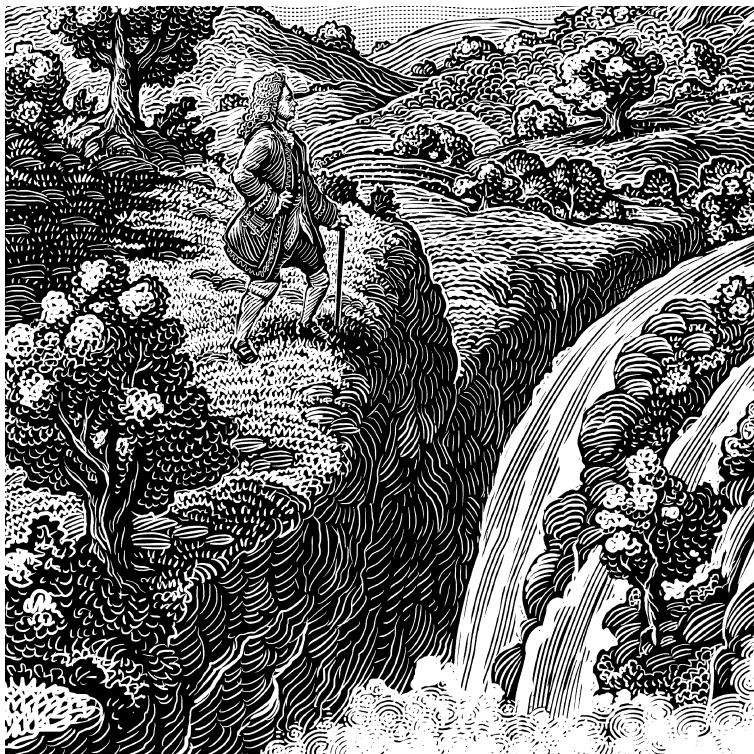
For when you go from a principle to execution, things are much more complicated: the output is simple to the outsider, the process is hard seen from the inside. Indeed, it takes years of study and practice, not counting natural edges and understanding of the payoffs and probabilistic mechanisms.

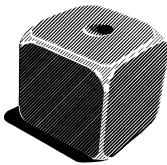
I said earlier that Mark’s edge came from pit trading and a natural (noncontrived) understanding of the mathematics of tails. Not quite. His edge has been largely behavioral, and my description of hardheaded was an understatement. Perhaps the most undervalued attribute for humans is dogged, obsessive, boring discipline: in more than two decades, I never saw him once deviate a micro-inch from a given protocol.

This is his monumental *f*** you* to the investment industry.

Part One

What Comes First





At War with Luck

WRITTEN IN BLOOD

In the words of the nineteenth-century German philosopher Friedrich Nietzsche, thus spoken by his ancient Persian prophet Zarathustra, “Of all that is written, I love only what a person hath written with his blood.”

If so, Nietzsche would have loved this book.

It was written with the blood of war against luck, fought over the last more than a quarter century in my life as a trader. It grew organically out of an investing and risk-mitigation practice as a hedge fund manager and professional *safe haven investor*. The message of this book has been and will always be lived by me and my hedge fund firm, Universa Investments. (It is our manifesto.)

Talk is cheap. Ideas and commentary are just that. Significance only comes from the doing, from action within the arena. It is not my business, like Sherlock Holmes, “to know what other people do not know.” It is my business to *do* what other people do not and cannot *do* (as well as, just as importantly, to know what *I* do not know). Doing and demonstrating effective

safe haven investing is far, far more important than arguing about what it should be. And even among most of those who claim to do it, they neglect those pithy words from Hemingway to “never confuse movement with action.”

This book tells of the foundation and methodology behind how, as of this writing, Universa risk-mitigated portfolios have, over their decade-plus life to date, outperformed the S&P 500 by over 3% on an annualized, net basis. More to the point, this performance is a *direct consequence* of having *far less risk*. This level of outperformance is rare in the hedge fund industry and among risk-mitigation strategies in general, which have pretty much all underperformed the S&P 500 during this and most periods. The markets have been good to us because we haven’t tried to cheat them; we haven’t tried to predict or outsmart them. We have only aligned our investing, in a focused way, with our beliefs about the way they work.

People think of risk mitigation as a liability, as a trade-off against wealth creation, because it usually is. Universa is, if nothing else, a real-life case study and out-of-sample test that unequivocally proves the point that risk mitigation doesn’t have to be viewed that way. Risk mitigation can and should be thought of as being additive to portfolios over time—with the right risk mitigation, that is.

This is the mark that I want Universa to make in the markets.

Writing this book has been a labor of love, though it has had a difficult time competing for my attention, which is consumed by Universa. But the book has provided very important opportunities for introspection. It has also made me think more deeply about questions that I am always asked by people about what small “lay” investors can do to protect their portfolios.

As this book is, in part, a response to those questions, I do want to ensure that expectations are set appropriately at the start. This is not a “how-to” book, but it is a “why-to” as well as a “why-not-to” book. Let’s be clear: What I do specifically as a safe haven investor is not to be attempted by nonprofessionals

(nor—perhaps even especially—by most professionals). Nothing that I could tell you in a book will change that.

So, I will not be holding your hand and teaching you how to do it; I will not be revealing much in the way of trade secrets, and I have no interest in selling you anything as an investment manager. This book is not about the workings of a specific safe haven strategy, *per se*; nor is it an encyclopedic survey of all the major safe haven investments. Moreover, it has little if any current market commentary—as this would be entirely unnecessary to the book’s point.

That said, there are big investing problems to be solved, and I do explicitly employ at Universa their conclusive solution that will be found over the course of this book. Surely, that’s a good thing. After all, if it’s such a great solution, wouldn’t it be a big red flag if I didn’t put it into practice?

My intention in this book is to present the basic concepts underlying my approach in a straightforward manner. One-eighth of the iceberg is above water, and that’s all we need. (While I am forced into the mathematical weeds at times, believe me, I tried my best to stay out of them.) I offer a logical and practical analytical framework to demystify safe havens, for viewing and thinking about their value in mitigating systematic risk, and what that even means in the first place. That is to say, I offer a framework for rigorously testing hypotheses about safe havens and their very existence.

If the only things readers get out of this book are a more realistic and rational premise of safe haven investing and a foundation from which to assess and tackle it—and thus avoid its traps—then the book will have achieved its purpose. It should help the reader and pay back their expense of buying this book manyfold. You will make money investing and you will lose money investing, but, when you look back at it all, what really will have mattered is getting that foundation right.

Investing is a deceptive, uneven playing field for many reasons, and I aim to help level it out a little. (To show you the

honor of my intentions, I pledge all of my proceeds from the sales of this book to charity.)

PROBING BETS

This book is the result of a discovery process and problem-solving effort that began many years ago. I grew up a scrappy, poor kid in the Chicago commodities trading pits, back when they were the center of the financial universe. As a mere teenager, I learned from my mentor, Everett Klipp (“the Babe Ruth of the Chicago Board of Trade”), who told me over and over that “a small loss is a good loss,” and that risk mitigation and survival are everything in trading and investing. His words still ring true today: Take care of the losses; the profits will then take care of themselves. Profits matter only relative to the losses; stay in the game by protecting your capital base, your means of playing the game. Don’t predict.

Pretty obvious stuff, except people don’t really focus on losses, especially the potential for big ones. In all my experience, most investors don’t think about the impact of the downside the way they need to; they just don’t.

For me, it began with hands-on, trial-and-error experiments in my twenties as a “local” (or independent) trader in the bond pit in Chicago. (I earned much of my stake in college by writing and then selling the first portfolio management handheld computer program on the trading floor.) It continued in my thirties as a bank proprietary and hedge fund derivatives trader in New York, and even a bit in the hallowed halls of New York University’s Courant Institute of Mathematical Sciences. I hashed it out in endless discussion-walks through the streets of Manhattan with Nassim Nicholas Taleb, in the days when we started the very first formal tail hedging program, and he would later become Scientific Advisor at Universa. These ideas were the point of every conversation during countless,

reckless longboard skateboard cruises up and down the treacherous hills and dales of Central Park with Brandon Yarckin as we plotted the launch of Universa, where he would become COO. (I still blame Brandon for my separated shoulder.)

And it goes without saying that I have not made these observations from scratch. I owe an enormous gratitude to the explorers who plumb the depths (“the triad”).

These were the formative years of probing bets, of bold conjectures and refutations, and finding answers to how things worked through success and failure—of a bloody war against luck. The conclusion was my decision to start Universa in 2007, where we have taken our discoveries and solutions and transformed them into a formal, rational, and practical investment approach that solves the big problems and *moves the needle* for my investment partners.

By opening this book and, I would hope, opening your mind to the ideas it contains, you will have the opportunity to change your perceptions about investing and risk mitigation. These pages will present a fundamentally different, unconventional perspective that I firmly believe is the most effective one for successful investing. It opposes so much of what is hailed as gospel within the collective that is the investment profession. So, we need to think objectively about the orthodoxy and dead-end dogma of modern finance. We need to be the uncarved block.

To be sure, I have no interest in changing the existing investing paradigm by making it obsolete. I’m no pied piper, and I harbor no delusions of grandeur that the message of this book will ever become “the new gospel according to Mark.” I do not expect for one moment that my approach will ever become another cookie-cutter, rubber-stamped strategy of the investment consultant herd. And that’s important. Becoming conventional is self-defeating in this business. It’s the kiss of death. We take the road less traveled by, and that has made all the difference.

I have often exclaimed to my team at Universa, plundering the words of Steve Jobs, “We are pirates! Not the Navy!” (Mine are the smartest, savviest, and most experienced Great Pirates in the derivatives world.)

WHAT'S A SAFE HAVEN?

Everyone has some intuitive understanding about what a safe haven is and why we would invest in one. Most likely, it would go something like “a place of refuge for when things go bad” or, more specifically, “an asset that provides safety from risk.” These are spot on. The term *risk* would likely mean scary things like stock market crashes, financial and banking crises, pandemics, monsters hiding under the bed, and so forth. Risk, then, is circularly defined as that equivocal thing we need safety from.

Plain and simple, risk is exposure to bad contingencies. Most of these bad contingencies will likely *never* happen, but they *can* happen. In investing, the bad contingencies have financial consequences of economic loss within a portfolio. Investment risk isn't just some theoretical and spurious numerical value, like *volatility* or *correlation* or whatever. It is the potential for loss, and the scope of that loss. Nothing else.

We have many diverging roads ahead, many potential paths forward with so many twists and turns, more than we can ever count. Some of those potential paths will be very pleasant, and some of those potential paths won't be. Of all the potential paths, we don't know which is the one and only path that we will actually traverse. Now, that's risk!

A safe haven is an investment that mitigates risk, or the bad potential economic contingencies in your investment portfolio. That is a necessary condition for safe haven status. It protects against consequential loss that happens to everyone, everywhere, all at the same time, because that loss is tied to the cycles of broad macroeconomic growth and contraction. Because of

its ubiquitous and systematic nature, you can't just diversify that risk away with groupings of things that supposedly won't experience such loss simultaneously.

And remember this: A safe haven isn't so much a thing or an asset. It is a *payoff*, one that can take many different forms. It might be a chunk of metal, a stock selection criterion, a cryptocurrency, or even a derivatives portfolio. **Whatever forms they may take, it is their function that makes safe havens what they are: They preserve and protect your capital. They are a shelter from financial storms.**

So *safe haven investing* is *risk mitigation*. To me, these two terms are synonymous, and I will be using them interchangeably throughout this book. (The former made for a catchier title.)

What's more, risk mitigation *is* investing *itself*. Treat this as a fundamental premise. Even the most renowned proponent of the bottom-up approach to investing, Benjamin Graham, the “father of value investing,” declared: “The essence of investment management is the management of risks, not the management of returns. Well-managed portfolios start with this precept.” Moreover, “Confronted with a challenge to distil the secret of sound investment into three words, we venture the motto, Margin of Safety.” Truer words have never been written on the subject. For Graham, “safety of principal” is what separates investing from speculating. *It makes investing—investing!* (He learned the hard way, in the 1929 stock market crash, that all great ideas can be dashed, simultaneously and systematically.)

But this is the pretty obvious part. It still misses what's so special about what a safe haven should be. Any punter can devise something that does well in a financial crash. Safe haven investing is so much more. And this is where they start to look really different from each other—so different that our classification that would put them all in the same category starts to lose its meaning. Often, they are more different than they are alike. We run into issues similar to what biologists encountered when trying to define what a species is. We will need a specific *safe haven*

concept—like their *species concept*—in order to classify them and evaluate if they are even what they claim to be. **This will be a major line of inquiry in this book: Are safe havens a classifiable thing? And can they really add economic value?**

THE GREAT DILEMMA

There is a monumental problem facing investors, *the great dilemma of risk*. If you take too much risk, it will likely cost you wealth over time. And at the same time, if you don't take enough risk, it will also likely cost you wealth over time. You are trapped in a “Catch-22”: damned if you do and damned if you don’t. Pick your poison. You can try calibrating between these two bad choices in hopes of finding a happy medium, but this still leaves you with a bad choice—it is still poison. Modern finance is really all about the quest for this theoretical happy medium, the supposed “Holy Grail of investing.” Despite this valiant quest and lofty name, the results have shown that this Holy Grail is a myth; the happy medium is not so happy, and it can even provide the *worst* of both worlds. And so, with this thinking, you are left with only one real choice: to make bold predictions and then roll the dice on them.

This great dilemma is the most important problem in all of investing; it is one that desperately needs solving. It is also the rationale for what I do as a hedge fund manager, and the reason for this book. Thanks to the sheer scale and scope of the problem, the stakes have never been higher. In particular, the broader problem is of liabilities exceeding assets, and this applies to mammoth pools of capital and even to individuals with small investment accounts. Just think of the massively underfunded public and private pension funds today, which must generate specific, high-target rates of return over many years or else face insolvency as their liabilities consume their capital. They can’t just hide away, idling in less risky assets in an impaired portfolio, or try to diversify away their risks; and yet investing in riskier

assets brings, by definition, acute risks of unrecoverable loss. The standard approach to risk mitigation has really failed them—just as it has failed everyone. And the problem is only going to get worse. It is a looming, ticking time bomb.

The consequences of failing to solve the great dilemma of risk won't just appear as some abstract figures in the newspaper. They are all too real: people's savings wiped out, governments that must tax or inflate their economies to death—human tragedy with real economic consequences. This is not my opinion. It is just simple math.

This monumental problem is further complicated today by the massive distortions built up in global financial markets from years of hubristic monetary interventions by global central banks, enabling the reckless accumulation of debt and leverage. Though these distortions are on an unprecedented scale and are intricately related to the underfunding problem itself, they are nonetheless beside the point. They are both beyond the scope of this book (I have already written plenty about them elsewhere) and, most importantly, completely unnecessary to the book's message. I don't need to convince you of any ideological, Cassandra-like premise that markets are risky so that you will accept my conclusions about safe havens. It will not matter to our methodology. We can and will remain agnostic, not roll the dice, and, most important, *not predict*.

To find a solution to this monumental problem, we need to reduce the costliness of risk—specifically the costliness of losses—and do so in a way that does not end up costing us even more. In other words, **we need a cure that is not worse than the disease. Risk mitigation must be cost-effective.**

In this book, we will learn how finding that solution comes from recognizing that not all risks are created equal—because not all losses are created equal. They don't all add up cleanly in an accounting ledger. Therefore, we need to think about losses and our investment returns differently, through a different lens and a different framing.

As in all things, “the good God is in the details.” And in our case, these details, while not terribly complicated, often appear counterintuitive and paradoxical. As we will see, there are *emergent* dynamics at play here that make cost-effective risk mitigation extremely challenging, perhaps more so than anything else in the realm of investing. We need to proceed cautiously.

The problem is that investing is approached by most professionals and academics (and even the reigning PhD quants of modern finance) in a highly *reductionist* way. But, as we will see throughout this book, in safe haven investing the whole is, indeed, not the same as the sum of its parts—and it is often much greater.

Cost-effective safe haven investing will turn out to be an awesome variation on the theme from my first book, *The Dao of Capital*. It’s an idea that has perhaps become my shibboleth: *roundabout* investing. That is, the indirect approach, seeming to go backwards in order to go forwards, as in Sun Tzu’s and von Clausewitz’s approaches to “lose the battle to win the war.” What will look like a bad idea for one roll of the dice strangely becomes the best idea over many.

But how is successful investing possible without predictions? It sounds too good to be true. That investing is about forecasting returns is a tenet of the industry. As such, most people think they need to look very far ahead in investing and risk mitigation—with a magic crystal ball; they think that they need to see around corners. Not only is that pretty much impossible, it is actually a misconception about investing. **Investing really needn’t be about making grandiose forecasts**, any more than it is in, say, sports or other games like poker or backgammon—though one could easily make that mistaken assumption from the outside looking in. It isn’t even necessarily about getting the probabilities right. You can get the probabilities right all day but still do very poorly. It’s really about *getting the payoffs right*. Playing good defense that leads to good offense. So there’s more room for error, more room for being

right, more room to get it right after getting it wrong. This is cost-effective risk mitigation. You look and feel like you can see around corners, even though, in actuality, you can't.

As an archer, you don't try to forecast or pinpoint exactly where your arrow will hit once it leaves your bow. That would be an unproductive way to approach it—leading to *target panic*. Once you shoot the arrow (and even *as* you shoot the arrow), it is out of your control and susceptible to endless perturbations. So, instead, as in Herrigel's *Zen in the Art of Archery*, you aim by deliberately *not* taking aim—you hone your process and structure (focusing “behind the line” rather than down range) with the intent to specifically tighten your shot grouping around your target. There is this ancient Stoic notion of a *dichotomy of control* that applies here to investing, as it does to archery: **We need to control what we can control in a way that gets us closer to our target (of higher wealth)—and certainly not further from it.**

This is cost-effective risk mitigation. You look and feel like you can see around corners and can always hit the bullseye, even though, in actuality, of course, you can't.

You see, a cost-effective safe haven doesn't just slash risk. It actually lets you simultaneously take more risk. If that twist gave you pause for a moment, then good. It should!

FIRST PRINCIPLES

We will start here at square one with a few basic foundational truths about investing. As the great fourth-century BCE Greek philosopher (and the world's first *real scientist*) Aristotle wrote, “The naturally proper direction of our road is from things better known and clearer to us,” from what he called “first principles” or “the first basis from which a thing is known.” They are what comes first, our *a priori* propositions or universal premises.

We start with these first principles and use them as conceptual building blocks to eventually form deductive,

testable hypotheses. While these first principles may sound obvious and sort of trivial at first, they are not. In fact, they are going to become really important as we explore some counter-intuitive things about a pretty technical subject. They will allow us to change and even exploit the commonly held, though false, heuristics at the core of modern finance. They will even afford us a certain existential authenticity, allowing us to make our investing consistent with what we believe—to “bet our beliefs” as they say, despite all the external pressures to conform.

Principle number one is that investing is a process that happens sequentially through time. Investing is not static. It does not occur in just one interval of time, nor in many intervals of time aggregated together as one. (Albert Einstein purportedly noted that “the only reason for time is so that everything doesn’t happen at once.”) Time is the medium through which life takes place, and so it is the medium through which investing takes place. We are stretched across time. Investing and risk are a multi-period problem; and returns are an iterative, multiplicative process. *They compound:* In each period, we generally invest what we are left with from the last period. Like the geometric growth of offspring across generations, *we parlay our capital.* This principle fundamentally determines the nature of investing and the way we need to think about and interpret returns.

But as obvious as it is, just try telling that to a hedge fund manager whose incentive fee is based on annual performance: *investing happens through time.* Or, deliver that message to the pension fund that is harshly judged on its ability to meet an annual benchmark over the short term rather than over a timeline consistent with its beneficiaries. And try telling that to the economics and behavioral finance communities who label behavior “irrational” when it doesn’t appear optimal within their single-period, timeless framework. Do so and you should expect funny looks. But they criticize what they can’t understand; they’re no Einsteins. As for us, we need to ask ourselves

every day: What is the meaning of time in investing? The answer, as you'll see, changes everything.

Principle number two is that there is only one explicit purpose or goal of investing, and that is to maximize our wealth over time. Period. This is exactly what we are trying to do with every additional, incremental decision that we make as investors. It is the target we shoot at. I'm not talking about the elusive *mathematical expectation* of wealth, nor our wealth relative to some arbitrary benchmark (though there are plenty of managers incentivized to care only about that). Rather, I'm talking about our *actual* realized ending wealth—meaning the outcome we're actually left with. (They are not the same.) This is equivalent to maximizing the rate that we grow or compound wealth over time—our compound annual growth rate, or CAGR. All investors are absolute return, compounding investors. I don't believe any thinking person, and certainly not any practitioner, should disagree with this principle. It is common sense.

And yet, some would still protest that the goal of investing should be to further humanity's progress, ease its burdens, do good to consumers and the world—and the profits will follow. But this is only another way of restating our principle. The consumer is the sovereign king whom capital must serve in order to be profitable; it is because of this that capital investment and entrepreneurship have objectively done more good for the world than any government or charity ever could.

Others might still protest that the goal of investing should be to maximize our wealth, given a certain level of theoretical risk taken. (This is where things would start to get a little muddled were it not for our next principle.) Since we know that risk mitigation is investing, we can deduce that the explicit purpose of risk mitigation is the very same as the explicit purpose of investing: to maximize the rate at which we compound our wealth over time—in other words, to *cost-effectively lower risk*.

This leads to principle number three: If a risk-mitigation strategy achieves its purpose by cost-effectively

lowering a portfolio's risk, then adding that strategy raises the portfolio's CAGR over time.

It makes sense. If we mitigate risk effectively by constraining it deliberately, shouldn't the point be to experience less loss as a result, such that *over time* we end up making more? And if we don't end up making more, will we still be glad we did it? What would the point have been? Is there any other reason to mitigate risk?

Risk mitigation, when done well, should provide a tangible, positive economic effect relative to its cost. That is, it should be cost-effective, and thus a good value proposition. Accordingly, a risk-mitigation strategy should be evaluated based on its degree of cost-effectiveness at lowering risk—not just on its effectiveness at lowering risk.

Of course, we may have mitigated the risk of a remote, extreme loss that never happened. And yet, such a remote loss could happen suddenly at any time, and our risk mitigation could thus raise our CAGR (relative to our position had we not used that mitigation). This is the problem of induction, where the arrival of just one black swan falsifies any claim that all swans are white. But when I say that cost-effective risk mitigation raises a portfolio's CAGR over time, this also means over a sufficiently broad range of observable outcomes, which largely resolves these epistemological problems. (We will address this with what is known as a bootstrap in later chapters.)

Amusingly, this principle that risk mitigation, done well, should raise our CAGR over time is actually quite controversial. In fact, most practitioners and academics would probably call it a crackpot idea. Lower risk comes at a cost, they believe, so risk mitigation is incompatible with higher returns.

To wit, one of the historic commodities trading houses had the German motto: “*Besser gut schlafen, als gut essen.*” (“It is better to sleep well than to eat well.”) And academics claim that lower returns actually accompany lower risk or volatility *as a*

consequence, ipso facto. Their story goes, as you hedge and diversify away all of your correlated and uncorrelated risks, respectively, your returns will approach the lowly *risk-free rate*. Or going the other way, the academics argue that in order to induce an investor to hold an asset that is relatively volatile, its price drops until its expected return becomes high enough to justify the additional risk. In their world, it sounds reasonable, and it's a comfortable story, asserted but not proved: You've got to take more risk to make higher returns; sleeping well comes at a cost. No guts, no glory.

To make matters worse, academics furthered this idea by positing that investing and risk mitigation are about lowering or calibrating a portfolio's volatility relative to its average return—the *risk-adjusted return* or dreaded *Sharpe ratio*—unwittingly at the expense of the growth rate of wealth. They thus claim an intellectually dishonest victory based on their own theoretical scoreboard. It is a solution in search of a problem, and a bad idea. (It's even a big reason for our great dilemma.) I don't really believe that most investors even have this bad idea. Rather, to paraphrase Carl Jung, the idea has them.

We need to measure our success as investors by the practical scoreboard that counts, rather than the theoretical ones that don't. And there is just one scoreboard that counts, just one bullseye.

But we are often lured away from such practical objectives by gratuitous mathematical formulas. Modern quantitative finance suffers from a certain science or physics envy. After all, according to the American physicist Richard Feynman, “Physics is like sex: sure, it may give some practical results, but that’s not why we do it.”

Well, practical results are precisely why we do what we do in investing *and* risk mitigation: to maximize the growth rate of wealth by lowering risk. And the best practices of the scientific method can actually help us with this.

MODUS TOLLENS

Aristotle is generally considered to be the earliest and foremost developer of the idea of *deductive* reasoning, or *syllogismos*. Deduction is “top-down” logic, whereby general rules or premises are applied to particular cases or conclusions. This contrasts with induction, which is “bottom-up” logic and goes in the opposite direction, whereby particular cases or premises are applied to reach a general rule or conclusion. **Examining the geometry of a die to estimate the frequency that any side will come up over repeated rolls is deductive reasoning. Reasoning in the other direction, by repeatedly rolling a die and using those results to estimate the geometry of the die, is inductive reasoning.** (We will be rolling the dice in both directions in this book.)

A syllogism applies deductive reasoning to draw a valid conclusion from assumed premises. One example is the syllogism called *modus tollens* or “denying the consequent.” It is the main logical method to avoid mistakes of reason in science—what Feynman has described as “what we do to keep from lying to ourselves.” It is an ideal BS filter (so don’t be too surprised if you haven’t encountered it in the context of investing).

A *modus tollens* takes the form of “*If H, then O. Not O. Therefore, not H*” (with H for hypothesis and O for observable). There are two premises—an explanatory hypothesis, made up of an antecedent and consequent, paired with an observable; brought together, they yield a conclusion, which follows logically from the premises. The logic goes, if a statement is true, then so is its contrapositive.

Think of this example of *modus tollens* involving my dog Nana:

- *If Nana is good at catching groundhogs, then I won’t have a groundhog problem.*
- *I have a groundhog problem.*
- *Therefore, Nana isn’t good at catching groundhogs.*

We can see that a *modus tollens* serves the specific role of *falsifying* or eliminating a hypothesis. But neither it, nor anything else for that matter, can ever be used to *verify* a hypothesis as *true*. When we pair our proposed hypothesis with a minor premise that is an observable fact, we have a well-constructed test of that hypothesis. *Modus tollens*, then, is the logical principle of the empirical sciences, and the scientific method itself; it allows us to clarify our ideas and move them away from mere *metaphysics*. Scientific rigor demands that we be able to pose, experimentally test, and ultimately falsify theories or conjectures in this way. When, like sleuths, we disqualify false theories whenever we can, then step by step we approach the truth. It's all very Sherlock Holmesian: "When you have eliminated the impossible, whatever remains, however improbable, must be the truth."

Most significantly, the twentieth-century Austrian philosopher of science Karl Popper constructed his whole *falsification principle* around it—as the fundamental demarcation between science and pseudoscience. "Universal statements are never derivable from singular statements, but can be contradicted by singular statements," as Popper wrote in *The Logic of Scientific Discovery*. "Consequently, it is possible by means of purely deductive inferences (with the help of the *modus tollens* of classical logic) to argue from the truth of singular statements to the falsity of universal statements. Such an argument to the falsity of universal statements is the only strictly deductive kind of inference that proceeds, as it were, in the 'inductive direction'; that is, from singular to universal statements."

So far, we have been discussing cost-effective risk mitigation as if it were something worthy of our attention—something that *exists*. Even uttering the phrase presupposes it. (And this is why no one ever really utters the phrase "cost-effective" in the context of risk mitigation in investing. Have you noticed?) Taking such a conclusion for granted is begging the question.

It might even appear that we did this in our principle number three. However, the principle only claimed what risk

mitigation should be, not necessarily what it always is. Cost-effective risk mitigation could still be only theoretical, and not actually possible.

So, instead, we need to treat this principle as a conditional premise. It is an explanatory hypothesis, and this conveniently suggests our own *modus tollens* syllogism for safe havens, which we will be testing and investigating over and over:

- *If a strategy cost-effectively mitigates a portfolio's risk, then adding that strategy raises the portfolio's CAGR over time.*
- *Adding that strategy doesn't raise the portfolio's CAGR over time.*
- *Therefore, it does not cost-effectively mitigate the portfolio's risk.*

What we have here is a natural, testable conjecture about safe haven investing. And it's important to understand what this hypothesis testing can and cannot do. It can only refute or falsify the hypothesis. If a safe haven strategy does *not* raise a portfolio's CAGR over time, then the null hypothesis—that the strategy cost-effectively mitigates the portfolio's risk—does not hold. If it disagrees with experiment, it is wrong—it is not a cost-effective safe haven strategy. What we cannot do, however, is prove that something *is* a cost-effective safe haven strategy. Such is the scientific method.

To illustrate why you can't prove things in reverse, it's important to note that I could not have posed this syllogism instead, as the inverse of our premises: *If a strategy does not cost-effectively mitigate a portfolio's risk, then adding that strategy lowers the portfolio's CAGR over time.* That would be deductively invalid; it mistakes a sufficient condition for a necessary condition. **Observing that adding the strategy raises the portfolio's CAGR over time actually proves nothing about cost-effective risk mitigation. This is because there are other ways that the strategy could have raised the portfolio's**

CAGR; the strategy needn't have even mitigated risk at all, and it may have even added risk. We would need to delve deeper into the source of that outperformance. (As Hemingway said, “Being against evil doesn’t make you good.”)

This is equivalent to the fallacy of *affirming the consequent*: If “O is true,” can we then conclude that “H is true”? Thinking that we can is a mistake often committed even in the physical sciences: “If my theory is correct, then we will observe this data. We observe this data; therefore, my theory is correct.”

In my previous example with Nana, what if I *don't* have a groundhog problem? Can I proudly claim that my Nana is good at catching groundhogs? After all, there could be myriad other possible reasons that I *don't* have a groundhog problem. Maybe they were scared off by our resident fox. Or perhaps my son has been playing in our woods with his bow and arrow and ghillie suit.

We would similarly mistake sufficiency for necessity with the fallacy of *denying the antecedent*. In this case, we might conclude that I have a groundhog problem as a logical consequence of knowing that Nana is not good at hunting groundhogs.

All knowledge is a hypothesis; it is all conjectural and provisional, and it can only ever be falsified, never confirmed.

Now, a critical part of this scientific method is the way we go about choosing the very hypothesis that we are putting to the test. We specifically need to avoid *ad hoc* hypotheses that simply fit our observations. They are always there, ripe for the picking. We need logical explanations that are independent of and formed prior to those observations.

Scientific knowledge is not just to know that something is so; it is just as important to know why something is so.

The deductive thinking behind my hypothesis “Nana is good at catching groundhogs” was so important because it’s

going to hang around as sort of our working hypothesis until I manage to falsify it. Did I have a sound deductive reason to think that her skill, if it exists, would really result in the disappearance of groundhogs? Skilled or not, does she prefer to spend her summer days sleeping indoors? (As a Bernese Mountain Dog, she much prefers snow and air conditioning.) Does she more often chase or get chased by the groundhogs?

DEDUCTIVE DICE

We need a sound, deductive framework for understanding why and how risk mitigation can lead to higher compound growth rates. Is it even possible? How can we expect risk mitigation to be cost-effective? What's the mechanism behind it? And how might we recognize this ability if or when we see it?

There are so many forces swirling around in investing and markets; any attempts at explaining risk mitigation based on that swirling data will likely get us into trouble. So we will need to figure out, deductively, the mechanism that gives rise to our hypothesis. It won't be enough just to show that a strategy raises wealth and, *poof!*, it is cost-effective risk mitigation. We need to understand the forces at work to make that happen.

The best deductive tool at our disposal will be the same deductive tool used from prehistory right up to today to discover and comprehend the general science of probability and the formal idea of risk.

Archaeological excavations have uncovered collections of talus bones, or ankle bones of goats and sheep, dating back to 5,000 BCE. These four-sided bones were the oldest of all gambling devices. Our more familiar six-sided “bones” started showing up by 3,000 BCE. Visibly, dice have been embedded in civilization’s history as the generators of fate, then chance, and then even skill (in the early precursors of modern backgammon). They were ubiquitous throughout both the depth

and breadth of that history and are a part of our collective unconscious.

But it took ages, and the need to better understand wagers on games, for dice to become the intuitive pedagogical tools of deductive inference that would set in motion a theory of probability. As early as the fourth-century BCE, Aristotle casually pointed out that, while it is easy to make a couple of lucky rolls of a die, with 10,000 repeated trials, divine intervention be damned, the luck of the die evens out: “The probable is that which for the most part happens.” Imagine, this was revolutionary stuff! But the ancient Greeks and Romans never really got it—they never even bothered to make sure their dice faces were symmetric. If everything was fate anyway, what difference did it make? Julius Caesar’s famous line “the die has been cast” was not a statement about probability. (For all the wisdom that we ascribe to the ancients, if you had the ability to go back in time, you would totally clean up gambling against them.)

It wasn’t until much later, by the seventeenth century, that Galileo and then Blaise Pascal and Pierre de Fermat became gambling advisor-mMercenaries to various noblemen. For instance, the Chevalier de Méré needed advice on his costly observation that betting with even odds on the appearance of a 6 in four rolls of a single die was profitable in the long run, whereas betting with the same odds on a double-6 in 24 rolls of two dice was not. (In 1952, the famed New York City gambler “Fat the Butch” rediscovered this same deductive fact in his own rather costly hypothesis test.)

At that point, probability was all about deductive reasoning, starting with the known properties of the generator (a die) and then reasoning forward with expectations about its particular outcomes. Repeatability was implicitly a necessary condition to probabilistic inference. This was the *frequentist* perspective, where the very meaning of probability was the frequency of occurrences over many trials. It is the logic of the gambler with an edge, the logic of the casino. Probability was truly coming

of age as a neat trick to allow mathematicians to pick off degenerate gamblers. These were the original *quants*—money on the line has a way of sparking innovation. (Heck, it took having an options position for me to ever start really thinking about math.)

Of course, we have always understood risk and its mitigation in our bones; that's how we made it this far, after all. But along with advancements in our understanding of probability grew a gradual formalization and sophistication of risk mitigation. And we can think of the growth of that formality first and foremost as the growth of innovations in insurance—which itself would facilitate an explosion in risk taking and innovations. Insurance is an ancient idea, and a key part of the very progress of our civilization. It began as solidarity, as risks were shared—spreading throughout small villages, for instance, as commitments to mutually self-insure and share the replacement costs of homes within the community. **This aggregation of individual risks created a frequentist's perspective where there otherwise was none, effectively expanding an individual's sample size from 1 to the size of their community.**

Fast forward to the twentieth century, and an epic nerd skirmish would erupt over this perspective. The newly founded *Bayesians* and Popper's *propensity theory*—where *probability* instead meant “degrees of belief” or “tendencies,” respectively—went head-to-head with the simpleton frequentists. And it doesn't really matter who was right. All that matters is which perspective is being used. When your sample size is small, and worse yet unique and unrepeatable, no matter your subjective probabilities, there is so much noise in your sample you can hardly know anything anyway. Your N equals 1. You are a punter, hoping for good luck or good fate. But if your success or failure relies on many outcomes, over many rolls of the dice, then you naturally care about the properties over many rolls of the dice. Your N is large. You are the house exploiting the “house edge” through repetition, to quash the randomness.

And the house doesn't gamble. You are, as the poker theorist David Sklansky wrote, "at war with luck."

Most people would say (or at least their actions imply) that they are the house in their investing. And 93% of people also say that they are above average drivers. They aren't, in either case.

"At war with luck"—using our "skills to minimize luck as much as possible"—does indeed apply to risk mitigation. That is precisely how this war is fought in investing. In my case, it is no less than everything I do as an investor. So it is fitting that we begin to understand risk mitigation by deductively stripping it down to its bare bones, literally.

This is one of the most valuable things I have learned from Nassim Taleb, his valid warnings against the *ludic fallacy* notwithstanding (where "the narrow world of games and dice" have so little in common with the untamed risk of the real world): that playing around with and meditating on simplified Monte Carlo simulations, or "alternative histories," is the best way to figure things out.

After all, according to Popper, science is "the art of systematic over-simplification."

Beyond epistemological rigor, the biggest advantage I gain from building my safe haven hypothesis deductively and piecemeal using games of dice is *transparency*. You are going to see some things about safe haven investing that will seem to defy common sense. Couple that with the fact that there are frighteningly many ways that the investment industry regularly smokes people with complicated and unfalsifiable (and thus pseudoscientific) theories and cherry-picked market data, and you can see my concern about a healthy skepticism. "Trust, but verify": When something doesn't smell right, go back to the beginning, to our simple and transparent deductive dice illustrations. Roll your own and play along at home. There's no place to hide there.

As Feynman famously said:

In general, we look for a new law by the following process. First, we guess it. Then, we compute the consequences of the guess to see what, if this is right, it would imply. And then we compare the computation results directly with observations to see if it works. If it disagrees with experiment, it's wrong. In that simple statement is the key to science. It doesn't make any difference how beautiful your guess is, it doesn't make any difference how smart you are who made the guess, or what his name is—if it disagrees with experiment, it's wrong. That's all there is to it.

This will be my analytical framework for this book.

In Part One, we start with “what comes first” (the *a priori*), with an intuitive construction and examination of those fundamental safe haven mechanisms, with the help of our deductive dice. “First, we guess it.” Then in Part Two, with “what comes after” (the *a posteriori*), we start to formulate testable safe haven hypotheses based on those mechanisms—hypotheses about how we might expect them to work. We will conduct clinical trials or experiments on different idealized safe havens (what I call cartoons)—to “compute the consequences of the guess.” Then, we can compare those results “directly with observations to see if it works,” by running those same experiments on the diverse range of real-world safe havens themselves. Our aim is to try to falsify, in a meaningful and rigorous way, the hypothesis that safe havens as a group—and various safe havens in particular—can raise wealth by lowering risk. This is not a foregone conclusion; after all, it is considered a crackpot idea.

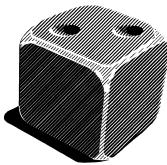
Through this methodology, you will hopefully understand what works in risk mitigation, what does not, and why. And this understanding will protect you more than any individual safe haven ever could. It will guide you toward our goal as investors.

If you think about it, cost-effective risk mitigation—or raising compound growth rates and thus wealth through lower risk—is really our comprehensive

goal as investors. It is the true essence of investment management. In and of itself, it is the specific meta-purpose or meaning we pursue when we deploy capital—what we hunt for relentlessly, our buried treasure.

Yes, there really is a buried treasure for investors, one that solves our monumental problem by showing that the great dilemma of risk—the ostensible tradeoff between higher returns and lower risk—is actually a false choice. But this treasure wasn’t so much hidden away by pirates of lore as it was cloaked behind the flawed apparatus of modern finance, shrouded behind its veil of rigor. As a result, it appears as a myth, an idealized and elusive goal. But that’s only because investors have been looking too narrowly and in the wrong places for it. We need a more holistic approach; we also need a treasure map to know where to dig.

But just because that buried treasure exists doesn’t mean we will ever find it. The greatest value—more than in the treasure itself—will be in what we gain from the hunt.



Nature's Admonition

THE SWISS FAMILY BERNOULLI

The city of Basel is perched at the northern corner of Switzerland along the Rhine where the river forms a crossroads with France and Germany today, as it races through steep gorges toward the North Sea. In the seventeenth century, this geographic position made it the commercial hub of central Europe. Basel was among the Free Cities, having gained its recognized independence from the Holy Roman Empire in 1648. Likewise, it became a banking and cultural capital, a place for free thinkers, and even came to be thought of as a *safe haven* from the political turbulence of Europe.

The Swiss family Bernoulli was among the most prominent in Basel. While the family business was mostly spice trading, they spawned two mathematician brothers, Jacob and Johann, starting a dynasty. In time, the brothers formed a renowned competitive and belligerent mathematical relationship, certainly to the benefit of each other's careers, if not their sanity.

Among the problems they tackled together was the *Brachistochrone problem*, whereby a marble is rolled down a ramp,

and the objective was to find the optimal shape of the ramp to achieve the quickest descent of the marble. Johann demonstrated that a very particular curved ramp won the day—a counter-intuitive design because this *roundabout* route required the marble to travel a farther distance than the straight-shot ramp. Thus, the Bernoulli brothers worked out the infinitesimal “calculus of variations”—which would ensnare naïve options traders for eternity.

But it was Jacob, by then a professor of mathematics at the University of Basel, who really changed everything. Jacob’s book *Ars Conjectandi*—fortunately for the uber-competitive Johann, it was published posthumously in 1713—included a discovery that remains significant today: the “law of large numbers,” or what he called his *Golden Theorem*. Put simply, as you accumulate more and more data in a random sample, you should expect that sample’s average to converge to the true average of the generator, or population. The more you roll a *square* (or fair) six-sided die, for instance, the more the percentage of all those rolls in which you see any particular number will converge toward 1/6, or 16.66%. But here, Bernoulli reversed the reasoning: starting with the properties of the outcomes under many trials and inductively reasoning backward to the generator. This was like a bombshell going off, creating a formal statistical inference and the blossoming of actuarial science. Jacob brought probability from essentially a field of practical argumentation among degenerate gamblers to one of mathematical rigor.

Even so, Jacob Bernoulli provided more mathematical grist for the gambler’s logic, ostensibly started by Aristotle, Galileo, Pascal, and Fermat, whereby the meaning of probability and expectation came down to the frequency of occurrences over many repeatable experiments—not to single events.

After Jacob’s death, Johann needed a new target for his mathematical bickering, and he found one in his son, Daniel, yet another talented Bernoulli mathematician. After a slow start in Italy, highlighted by an analysis of the then-popular Italian

casino game of faro, Daniel had a stint as a professor of mathematics at the Academy of Sciences in Saint Petersburg, Russia, from 1725 to 1733. Upon returning home to Basel, he assumed the chair of anatomy and botany at the University of Basel.

In 1735, Daniel and his father shared the Grand Prize of the Paris Academy for their work on planetary orbits. That proved too much for the ornery elder Bernoulli. Johann threw Daniel out of the house over the prize he felt should have been his alone (though perhaps it was high time for the 35-year-old Daniel to move out anyway). They never spoke again, and Daniel would win that prize many times more, mostly for nautical improvements such as the stability of ships' hulls against stormy seas.

And, in 1738, Daniel published his book *Hydrodynamica*, which he had already completed back in 1733. In it, he established the *Bernoulli principle*, expounding breakthrough properties of fluid flow by which we understand the lift of aircraft wings today. This so riled Johann, he backdated his own later and curiously similar *Hydraulica* to 1732. (Daniel's version was rightfully judged to be the authentic one, and he would eventually be appointed to the chair of physics at the University of Basel.)

THE SAINT PETERSBURG PARADOX

That same year, in 1738, Daniel presented another “Bernoulli principle,” as it should be called—far lesser known though at least as important as the original. The principle was contained in his newly published *Specimen theoriae novae de mensura sortis (Exposition of a New Theory on the Measurement of Risk)* in the *Journal of the Imperial Academy of Sciences* in Saint Petersburg. In it, Daniel offered a solution to a vexing problem posed by his cousin, Nicolas Bernoulli (the son of another brother of Jacob and Johann—these Bernoullis keep popping up like rabbits), also at the University of Basel, and named after the city where

Daniel worked on and published it: *the Saint Petersburg paradox*. This was yet another case of a simple dice game changing the very way we think. Daniel's solution was monumental in the understanding of risk, its perception, and its effect. But it was little understood and appreciated, then or since; as a result, it would inadvertently end up becoming a profound distraction for economists for centuries to come.

For our purposes, though, Daniel Bernoulli's solution to the Saint Petersburg paradox is central to safe haven investing.

The original Saint Petersburg paradox involved a simple game with a single die. (Nicolas's game was later described equivalently by others, including Daniel, as a coin-flipping game, but I'll keep to Nicolas's original die.) Nicolas envisioned a gamble based on rolling a die repeatedly until a specified number, let's say the number one, turned up on the die, at which point the game would be over. If it happened on the first roll, the wagerer would receive \$1 (originally one ducat), \$2 if it happened on the second roll, \$4 on the third, \$8 on the fourth, with the payoff continuing to double with each subsequent roll until the number one appeared for the first time.

Now, clearly, this game could go on for a very long time. You can imagine a scenario where you could keep rolling the die forever without the number one ever turning up, with the payoff doubling each time. And for a very rare series of rolls, that nonstop doubling is enough to create an expected average payoff—or expected ending wealth—that equals *infinity*. (More precisely, it is *undefined*.) So, the big question from Nicolas was, how much would you wager to play this game? **Not surprisingly, most people, rightly, wouldn't pay anything close to that infinite expected payoff, or even very much at all, in order to get to play this game. And therein lies the paradox.**

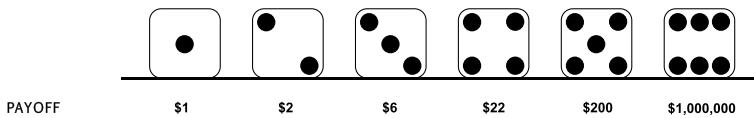
Clearly this is because you wouldn't be very likely at all to ever receive infinity for your wager—in fact, you never

would—even after repeating the wager over and over again. All that gamblers thought they knew about pricing wagers, from Aristotle to Galileo to Bernoulli, went out the window just like that when the expected value of a wager was unreliable after many repeated rolls of the dice. The frequentists had met their match. Or so it seemed.

This crazy infinite expectation, however, is not the point in all of this, and it sort of even obscures the real point. In most discussions of the Saint Petersburg paradox, the takeaway becomes: Just stay away from infinite expected value wagers, and all is fine. But not so fast. We don't need infinity to get the paradox. Any sufficiently *positively skewed* payoff distribution—those with a few very high payoff outcomes—will do. So I will simplify the game drastically by swapping Nicolas's dice game for a cartoon version of it; and in doing this cartoonization, we won't lose any of the meaning (and that's what I call a good trade).

Our new and improved Petersburg wager will require just one roll of a die. The winnings corresponding to whatever side of the die comes up are set according to the approximate size and frequency of the winnings from Nicolas's original wager. Here is a diagram depicting our new cartoon payoff profile, with each die outcome shown above its corresponding winnings:

The (Cartoon) Petersburg Wager Payoff Profile



Now we have a nice straightforward and equivalent game to see just how Daniel Bernoulli approached this paradox. (We will henceforth treat and refer to this simplified wager as the Petersburg wager—and if you want to apply everything you learn from this to the infinite case later, on your own, then you get extra credit.)

The arithmetic average or expected value of this wager is just the arithmetic average of every possible outcome:

$$(\$1 + \$2 + \$6 + \$22 + \$200 + \$1,000,000) / 6 = \$166,705$$

\$166,705 is nowhere near *infinity*, but it's still high relative to what most people would surely pay to play. (I could have set the amount corresponding to a roll of a six to something much, much higher than \$1 million, but it wasn't necessary.) As you can see, in five of the six rolls, you would regret having paid anything close to \$166,705 to play this game.

The very first thing Bernoulli showed—his first principle—was that the fair value of a wager was “dependent on the particular circumstances of the person making the estimate,” and so needed to be expressed as a percentage of the player’s total wealth. That means some fraction of your wealth that you stand to lose—in other words, how badly the loss would hurt you—would drive what you would risk on a wager. A given loss “is more significant to a pauper than to a rich man,” which makes sense. An amount that would bankrupt the former would represent a mere rounding error to the latter. These people are facing two very different propositions, clearly.

For instance, let’s assume you have a starting total wealth of, say, \$100,000, and you decide to wager half of it, or \$50,000, on one roll of the die. (And you have a gambling problem, by the way.) Here’s what the result of each outcome of the die would now look like:

The Petersburg Wager Ending Wealth

STARTING WEALTH	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000
WAGER	-\$50,000	-\$50,000	-\$50,000	-\$50,000	-\$50,000	-\$50,000
PAYOUT	+\$1	+\$2	+\$6	+\$22	+\$200	+\$1,000,000
ENDING WEALTH	\$50,001	\$50,002	\$50,006	\$50,022	\$50,200	\$1,050,000

Nothing much new here. Your average or expected value of ending wealth is still \$216,705 (which is just the same average winning of \$166,705 from before, plus your \$100,000 starting wealth, less your \$50,000 wager). \$216,705 is higher than your \$100,000 starting wealth, but you're still unlikely to pay \$50,000 to play, since you could be down almost 50% of your wealth on five of the six rolls. But there is nothing systematic about this decision. If you wouldn't wager \$50,000, then how much would you wager?

EMOLUMENTUM MEDIUM

Bernoulli's central concept in his 1738 paper was a curious mathematical appraisal that he called the *emolumentum medium*. When his paper was finally translated into English from its original Latin (which, incredibly, didn't happen until 1954), *emolumentum* was translated as either "utility" or "moral," so *emolumentum medium* was translated as "mean utility" and even "moral expectation" (borrowed from the Swiss mathematician Gabriel Cramer).

A more accurate translation of *emolumentum*, however, is "advantage," "benefit," or even "profit," and *medium* is "mean," "average," or more literally "in the middle." (If this implied that Bernoulli's *emolumentum medium* referred to something more like the middle value of the Petersburg wager's range of potential profits, then, as we'll see later, Bernoulli was definitely on to something.)

Bernoulli's approach eventually began to seep into the profession of economics, even though it had been neglected initially by economists for over a century, specifically in the form of "diminishing marginal utility." Diminishing marginal utility simply means the more you have of something, the less the next additional unit of that something will mean to you. And the reverse would be the case as well: the less you have of

that something, the next unit lost means more. This applies to food, houses, shoes, phones, Ferraris, goats (well, maybe not to goats), whatever. And we could generalize it by replacing that “something” with “wealth.” The best description, to my mind, was written by my indirect investment partner Ian Fleming (in *Moonraker*):

Before he slept he reflected, as he had often reflected in other moments of triumph at the card table, that the gain to the winner is, in some odd way, always less than the loss to the loser.

In some sense, Bernoulli had anticipated risk aversion itself, though what people miss is that Bernoulli’s discovery really makes risk aversion something of a tautology. “A bird in the hand is worth two in the bush.” But when your bird compounds (or reproduces), if you lose one bird while trying to get two, then you’ve just lost more than two birds.

Although they didn’t refer to Bernoulli, the idea of diminishing marginal utility was a foundational principle in the *Marginal Revolution*. This refers to the crossover in the early 1870s from classical economics into modern subjective value theory, which is conventionally credited jointly and independently to Carl Menger in Austria, Léon Walras in Switzerland, and William Stanley Jevons in England. Among other innovations, these three economists solved the so-called *water-diamond paradox*: Why do diamonds fetch more in the market than water, even though the latter is essential to life? The value of something is relative to what we already have of it. Generally speaking, people have access to more units of water than they need to satisfy their diverse uses for it; thus, “on the margin,” water has a very low market value. But if you were dying of thirst in the desert, you would certainly give a diamond for a glass of water. Simple as it sounds, without this idea of diminishing marginal utility of particular goods as their stockpile increases, economists couldn’t easily explain market prices.

The early pioneers of the Marginal Revolution didn't really incorporate Bernoulli's framework because they developed their new approach to utility and value in the context of certainty, not chance. However, by the time von Neumann and Morgenstern published their famous work on the theory of games in 1944, modeling behavior under *uncertainty* was front and center. Like Bernoulli, von Neumann and Morgenstern assumed rational agents dealt with uncertainty by maximizing the expectation of some objective function. To this day, economists call such an objective function a Bernoulli function or a von Neumann–Morgenstern utility function, in homage to the developers of the approach.

Bernoulli would take a lot of unfair posthumous flak over the years from people presuming that he was advocating that everyone operates under a specific utility function. Bernoulli's objective function was even cited over the years as a rationale for progressive income taxes—so he has that mark against him, deserved or not. He was even skewered by people such as the eminent Austrian economists Ludwig von Mises and Murray Rothbard, who focused their ire on the particular application Bernoulli made, using a functional form; in my view, however, they missed his broader point—a broader point which is entirely in sync with the Austrian school.

Bernoulli's innovation was a simple expansion of his common sense insight that profit and loss have to be scaled by someone's total wealth, such that "any increase in wealth, no matter how insignificant, will always result in an increase in *emolumentalum* which is inversely proportionate to the quantity of goods already possessed." (Think of it this way: If Scrooge McDuck won \$1,000,000, he likely wouldn't notice. But if the guy on the corner won \$1,000,000, or even \$100,000, it could change his life. The value of what each of them gains is relative to what they already have.)

Bernoulli then translated that concept into a straightforward functional form. When this relationship is integrated over

infinitesimal increments, or taken to the continuous case, it leads us right to the (natural) logarithm:

$$\text{change in emolumentum} = b \times \frac{\text{change in wealth}}{\text{wealth}}, \text{ so that}$$

$$\text{emolumentum} = b \times \log(\text{wealth}) + a$$

Put simply, *emolumentum* is the **logarithm of wealth**. (Technically, it is *directly proportional* to the logarithm of wealth, but the value of *a* and *b* are unimportant to us here.)

Now, Bernoulli defined his *emolumentum medium* using the following “fundamental rule”:

If the emolumentum of each possible profit expectation is multiplied by the number of ways in which it can occur, and we then divide the sum of these products by the total number of possible cases, an emolumentum medium will be obtained, and the profit which corresponds to this emolumentum will equal the value of the risk in question.

In mathematical terms, Bernoulli's emolumentum medium (EM) is the average of the logarithms of all potential total ending wealth outcomes. In the case of our Petersburg wager example (where we wager half of our \$100,000 total wealth):

$$EM = \frac{\log 50,001 + \log 50,002 + \log 50,006 + \log 50,022 + \log 50,200 + \log 1,050,000}{6}$$

And “the profit which corresponds to this *emolumentum*” is Bernoulli’s “value” in question—the *Bernoullian expected value (BEV)* of the wager. (For the mathematically minded, this requires the exponential, or the inverse function for the logarithm, in order to back out of the logarithmic mapping and into the units of the profit):

$$\begin{aligned}
 BEV &= e^{EM} \\
 &= e^{\frac{\log 50,001 + \log 50,002 + \log 50,006 + \log 50,022 + \log 50,200 + \log 1,050,000}{6}} \\
 &= e^{\$83,114}
 \end{aligned}$$

So there you have it. Take the exponential of the average of the logs of your different potential ending wealth outcomes, and you have Bernoulli's expected value of your wealth from playing that wager. It's a mouthful, but it's pretty simple, really.

Let's make it even simpler: Don't wager \$50,000 on the Petersburg wager when your total wealth is \$100,000, because the Bernoullian expected value of wagering that amount—based on the average log of the potential ending wealth outcomes after playing—is lower than your current wealth. (Current wealth of \$100,000 is greater than *BEV* of \$83,114). In other words, given a choice between having \$100,000 for sure, or facing the Petersburg wager, which is valued at \$83,114, you would obviously prefer the \$100,000. Thus, for someone starting with \$100,000, wagering \$50,000 on the dice game will make them poorer.

THE GEOMETRIC AVERAGE

On the surface, you can see how academics ran with this over the years, as Bernoulli seemed to have given a psychological explanation for the perception of risk that creates all sorts of opportunities for mathematical torturing of theories and data. (Specifically, economists took Bernoulli to be assuming that people have a logarithmic *utility function of wealth*.) But what Bernoulli really had in mind was something entirely different.

His use of the logarithmic function wasn't just a psychobabble presumption used to create the impression of rigor from

esoteric math. On the contrary, it is actually grounded in the physical reality of the real world. Let's see what I mean by that.

This logarithmic function harkens back to the Babylonians about 4,000 years ago, and more formally to a Swiss clockmaker (Bürgi) and Scottish mathematician (Napier) in the seventeenth century. They found a simplifying mapping between multiplication (for positive numbers) and addition—which is naturally much easier: Add (or subtract) the log of two numbers and you get the log of their product (or ratio); similarly, divide the log of a number by n and you get the log of the n^{th} root of that number. (The logarithm is still used for that purpose to this day, as in the slide rules that quickly reduce multiplication problems down to addition problems for geeks immemorial.)

You see, that mapping from multiplication to addition conveniently allows us to restate Bernoulli's expected value formula as something much more comprehensible and meaningful: the geometric average:

$$\begin{aligned} BEV &= e^{\frac{\log 50,001 + \log 50,002 + \log 50,006 + \log 50,022 + \log 50,200 + \log 1,050,000}{6}} \\ &= (\$50,001 \times \$50,002 \times \$50,006 \times \$50,022 \times \$50,200 \\ &\quad \times \$1,050,000)^{1/6} \end{aligned}$$

As you can see, the geometric average is multiplicative. Unlike the arithmetic average where we add up all the data points, to get the geometric average we multiply them all together. Then, we need to scale them back down to size. In the case of the arithmetic average, this is done by dividing their sum by the number of data points (let's say there are n of them). In the case of the geometric average, this is done by taking the *root* of their product (specifically, the n^{th} root, or taking the product to the $1/n^{\text{th}}$ power). The geometric average definitely plays second fiddle to the arithmetic average, as the arithmetic average is the one that typically gets all of the attention; it's what we

think of whenever we use the term *average* on its own (or the word *mean*, which is interchangeable with the word *average*). When it comes to investing, however, it should play second fiddle no more.

Don't worry about the math here. The big idea is that Bernoulli's expected value of a wager is simply the mathematical equivalent of the geometric average of all potential ending wealth outcomes, wrapped around a slick objective function in the form of the logarithm.

Bernoulli was not explicit about how all this works, but he relied on it, nonetheless. It was his whole point. As Bernoulli phrased it, his *emolumentum* “suggests” the rule of taking the geometric average ending wealth, without ever even calling it by name or making the broader economic case for it. He even wrote, regarding the use of the geometric average to value risky bets, “I would elaborate it into a complete theory as has been done with the traditional analysis, were it not that, despite its usefulness and originality, previous obligations do not permit me to undertake this task.”

Ultimately, Bernoulli put a stake in the ground for using the geometric average (rather than the expected value or arithmetic average) of wealth outcomes as the principle “essential for the measurement of the value of risky propositions.” He was the first, and the rest was history. We’ll see in the chapters ahead that it literally changes everything, especially our understanding of risk mitigation.

But for now, let’s return to our previously posed question. What is the most you would be willing to pay to play the Petersburg wager? Keeping with our assumed starting wealth of \$100,000, we can try a few more examples.

Let’s try betting all of it, the entire \$100,000—bet the ranch (since we’ve already determined that you have a gambling problem). Here’s what that range of potential ending wealth outcomes and their geometric average look like:

STARTING WEALTH	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000
WAGER	-\$100,000	-\$100,000	-\$100,000	-\$100,000	-\$100,000	-\$100,000
PAYOUT	+\$1	+\$2	+\$6	+\$22	+\$200	+\$1,000,000
ENDING WEALTH	\$1	\$2	\$6	\$22	\$200	\$1,000,000
ARITHMETIC AVERAGE: \$166,705						
GEOMETRIC AVERAGE: \$61						

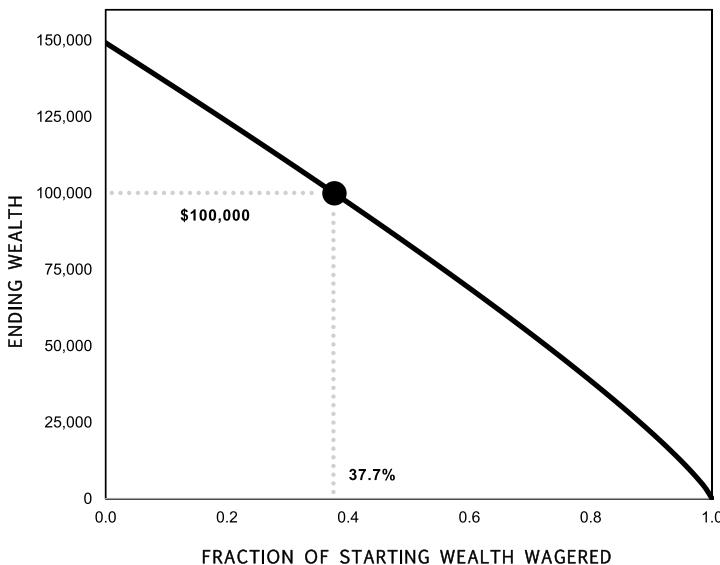
Just \$61. Not good. How about betting just 10% of your wealth, or \$10,000? Here's what that looks like:

STARTING WEALTH	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000
WAGER	-\$10,000	-\$10,000	-\$10,000	-\$10,000	-\$10,000	-\$10,000
PAYOUT	+\$1	+\$2	+\$6	+\$22	+\$200	+\$1,000,000
ENDING WEALTH	\$90,001	\$90,002	\$90,006	\$90,022	\$90,200	\$1,090,000
ARITHMETIC AVERAGE: \$256,705						
GEOMETRIC AVERAGE: \$136,445						

Now your geometric expected value is \$136,445. It's finally higher than your starting \$100,000, so that's good. We can keep trying more and different bet sizes (expressed as a fraction of your total starting \$100,000 wealth), plot the results on a graph, and then see the range of geometric average ending wealth for each. The point at which that expected ending wealth crosses \$100,000 is the fair value of that wager for you, expressed as a fraction of \$100,000.

In the case of \$100,000 starting wealth, the fair price of our Petersburg wager, based on breaking even in the geometric average of all outcomes, is 37.7% of that starting wealth, or \$37,708. That's what making this bet is worth to you.

The search for the fair value of the Petersburg wager, with starting total wealth = \$100,000



THE OTHER SAINT PETERSBURG PARADOX

Bernoulli's solution to the Petersburg paradox was a minor point tucked away at the end of his paper. His primary focus was his methodology. And then there was yet another, far lesser-known Saint Petersburg paradox that Bernoulli addressed briefly in that paper; it was a much more practical case study, as well as a more dramatic and intriguing one.

This problem involved a Saint Petersburg merchant who has purchased commodities in Amsterdam and wishes to ship them home to Saint Petersburg to sell for a tidy profit. But he faces substantial financial risk in transporting those commodities some 1,100 nautical miles across the Baltic Sea to Saint Petersburg. It sounds like a benign enough trip. But this was the golden age of piracy, after all; the dreaded Dane, "Jack of

the Baltic,” was actively looting cargo ships in and out of Saint Petersburg in his ominously named pirate ship, the *Sudden Death*. (He was that rare, real pirate cliché who drowned all his victims by making them walk the plank before scuttling their seized ships.) Given those risks, how can our merchant *cost-effectively* mitigate them?

Let’s say the net value of the Petersburg merchant’s commodities (net of shipping costs, etc.) that he intends to sell is 10,000 rubles; in addition, he has savings of 3,000 rubles. (It’s a levered business.) So his total wealth, upon making his sale in Saint Petersburg, is 13,000 rubles. Typically, for every 100 ships that sail from Amsterdam to Saint Petersburg, 5 end up seized by pirates or the sea—or a 5% probability of a 10,000-ruble total shipment loss to the merchant. Perhaps some risk mitigation could help, like insurance. Let’s say the best price the merchant can find for insuring his entire precious 10,000-ruble cargo is 800 rubles—which he considers “outrageously high! *Ochen’ dorogo!*”—and not at all cost-effective. He would appear to be right: Based on history, the actuarial expected value of such a contract is $(-800 \times 95/100) + (9,200 \times 5/100) = -300$. This would really eat into his expected return from each 10,000-ruble cargo. Without mitigating his risks, this shipment would perhaps be riskier than he could bear. But the insurance industry was seemingly a loser’s game, merely preying on its customers’ fears; as the calculation indicates, the premium being charged was higher than the actuarially “fair” amount. The Petersburg merchant has quite the dilemma of risk.

So, he considers alternative risk-mitigation strategies, such as diversifying his risk. In fact, Bernoulli made a point of this as a logical derivation of his methodology. (Because of this, some call him the originator of the formal concept of diversification, a rightful claim. The University of Basel beat the University of Chicago by more than 200 years—sorry, Maroons.) As Bernoulli sagely advised: “This is the rule that it is advisable to

divide goods which are exposed to some danger into several portions rather than to risk them all together."

Easier said than done, it turns out to our merchant. He gets a pretty good deal with the shipper that he's been using for years. If he were to start paring that down and trying to send smaller cargos with a handful of other shippers instead, he would suddenly find that he would be paying much higher shipping costs. What's more, the Baltic isn't the Atlantic; there are fewer ships and fewer diversifying routes. And it's pretty naïve to think that old Jack of the Baltic would let a handful of ships sail right by unimpaired, even if separated by days, and choose only one to seize; any diversification value would likely be overstated. (This is an uncanny parallel to the shortcomings of today's financial market diversification, which we will discuss later.) So much for pirate and weather diversification.

Our merchant is left hiring a single ship, setting sail at the mercy of Captain Jack and the Baltic. When that ship leaves port, what follows is only one outcome out of all that might happen. In other words, he gets to sample only one outcome from the enormous sample space of possibilities. (His N equals 1.) Of course, he expects to keep parlaying such shipments throughout his career, thus diversifying through time; but one 10,000-ruble loss will really set him back. The only other way that he might reduce his risk is to just take less of it—with a smaller ship and smaller and less valuable cargo, or else lay off some of his interest to partners. Sometimes that can be a good strategy. He could even decide not to sail at all, keeping the ship in the harbor, as it were. But there must be a better way, he thinks. He doesn't want to cut and run. The only way he can remain a successful merchant is by exposing himself to the risks of the high seas and the pirates lurking therein. He even has his motto framed on his Saint Petersburg office wall: "*A ship in harbor is safe ...*"

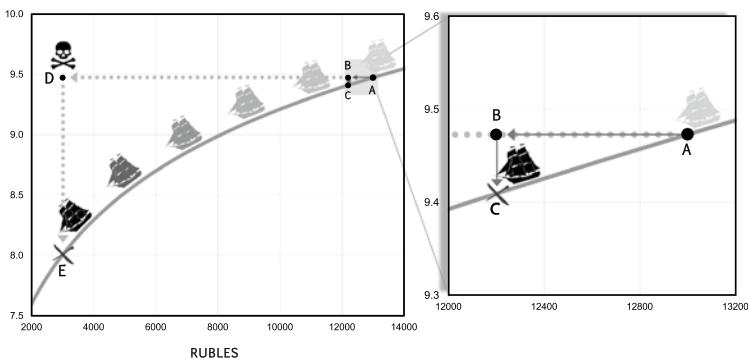
(What follows is implied, as written much later by John Augustus Shedd: "... but that is not what ships are built for.")

He needs to roll the dice on his financial fate. He spends countless days and sleepless nights plotting his course over the Baltic, with reports on the whereabouts and sailing patterns of the *Sudden Death* and reams of weather reports and forecasts. He sees this as his treasure map to navigate his precious cargo past the financial destruction of menacing pirates and financial storms to safe harbor at the far shore across the sea. But, of course, in the end, all of this would be about as useful as holding his finger to the wind.

If only our merchant had read Daniel Bernoulli instead of all of those spurious pirate and weather reports.

You see, Bernoulli's framework would have provided him with the intuition to solve his otherwise counterintuitive problem: We start with the merchant's 3,000-ruble savings plus the 10,000 rubles he would receive from selling his commodities in Saint Petersburg. This is point A on the following chart. Next, we subtract the 800-ruble insurance premium, moving from point A to point B, to see the *logarithmic cost*—the vertical line from B to C. (You get a blown-up view of this in the chart on the right.) This is the cost of insuring—and thus removing—a potential loss from point A to point D, representing the 10,000-ruble total loss of the cargo at sea. And the logarithmic cost of doing that is represented by the vertical line from D to E (as the poor seized merchant vessel plunges down into the abyss of the sea).

Plunging into the Abyss: Mapping the Petersburg Merchant Trade



The sum of 100 horizontal losses from A to B (the cost of insuring 100 shipments) exceeds the sum of 5 horizontal losses from A to D (the expected 5 times that there will be a claim over those 100 insured shipments). The difference in the average is the -300 expected loss to the merchant for buying insurance (and the expected actuarial profit to the underwriter). However, the sum of 100 vertical losses from B to C *does not exceed* the sum of 5 vertical losses from D to E. Not even close. And this shows the impact that owning insurance at this price to remove those 10,000-ruble losses would have on the geometric average of all possible outcomes for the merchant.

This is what I will forever call the *Petersburg merchant trade* (even though it remains a mystery to our poor merchant): A risk-mitigation strategy that mitigates the right risk in a portfolio—and thus prevents it from plunging down the logarithmic curve—and at the right price can both lose money on its own (-300 rubles on average per trip, in this case) and yet raise the portfolio's rate of compounding and its ending wealth.

This is what's so decisive about the Petersburg merchant trade: The arithmetic cost of its risk mitigation is more than offset by its geometric effect—such that its net portfolio effect is positive. Just let that simmer for a bit.

Without the logarithmic shortcut to the geometric average, this net portfolio effect would be really difficult to visualize, let alone believe. So difficult, in fact, that our Petersburg merchant is too busy plotting his treacherous course to give it any attention whatsoever.

Notice on the logarithmic map that, if you ever suffered a one-period loss of 100%, taking you all the way to zero on the x -axis and down the curve, then it's game over. You lose all your wealth, and no amount of future profits can compensate. In a string of *total returns* multiplied together as they compound, just a single "0" makes the whole thing zero—and this is why, as x approaches 0, the logarithm of x approaches

negative infinity. More simply stated: bet it all, lose it all—there's no coming back.

In contrast, if we calculate the *arithmetic* average, then adding in a total return of 0 isn't catastrophic; it just pulls the average down.

The arithmetic losses (represented by the horizontal lines) are but an illusion, existing only in a timeless world. This is because those horizontal incremental losses are not all equal when compounded; they don't simply add up in our merchant's accounting ledger—and this is why he is so blind to the correct accounting.

The relative vertical losses are what essentially add up to the merchant's eventual wealth. By focusing only on the horizontal profits and losses, and summing (or averaging) them, our merchant concludes that this risk mitigation is a net cost. Our merchant believes he would be paying more than the insurance is "actuarially worth."

What he doesn't see is that by summing (or averaging) his vertical profit and loss, he gets the real picture of what is going on with his wealth, and why buying (seemingly) "overpriced" insurance is well worth it.

To look at this in terms of the geometric average of the potential outcomes, just as Bernoulli did, we can look at the case where the merchant abstains from insuring himself, and compare that to his insured case where he is guaranteed a fortune of 3,000 rubles plus the 10,000 ruble proceeds (either from selling his commodities or from the insurance underwriter) less the 800 ruble insurance premium, which is $3,000 + 9,200 = 12,200$ rubles. On the other hand, without insurance, his geometric average fortune would be 3,000 rubles plus 10,000 rubles in proceeds on 95 trips, and on 5 trips he would only have his original 3,000 rubles (10,000 rubles in commodities lost to Captain Jack). We thus get a Bernoullian geometric expected value, like in the Petersburg wager, of:

$$BEV = ((3,000 + 10,000)^{95} \times (3,000)^5)^{1/100} = 12,081 \text{ rubles}$$

Strangely, the insurance contract is not a zero-sum game. The merchant has a geometric expected value gain (from 12,081 rubles to 12,200 rubles, or +119 rubles per shipment) and the insurance underwriter has an actuarial arithmetic expected value gain (of 300 rubles per shipment). Thus, the granting of the insurance contract represents a gain (measured in their own frameworks) for both the merchant and the insurer—it's a win-win, mutually advantageous arrangement.

Unbeknownst to the merchant, the insurance premium was both outrageously high and outrageously low—*Ochen' dorogo i ochen' deshevo!*—both at the same time. Therein lies this second Saint Petersburg paradox.

Now think about what the geometric average means here from an economic standpoint. Think of the merchant's profits on each shipment in terms of a total return on whatever capital investment was needed to fund that shipment. The total return ratio is simply the ending wealth divided by the beginning wealth, or one plus the return on the starting wealth, which produced the ending wealth.

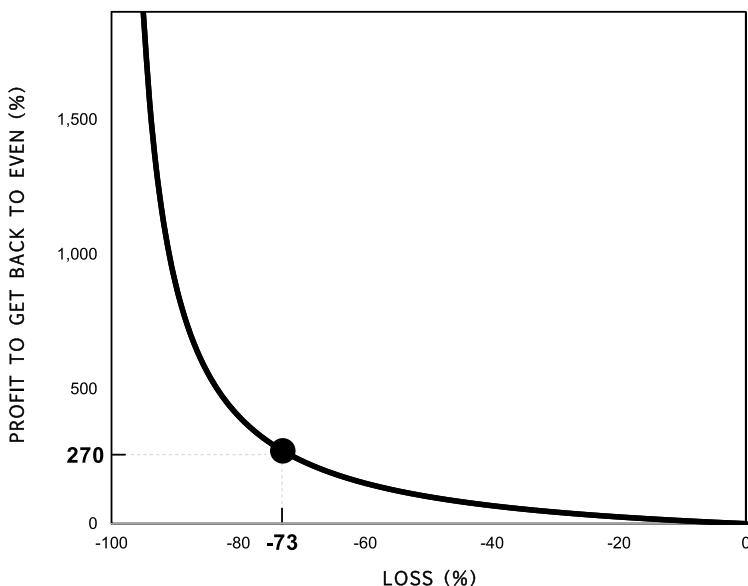
Let's say that the investment needed for that 10,000 rubles in proceeds for his commodities sale was 8,000 rubles. This means he started with $3,000 + 8,000 = 11,000$ rubles; if successful, he ends up with $3,000 + 10,000 = 13,000$ rubles, or a $13/11 = 1.18$ total return (or an 18% profit). But if his shipment is lost, he ends up with just 3,000 rubles, or a $3,000/11,000 = 0.27$ total return (or a 73% loss!).

Of course, our merchant wouldn't be done after he unloads his commodities in Saint Petersburg. This is his business, and he plans to keep doing this for as long as he can, parlaying his capital on shipment after shipment. His aim is to compound his capital by adding (or subtracting) each of his previous winnings (or losses) to the capital needed for each next shipment, and thus grow his capital geometrically. The words *compound* and *geometric* refer to a change or growth in the size of something that is proportional to that thing itself—as in his wealth. Compound

or geometric growth is thus multiplicative growth, represented by a geometric progression of returns, where each subsequent outcome is determined by the previous outcome multiplied by the next total return. (And this is the wonderful thing about working with total return ratios.) Each output becomes the new multiplicative input—it is a *recursive map*.

Should he suffer that 0.27 total return, or 73% loss, he would need to make a profit of 270% from there just to get himself back to even. It is a most insidious wealth tax. (So his pirate and weather forecasts had better be right!) It gets worse and worse, the more grave the losses, as shown in this chart:

An Insidious Wealth Tax: The Greater the Loss, the Greater the Profit Needed to Get Back to Even



And this is just another way of thinking about the meaning of that logarithmic map. (Flip this curve over horizontally and it becomes something like the logarithmic curve.)

Let's say for the merchant's next 100 shipments, 5 of them are total losses (exactly as expected). In that case, his geometric average total return—or more familiar *compound growth rate*—per shipment over those 100 shipments would be:

$$((1.18)^{95} \times (0.27)^5)^{1/100} = 1.098$$

And, sure enough, his starting capital of 11,000 rubles times 1.098 equals 12,081 rubles, his geometric expected wealth after just one shipment. (These total return calculations assume that our merchant reinvests the same fraction of his total wealth each shipment, and don't worry about that.)

He can expect to parlay his wealth at the rate of 9.8% per shipment without insurance—with a lot of risk. With insurance, he will parlay his wealth at the rate of $12,200/11,000 = 1.11$, or 11% per shipment—and he will achieve this higher rate of return with no risk.

This is a bizarre notion that even most in the insurance industry likely don't fully appreciate. (The modern investment industry certainly does not.) It should sort of blow your mind. In this example, we've seen that it's possible to invest in an asset (an insurance policy) that by itself yields an expected loss, and yet in so doing we remove all risk from the portfolio while also raising the expected rate of return on the portfolio. The contrast between our example and the general rules from the financial academics couldn't be starker.

This is where the geometric average has real economic meaning: It isn't just the wager on this cargo that drives the value. It is the iterative, multiplicative impact of that result on the next wager, and on the next! A large loss disproportionately lowers our merchant's geometric average return, because it leaves him with a much lower stake, or capital base, to reinvest and compound on his next shipment. The logarithmic loss shows the true (higher) value-added for him when he insures against it.

But, sadly, the Petersburg merchant will never know, because he never looks at things that way.

The subtle implication, then, is if you're going to play a wager once, it had better make sense to make that same wager repeatedly, compounded many times—for an eternity even—whether you actually will or not. One wager or a million wagers, the geometric average return is the one that matters.

CONCAVITY OF CURVE

Now, clearly, Bernoulli could have just said “geometric average” and been done with it (and saved generations of economists from diving down the rabbit hole of utility theory). His logarithmic objective function is just a nerdy little trick. So what? We don’t need mathematical shortcuts and slide rules; just punch in the numbers and move on.

In using the logarithmic function the way he did, Bernoulli gave us a way to think about the problem that we might not have arrived at naturally. As we saw in the logarithmic map of the Petersburg merchant trade—translating from arithmetic to geometric returns—the logarithmic function allows us to better process *mentally* the ongoing, recursive accruing of geometric returns. It makes the math of compounding intuitive. And it allows us to view and think about raw returns correctly—in the way that they actually impact our wealth over time. Without this map, I’m not sure we could otherwise do that.

This is how Bernoulli intended this function to be used. We’re not viewing returns, or profit and loss, simply as we experience them, one at a time, as distinct and separate events—“exclusively in terms of themselves”—in their raw, linear, arithmetic form. To get what’s going on, we need to experience our returns through the lens of the logarithmic function. In other words, geometrically.

But here’s the rub. The math of arithmetic averaging is intuitive; the math of compounding is not. **We experience profits**

and losses and all accounting ledgers arithmetically; we experience life arithmetically—one thing after another. This is linear thinking versus geometric thinking. It's a big difference and essential to our understanding of risk and the disastrous impact of losses on wealth. But it is highly counterintuitive. Here you face an inconvenient, uncomfortable but crucial truth:

Your raw, linear returns are a lie; your true returns are crooked.

Bernoulli's call to map returns through the logarithmic function was thus a normative one, not a positive one. In basing decisions on the geometric average of expected wealth or returns, not on the arithmetic average, Bernoulli was showing us how we *should* view risk—not how we necessarily *do* view risk. And this is precisely where economists got it so wrong.

In fact, in 1979 behavioral economists Daniel Kahneman and Amos Tversky developed a theory of decision-making under uncertainty known as *prospect theory*. This theory implied that people have diminishing marginal utility with increasing gains, like the logarithmic function—as well as with increasing losses. The latter completely contradicts the logarithmic function's *increasing* marginal utility with increasing losses. **If true, prospect theory can explain why, at least in investing, people generally do not do what Bernoulli prescribes—as they don't have his prescribed objective function—and why people seem to stubbornly ignore the risks that matter.** (There's no grand conspiracy theory needed, just a bit of humanness.)

As investors, what we are really doing is trying to perform a mathematical optimization of this logarithmic objective function so we can maximize our geometric return. This mathematical optimization is a loss or cost function that maps raw returns onto their cost to the portfolio's rate of compounding. The goal, therefore, is to maximize that loss function, or minimize its cost.

The mathematics of compounding is translated into this objective function. It becomes a way to gauge risk based on

how it mathematically describes the consequence of that risk and loss. **It shows us what matters to compounding. It is a risk-enforcer and focuses the mind on which risks move the needle and which do not.**

Whether we interpret Bernoulli's fundamental idea as a *log utility maximization criterion* (as economists and even most in mathematical finance would describe it), a *geometric mean maximization criterion*, or, simply, a way to protect wealth given that profits and losses compound over time, it doesn't matter. If you take away nothing else from this part of the discussion, if the math made your eyes glaze over, then remember this: **By formulating the logarithmic function as our objective function—as the most effective way to value risky gambles—Bernoulli inadvertently revealed the geometric average as the optimal criterion for valuing those risky gambles. Arithmetic returns are false hopes; the truth lies in geometric returns.**

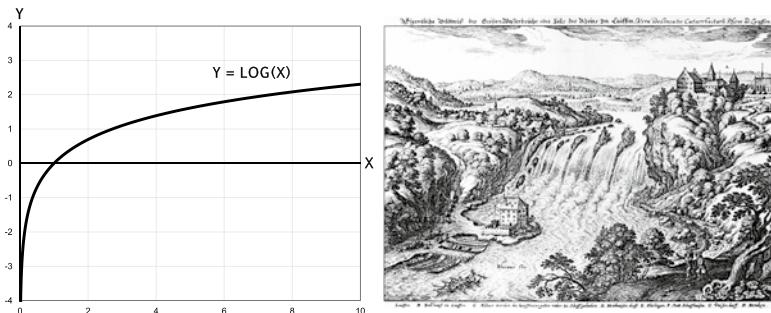
This criterion is the *other* Bernoulli principle. The first Bernoulli principle, if not violated, prevents airplanes from crashing; and this one, if not violated, likewise prevents portfolios from crashing. (And this was a very pleasing link for me back in my active pilot years.)

THE LOGARITHMIC RHINE FALLS

Bernoulli's academic fascination with the behavior of turbulent fluids makes it easy to picture his day trips from Basel up the High Rhine to the Rhine Falls in Schaffhausen, the most powerful waterfall in all of Europe. It is also easy to picture in their cascading cliffs what Bernoulli called the *concavity of curve*: deceptively placid waters that grow incrementally steeper and more turbulent as you plunge over their precipice into the abyss—from which you might never return. The danger is barely noticeable, until it is too late. The further you go down

it, the more you plunge, the harder it will be for you to ever claw your way out. (You will ultimately drown in the insidious wealth taxes of negative compounding.) Hopefully, this frightful image becomes etched in your mind to help you easily access the meaning of the logarithmic function to investing.

Over the Falls We Go: The Logarithmic Curve and the Logarithmic Rhine Falls



Bernoulli described this logarithmic concavity of curve as “nature’s admonition to avoid the dice altogether.” As we will keep seeing, even “absolutely fair” games of dice (and, often, of investing) can be exceedingly unfair. Best to avoid them.

Because the logarithm is a concave function that curves downward, it increasingly penalizes negative raw returns the more negative they are. The steeper the losses, the disproportionately larger the damage they inflict—far greater than profits of the same size can overcome. The more negative those losses are, the more they increasingly and disproportionately lower the geometric average return (as we saw when the Petersburg merchant’s ship plunged down the curve and over the falls).

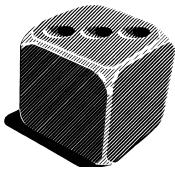
We know this concavity of curve in our bones—the real bones. It pervades our collective wisdom about investing, perhaps most practically today from Graham’s “safety of principal”

admonition. And then along came his greatest pupil, Warren Buffett, whose single-minded emphasis on compounding capital required his cardinal rule: **“Don’t lose money.”** And now we really know why.

The corollary is clear: **Profit is finite. Risk is infinite. You need to avoid plunging down the logarithmic Bernoulli Falls! This is, by far, the most important concept in safe haven investing—nay, of all investing.**

In the end, time resolves the Petersburg paradox. If you take the exponential of the average log return of your next wager, then you get the geometric return that you can expect by parlaying that same wager forever. You do not have to run the machine through time to figure that out. So, you had better care about the exponential of the average log return of your next wager.

So, you see, the logarithm is not just an intellectual idea or psychological theory or esoteric quant model; and it requires no assumptions or predictions about return distributions, or whatever. Rather, it is a physical fact of precisely how compounding and investing work in the real world. As we saw, it is why an arithmetic cost can be more than offset by a geometric effect in the Petersburg merchant trade. This will become clearer and clearer in later chapters, so for now, just keep letting that simmer.



The Eternal Return

AN EXISTENTIAL IMPERATIVE

In 1879, at only 35 years of age, Friedrich Nietzsche held the classical philology chair at the University of Basel in Switzerland—the same institution that housed the bickering Bernoullis over the preceding centuries. (It's a historic place—ground zero.) Nietzsche had held this venerable position for 10 years, which was unheard of at such a young age.

But he much preferred the country life to the city life, and he would make sojourns from Basel into the Swiss countryside whenever he could. The forests bordering the High Rhine were among his favorites, such as around Daniel Bernoulli's logarithmic Rhine Falls—whose rumbling inspired Nietzsche as it cascaded “headlong towards infinity.” The area would purportedly always have a special connection with his writings.

Unfortunately, his health had been increasingly in decline. As a result, he abruptly decided to abandon Basel and retire to the life of a full-time wandering writer. Having revoked his Prussian citizenship, and with multiple failed awkward attempts at marriage proposals, he became a stateless, reclusive, wandering philosopher

for the remaining two decades of his short life (though syphilitic insanity would tragically consume his final decade). He wintered in Nice, Genoa, and Turin, and summered in Sils-Maria near Saint Moritz in Switzerland's Engadine Valley. He spent his summer days hiking among the mountain goats and sheep in the high Engadine woods (in accordance with his belief that "only ideas won by walking have any value"). His most notable hike was along a lake at Silvaplana (a hike that I can highly recommend, better yet in winter to take the winding toboggan run down). It was there along its shore in 1881, at a pyramidal rock formation with a pebble plunging off its side with a splash like a boulder over a fractal cliff, that Nietzsche had a lightbulb moment. His self-proclaimed fundamental doctrine of the "eternal recurrence" or the "eternal return of the same" was born.

Nietzsche eventually expanded the eternal return into a book of quasi-biblical parables, his 1885 magnum opus *Also sprach Zarathustra* (*Thus Spake Zarathustra*). First, though, he would introduce it by sending up a trial balloon. At the end of his 1882 book *Die fröhliche Wissenschaft*, or *The Gay Science* (not to be confused with the truly "dismal science" of economics), under the heading "The Greatest Weight," Nietzsche proposed a thought experiment:

What if some day or night a demon were to steal after you into your loneliest loneliness and say to you: 'This life as you now live it and have lived it, you will have to live once more and innumerable times more; and there will be nothing new in it, but every pain and every joy and every thought and sigh and everything unutterably small or great in your life will have to return to you, all in the same succession and sequence—even this spider and this moonlight between the trees, and even this moment and I myself. The eternal hourglass of existence is turned upside down again and again, and you with it, speck of dust!'

Would you not throw yourself down and gnash your teeth and curse the demon who spoke thus? Or have you once experienced a

tremendous moment when you would have answered him: ‘You are a god and never have I heard anything more divine.’ If this thought gained possession of you, it would change you as you are or perhaps crush you. The question in each and every thing, ‘Do you desire this once more and innumerable times more?’ would lie upon your actions as the greatest weight. Or how well disposed would you have to become to yourself and to life?

I must admit, the first time I encountered this, it rattled me. I started looking at things differently. Every moment seemed to slow down and somehow became perfect, even when it wasn’t. It had to be. Nietzsche called this his “highest formula of affirmation”—life affirmation. And in it I also found something that applied specifically to investing, something I had not been able to put my finger on or articulate before.

There is so much muddled, superficial narrative in the investment industry. So much movement, so little action. There are grandiose forecasts of when to take risk and when to retrench—but which ignore the results of these forecasts. Wise people speak of shunning risk through diversification, dubbed “the only free lunch in finance,” using financial engineering terms that few even bother to understand, and spreading risk across assets in hopes of capturing some safer, mediocre average performance. No matter what it cost you, your intentions were good, and at least you evaded disaster; your *risk-adjusted returns* were high—though you’re poorer.

The conventional approach to risk mitigation in the investment industry is deceptive and defeatist, with so little substance and significance, and so much smoke and mirrors. **It disregards economic meaning in favor instead of quantitative meaning and accepts bad results all in the name of safety from bad results. Fate loves irony.**

It is nihilistic financial theater.

Investing can’t just be about taking bold bets on our clever expectations and then downplaying their outcomes, as if

renouncing any attachment to the fruits of our actions. “I was right, but unlucky.” We know we cannot judge our decisions only by their outcomes—as good decisions can easily have bad outcomes. But we only get one outcome. If Nietzsche’s demon is correct, and we must live with our results “*once more and innumerable times more*,” do you really want to keep on ignoring the same bad outcomes over and over for eternity? You need a better perspective to become a better investor and, whether we accept Nietzsche’s perspective as true or not, I am convinced his is the one.

Nietzsche’s “joyful wisdom” has been around a long time. It’s an ancient idea, this concept of a cyclically repeating time. As a woodland dwarf perched on the pyramidal rock exclaims to Zarathustra, “Everything straight lies, all truth is crooked, time itself is a circle.” This belief has been consistent throughout our human history, in the ancient Mayan, Aztec, Egyptian, Judaic, and Greek traditions (with the latter, specifically the Pythagoreans and the Stoics). Christianity largely put an end to this belief in the west, yet in the east it is central to such traditions as Indian Hinduism and Buddhism. (Nietzsche even called the eternal return a “European form of Buddhism.”)

When Nietzsche writes that “the task is to live in such a way that you must *wish* to live it again,” it sounds as if his teaching is all about the wish; but then he follows that with “—you will do so [live again] *in any case!*” Nietzsche was seemingly compelled by the eternal return as a cosmological fact, and even worked out physical proofs in his unpublished notes exploring the eternal return as material reality. And this notion was taken up eight years later by the great French polymath mathematician Henri Poincaré, in his “recurrence theorem,” which asserted that certain mechanical systems will inevitably and eternally return to any given state. This was a more rigorous version of Nietzsche’s own attempt, where he observed: “In the great dice game of existence, [the world] must pass through a calculable number of combinations. In infinite time,

every possible combination would at some time be realized; even more, it would be realized an infinite number of times.” Since this implies that we aren’t just repeating *one* path, but *all paths*, Nietzsche’s proof here loses some of its punch, but it deserves props for effort.

Nevertheless, the proofs of tradition and science were still just mental devices for Nietzsche to convince or fool the mind into believing in the eternal return and internalizing it—in order to “wish” it. As he wrote in a letter, “If it is true, or rather: if it is believed to be true—then everything changes and spins around, and all previous values are devalued.” The act of *believing* was far more important than the validity of the belief. The eternal return was intended by Nietzsche to be a normative, *existential imperative*. Like Bernoulli’s *emolumentum medium*, it was prescriptive, an internal valuation metric, and a practical guide or perspective for our actions; it was not a positivist claim. At its heart, it is even a psychological hypothesis: **“Do you desire this once more and innumerable times more?” Would you curse or kiss the demon?**

This question is at the very heart of successful investing in general, and safe haven investing in particular. The ability to answer “yes” to the prospect of experiencing the same investment return as an *eternal return* is a most powerful force and focuses the mind. **It should change the way you invest by changing your internal valuation metric: that is, the value of getting *this* path right eclipses the value of getting the expected path right.**

It’s a little unsettling to think about: You ultimately endure the weight of only one path, *the actual path*. And really grasping this unmistakable fact is what makes the eternal return thought experiment so powerful. Whether or not you actually repeat *this* path over and over again forever, if simply believing that you will predisposes you to getting *this* path right, then it has done its job. You just need to act as if you will. If taken seriously, Nietzsche’s idea can have a monumental impact,

the greatest weight—shattering and transforming your temperament and disposition. Arguably, these two sentiments are the most important things to get right as an investor.

We have just one life, but our fate is a range of outcomes. The one realized outcome is naturally not deterministic (even though our ancient ancestors would have disagreed). Against this realization, Nietzsche's demon throws down a psychological gauntlet: care more about getting it right than casually gambling with that range of fate. In Nietzsche's thought experiment, the sample size equals 1, Nietzsche's $N = 1$. His demon just wakes us up to that fact.

Thanks to multiplicative compounding—as we saw in the Petersburg game—we don't really have a series of moments that just aggregate. We don't have an ensemble of games to play, though it seems like we do. We get to select just one outcome from the infinity of the sample space. So we cannot afford much sampling error in that range of possible outcomes, and we cannot fixate on what the expected value might be. In the real world, things don't even have a defined, coherent expected value. But that is beside the point. When $N = 1$, the machinery of probability theory fails.

That's not so obvious to understand—and it's even harder to act consistently with that reality. What Nietzsche was surely trying to do was shine a bright light on the significance of *this path*—the one you're on—and ignore all the others. Own up to it: you're going to live this one path *for eternity*. So, to hell with all the other alternative paths; to hell with your guestimates of probability, expectation, and risk. No more, “Oh, I just got unlucky, but my expectation was right!” We don't have the luxury to just be right in expectation or in theory; we have to just be right. We only get one go at this, and *that's it*.

This certainly doesn't mean that expectations don't matter. The eternal return cuts both ways. Focusing on this path means not succumbing to any potential path—no matter how unlikely—that gives you a horrible expectation, just as it means not having

a great expectation that you'll rarely if ever realize. And yes, there are repeatable trials in investing; sometimes along our one path we can get many bites at the same apple. But it's not automatic. And it's far more likely that you're getting far fewer attempts or trials than you think. Most likely, you're getting only one.

It was great for Babe Ruth to swing for the fences, even though that strategy came with a career total strikeout record that stood for 30 years (when Mickey Mantle took it over). But what if he was given *just one* at bat for his entire career? Then what?

By giving all the weight to *this* path, we essentially need to have gotten pretty much every possible path right. We need to be robust to the realized path—to have “covered all the bases.” This means optimizing risk by investing in a way that, whatever happens, we can declare, as Nietzsche exhorts, “Thus I willed it!” When it comes to the function of risk mitigation in an investment portfolio, what better statement could there be?

INTO THE MULTIVERSE

Think of the opening line to that Robert Frost poem “The Road Not Taken” (a poem which my dad always reminds me of, still):

*Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood*

Are we sure we cannot travel both? If we could, it would be the *opposite* of the eternal return. What would it mean to act as if we could?

Consider a tweak to our last thought experiment. Let's say that, the next day or night, much to your chagrin, another

demon steals after you again, into your loneliest loneliness. This time, he tells you that, rather than reliving this life once more and innumerable times more, you are going to live an innumerable number of *parallel, alternate lives*—all at once and at the very same time. “Don’t believe that other demon from the night before,” he snarls. “Instead of living just one life repeatedly and infinitely, you’re actually going to live infinite lives, each one branching off, side-by-side.”

You are your own Schrödinger’s cat, the thought experiment concocted in 1935 by Austrian physicist Erwin Schrödinger, whereby events branch off in such a way that a cat trapped inside a box and randomly poisoned gruesomely exists both alive and dead, simultaneously. More precisely, Schrödinger’s cat is in a *quantum* mechanical state, and the accounting can get a little tricky when you try to calculate all of the potential dead and alive states of this poor, abused (thankfully, hypothetical) cat. But mathematically it’s perfectly valid.

According to this new demon—let’s call him Schrödinger’s demon—you, too, will experience both joy and pain, life and (God forbid) death, all simultaneously. You will be living in what has come to be known to physicists as the *multiverse*. Like the eternal return, it is another hypothetical concept of reality and time, one where infinite multiple universes coexist. In this version, starting right now, a new universe is spawned with everything that happens to you—“everything unutterably small or great,” whether it’s your luck randomly turning a different way, your next decision changing, or whatever. Every new fork in every new path is followed by another copy of you—your doppelgänger. Instead of Nietzsche’s circle, time is now a tree with infinitely many tangled branches. The multiverse is the entire sample space of all the branches and all the ways that things could have happened.

This notion of the multiverse is supported by science and is even indirectly, experimentally testable, in a way that is ironically very similar to Nietzsche’s own “great dice game of existence”

proof of the eternal return. Here, quantum mechanics imagines a thrown die landing on all six sides simultaneously. It's just like from Nordic lore, where a rolled die miraculously splintered into six pieces, such that all six sides turned up on the same roll. While we see just one side land from the narrow perspective of our own universe, there are five other branching universes, each with their own alternate outcome. Each quantum roll of the die becomes a new branch point, creating an endless proliferation of ever-splitting branches of parallel, alternate universes that become the infinite multiverse. And that's what Schrödinger's demon claims you will experience.

Sound crazy? Well, consider this: from this perspective, you'll actually know what it feels like to *be* the casino, to get to run repeated, concurrent trials of your life's rolls of the dice, over and over again for eternity. No more good or bad luck, no more sampling error, just one realized expectation across the multiverse. You can make sound decisions based on that expected value, as you get to experience every possible path.

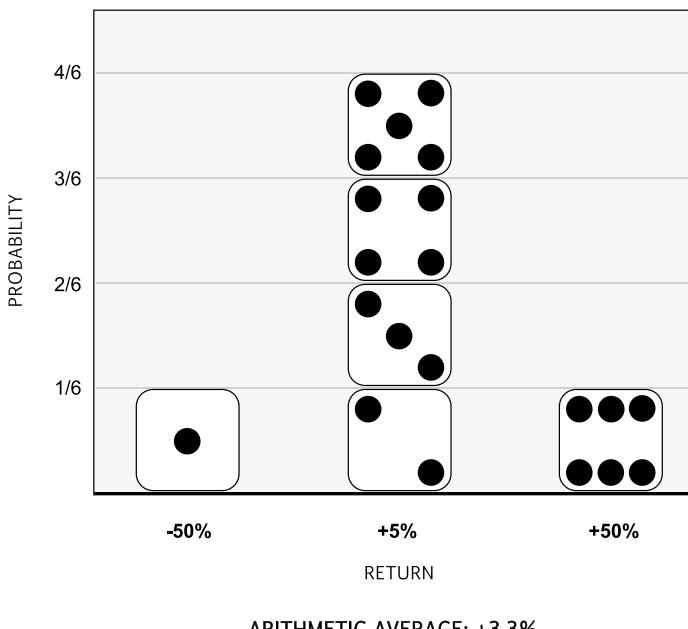
These two perspectives from our two opposing demons parallel the opposing perspectives of probability itself—the single subjective trial vis-à-vis the many frequentist trials. Which demon do you believe, and how does your choice affect your approach to life and to your investing? Is your choice a decisive factor in the way that you would invest, and, most importantly, your likely results? We need to understand both perspectives, as Nietzsche meant for his eternal return to be used, as hypothetical tests to shape the way we live.

DICE WITH SCHRÖDINGER'S DEMON ($N = \infty$)

Following your two demonic encounters, you find yourself seated at a table with a big stack of cash in front of you—your bankroll of entire life savings. Schrödinger's demon sits down across from you and offers you a wager for your stack of cash:

You'll roll a fair six-sided die (which he happens to have on him) once, and if the 1 comes up, you pay Schrödinger's demon 50% of what you have there on the table; if the 6 comes up, he pays you 50% of what you have there on the table. Otherwise, if a 2, 3, 4, or 5 comes up, he pays you 5% of what you have on the table. Here is a diagram of the payoff profile for this wager:

Demonic Dice Payoff Profile and Probability Distribution



This is sort of a toned-down version of our simplified Saint Petersburg dice game from the previous chapter, only we are now wagering *all* of our wealth in this case (we just don't lose it all with a bad roll, just 50% of it). Here, the dice are stacked on top of each other to indicate that more than one die face corresponds to a specific return. In stacking the dice in this way, this payoff profile depiction now also happens to display a nice *discrete probability distribution* of each roll during the game. Each die

face represents a 1/6 equal probability, so when we stack them above their corresponding return outcome, their height neatly represents the probability of that discrete return. For instance, your 5% win occurs with 4 of the 6 die outcomes, so that tower of dice indicates a 4/6 probability of that outcome.

So how does this bet sound? It's nice and symmetric, with an obvious edge to you from that extra 5% that you should make two-thirds of the time. But let's calculate your exact edge, or your expected value from rolling the die.

First, you'll naturally want to ensure that the die is *square*—he is a demon, after all. Thanks to Jacob Bernoulli's Golden Theorem, we know that, if the die is fair, then the more you roll it the more, in aggregate, each side should come up 1/6 of the time. You check this by rolling the die 10,000 times—it's okay, the demon will wait—and find that you get within 0.01% of 10,000/6 of each of the 6 numbers coming up. All good there.

Next, you can calculate the arithmetic average across the sample space of your six equally likely rate-of-return outcomes to arrive at your mathematical expected rate of return for this bet:

$$(-0.5 + 0.05 + 0.05 + 0.05 + 0.05 + 0.5) / 6 = 0.033$$

You expect to make 3.3% with one quick roll of the die. This is a pretty darn good expected return on your money. A mathematical edge like that (completely uncorrelated with the market) would make you the envy of the entire masters of the universe hedge fund community. What's more, you're playing against Schrödinger's demon, and his house rules apply: You will experience all six sides of the quantum die, simultaneously, across the multiverse. You are literally *guaranteed* this 3.3% return on every single roll, a simple arithmetic average.

This is critical, so let me emphasize how it works: On each roll, Schrödinger's demon's game looks at the outcome in all six possible universes, and then takes the arithmetic average

across all those six outcomes for the amalgamated outcome; you simultaneously experienced equally all of the good and bad rolls (like the splintered die showing all six sides on the same roll, and Schrödinger’s cat both alive and dead at the same time). This is why I say you are literally guaranteed that 3.3% return on each roll, because infinite copies of yourself experience every possible outcome on each roll, and Schrödinger’s demon pays you according to the simple average across these outcomes. Your $N = \infty$.

With such a setup, why not let it run? Repeat this lucrative game over and over with that poor sap of a demon. And, just your luck, Schrödinger’s demon is not so good at simple math, so he takes that wager. You agree to play the game 300 times, settling up after each roll, and then continuing on with the next one. You aim to compound your capital through multiplicative growth—what some say Einstein called “the eighth wonder of the world,” and even “the most powerful force in the universe.” (Though there is an absence of evidence supporting these attributions, that’s no evidence of their absence.)

For simplicity, we will assume that you start with a total wealth of 1 unit of something (it could be units of dollars, franc, ducats, or whatever, and hundreds, thousands, or millions thereof). Your wealth after the first roll would be 1.033 from your guaranteed 3.3% return; this 1.033 is your total return (as in $1 + 0.033 = 1.033$). Like we did with the Petersburg merchant, we can then calculate the recursive geometric progression of what happens to your starting stack of cash after each roll of the die by sequentially multiplying each total return ratio by the next, one at a time. (As we know from basic probability theory, the expected value of the product of random independent variables is simply the product of their expected values.)

So, your wealth after 300 rolls against Schrödinger’s demon would be:

$$1.033 \times 1.033 \times 1.033 \times \dots = 1.033^{300} = 18,713$$

Look at that. Compounding your 3.3% expected arithmetic return 300 times leaves you with almost 19,000 times your starting wealth, on average. (If you started out with \$1,000, that means the mathematical expectation of your ending wealth from playing this game 300 times is almost \$19 million.) This astronomical number is precisely what you expect to—and, in this case in fact, *will*—make across all of the possible paths of the quantum die—all six splintered sides coming up—across the breadth of the multiverse. Looks like that Einstein was a genius.

DICE WITH NIETZSCHE'S DEMON ($N = 1$)

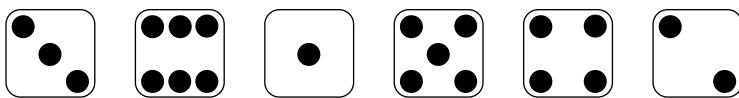
Nietzsche liked the dice analogy, not surprisingly, as he elevated what he called the *Dionysian* ideal of play. He saw life as a dice game, “the great dice game of existence.” He wrote of Zarathustra playing “dice with the gods at their divine table,” and of the dice falling back to be thrown again and again, eternally returning. Thus, they represented what Nietzsche took to be his greatest insight.

So, it is appropriate that Nietzsche’s demon shows up again and wants to play. He takes the place of Schrödinger’s demon across the table from you, and offers you the same dice game, playing for that stack of cash of yours. But now, Nietzsche’s demon’s house rules apply. Rather than experiencing all six sides of the splintered die for every roll in the multiverse, you experience just one side for each of the 300 rolls, and only one path. (And, lest you forget, you will relive that exact same 300-roll path for eternity.)

Now you have to really think things through. The game was so much simpler in the multiverse. Here, you’re back to living in the messy world of just one universe, where with one roll of the die you won’t always actually receive that 3.3% average. In fact, in this case you *never* will because it was purely theoretical. You *either* make 50%, make 5%, or lose 50%, nothing in between. It’s not as bad as the Petersburg wager, but that’s still

a lot of sampling error, which means risk. One-sixth of the time, your net worth actually gets cut in half, and that kind of risk is probably unacceptable to you. But then you think of old Jacob Bernoulli again and it occurs to you that, when you keep playing this game over and over with independent rolls, you should quash the randomness and realize your expected fat edge. Just as his Golden Theorem assured you that the die is square, so it can assure you that, with enough rolls, you can expect each side of the die to come up about one-sixth of the time. Whew, you were entertaining some scary thoughts there for a second (as if playing dice with demons wasn't unnerving enough). And so, your confidence is restored that your average return across all these rolls will converge to 3.3%. You feel as if you are back once again living placidly across the multiverse.

It's a comforting thought but, on closer inspection, something looks awry. For instance, let's say the outcomes of your first six rolls are as follows:



Your wealth (or total return) after the first roll here would be 1.05. After the second roll, your wealth would be $1 \times 1.05 \times 1.5 = 1.575$; by the sixth roll, it would be:

$$1 \times 1.05 \times 1.5 \times 0.5 \times 1.05 \times 1.05 \times 1.05 = 0.912$$

And this is after, in this case, each side of the die randomly turning up exactly once. It would seem that this should be something like your average, right? And yet you're underwater? For the full 300 rolls, you would, of course, continue these multiplicative steps all the way to your ending wealth. (This is what is known as a *geometric random walk*.)

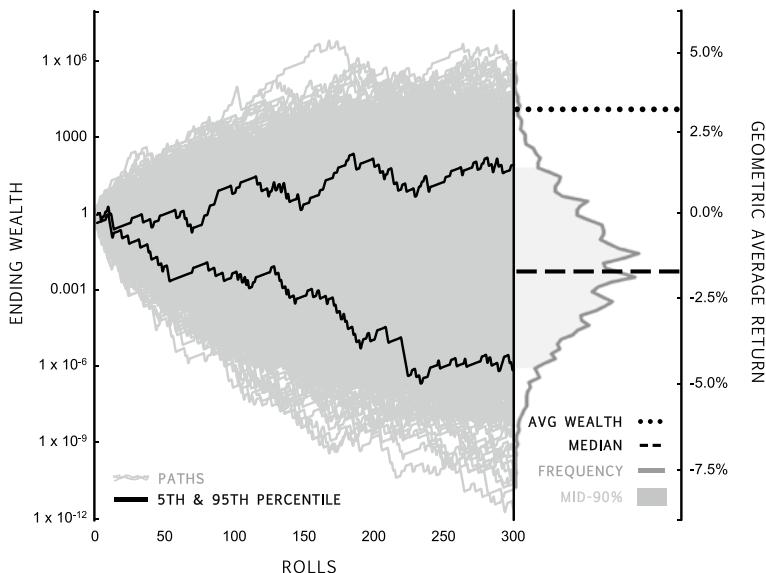
Something to note from this multiplicative compounding example: Because each subsequent return is multiplied by the

next, and thanks to the commutative property of multiplication, it doesn't matter when that 50% loss happens. Whether the side with a 1 comes up in the third or the last roll, the effect on your final wealth is the same.

Clearly, things have changed with Nietzsche's demon: *This time* you get to randomly select only *one* path—not *all* of the potential parallel 300-roll paths in the multiverse. It now appears that your sample size has really collapsed from infinity down to 1 ($N = 1$)—and that's scary.

Here are each of those games played out ten thousand separate times, shown as a cloud of separate individual diverging paths. Think of this cloud as a representation of the sample space of outcomes across the multiverse. The frequency distribution of these ending wealth outcomes is shown at the right, corresponding to the ending values of each respective path.

You Get What You Get, Not What You Expect



You will traverse only one of these paths. Better pick a good one!

Note that the y -axis is logarithmically scaled so that we can better see the compressed data. As we can see, that nice expected value of your ending wealth being almost 19,000 times what you started with—the outcome you were guaranteed by Schrödinger’s demon—is actually an incredibly rare event when playing against Nietzsche’s demon. It isn’t even within the shaded middle 90% *confidence interval* of possible outcomes, which spans the 5th to the 95th percentile values. In fact, **your probability of ending up with 19,000 times your starting wealth or greater is a mere 0.5%.**

So what happened? The culprit is time and multiplicative compounding. You end up with a distribution of potential ending wealth outcomes across many different 300-roll games, which is highly positively skewed—meaning there are disproportionately very many outcomes with very low values and very few outcomes with very high values. The latter are so high that they really raise the total distribution average. (The logarithmic scaling in the graph makes this positive skewness harder to see, such that the distribution looks symmetrically bell-shaped, but it’s there if you look at the y -axis values.) **The bottom line: when you only get to realize one path, that expected ending wealth is a very rare event, indeed, and clearly not very expected.**

THE HUSTLE OF NON-ERGODICITY

Setting aside our demons, this is a real-world problem. When you roll the die 300 times, you would rightly expect to see each of its six sides come up about 50 times. The problem is that expectation just doesn’t translate quite so obviously into your theoretical expectation of ending up with 19,000 times your starting wealth. Here’s the geometric progression of those expected 50 rolls landing on each side of the die:

$$0.5^{50} \times 1.05^{50} \times 1.05^{50} \times 1.05^{50} \times 1.05^{50} \times 1.5^{50} = .010$$

This logic seems to imply that you will be left with an ending wealth of essentially zero. That's right. With the expectation of equal outcomes from each side of the die, your compounded wealth—your stack of cash, your entire life savings—would be 99% gone to Nietzsche's demon. What happened to those expected 300 rolls that won you 19,000 times your starting wealth across the multiverse? **With Nietzsche's demon (who annoyingly reflects what happens in the real world), you are not likely to get a very good eternally recurring fate.** Multiplicative compounding looks more like a *most destructive force in the universe*. (That Einstein—so overrated! And the Golden Theorem—not so golden!)

Recall from the previous chapter that the geometric average of the 300 returns in this geometric progression is just the 300th root of their product, or $0.010^{1/300} = 0.985$, or a -1.5% compound growth rate.

And we know that this 0.985 geometric average total return per roll is the same as the Bernoullian expected value of the wager, or the geometric average across just one roll's six possible returns:

$$\text{BEV} = e^{\frac{\log(0.5) + \log(1.05) + \log(1.05) + \log(1.05) + \log(1.05) + \log(1.5)}{6}} = 0.985, \text{ or a } -1.5\% \text{ compound growth rate}$$

This is more evidence that the expected geometric average return of a single wager gives you the same expected geometric average return as valuing it as an eternally compounding wager—regardless of what you actually plan to do. This is the cool, intuitive shortcut of Bernoulli's logarithmic objective function.

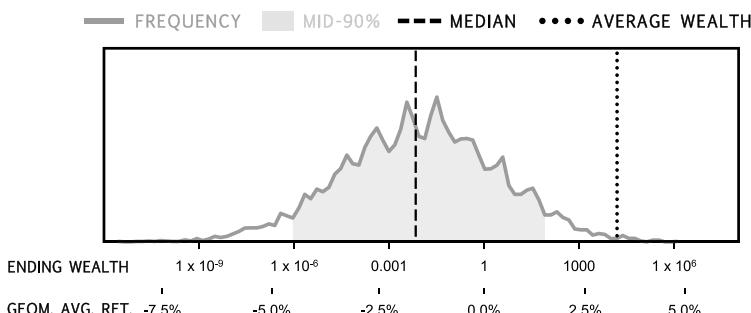
However, there is an even more direct and intuitive way to think about this, as there is a third equivalent way to calculate that -1.5% expected compound growth rate per roll. As it turns out (under fairly robust statistical convergence), the ending wealth that corresponds to -1.5% compounded 300 times (or $0.985^{300} = 0.01$) is also the median ending wealth outcome. That's what you get at the bullseye, or the value right *in the middle* from playing

the game, across the multiverse of all possible ending wealth outcomes (or Bernoulli's literal "in the middle profit"). It makes sense, if you think about those expected 50 rolls landing on each side of the die; that is your median roll outcome (where half of the possible roll outcomes realize more rolls landing on any given side and half realize less), so it stands to reason that it should produce your median ending wealth outcome as well (where half of the wealth outcomes are higher and half are lower).

You needn't get all geeked up over this mathematical nuance. But you do need to remember this conclusive point (which is summarized on the following chart): **The most intuitive way for us to think about the meaning of the expected geometric average return and, equivalently, the geometric average ending wealth outcome under multiplicative growth (like our dice game) is simply as the expected median ending wealth outcome.**

And in our dice game, the probability of exceeding the median (which, by definition, equals 50%) is far greater than the chance of exceeding the arithmetic average. So you can see why the geometric average return, rather than the arithmetic average return, is closer to what you should expect from one random sample from all possible ending outcomes.

The median ending wealth, the expected log of ending wealth, and the median and expected growth rate all correspond to the same thing.



Which is better: maximizing your expectation of wealth that you never actually expect to realize—or maximizing your expectation of your *growth rate of wealth* corresponding to your median of ending wealth that you actually do?

When playing dice against Schrödinger's demon, when $N = \infty$ across the multiverse, we care about the average across the multiverse. When playing our single game of dice against Nietzsche's demon, however, when $N = 1$, we care about only one path. More to the point, we really care about the one path that we are likely to get. To insulate ourselves from luck, we need to care about lower percentile paths like, for instance, the median.

When playing against Nietzsche's demon, you might think that there's some sort of hustle going on. Perhaps like the deceptive variance in poker or backgammon (how I miss the Mayfair Club in the 1990s), your edge was an illusion—there only to keep the fish playing. No, the edge is still there, it's just made to be exceedingly rare. You can think of this as a deceptive sort of vigorish or tax being levied on your median (or geometric average) wealth by this real-life demon. It is a tax extracted by the multiplicative dynamics of compounding, what I have dubbed the *volatility tax*—and it is a most *insidious wealth tax*. It is the geometric cost to your wealth when it plunges down the logarithmic Bernoulli Falls. The further you go, the harder it is to claw your way out. But to those who live only in arithmetic space, it is an entirely hidden tax.

In probability theory, a random process is called ergodic when its arithmetic average across the sample space of all possible outcomes over a period of time (known as the *ensemble average*) is the same as its geometric average outcome over that same period (known as the *time average*).

But let's not overthink this, and let's keep it simple: Non-ergodicity effectively just means that your average outcome is much higher than your median outcome; so, your distribution is very positively skewed. Focusing on that average means you are focusing on something that, unlike the median, you expect to exceed less than (and sometimes far, far less than) half of the time. That's it.

The multiverse, then, is ergodic—as you actually experience the arithmetic average return compounded over time (and the average outcome is thus the same as the median). But none of us lives in that ergodic multiverse. Only with Schrödinger's demon do we get to experience the average return across many 300-roll games. Alas, we are not a casino. Rather, we are more like a single lottery ticket (though, in this case, one with a very positive edge) as we stand in just one universe, experiencing only one 300-roll game.

The eternal return is clearly highly non-ergodic. Even when we have many compounding steps, or 300 rolls of the die, because of non-ergodicity our N still equals 1. We should feel *the greatest weight* from that.

To sum it up here briefly, the two demons' perspectives are mutually exclusive and collectively exhaustive; we have to accept one or the other. Our expectation formed from the multiverse return won't tell us much about what to expect from the eternal return. And, of course, the latter best represents our reality. The frequentist perspective of the multiverse is an illusion, and it will therefore abjectly fail us; it will fool us into doing the wrong thing.

Like the Bob Dylan song goes, “Tomorrow is never what it is supposed to be. Thanks to non-ergodicity.” Or something like that.

MAGIC TRICK OR MATH TRICK?

The big advantage to the geometric average return calculation is that it avoids the non-ergodicity problem; it actually maps and tracks the evolution of your capital base through time, something which is lost within the arithmetic average. The geometric return actually *is* your capital base—it directly translates from returns to wealth. With the arithmetic return you also need to know what the path looks like in order to make that translation; it is *path dependent*. The capital base is the stake—the very thing that returns are *built on*, so modern finance’s focus on returns while ignoring what they mean for that capital base is just nonsensical. It’s shortsighted and naïve; it’s as if time is irrelevant, and “everything happens at once.”

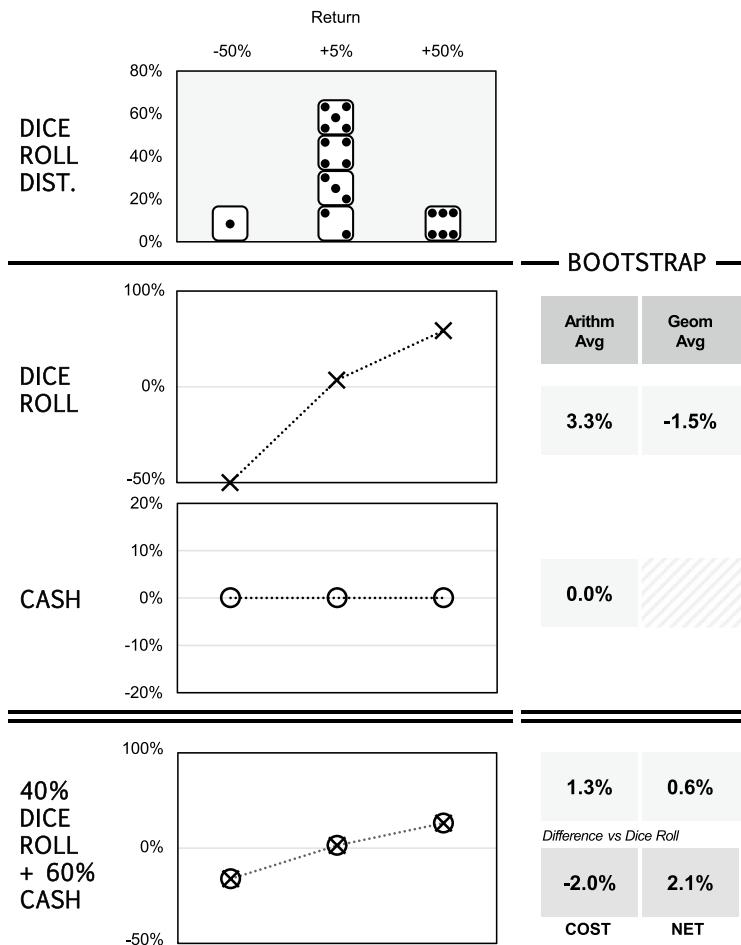
It’s like a farmer focusing on crop yields while ignoring soil degradation. Oops, most do that too through modern industrial agriculture’s reliance on monoculture crops, chemical fertilizers and pesticides—except, of course, for those of us who practice regenerative agriculture (such as rotational grazing).

But when you shift your focus to that capital base and the geometric average of returns, magical things can start to happen.

So, can you do the same thing with your demonic dice games, something a little more *regenerative* (like those farsighted farmers preserving the soil)? Let’s say that, instead of always going all-in on each roll, you only bet 40% of your total remaining cash on each roll. You keep the remaining 60% on the sidelines earning nothing, and this means that you are cutting by 60% your previous 3.3% expected average return each roll. On the following page is a diagram of this new *risk-mitigated* payoff profile.

This “Xs and Os Profile” diagram is going to be crucial throughout this book. We will eternally return to it as we examine different case studies. So, it is very important to

Xs and Os Profile: The Kelly Criterion



understand it. It shows the basic delineation among the moving parts of a risk-mitigation strategy and how they interact. And best of all, it shows the net portfolio effect by aggregating and framing these parts correctly and coherently into a whole, all on the same page, as a *risk-mitigation scoreboard*. It literally shows the Xs and Os of risk mitigation.

Notice what's going on in it. We are melding the main dice game payoff profile (the Xs) with the cash payoff profile (the Os) and getting a combined payoff profile (the \otimes s). If we just apply Bernoulli's *BEV*—or the exponential of the average logarithmic return—to this combined profile, then you get the geometric average return equal to the median geometric growth rate if you compound this wager 300 times, and repeat that path 10,000 times.

By simply betting less of your stack each roll, your arithmetic average return *falls*, predictably, from +3.3% to +1.3%; think of this as your arithmetic cost. Before you get disappointed, though, think about what we just discussed (that non-ergodicity stuff). The arithmetic average is not where we focus our attention; rather, it's all about the geometric average return that reflects what happens with compounding.

Your geometric average return *jumps*, surprisingly, from -1.5% to +0.6%; this is your net (portfolio) effect from this combined strategy. This is more than a little perplexing, a mathematical oddity. From our previous experience, it seemed as if playing this dice game was a bad idea, at least according to the rules of Nietzsche's demon. But now it looks like we're saying it's a great game to play, so long as you only risk a portion of your wealth each roll. What gives?

When playing against Schrödinger's demon in the multi-verse fantasyland, using our suggested risk-mitigated betting strategy, your ending wealth after 300 rolls falls to 53 times your starting wealth, rather than 19,000; you experience only that arithmetic cost. But when playing against Nietzsche's demon, your expected median (or geometric average) ending wealth jumps from about zero to about 7 times your starting wealth; you experience only that net (portfolio) effect. Each demon clearly has a different scoreboard, and Nietzsche's is the one that matters in the real world.

Our suggested betting strategy is an example of what is known as the *Kelly criterion*, dating back to 1956, and named after John Kelly, who was a researcher at Bell Labs. Kelly came

up with the criterion as an extension of his colleague Claude Shannon's concept of information entropy (or the degree of information or "surprise" within a crackly communicated message). Kelly's simple formula sized gambling bets based on one criterion: maximizing the expected geometric average of ending wealth (even at the expense of the arithmetic average). You could think of it as formalizing what Daniel Bernoulli first demonstrated back in 1738. And it was first applied formally to the world of investing by Henry Latané in 1959, though abjectly scorned. (Of the two, only Latané read and was heavily influenced by Bernoulli and his paper that was recently translated at the time.) My dice game examples in this chapter very much piggyback on Latané's important work, specifically; Latané was a trailblazer, and deserves so much more credit in investing than he ever gets.

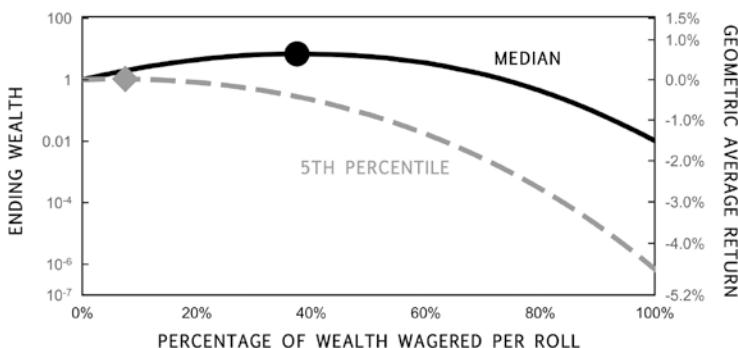
Since then, others have carried the ball for Bernoulli, Kelly, and Latané. There was John Burr Williams in 1936 (perhaps the first to emphasize geometric mean maximization since Bernoulli) and Leo Breiman in 1960 (who showed that a geometric mean maximizing strategy both minimized the time to reach a target level of wealth and maximized the level of wealth reached after a given amount of time—and who wouldn't sign up for that?). Ironically, even Harry Markowitz, the original architect of modern portfolio theory in 1952, had become a proponent of the geometric mean criterion by 1959 (and very much so by 1976); but it was too late, as his modern portfolio theory framework had already taken hold—and the rest is history. Perhaps most notable was the magisterial work of Ed Thorp, who has both written about it and put it into practice since the 1960s. Much more recently, Ole Peters has written exhaustive and insightful papers on non-ergodicity's implications for economic theory. And, of course, Nassim Taleb took up the point in his 2018 book *Skin in the Game* of the non-ergodicity of the one-period ensemble average versus the multi-period time average. (As Nassim wrote, "more than two decades ago, practitioners

such as Mark Spitznagel and myself built our entire business careers around...the effect of the difference between ensemble and time." That pretty much sums it up.) For a good, not-too-technical read on all of this, see the 2005 book *Fortune's Formula* by William Poundstone; by 2005 I had already long been up to my neck in all of this, and yet it further opened my eyes to the implications of this simple distinction.

All three of our triad, Bernoulli, Kelly, and Latané, had their own spin—as well as those who have carried it on. But each points to the very same geometric mean maximizing criterion of our Petersburg merchant trade.

Kelly's exact formula here isn't even important; it won't translate very well into the much more nuanced real-world distributions of financial markets anyway. Your roughly 40% Kelly-optimal bet size in this dice game can be conceptually found here by moving around the weights in the previous diagram and recalculating the geometric average return or median ending wealth for each weight. (Recall that this is very similar to the iterative search that we did to find the fair value of the Petersburg wager.) The weight with the highest median ending wealth is the Kelly-optimal bet size. Let's keep it simple. Here is the graph of that relationship:

Finding the (Kelly) Optimal Bet Size



It seems the Kelly criterion could be more descriptively called the Goldilocks criterion; it must be *just right*. Setting aside too much of your cash is a bad idea because you aren't betting enough; it's too conservative. Not setting aside enough cash is also a bad idea because you're betting too much; it's too aggressive. Somewhere in between—in this case, just under 40%—is just right. (Don't think that this contradicts the unhappy medium of our great dilemma of risk; it doesn't, as you will see in later chapters.)

This also shows why, in case you were tempted, you can't just bet $1/300^{\text{th}}$ of your wealth each toss, and thus receive the arithmetic average across 300 tiny bets. Well you can, but it would be a waste of time. Only a casino can do this by dicing its bets up each period (diversifying its risk, Daniel Bernoulli-style), not just dicing them up across time, because it has so many independent, simultaneous rolls of the dice available to it each period. But you don't have a room full of Nietzschean demons to play simultaneous, independent games against. (You are not a casino.)

One might say that there is a certain arbitrariness to selecting the 50th percentile to maximize. It could seem rather chauvinistic toward other percentiles. The other, lower curve on the graph shows what happens to the 5th percentile ending wealth outcome (the lower bound of the shaded middle 90% confidence interval in previous graphs), meaning the level of wealth that 95% of the time you expect to meet or exceed. That curve peaks at just under a 10% bet size, a much lower percentage of wealth per roll than the almost 40% where the median curve peaks and then falls off precipitously, while the median ending wealth curve has more room to rise with higher bet sizes. The Kelly criterion weighting maximizes the median outcome, though not the really bad outcomes. **You can see why professional gamblers often employ a “fractional” Kelly bet size, which effectively maximizes arbitrarily lower percentile outcomes like this 5th percentile curve (which is maximized at about a quarter-Kelly), at the expense of the median outcome.**

This 5th percentile outcome is known in the investment industry as *value at risk*, or the 5% VaR. In our case, where the sample space of outcomes is well defined, this 5% VaR is an excellent way to define the degree of risk in the game. After all, we defined risk as exposure to bad contingencies, or these worst potential paths. So think of these worst paths as Graham's margin of safety; the higher that 5th percentile outcome, the greater the margin of safety, and the safer the wager.

In the real world, of course, these bad outcomes are not so well-defined. There is a spuriousness to the measurement of a portfolio's VaR, and an extremely naïve lack of robustness to its estimation, to the point that its use can do far more harm than good when actually relied upon. This will be a very important point for us in later chapters. But for our dice games, the 5% VaR is an ideal proxy for risk.

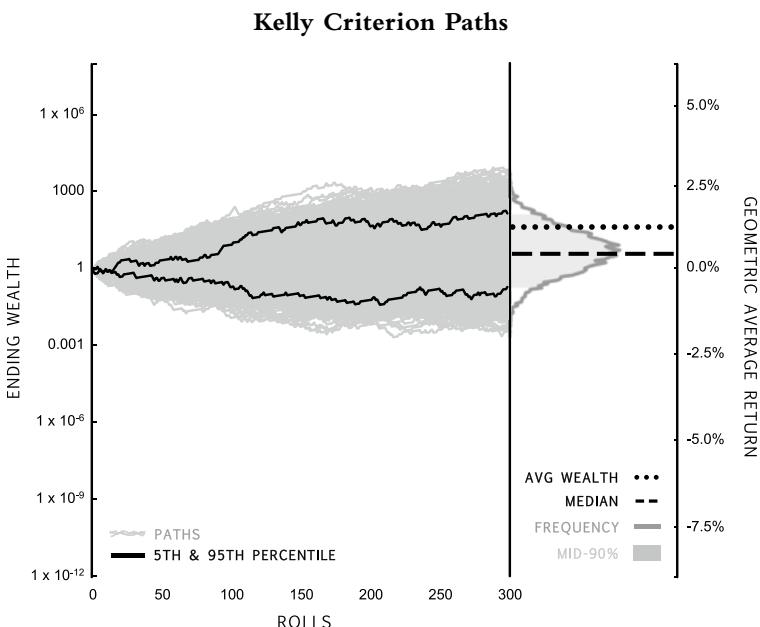
As we can see, beyond the Kelly optimal bet size, it gets far riskier, and too much of a good thing is not such a good thing. You can overplay your hand, and thus creep too close to the edge of Bernoulli Falls. **Yet, curiously, the tools of modern finance would insist that leverage is basically always good when the expected arithmetic returns are positive like this. After all, leverage simply raises the arithmetic average, or expected return, and it doesn't affect the ratio of the average return to the standard deviation of those returns.** (A plot of the Sharpe ratios overlaid on the previous chart would simply be a horizontal line—more free money for all as leverage increases, meanwhile ending wealth plunges.) And less risk would always only mean less return. What a disaster those superficial, pseudoscientific tools are! Leverage can indeed kill the golden goose. (Just ask the investors of the hedge fund Long Term Capital Management.)

Now think about this for a second. If setting aside 60% of your stack of cash raises your end-point wealth from 0 to 7 times your starting wealth over 300 rolls, then in a vacuum you could reason that the rate of return on that cash must have

compounded at a fixed 0.8% on each toss—like a fixed annuity. But in fact, our sidelined cash did not earn any interest in the game at all.

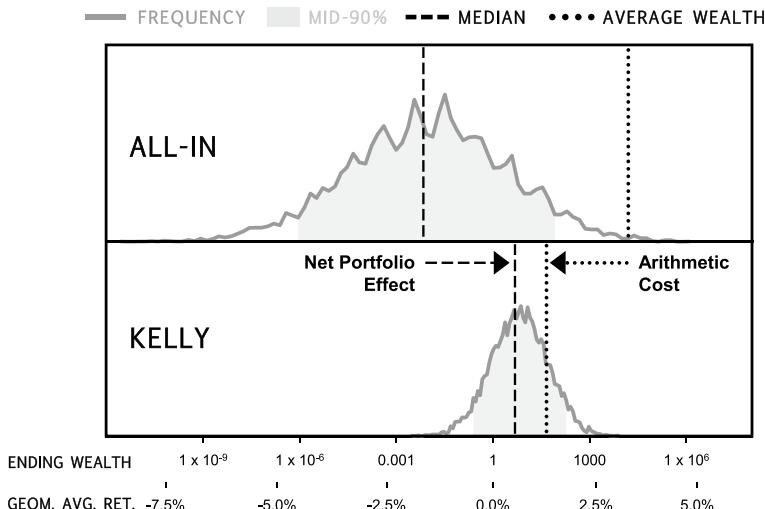
How does Kelly pull a higher geometric return rabbit out of a lower arithmetic return hat? Is it a magic trick, or is it just the plain, ordinary mathematics of compounding? The answer is that it works by altering the nonlinear, multiplicative dynamics of the game—in other words lessening the pain of bad contingencies (the pain of the concavity of curve) in a way that raises the median contingency. Under multiplicative dynamics, it's really hard to recover from big losses.

And another good measure of the improvement from moving to the Kelly optimal weighting from a larger bet size is the improvement to that 5th percentile outcome that we saw in the previous graph. Here we can see it even clearer in a new, risk-mitigated distribution, using our new Kelly betting strategy:



And here's a better look at the two frequency distributions, the all-in bets next to the 40% Kelly-sized bets, side-by-side:

Arithmetic Cost vs. Net Portfolio Effect: The All-In Bets vs. The Kelly-sized Bets



The interesting thing is that the arithmetic average return is lowered (visible in the arrow pointing to the left), and everything else being equal that would also lower the geometric average return. But the geometric average or median return is actually raised, in what we will call the net portfolio effect (visible in the arrow pointing to the right). **There are really two contrary forces acting on our distribution of outcomes: a visible one lowering it—the arithmetic cost—and a hidden one raising it—the geometric effect. When the latter is greater than the former as it is here, the result is a positive net portfolio effect and *cost-effective* risk mitigation. The tension between these two often hidden forces is at the very heart of safe haven investing.**

The pickup in the median wealth from the Kelly betting strategy is clear—it is what is being maximized, after all. But you can see that it raises the entire distribution. The 5th percentile

outcome (at the lower end of the middle 90% range of outcomes), for instance, has risen from essentially zero to about 0.3.

Think of this, again, like an archer slinging arrows at a target. Kelly seeks to get your median arrow closer to the bullseye (as in higher wealth), or more accurate. And, in the process, it tightens the shot grouping, meaning the range is narrower or more precise. There are fewer fliers (stray arrows) than before—less entropy, less required luck. But they are not gone. The fliers aren’t what Kelly optimizes. Imagine William Tell—the fourteenth-century Swiss folk hero and expert marksman who led the Swiss Confederacy’s rebellion against their Austrian oppressors—forced to shoot the apple off his son’s head. He can miss, but only in one direction, and the stray arrow matters at least as much as his median arrow. He aims to minimize his exposure to bad luck. **William Tell’s shot requires both precision and accuracy—aim small, miss small. (Contrast this with maximizing a Sharpe ratio by increasing precision at the expense of accuracy.)**

Those remaining stray arrows are a fair criticism of the aggressive Kelly betting strategy, as it still has an abundance of risk. That 5th percentile outcome of 0.3 means a 70% loss—so a lot of bad things can still happen between the 5th and 50th percentile of our new shot grouping. Because of this, some have even cynically called it the *Kamikaze criterion*. The economist Paul Samuelson was particularly contentious of the Kelly criterion, and he mockingly wrote a critique of it using only single-syllable words—all that he thought his detractors could understand. A typical passage from his paper reads: “We should not make mean log of wealth big... When you lose—and you sure can lose—with N large, you can lose real big. Q.E.D.”

What is important to recognize here, which may not be obvious, is that Kelly’s system of keeping (in this case) 60% of your total wealth in reserve is the equivalent of allocating 60% of your total wealth to a *safe haven*. With each roll, that cash just sits there earning zero interest (and presumably losing no real value from inflation); it remains available to use, if you so desire, on the next roll. **All it does**

is hold its value in order to cushion a loss from the game. It is what we will refer to as a “store-of-value” safe haven.

SIDE BETS

Let us return briefly to Bernoulli's Petersburg merchant from the last chapter. We can understand his situation better in the context of our demonic dice games. We'll make a few replacements: the player of this game with the hapless merchant, the die roll with random weather and pirates, the payoff with the economic results of the ship full of cargo traversing the Baltic Sea, and Schrödinger's demon for an insurance underwriter. You can see the implications. (Our probabilities and payoffs are a little different this time, but the point is exactly the same.)

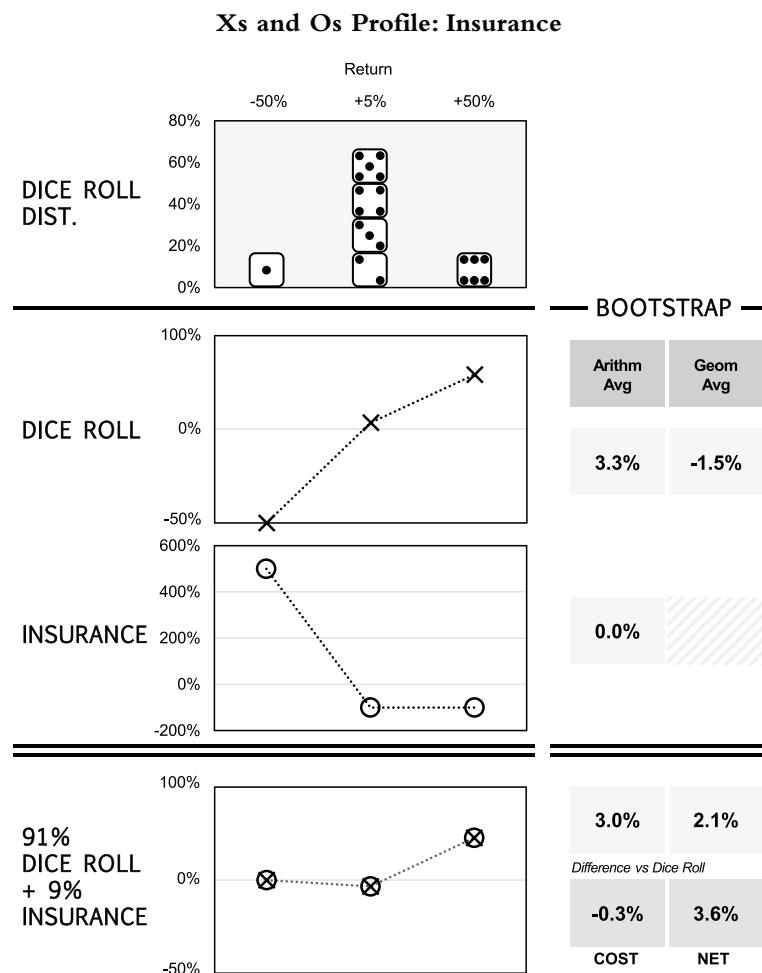
When you buy insurance on your house, for instance, your intent is for the policy to pay the cost of damage or destruction to your house, spread across many instances in the multiverse. **Insurance is, in that sense, letting you act as a casino, playing many simultaneous games against fate. The really bad fates no longer really matter, as the other good fates share the cost.**

But if setting aside a portion of capital in a safe, non-returning asset can actually raise the compound growth rate of the total, it must be because that safe asset is providing something to that growth rate other than its own particular capital appreciation. It is providing something hidden, sufficient to overcome its opportunity cost.

Since we are trying to use that set-aside cash to blunt the blow of our losses when they happen, it would make sense for us to look instead at an insurance contract on playing this game. An insurance contract is basically a side bet on the main event and is not the main event itself. It is a bet on the results of another primary bet. Like the side bets in craps or in sports, it is separate from the game itself. It is a derivative, or a contingent claim, whose value is derived from something else. (Insurance

companies take great pains to ensure that insurance payoffs aren't actual wagers, like taking out a life insurance policy on someone whose death doesn't impact you.)

Consider this diagram of an insurance side bet *risk-mitigated* payoff profile and probability distribution, where the insurance contract pays out 500% of your premium when a 1 turns up on the die, and loses 100% of the premium when any other number turns up:



Note, again, that we need only figure out the geometric average return of the combined \otimes payoff profile to find the expected geometric average return—and the median geometric return—from playing this game 10,000 times.

Compare this Xs and Os profile diagram with our previous one and you can see that the new insurance payoff replaces the old simpler cash set aside. Here, only with a roll of a 1 do you make a tidy profit of 500% on your insurance side bet. Otherwise, you lose your entire side bet. The arithmetic average of this insurance payoff, specifically, is exactly zero. (Clearly, as to be expected, the geometric average return of this payoff is -100% (as whenever you multiply any number by zero, or $1-100\%$, you get zero) as is its median return. That might not sound very good until you remember that this is in no way intended to be an all-in, stand-alone wager, as you can see. This is a side bet that acts like an insurance contract on your original wager.)

For instance, let's take that last betting scheme you had against Nietzsche's demon, the Kelly betting system, where you only bet 40% of your total remaining cash on each roll, and socked away the remaining 60% in the store-of-value safe haven of cash. Except this time, you will bet 91% of your remaining cash each roll, and you will allocate 9% to the insurance side bet. Schrödinger's demon will do you the favor of taking the other side of your insurance bet, while Nietzsche's demon will once again be your opponent in the original dice game.

Here we have yet another instance of a safe haven. **This one doesn't just hold its value, but rather provides a high *conditional return*—conditional on the results of the game—in order to cushion a loss from that game. It is what we will refer to as an *insurance safe haven*.**

This time, your expected compound return after 300 rolls *jumps* from -1.5% (which implied an ending wealth of about zero) to $+2.1\%$ (which implies an ending wealth of about 495 times your starting wealth). And yet your arithmetic return *falls* from $+3.3\%$ to $+3.0\%$. Compared to the Kelly betting strategy, the arithmetic average predictably drops less, since we are allocating less to a 0% average-returning side bet. But the

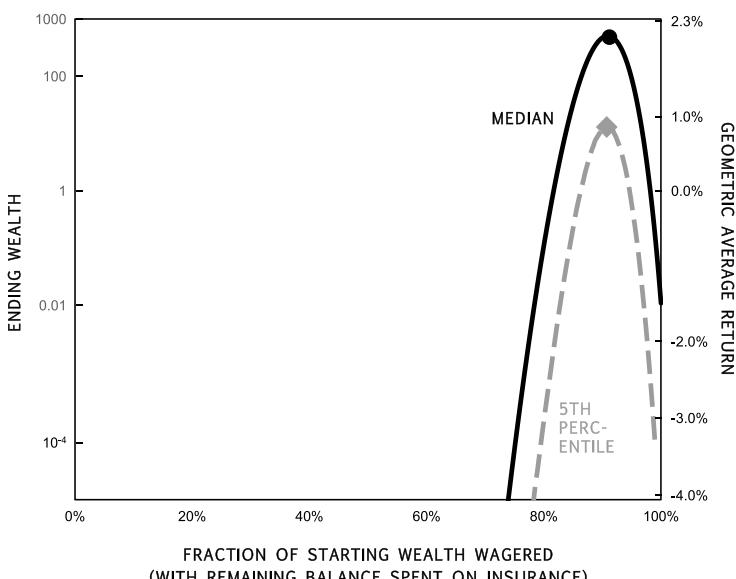
geometric average return jumps a whole lot more—thanks to the risk-mitigation effect—and as we know by now, this is the return that really matters.

And notice that, just as the allocation to cash on the side-lines each roll in the Kelly payoff earned precisely zero, so too does the allocation to the insurance side bet, on average. (It is only insurance, after all.) For this 9% allocation to raise your end-point wealth from 0 to 495 over 300 rolls, you might reason that the rate of return on that cash must have compounded at a fixed rate of 2.9% on each roll—again, like a fixed annuity. But, in fact, it earned only 0% on average.

We are pulling an even higher geometric return rabbit out of a lower arithmetic return hat.

Just as we found the Kelly-optimal weighting last time, we can find the optimal weight to allocate to insurance by moving around the weights in the preceding diagram and calculating the geometric average return of just one roll of the die. Here is the graph of that relationship:

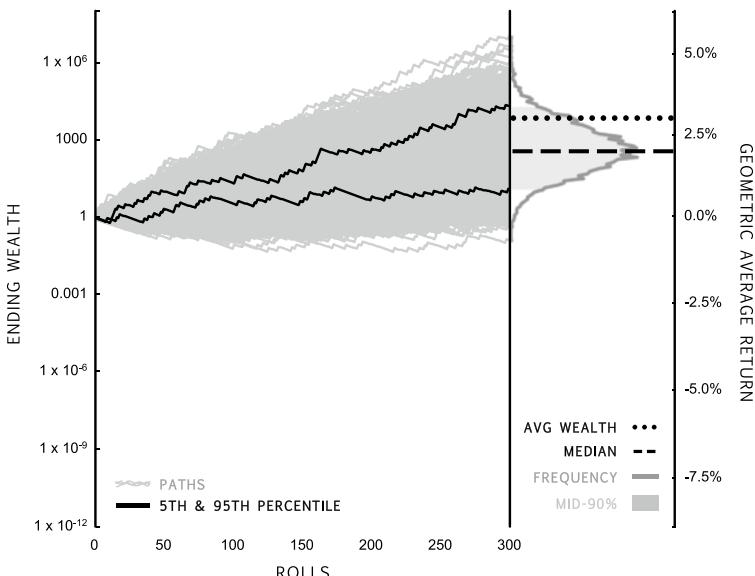
Finding the Optimal Bet Size (with Remaining Balance Spent on Insurance)



Once again, we see the Goldilocks weightings, not too hot and not too cold. You can overplay your hand. Too much of a good thing is no longer a good thing; but, for insurance, “too much” happens at a much lower allocation (or a much higher main bet size). It doesn’t take much set aside for the insurance. **It’s like a pinch of salt—just a pinch becomes the most important ingredient to the dish, whereas more than a pinch ruins it.**

But here we see that, unlike the Kelly-optimal weighting, the insurance weighting approximately maximizes *both* the median and the 5th percentile ending outcome. Moreover, by maximizing this range of percentile outcomes, you are also maximizing the likelihood of exceeding all these ending wealth outcomes—and lowering the expected time to exceed them (as we know from Breiman in 1960). Samuelson would have been most glad, as “you can lose real big no more.”

Insurance Paths: Just the Right Pinch of Risk Mitigation



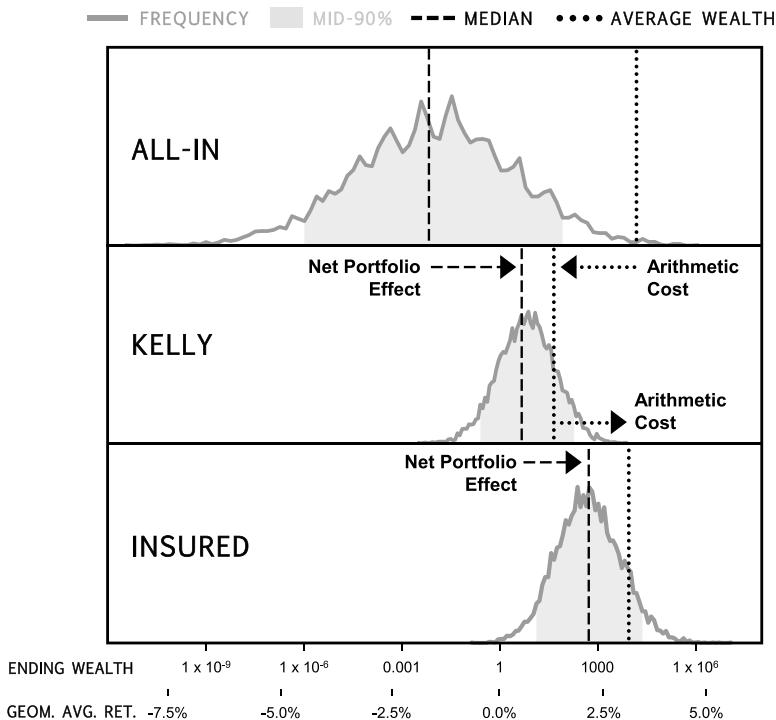
This time, we can see that the cloud of sample space paths forms a very different frequency distribution of ending wealth outcomes compared to the original game, and to the Kelly betting strategy. This fairly priced, zero-returning insurance has counterintuitively raised the median ending wealth, but, perhaps even more significantly, it has also raised the 5th percentile to an acceptable level, from essentially 0 in the original game to 20 with insurance. **It has raised, and even approximately maximized, an *interval estimate* across percentile values, rather than an arbitrary *point estimate*. Like in the Kelly strategy, you have improved your precision by tightening your shot grouping—and you have also dramatically improved your *accuracy* by moving them all much closer to the target. By aiming small, you miss small. This is the William Tell shot—both precision and accuracy, tightening and raising the entire sample space, insulating from luck.**

On the following page, we can see this advantage to the insured wager by again comparing the frequency distributions side-by-side, this time the all-in bets next to the 40% Kelly-sized bets next to the insured bets.

This time, as we move from the Kelly bets to the insured bets the arithmetic cost actually goes down (visible in the arithmetic cost arrow pointing to the right) while the net portfolio effect also further increases (visible in that arrow also pointing to the right). **This double whammy of arithmetic cost savings plus greater net portfolio effect is what's referred to as an *economically dominant strategy*—and the cost saving actually helps lead to the net effect.**

All the 50% losses from rolling a 1 have been mitigated, at the expense of a 9% cost for all other rolls. And, on average, that insurance bet just broke even. But what if we lower the insurance payoff, from 500% with the roll of a 1 to something lower—meaning we lower the arithmetic return of the standalone

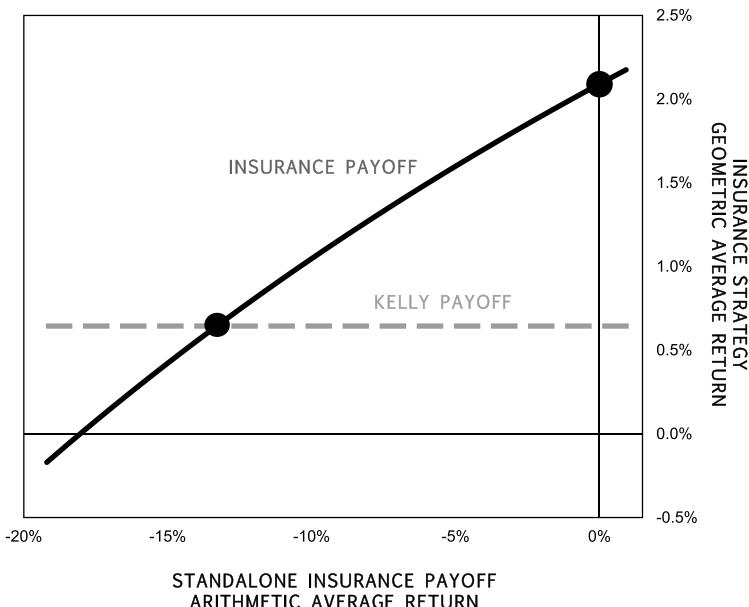
The All-In Bets vs. The Kelly-sized Bets vs. the Insured Bets



insurance side bet to below 0%, so that the insurance is profitable to the underwriter; and we will simultaneously raise the insurance weighting (above 9%) so that the aggregate wager remains fully protected (or loses 0%) with the roll of a 1. What is this insurance worth? How much would you be willing to “overpay” Schrödinger’s demon to underwrite your gambling habit?

Here is a chart of the expected or median geometric return of that aggregate strategy corresponding to different arithmetic returns of the standalone insurance side bet (using our reweighting methodology to mitigate our worst die roll):

Not Zero Sum: Median Growth Rate of Insurance Strategy for Different Standalone Insurance Payoffs



The arithmetic return per-roll of this insurance can drop as low as -13% before the geometric return of the strategy dips to the level of the Kelly weighting strategy. And with a -10% average insurance return (putting very large profits in the pocket of the Schrödinger's demon insurance underwriter, by the way), the per-roll geometric return to the insured is still as high as about 1% . This is what the Petersburg merchant never saw when considering whether to insure his cargo shipments against pirates and the sea: **insurance is most certainly not a zero-sum game.**

Perhaps Bernoulli should have instead described the logarithmic *concavity of curve* of his objective function as nature's admonition to either avoid or *insure* the dice.

A GLIMPSE OF TREASURE

Let's summarize what you have seen in our deductive games of dice up to this point. (And if you skipped the math, you can catch up here, although that means you'll just have to *trust me*, and you missed out on all the dramatic reveals—poor you!)

To start, you have seen what the dynamics of compounding mean for risk mitigation. More specifically, you have seen how the multiplicative dynamics of gains and losses, compounding one after the other, bring you to your wealth at any moment; and you have seen how changes in those dynamics through risk mitigation can impact the expected growth rate of that compounding. The bigger a loss, the more it incrementally and disproportionately lowers that growth rate, more than just the visible amount of that loss. **Not all losses and not all risks are created equal, so not all risk mitigation is created equal.**

Our aim as investors is to maximize the rate at which we compound our wealth over time on our one and only realized outcome. This is among our first principles of investing, what we now know as Daniel Bernoulli's principle of investing. And it entails raising or maximizing our expectation of the geometric average—or the median as well as, better yet, all the other percentiles—across all our potential ending wealth outcomes. To do this, we need the concave logarithmic function as our objective function. Don't plunge off Bernoulli Falls!

Put simply, we need a risk-mitigation strategy that makes our returns both more accurate and more precise, to win the bloody “war with luck.”

Best of all, you have seen the fundamental mechanism in action that does that—the mechanism underlying the Petersburg merchant trade and essentially all cost-effective risk mitigation. You have seen it in two basic safe haven strategies: the store-of-value safe haven (or Kelly-optimal strategy) and the insurance safe haven. These two strategies will represent the

two far ends of the diverse spectrum of safe haven mechanisms. As we will see in Part Two, **in the real world, when cost-effective safe havens like these actually exist—if they do at all—they fall somewhere along this spectrum. And depending on where they fall, they can be very different from each other in their cost-effectiveness.**

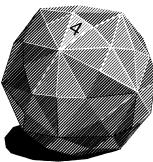
Most importantly, we now have the deductive machinery in place to establish our safe haven hypothesis.

We are on a treasure hunt. We have a compass, facing true north—to maximize our compound growth rate. We are still in search of our map leading to that elusive buried treasure. But we know we are getting close.

Part Two

What Comes After





A Taxonomy

ESSENTIALISM

What makes a safe haven a safe haven? How do we classify a safe haven from a non-safe haven, and especially a good one from a not-so-good one?

These questions go directly to the heart of our goal as investors: to increase wealth *by* mitigating risk. It's important to remind ourselves because much of the investment world would convince us that this is not possible. To their way of thinking, risk mitigation is a necessary evil—a pound of flesh, as it were—extracted in the name of prudence; it accepts bad results, all in the name of safety from bad results. So, because we believe that it is, indeed, possible to increase wealth while mitigating risk, we had best be sure that we are choosing the optimal safe haven for the job—one that can. We can't rely on the followers of modern portfolio theory to tell us; if they acknowledge the question at all, they can't answer it with the superficial tools at their disposal. And if we naïvely expect someone to hand a safe haven to us, tied up neatly in a box with the assurance of “trust me—it works,” then we might as well abandon the scientific

rigor of our demonic dice games and go find some back-alley game of craps.

No, we must do the hard work (but take heart, it's not that hard) to investigate our questions: of the "what" and "how" of safe havens, and how they compare, each against the other. We are empowering ourselves with the tools of the naturalists—from Aristotle once again, the very first. And to do the job, we will need the right taxonomy—to name, describe, and classify the "creatures" among our safe havens. We need specific language and the understanding of its importance because we're embarking on something that, quite honestly, the vast majority of investors (and that includes professionals) never give much thought to doing.

You see, people tend to accept the classification of safe havens by common parlance. Think of our previous definition as a payoff that mitigates risk or the bad potential economic contingencies in a portfolio; as such, a cost-effective safe haven is one that, in addition, raises wealth over time. But how do we recognize a safe haven's capacity to do this *before* it does? (What good is knowing *after*?) Is there anything particular about them—some essence, or lines of demarcation that define them for what they are?

More broadly, is "safe-haven-ness" even a classifiable thing—what we would call a "kind," or a group with shared traits? If so, is this kind basically one homogeneous blob? And if not, **how can we further organize them across their variations such that we can better understand them and, most of all, use them?**

Biologists struggled with similar classification problems when it came to species, or the *species problem*: if there were many inconsistent and unresolvable ways by which to divide biodiversity into groups of different species—known as the *species concept*—then how can we say what, or even if, a species is?

This notion of essences is from the *essentialist* framework, harkening all the way back to Plato and Aristotle, which defined

species as a grouping according to fixed essences or “essential” properties. Plato’s theory of ideas or forms was the perfect, idealized, cartoon version of all the messy instances of that idea in the real world. That messiness was just the “accidental” properties, while the pure cartoon form was the essential thing worth understanding. Plato saw these forms as the only true reality; the real world was but an illusion populated by flawed copies of the forms. From his parable of the cave, we are prisoners who can only see shadows cast on the cave walls, not the true forms projecting those shadows from the outside. So, if he’s right, it might make sense to try to decipher what is essential in things.

It’s a nice idea: Filter out the accidental stuff and come up with a clean and pure cartoon picture of it. Once you understand the cartoon essence, then you understand the thing, or so the thinking goes.

The point of trying to classify things into “natural kinds” is to make generalizations according to characteristic properties that they all share, and which are “necessary and sufficient” to be a member of a kind. This is what Plato notably and somewhat gruesomely referred to as “cutting nature at its joints”—to understand things by dividing them up in their most natural and essential ways.

The first systematic attempt to classify living things was undertaken by Plato’s most well-known student, Aristotle. (As the world’s first real scientist, he was first and foremost a biologist.) The categorization and grouping of things in this essentialist way have been the foundation of thought and discovery by naturalists and scientists in general ever since. It was the motivation for the science of classification known as taxonomy—the scaffolding of knowledge through arranging similar things or concepts in order to understand them.

Aristotle’s basic classification system is still used today. But he never really spelled out exactly how to do it, presumably because he saw how tenuous it was: “It is impossible to determine

the exact lines of demarcation, nor on which side thereof an intermediate form should lie.” (He never actually even tried to define a “species,” other than human beings.)

Aristotle’s essentialist thinking dealt less with essential “properties” and more with essential “functions” (the first principle of everything, even investing). His focus wasn’t on the quirky essential attributes themselves, but rather on how those attributes and parts interacted with each other and their environment. Essences were then about the degree of success in the functioning and development of organisms within their environments—known better as *functional essentialism*.

In this sense, Aristotle and his nineteenth-century fellow naturalist and biologist Charles Darwin had more in common than is often thought (beyond Aristotle’s dice contemplations and Darwin’s obsessive nightly backgammon game). Darwin was rather unconvinced about the existence of species in the first place. In particular, *diversity and change* were so dramatic, they could no longer be thought of as static. This led him, of course, to a theory of natural selection and his opus, *On the Origin of Species*.

What Aristotle and Darwin observed in the natural world can guide us in our study of safe havens. The *diversity and change* within the safe haven species is so great that it, too, could form new ones. Its members have their own different phenotypes, making some far more advantaged or cost-effective (*fitter*) than others. Thus, we have our own safe haven species problem: Can we identify a safe haven “essence” and use it to classify them? Or are they all just individual things—each one of a kind?

Further confounding the problem, our classifications are a moving target. Essential safe haven features may emerge at one point in time, and later vanish, just as biological traits can change with time. Treating them like they are fixed—like Plato’s unchanging essences, and as many did when considering species before

Darwin—is to naïvely succumb to the retrospective safe haven fallacy.

But if we cannot classify them by their essentials, it will be impossible to see if our dice game “guesses” thus far about how they work actually agree with real safe havens. If we can’t get that far, then this was all just more of the same financial theater—more ambiguous risk-mitigation narratives or, worse yet, academic exercises. To put it in blunt terms, if we cannot identify safe havens that are cost-effective, then they are only places to hide out—like a ship in harbor. (“A ship in harbor is safe...”)

MORE DIFFERENT THAN ALIKE

Back in Chapter 1, I introduced Nana, my Bernese Mountain Dog who may or may not be good at hunting groundhogs. We actually have three dogs (or, rather, they have us): Jojo, Gigi, and, of course, Nana. But I always prefer to call them Moe, Larry, and Curly—collectively, “The Stooges.” Moe is the bullying, slapstick pug; Larry is the passive, mop-headed Shih Tzu; and Curly is the lovable, pudgy Bernese (which doesn’t seem to stop her from massacring groundhogs). There’s an uncanny resemblance, down to their vaudevillian routine. And that’s about the only thing they have in common with each other. By looking at them, if you didn’t know any better, you may not even suspect that they are all different breeds within the same *canis familiaris* species.

There’s the monkey- and frog-faced pug, the cat-like Shih Tzu, and of course the heraldic beast of Bern, the Bernese bear. These are their accidental properties, varied and distinct, while still allowing them to be dogs. Their dogness, what little there is, is their essential property. It is necessary and sufficient to make them each a dog. In the case of the Stooges, it’s just not clear what that is. But someone had to decide which qualities

are essential and which are accidental. Which features counted, and why. The species problem becomes acute in the case of the Stooges because they are more different than they are alike. (There is the Biological Species Concept of interbreeding to define a species, but even then the thought of a Bernese pug is just cognitively dissonant.)

Among investment strategies, the best example of this problem of classification is in value investing. Started by Benjamin Graham, it is about buying securities cheap compared to their *intrinsic value*—and good luck agreeing on the meaning of intrinsic value. In Graham’s case, this mostly meant book value, or tangible value of a company’s assets. For Graham, buying cheap to book often meant purchasing “cigar butts,” as Warren Buffett called them, or companies that were on their last puff and priced accordingly. These companies typically have very low profit margins and very low returns on invested capital. In fact, most basic value screens tend to align with these low returns on invested capital. But tell that to Warren Buffett, considered the greatest value investor ever, and who explicitly screens stocks based on *high* returns on invested capital. A company’s intrinsic value is elevated by higher perceived returns on its invested capital, and this can create value relative to its stock price. It is difficult to find an essence of the species among value stocks. They are too different, and those differences are always in flux; there are too many “accidents.” Value can become a misnomer.

It might be even harder to find an essence of safe havens. And yet people nonchalantly classify them that way anyway.

They are more of a heterogeneous than a homogeneous set. As we will see, **not all safe havens are created equal. Indeed, not all safe havens are even safe havens—and certainly very few, if any, are cost-effective.**

But we owe it to ourselves to find out, and to at least establish a criterion for measuring them against each other.

PHENOTYPES

We need a *safe haven concept*, or definitions to determine whether something should be included in the safe haven category. We need to describe that essential cartoon safe haven form. We start with phenotypes—the expression of an organism’s observable traits or responses as it interacts with its environment. This is also the best way to approach the cartoon essence of safe havens. How a safe haven interacts with its environment, or its functional essentialism, is another way of saying its payoff relative to the dynamics of the broad macroeconomic environment in which it lives. We have seen payoffs defined previously in our dice games, as returns *conditional on* other events like rolls of a die. The payoffs were characterized by their *shapes*, relative to this range of outcomes. A safe haven payoff is no different. We will start with cartoon payoffs defined along just two dimensions: their return in a crash and their return in a noncrash.

We saw in Part One the two extremes of the spectrum of safe haven payoffs: the store-of-value and the insurance payoff. In the middle of that spectrum, I will add another data point, what I call the “alpha” safe haven payoff.

The following table is our safe haven concept:

A Taxonomy of the Three Prototypical Safe Havens

	CRASH RETURN	NON-CRASH RETURN	PAYOUT TYPE
STORE-OF- VALUE SAFE HAVEN	+ or 0	+ or —	“Low Correlation”
ALPHA SAFE HAVEN	+	+ or —	“Negative Correlation”
INSURANCE SAFE HAVEN	+++...	—	“Convexity” (“Crash-Bang- for-the-Buck”)

This taxonomy of safe haven varieties represents the full spectrum of safe haven payoffs that we can expect to see in the *far messier* real world—typically as *hybrids* between these different varieties. As we can see, the essential property of these three prototypical safe havens is their payoff in (or exposure to) a crash. As such, they represent increasingly nonlinear or curved payoff shapes.

The store-of-value payoff is essentially meant to be somewhat fixed in time and space, like an annuity or even an unproductive real asset. The key is having low or no correlation, as they say—though I would prefer to say *sensitivity*—to systematic exposure. It thus provides both a cushion and “dry powder” should a crash take place. It is basically a matter of diluting risk.

The alpha payoff is like the store-of-value, only its correlation is now expected to be negative. This means that, specifically during a crash, it is expected to generate a positive return of some sort. Think of it as the flight to quality dynamics that we tend to associate with safe havens, causing them to appreciate in a crash.

The last stop on our safe haven spectrum, the insurance payoff, is a much more extreme case of the alpha payoff. The insurance safe haven specifically needs to make a large profit in a crash, relative to its small expected losses the rest of the time—or a high crash payoff per unit of cost. In other words, it needs to be highly *convex* to crashes. The best way to describe this idea of convexity is an explosive payout. In return for a given amount paid (in the form of an insurance premium) you get an insurance payout when the event you’re insuring against (the crash) occurs. And the degree of asymmetry between those two amounts (one large, one small) is a direct measure of the degree of convexity in this payoff.

This is akin to the explosive power that’s so necessary to sports performance, general health, catching dinner, etc. Power, in the words of Pavel Tsatsouline, “demands a precise blend of

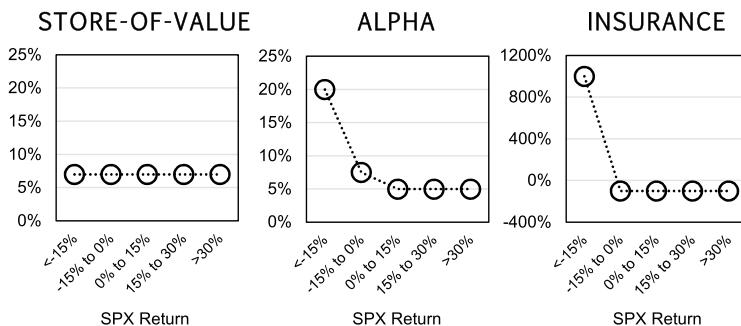
strength and speed.” Training for power leads to what he calls “what the hell effects”—not unlike what we will see later in the explosiveness of this insurance payoff.

Like my Stooges, these three cartoons are in many ways more different than they are alike. And we’ll see much later that this is often the case even within these varieties. (My pair of previous pugs, Papageno and Papagena, the precursors to JoJo, also couldn’t have been more different; neurotic New Yorker pugs versus the slapstick country pug.)

Let’s add a little more specificity to this safe haven taxonomy by creating cartoon depictions of these three prototypical safe haven payoffs—our safe haven spectrum. They are defined according to simultaneous returns in the SPX index. Like the S&P 500 on which it is based, the SPX is a stock market index of the 500 largest publicly traded companies in the US, weighted by their market capitalizations. It is surely the most accepted and appropriate index and gauge of the stock performance of the largest US companies, and thus of the macro economy in general.

Following are “tinker-toy models” of each safe haven’s payoff profile. Like Plato’s essential forms, they are a cartoonization, but without any loss of meaning:

Three Cartoon Safe Haven Prototype Payoff Profiles (by Simultaneous SPX returns)



Each of the three cartoon safe haven prototypes has its simple dynamics bucketed by four corresponding ranges of annual total returns in the SPX, just like we did with the three buckets in our dice games. (Think of these as contractual contingent payouts, with no noise or counterparty risk.)

Ranges of SPX returns were chosen as the underlying scenarios to define the different returns of these safe haven payoff profiles because they are a natural proxy for the systematic exposures in a portfolio. That is, the SPX represents the very risk in a portfolio that we are trying to mitigate; it does a very good job of capturing the gains and losses that come from having broad exposure to equities, as well as to broad macroeconomic growth and contraction in general.

The store-of-value prototype on the left makes a fixed 7% return each year (like an annuity), regardless of what the SPX returns. Or, as we might say, it provides a constant return with a zero correlation to the SPX in a crash.

The alpha prototype in the center makes a 20% nominal annual return in the crash bucket (when the SPX is down 15% or more for the year), 7.5% in the second bucket (when the SPX is down less than 15%), and 5% in the other two buckets. It provides a nice negative correlation in a crash and is always positive-carry. (This is obviously a highly idealized version of this alpha safe haven—what any investor would choose, for better or worse.) This looks somewhat like the intended performance of systematic trend-following commodity trading advisor (CTA) strategies, *global macro* and *long-volatility* strategies, or even gold. And it also looks like an “at-the-money put” on the SPX—that you’re actually *paid* to own.

The insurance prototype on the right makes an explosive profit of 1,000% in the crash bucket and loses 100% in every other year (whenever the SPX isn’t down by 15% or more). As we can see, it is highly nonlinear or convex to crashes—a “10-to-1 longshot,” or “lose one to make ten.” This is a

tenbagger, from Peter Lynch's writing on "Those Wonderful Tenbaggers"—a term borrowed from baseball (where a base is a "bag," so a *twobagger* is a two-base hit). He used *tenbagger* to refer to "a stock in which you've made ten times your money," (though he wasn't specifically referring to over a single year, of course, as I am here).

I prefer to call the asymmetric and explosive downside protection provided by the insurance cartoon payoff its *crash-bang-for-the-buck*. The more, the merrier.

RISK-MITIGATION IRONY

The big problem with safe havens is they aren't necessarily all that cost-effective. Just because an asset or strategy made the safe haven cut, doesn't necessarily mean that you would have been glad to have it in your portfolio. They are more different than alike, even within each variety.

Safe havens can be exceedingly costly, so much so that, as a cure, they can be worse than the disease. Nietzsche said it best: "Whoever fights monsters should see to it that in the process he does not become a monster." This is the risk-mitigation irony (and fate loves irony).

Such ironies are a cliché. Take the case of the *SS Eastland*. In response to the tragedy of the *Titanic* in 1912, safety regulations were imposed on passenger ships, such as requiring them to carry more lifeboats. This mandatory extra cargo made the *SS Eastland* exceedingly top-heavy, which caused it to suddenly capsize and sink in the Chicago River in 1915, killing 844 passengers. Ironically, these fatalities exceeded the number of passengers who perished on the *Titanic* (although the *Titanic* had many more crew). It is a well-intentioned though myopic and narrow view that we naturally expect from politicians and bureaucrats. (In *The Dao of Capital*, I spent a lot of ink on this mistake made by forest rangers and central bankers.)

But it's even a common mistake among investors as well. Do *something*—*anything*—to mitigate risk, even if it impairs and defeats the purpose; at least you can then say: “Well, I tried.”

The vast majority of presumed safe havens suffer from this same irony. They involve much movement, with little action. And they even do more harm than good—as monsters in disguise fighting monsters. They simply do not provide very much (if any) portfolio protection at all when it matters; therefore, the only way for them to ever provide meaningful protection is by representing a very large allocation within a portfolio. The problem, then, is that this very large allocation will naturally create a very large cost, or drag, when times are good—or most of the time—and even on average. After the dust has settled, you would have likely been safer with no safe haven at all.

Here we see the fundamental difference between a tactical versus a strategic investment, particularly in the context of safe haven investing. A *strategic safe haven* is about mitigating systematic risk in a portfolio through asset allocations that are more fixed in nature and then letting the dynamic interplay between its parts create the portfolio effect. A *tactical safe haven*, on the other hand, is about mitigating systematic risk in a portfolio by periodically and actively moving in and out of certain “safe” allocations, with the well-intentioned purpose of saving on the high cost of that safety when times are good. Such a tactical approach to risk mitigation is a very binary one, meaning either “on” or “off.” Doing this cost-effectively, by definition, requires timing and short-term forecasting skill—you need a magic crystal ball.

But this is an internal contradiction. Cost-effective risk mitigation can never require a magic crystal ball. We mitigate risk specifically as an acknowledgment and presupposition that we *don't* possess a magic crystal ball; if you had one, then you wouldn't have risk to mitigate, and you certainly wouldn't need this book. And lest I forget to mention, there are no magic crystal balls! (And the more someone disagrees with that statement, in my experience, the worse their crystal ball tends to be.)

If your risk-mitigation strategy requires one to be successful, well, then you are just doing it wrong.

While you can perhaps afford the luxury of prediction in other aspects of your investing, you certainly cannot in your risk-mitigation strategy, where the costs of being wrong are too great. Don't fall for it, and "don't predict."

As we will see later, to work cost-effectively, safe haven investing needs to be agnostic investing.

Cassandras typically and ironically lose more in their safety from looming crashes than those crashes would have even harmed them. (Cassandras make very bad investors.) Markets scare us far more than they harm us. They are very, very good at making us feel safe when we shouldn't and scared when we needn't. This is the market's inherent, constant deception to rid investors of their positions.

Cost-effective risk mitigation cannot be a specific act; it must be an ongoing policy. In the words of Aristotle: "As it is not one swallow or a fine day that makes a spring, so it is not one day or a short time that makes a man blessed and happy." In the same vein, it is not any well-timed trade or prediction that mitigates risk. Risk mitigation needs to be a sustained way of life or habit, not a transient state.

IMPOSTERS

Sadly, in addition to the irony of our cost-effective risk-mitigation problem, our safe haven classification system still has not solved our safe haven "species problem." In fact, it only illustrates how challenging a problem it really is. Aristotle's "exact lines of demarcation" are as ambiguous when applied to safe havens as he found them to be for animals. Our lines are broad strokes, and often there are assets or strategies that, by all accounts, look like one of these safe haven varieties, act like one of these safe haven varieties, and are presumed to be one of these

safe haven varieties. But, in the end, they are instead a different species altogether.

I call this subtly different intermediate species *safe haven imposters*. The following table shows a taxonomy of the three varieties within this safe haven imposters species:

A Taxonomy of the Three Prototypical Safe Haven Imposters

	CRASH RETURN	NON-CRASH RETURN	PAYOUT TYPE
HOPEFUL HAVEN	?	+ or -	"Fingers crossed!"
UNSAFE HAVEN	-	+	"Always goes up, so it must be safe!"
DIWORSIFIER HAVEN	-	+	"Loses less, so it's worth it!"

The first of these is the *hopeful haven* variety of imposters. It looks very much like the alpha or insurance safe haven varieties, except the big difference is their payoff is very noisy, or very unreliable—and as we'll see, it tends to get "warped" in different environments. Perhaps on average its expected crash return is the same as that of the alpha or even of the insurance (though not likely), but the range around how that is experienced really defeats the purpose altogether. If a lot of luck is required for a safe haven to do its job controlling risk, that means more risk, not less.

The hopeful haven as risk mitigation is like jumping out of an airplane with a parachute that only sometimes deploys; you're better off not wearing one in the first place and making a more informed decision about the risk you're taking.

A belief in the hopeful haven comes from a general attitude of having "figured it all out." And it really emanates from two commonplace fallacies, or traps, that we need to identify and carefully guard against. They are a corollary to my beseeching

“Don’t predict.” Let’s call them the retrospective and the prospective fallacies of safe haven investing.

These are connected, informal fallacies that involve down-right bad reasoning. And what’s worse, often this bad reasoning is not just an innocent accident of judgment, but rather a conscious deception in order to sell something like a strategy or service (this being a duplicitous industry with endless bad investment management services for sale, after all).

The retrospective safe haven fallacy, put simply, is playing Monday morning, armchair quarterback (meaning making judgments after a game is over, from the safety of an armchair, as opposed to while actually playing on Sunday when NFL games are typically played), second-guessing or reenacting real-time decisions after those decisions were actually made by someone else. It is also known more formally as *retrospective determinism*, *hindsight bias*, or, best of all, the *knew-it-all-along phenomenon*, whereby it is accepted that because a series of events, such as a market crash, happened a certain way under specific historical circumstances, what occurred was therefore the inevitable consequence of those circumstances. Risk somehow always appears so obvious and predictable, and the last crash always made so much sense, retrospectively, that is—based on what we now know, but what wasn’t known at the time. It’s a funny thing, isn’t it?

Given the brilliant and confident insights that one receives from the retrospective fallacy, one might easily extend that into grandiose forecasts about how things will happen next, and further spin that into a brilliantly effective risk-mitigation strategy. People actually do this, like all the time. I call this the prospective safe haven fallacy, and it takes the form of presumed skill in macroeconomic and market timing—based on the presumptions that the next crash will have similar characteristics and internal market relationships (or “cross-correlations”) to past crashes. The next crash rarely does—or it does just enough to catch those committing the retrospective safe haven fallacy in its

trap. To borrow the wise words of Victor Niederhoffer, there are “ever-changing cycles.” In many ways, the creeping escalation of complacency in naïve and “knew-it-all-along” risk mitigation is at the heart of why crashes happen in the first place.

A reliable indication that this fallacy is at work is when bold forward-looking statements about a particular risk-mitigation strategy are uttered by someone who has never actually done it, in real time (as in during the Sunday game, as opposed to on the following Monday from their armchair). It is a kissing cousin to datamining, or overfitting, surely the most well-trodden pitfall in the data sciences. There will always be flawless, successful strategies to be gleaned from past data, from *randomness alone*. There is a deceptive narrative basis to such strategies that always sound so reasonable and plausible; they have charm and seductive powers. So it’s a pretty easy sale, really. Sad to say, but heuristic storytelling plays a huge roll in what risk mitigation has become. It is financial theater.

This narrative is what also leads to the second variety of our imposters, the *unsafe haven*. The unsafe haven looks very attractive because this asset or strategy has so far always gone up, so it likely has a good story for why that should always be the case. The logic is then extended to their performance in a crash. But they are often as vulnerable in a crash (or even more so) as that which they are intended to protect. Perhaps they have even shown some evidence of that vulnerability. But that doesn’t change the optimism around their presumed safe haven status. This complacency—particularly around their use as risk mitigation—is most unsafe. (To continue the metaphor, an unsafe haven is like jumping out of an airplane with the conviction that you can fly.)

The unsafe haven is just plain myopic, extrapolated naïveté based on a story that is concocted to fit that performance. Often, it’s a fool’s errand to even try to make logical statements against it. Best to just recognize it for what it is, make some popcorn, and watch.

THE DOGMA OF DIVERSIFICATION

Our third variety of safe haven imposters, the *diworsifier haven* is without a doubt the most common form of safe haven imposter. It is pervasive throughout almost all investment portfolios. This is because diversification as a risk-mitigation strategy is the central pillar to the central paradigm in all of investing: modern portfolio theory. Most, and likely pretty close to all, investors have been led to accept this *dogma of diversification*. It is considered “the only free lunch in finance.”

Recall from Chapter 2 that the credit for this formal concept of diversification actually goes all the way back to eighteenth-century Basel, Switzerland, where Daniel Bernoulli proposed it as a solution for his hapless Petersburg merchant to get his cargo ship past pirates and across the Baltic Sea: break his cargo up into smaller cargos and send all those smaller cargos on different ships. It was a diworsifier for the merchant back then, much like it is for us now.

The diworsifier haven is named after what Peter Lynch referred to as *diworsification*. The thinking goes like this: Fill your portfolio with things that don’t all move around together and, as a result, your portfolio will move around less. And thanks to this diversification, your portfolio’s performance in a crash will likely fare somewhat better than the broad market (which, by the way, is also pretty diversified). Best of all, your volatility will be lowered. But so, too, will your returns, as this diversification comes at a pretty price in the form of underperformance costs during noncrash periods (by the same logic as its outperformance during crashes). Over time, the “diworsification” ends up costing more than it saved (hence the cute name).

But as long as your average returns are lowered less than your volatility (meaning your dreaded Sharpe ratio is raised), something purposeful is presumed to have happened.

This is so wrong on so many levels—not a terribly insightful comment by me. As Buffett himself has said, “Wide

diversification is only required when investors do not understand what they are doing.” What’s more, diversification is “a confession that you don’t really understand the businesses that you own.”

To add insult to injury, I would add that diversification is a confession that you don’t care about cost-effectiveness in your risk mitigation. You just want less risk, no matter the cost.

You see, diversification is fundamentally a dilution of risk, not a solution to risk. It is about evading risk. Moreover, the estimation of volatility is conflated as risk. (A little technical-speak interjection: Just as volatility is the square root of the average squared return, the geometric average is the exponential of the average log-return; only the latter has real economic meaning, as we saw in Chapter 2. The former is a mathematically convenient proxy for the latter. It works okay in some dice games, but not in the markets.) And diversification never tends to be as great (nor correlations as low) as it appears. When the investing herd heads for the exits in a crisis, most strategies and assets tend to get swept away, the baby with the bath water. (The pirates seize all the ships.) And no model can predict this effect, as it tends to change every time. Strategies that were once uncorrelated, stable, and liquid become the opposite of all of those things, as investors are forced to sell what they are able to sell, all at the same time. Investors are always left with more undiversifiable, systematic risk than they tend to recognize *ex ante*.

Because diversification lowers returns in the name of higher Sharpe ratios, investors who use this strategy but aren’t content with those lower returns are then forced to apply leverage in hopes of raising them back up. **True risk mitigation should not require financial engineering and leverage in order to both lower risk and raise compound annual growth rates. Doing so adds a different kind of risk by magnifying the portfolio’s**

sensitivity to errors in those spurious correlation estimates. To be fair, most investors are constrained (or perhaps too wise) to use leverage like this in practice, and instead live with their lower risk-mitigated returns.

Diversification, then, is either about potentially less risk in exchange for less return, or it is about moving from systematic or concentration risk to levered model risk. It is not a free lunch. There is no free lunch (though cost-effective risk mitigation does seem to look like getting paid to eat lunch).

INDUCTIVE DICE

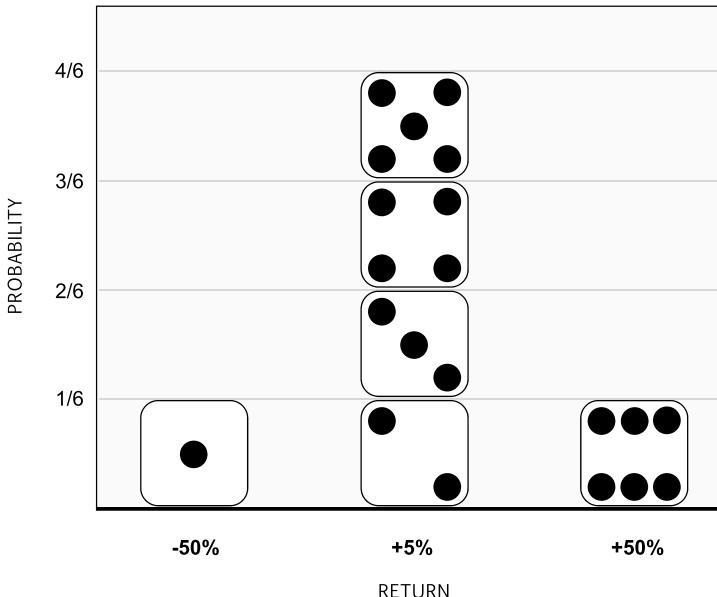
We have created these toy safe havens. Now, before we start playing around with them, we need to make a new toy to replace our dice from Part One.

We are inching closer to the grittiness of the real world. We've moved beyond the punching bag of dice games to now letting our safe haven prototypes spar it out. (As a wise person once said, "Everyone has a plan until they get punched in the mouth." While punching a bag and sparring are very different from the real thing of a fight, they are necessary training practices for the real thing—as long as contingencies like getting an elbow to the head or a kick in the groin are never assumed away.)

In our various dice games in Part One, we discovered our safe haven mechanisms by observing how different risk-mitigation strategies, or safe haven payoffs, transformed the potential outcomes of different wagers on a simple sequence of dice rolls. Each roll involved a multiplicative, geometric progression of the wagerer's wealth; and each recursive iteration of that progression was determined by the roll of the six-sided die and the payoff associated with it. Recall in Chapter 3 how

these different corresponding payoff profiles and die faces created a *discrete probability distribution* for each roll, where the height of the stacked dice indicated the probability of each corresponding return outcome below it. Here it is again, as a reminder:

Demonic Dice Payoff Profile and Probability Distribution



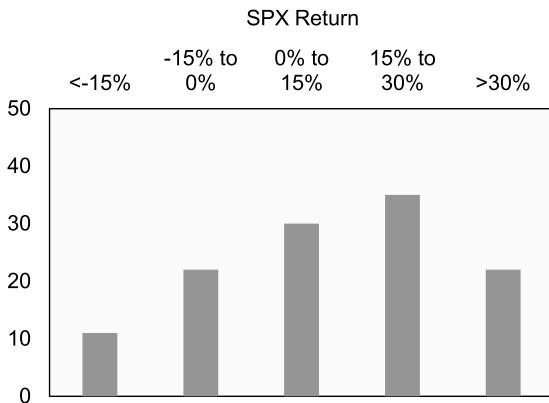
Now, we need to replace the six-sided die with something more granular, more like the real world. We need a die with more sides. How about as many sides as a die can possibly have? It turns out that the maximum number of possible sides on a fair die (or a convex polyhedron with identical sides) is 120. (This perfect symmetry across sides is key, of course, to ensure their equal probability—something which, as you may recall, the wise ancients never really appreciated.) This 120-sided “d120” die is known as a *disdyakis triacontahedron*. And the

d120 die even exists, so you can go ahead and roll your own in these chapters too, playing along at home, with the gods' ultimate dice.

Next, to add realism to our new distribution, we need more meaningful returns corresponding to each of these 120 die faces—something less arbitrary and more relevant to what we care about. We will assign one historical annual calendar-year return from the SPX (each unique and nonoverlapping) to each of our 120 die faces. So, we are going back 120 years, starting in 1901. (These returns also include the reinvestment of all dividends, so they represent what a holder of the SPX would experience.) Now whenever we roll our d120 die, whatever side comes up will correspond to one of those 120 historical years and annual SPX returns. (Conveniently, we can just assign the side with a 1 to the year 1901, with a 2 to the year 1902, with a 120 to the year 2020, and so forth.)

In order to produce a frequency distribution, like we did with our stacked dice, we can bucket those returns by the same five SPX ranges that we earlier used to define our cartoon safe haven payoff profiles. Here's how that frequency distribution looks:

Frequency Distribution of SPX Annual Returns, 1901–2020



We defined our safe haven payoff profiles in terms of returns in the SPX because we want to investigate their impact on a portfolio when mitigating this systematic risk—meaning when they are paired with SPX-like exposure in a portfolio. By simply replacing our old six-sided die and dice roll return distribution with this d120 die and SPX return distribution, then, we can directly observe this portfolio effect. In other words, we move from a simple dice game as a fun thought experiment to something that replicates real portfolios—and all that they represent: hard-earned dollars, nest eggs for the future, retirement savings, and at least a modest inheritance for the next generation. No shortage of emotion here!

In our tests we will be looking only at annual returns for two simple reasons: they are the most straightforward, and most portfolio rebalancing tends to happen once a year. But none of our results will depend on whether we are taking calendar years or starting at some other month for these annual returns.

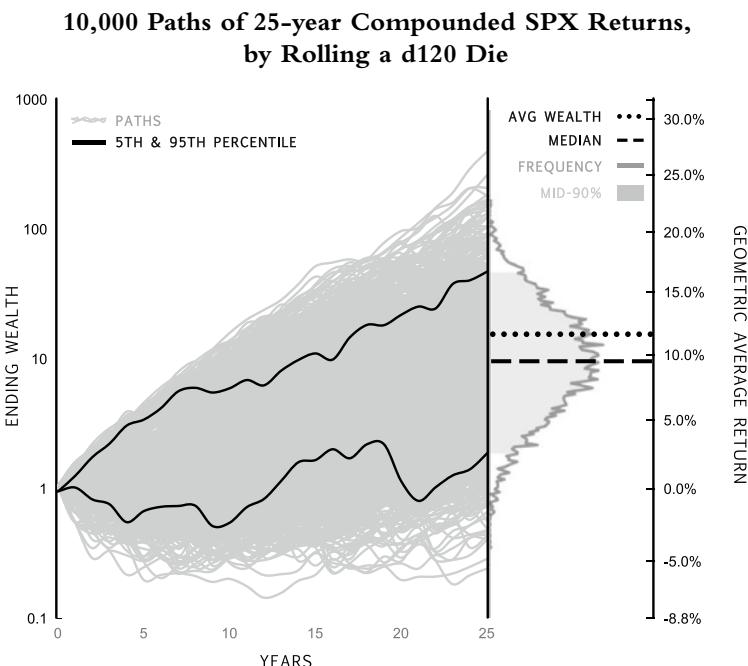
Notice that over the past 120 years there have been 11 SPX annual returns of -15% or lower. And so it turns out that our tenbagger insurance cartoon payoff would have just broken even, on a standalone basis—or a 0% arithmetic average return—over that period. And the standalone alpha cartoon payoff would have made a $+7\%$ arithmetic average return per year over that same period (as would have the fixed store-of-value cartoon payoff, of course).

And, if you’re interested, although $11/120$ is a higher percentage of years in the lowest SPX return bin than we would see sampling from only the last 25 years, for instance, if we had used monthly overlapping annual data (instead of calendar year annual data) over the last 25 years we would have found that there is actually a higher percentage of years in that lowest SPX return bin. In that sense, our d120 calendar year die thus *under-represents* the more recent historical probability of such losses. In summary, we are being conservative.

Now, just as we did with our dice payoff, we will replicate a path—in this case a series of 25 years by rolling the d120 die

25 times and compounding each of those 25 corresponding SPX returns to create one sample path. We are using 25 years in order to approximate a typical long-term investment horizon—though, like in our choice of calendar year returns, none of our results are sensitive to that assumption. This is just like the 300-roll path from our demonic dice games; no different. And then, just like those demonic games, we can keep rolling away and get 10,000 such 25-year paths. (If we roll quickly, this shouldn't take more than a week.)

Here are each of those 25-year paths, shown again in our familiar format of a cloud of 10,000 diverging paths (the sample space of outcomes across the multiverse). And each of those values at the end of each path of 25 randomly selected annual SPX returns is represented in the frequency distribution at the right.



Naturally, over the last 120 years, the SPX has realized only one specific path, realized a specific distribution of annual returns (as shown previously), and realized a specific CAGR of 9.5%. Now, with the help of our d120 die, we can visualize the many more ways that this path could have ended up. Moreover, all of these alternative potential paths are consistent with (since they were drawn and created from) that same specific realized empirical distribution of annual SPX returns.

We have an interesting turn of the dice here. In sampling all these empirical market observations by rolling a d120 die and then attempting to make generalizations about those observations, we are now essentially rolling an inductive die.

For instance, across all of these potential paths, notice that the median CAGR is 9.5% and the 5th percentile CAGR is 2.7%. These CAGR values will be key in our tests going forward. This is because this distribution of SPX paths can be thought of as our control group or *baseline* case as we go about combining them with various safe haven payoffs to see what happens next.

And what happens next is where things get interesting.



Holism

THE CUCKOO IN THE CLOCK

I have fond memories from when I was a very little boy, of watching my Swiss-German grandpa working away, a loupe over one eye, in the cramped basement workshop of his upstate New York home. A retired doctor, Grandpa took up clock-making with a passion, true to his roots (though it might also have been an excuse to steal away from Grandma to his workshop). I recall one particular big day when he went to work on an old prewar cuckoo clock. He dissected the box—more like a wooden chalet with a goat head carved into its gable—and meticulously removed all its guts. I spent hours looking over the little parts spread across the table. All those tiny gears and levers, the tattered bellows, and the lifeless wooden cuckoo bird looked like scattered pieces of old scrap to be swept into the bin. Seeing those separate parts, I had no way of knowing their former splendor when they were together as an interacting whole.

None of the parts, on its own, can even track the time—not even close! A reductionist might say that putting them

all together in an old wooden box with its carved goat head and hanging it on the wall won't change that, either. So, why shouldn't the properties of a thing be explainable by looking at the properties of the things that make it up?

Reductionism didn't work well for me with cuckoo clocks. The reason? The functional value of the individual components was only a result of their relation to each other. **There were what are called *emergent properties* that do not exist in the individual components. These properties are only apparent when viewed holistically as a whole.**

Emergent behavior arises in many well-known systems where interacting individual parts create complex, unpredictable, and irreducible behavior: flocks of birds, schools of fish, herding land animals, language, the mind, economies, markets, and so on. (I used to hone my pit trading by studying the movements of flocks of birds, real and simulated. There, you have a trade secret.) And the same is very true of safe haven investing.

As Aristotle might have said, "The whole is greater than the sum of its parts." He *might* have said that, but what he actually wrote in his *Metaphysics* was something different. **In Aristotle's words, "The totality is not, as it were, a mere heap, but the whole is something besides the parts." Moreover, "the whole is not the same as the sum of its parts."** Aristotle's words, above all others, are our risk-mitigation creed.

Like in his *functional essentialism* that focused on the inter-related parts of animals, Aristotle was onto something here. And this more precise translation from the Greek is so much more applicable to our context. We saw it in the Saint Petersburg paradox, where the whole (the actual realized wealth from playing the game) was so much less than expected from the sum of the parts (the average of all possible wealth outcomes). We also saw it in the Petersburg merchant trade, where purchasing a stand-alone, money-losing insurance contract would have raised the merchant's whole geometric wealth, even though it would have lowered his average wealth. We also saw it in our two demonic

dice games—a store-of-value safe haven and an insurance safe haven; by moving a portion of your cash to a wager with zero expected return, and away from a wager with a high expected return, you actually raised the whole of your wealth, even though it lowered your average (across the multiverse). (And I hope that I have convinced you by now that this was all due to the straightforward math of compounding, not some magic trick.) **The whole can indeed be much more than the sum of its parts—though it need not always be.**

The word *holistic* is a neologism dating back to only the 1920s. Its meaning reflects its Greek root *holos*, for “whole.” The whole is the only reference where the parts make coherent sense, not as a collection of parts splayed on Grandpa’s table or thrown into a covariance matrix box.

Investment management so often makes reductionist errors similar to mine as a child with the cuckoo clock, as each piece is analyzed on its own as well as part of a larger whole—a portfolio. Modern finance says to take these individual parts of a portfolio—understand and place a value on each of their individual expected arithmetic returns, volatilities, and covariances with each other—then combine them all within a box; and then the whole of that box is well understood by the sum of their arithmetic returns (and, in particular, by its Sharpe ratio or similar metric). However, the impact of this reductionism is that the most important portfolio effects—the ones driven by the recursive, multiplicative interactions of those individual parts, and even time itself—are reduced away into a more tractable, dare I say childlike, form.

In the case of the cuckoo clock, its many interacting parts remain independent, separate pieces. This is known as *weak emergence*: The interactions of the parts do not change each other; however, their interactions create properties in the whole that can only be observed in the whole, not the parts. Of course, the cuckoo clock’s dynamics were predetermined, top-down, by the clockmaker—in a mechanism dating back to the eighteenth

century; and there are Swiss watchmakers in the Vallée de Joux who could have glanced at Grandpa's messy workbench and immediately envisioned the clockwork as a whole. Emergence is relative to the observer. (But anyone who claims that a prewar cuckoo clock doesn't have its own unpredictable and irreducible behavior has likely never owned a prewar cuckoo clock.)

In the case of our many previous wagers, one might say that the same weak emergence is clearly at work. In all these wagers, the whole of the wager has properties—specifically its geometric average or median wealth—that the aggregate component wagers do not. The holistic properties emerge from the interactions of those component wagers as they are iteratively rebalanced and compounded. But when you look at it more closely, in the case of our dice games for instance, the reason the safe havens can add so much ending wealth to the game is due to the iterative nature of the game. They provide capital for the next dice roll by resetting or *rebalancing* the size of the wager at the end of each roll. Safe havens can thus top up or feed the wagers in the main game, particularly if the previous roll resulted in a big loss, without really costing the frequent positive wagers enough to matter. These cost-effective safe havens keep you away from the edge of Bernoulli Falls. **They actually transform the dice game—preventing a plunge in the size of any subsequent wager. The wagers now interact, rather than act independently, as they are no longer ring-fenced from each other. Thus, an entirely new whole is formed—one that is very different from the sum of its parts.** This is what's known as *strong emergence*.

This strong emergent property in the Petersburg merchant trade means that the value of a component wager can *only* be known relative to the whole wager. Its value on its own (in the case of the merchant's insurance contract, an average *loss* of 300 rubles per shipment) is very different when combined with the other components (resulting in a *total gain* of 119 rubles per shipment).

This is investing's own *theory of relativity*: There is no single value that we can assign to an investment, specifically a risk-mitigation investment. Rather, its value is unique or relative to the observer, or to the larger perspective of the observer's whole portfolio—specifically how it interacts with the multiplicative dynamics of that portfolio. Risk-mitigation investments are thus highly *context dependent*. And this is what so eludes the traditional reductionism that defines modern financial analytical frameworks.

KEEPING BOTH EYES

There is an old Russian proverb that goes:

*Dwell on the past and lose an eye.
Forget the past and lose both eyes.*

If we only look at the one way that things happened and obsess over it as the only likely outcome—in other words, if we over-extrapolate the past—then we are engaged in something called *naïve empiricism*. To avoid that, we need to look at the past in the context of the many other paths that *could* have happened, but never did, as well as our sensitivities to those outcomes. We will be using a technique called *bootstrapping*, which is an overt attempt to counter naïve empiricism—and keep both eyes.

Best of all, with the bootstrap we don't need some specific model of what the distribution of SPX returns will look like in the future. We could always come up with that, of course; and if we did, we would likely want to fit a distribution to past data, like the last 120 years or so of our new *disdyakis triacontahedron* d120 die. And then we would be right back where we started, except now we would have to employ complicated, wild distributions with multiple parameters to fit the data. Then

I would be exposed to fair accusations of slyly fudging those parameters in order to make my case. This is why bootstrapping is technically known as a nonparametric form of estimation, as it avoids these distributional assumptions. So, the point of our bootstrap, like the point of our dice games in Part One, is to keep things conservative, uncomplicated, intuitive, and, most of all, *transparent*. All we need is our d120 die, and everything is aboveboard.

Now, recall that we want to observe the impact of our three safe haven cartoon payoffs—as we defined them in the last chapter—on an SPX portfolio. Specifically, we want to observe their portfolio effect when mitigating systematic risk.

We have actually already started this bootstrapping process in the previous chapter when we created 10,000 25-year compounded paths of SPX returns (by rolling our d120 SPX die $10,000 \times 25 = 250,000$ times). These were our “alternative histories,” or the many more ways that the one realized SPX path could have happened, instead of what actually did happen.

In keeping with the same form throughout this book, within every one of those paths we will pair each of their 25 annual SPX returns with 25 safe haven returns, corresponding to the payoff of each of our three safe haven cartoons. The weightings that we will use for each of the three portfolios allocated to the store-of-value, alpha, and insurance safe havens are 36%, 28%, and 2%, respectively (and we’ll get to the rationale behind these allocation weightings shortly). Once we form these three new risk-mitigated SPX portfolios (with the safe haven allocations rebalanced after each roll), we can compare their compounded performance with the SPX on its own.

This is the bootstrap method (“with replacement,” since whenever we roll any number, we can always roll it again). This concept is inspired by the circular “pull yourself up by your bootstraps” (just as the fictitious Baron Munchausen claimed to have pulled himself out of a swamp by his own hair)—appropriately named because we are circularly sampling (or

rolling our d120 die) from yet another sample (or the past 120 annual returns in the SPX).

We can roll this die for both the SPX portfolio on its own and for the SPX-plus-safe-haven risk-mitigated portfolios. Then we can calculate the geometric average return (or median CAGR) for each, and thus we will have an apples-to-apples risk-mitigation scoreboard for our competing portfolios. Notice that this bootstrap allows us to run and observe many paths using different risk-mitigation strategies exactly the same way that we played many games against our demons—though now with a less understood and many-more-sided SPX-die rather than with a perfectly understood six-sided standard die.

If you’re scratching your head, let me put this as simply as possible: We’ve taken pains to create an experiment whereby we can test, side by side, what would happen to an all-SPX portfolio and also SPX-plus-safe-haven cartoon portfolios, based on the range of returns of the SPX over the past 120 years. Got it? Here we go!

CLINICAL TRIALS

We established our three prototypical safe havens in the previous chapter, in the form of three fictional cartoon payoffs. Now, it’s time to start testing them to see what they can do in clinical trials or experiments. We built these cartoons to formalize our “guess” from Part One about cost-effective safe havens. Our next step then, according to Feynman, is to “compute the consequences of the guess to see what, if this is right, it would imply.”

Everything in this book up to now has been leading to this point: testing if and how risk mitigation can raise wealth by lowering risk. It’s an exciting moment because this is contrary to what we have been taught and what we would have thought.

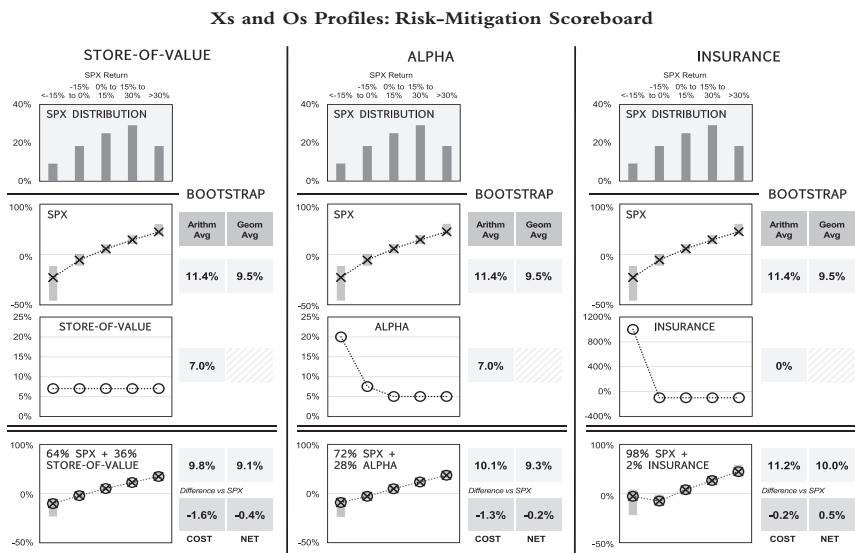
Just as in biomedical trials, we are constructing and then testing hypotheses about the effects of safe haven interventions or treatments. That is, is this safe haven treatment cost-effective? What are the side effects (or costs)? Does it add net value, with statistical significance?

Think of the bootstrapped relative performance of each of these risk-mitigated portfolios as the result of a test of our safe haven hypothesis for each cartoon payoff prototype. This was our null hypothesis, as introduced in Chapter 1: “A given strategy cost-effectively mitigates a portfolio’s risk.” Our aim is to falsify that null hypothesis, based on the deductive reasoning of *modus tollens*, and we can do that by negating the conditional premise: “Adding that strategy raises the portfolio’s CAGR over time.” If we negate that premise, then we negate that null hypothesis. The SPX acts as a control group or baseline case to test against our three risk-mitigated portfolios, as a straightforward significance test of whether their CAGRs are the same.

Bottom line: Safe haven investing has both a measurable arithmetic cost and a measurable geometric effect. A safe haven is cost-effective when its effect exceeds its cost—for a positive net portfolio effect.

The following risk-mitigation scoreboard for each cartoon safe haven presents the results of these experiments. They will look familiar by now—you have been prepped for this. It is the exact same framework that we used in the Xs and Os profile graph in the demonic dice games to determine the impact of each risk-mitigation strategy.

Recall that the charts along the top row depict the SPX frequency distribution of annual returns going back 120 years (and bucketed by $\leq -15\%$, $-15\text{--}0\%$, $0\text{--}15\%$, $15\text{--}30\%$, and $>30\%$). The second row is the payoff profile of those SPX returns (and note that, since this is just the SPX in each case, the whole row is identical). The third row is the payoff profile of the respective safe haven. And the fourth row is the resulting payoff profile of the combined portfolio. The two columns on the right (labeled



“BOOTSTRAP”) show the arithmetic returns of each of the parts as well as of the whole; at the bottom, its difference from the SPX is shown as “COST.” Plus, you can see the geometric average returns—or the median CAGR. **This, then, is the relative score for each of our risk-mitigated portfolios.** The CAGR impact or difference from the SPX (shown as “NET”) determines which risk-mitigation strategy is the leader on our scoreboard.

In all three cases, the simple arithmetic average return of the SPX portfolio, or 11.4%, was lowered in each portfolio when a cartoon safe haven was added: to 9.8% (-1.6%) by adding the store-of-value, to 10.1% (-1.3%) by adding the alpha, and to 11.2% (-0.2%) by adding the insurance. And this is obviously because each safe haven has a lower arithmetic average return on its own than the SPX, and the combined portfolios have the weighted average of their components’ arithmetic average returns. Or, put simply, averaging a lower number (a safe haven cartoon average) with the higher number (the SPX average) will always be lower than the higher number by itself. As you can see in the graphic, and as mentioned earlier, **the standalone arithmetic average return for both the store-of-value and the alpha safe haven is 7% (and yes, that was done on purpose to put them on an even arithmetic footing). The standalone arithmetic average return for the insurance safe haven is 0%.**

The geometric average return or median CAGR in each portfolio, however, is more nuanced: **The 9.5% median CAGR of the SPX portfolio was lowered in the store-of-value and alpha risk-mitigated portfolios to 9.1% (-0.4%) and 9.3% (-0.2%), respectively, but it was raised in the insurance risk-mitigated portfolio to 10.0% ($+0.5\%$).**

We know with 95% confidence that the median CAGR of the SPX is 9.4–9.6% (as estimated empirically within the bootstrap); this is the 95% confidence region of that median. **Accordingly, a median CAGR of 9.4% sets the boundary of our null hypothesis 95% rejection region.**

The median CAGR of the store-of-value portfolio of 9.1% is below that 9.4% rejection boundary. Consequently, we *must reject* (with 95% confidence) the null hypothesis that the store-of-value cartoon payoff is cost-effective risk mitigation. It doesn't make the cut. Similarly, the alpha portfolio median CAGR of 9.3% is also below that 9.4% rejection boundary; thus, the null hypothesis that the alpha cartoon payoff is cost-effective risk mitigation *must also be rejected* (with 95% confidence). It is eliminated from contention.

The insurance portfolio median CAGR of 10.0%, however, is not below the 9.4% rejection boundary, and therefore, the null hypothesis that the insurance cartoon payoff is cost-effective risk mitigation clearly *cannot be rejected* (with 95% confidence). (Remember, we can't prove that something works, only disprove it when it doesn't.) So, insurance makes the cut—and leads the field of risk-mitigated portfolios. (And it's a good thing, too, or this book would have a tragic ending.)

To put this in perspective, for a 2% allocation to a fixed annuity (or another store-of-value constant payoff) to raise the portfolio's geometric average return by 0.5%, as the insurance payoff did, that annuity would have to yield more than 30% per year—clearly a tall order. And compare that to the insurance payoff, which added that 0.5% with an average yield of 0% per year.

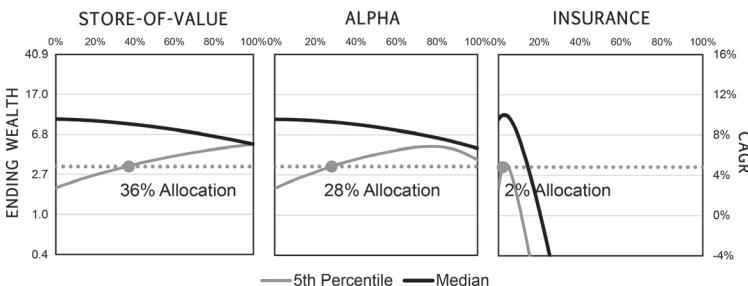
Here is a clear-cut case where the whole is indeed so much more than the sum of its parts. It is another case of pulling a higher geometric return rabbit out of a lower arithmetic return hat. (I promised you a “what the hell effect” from the explosive *crash-bang-for-the-buck* of the insurance cartoon. There it is.)

Our scoreboard uses the geometric average return (or the median CAGR) as the score that matters. The geometric average path is the median path, or the 50th percentile path, and when we maximize that we are raising the accuracy of our shot (the center mass). But as we saw with the Kelly criterion, this

is a somewhat arbitrary choice of percentiles to maximize, and even chauvinistic toward the other percentiles.

Here is a familiar graph of the dynamics of the 50th and the 5th percentile outcomes (ending wealth and CAGR) for the three cartoon safe haven risk-mitigated portfolios as we adjust the size of each safe haven allocation within each portfolio:

Finding the Optimal Cartoon Safe Haven Allocation Sizes



As in the case of the insured dice game, roughly the same insurance payoff allocation size maximizes *both* the median and the 5th percentile wealth outcome (and the whole range across percentiles). For the other safe havens (and like the Kelly criterion), they are inconsistent; you must choose an arbitrary point estimate to maximize. (If only Samuelson was still around to comment on this, monosyllabically.)

We also see that, for the insurance allocation, the Goldilocks weightings apply: not too hot and not too cold. You want only that pinch of salt for the insurance—and that pinch becomes the most important ingredient to the dish.

To frame our risk-mitigated portfolios correctly, and thus use an apples-to-apples comparison of their cost-effectiveness in mitigating risk, we need to standardize the degree of risk in each portfolio. The best way to do that is to equate the results of their bad paths (the worst-case scenarios), such as their 5th percentile paths. The dotted line in the previous chart does that. The allocation weightings in each of those safe havens of

36%, 28%, and 2% for the store-of-value, alpha, and insurance safe havens, respectively, correspond to a 5th percentile CAGR for those risk-mitigated portfolios of 4.8%. **You can see that 4.8% was chosen as a good, consistent 5th percentile CAGR to establish across all three of these portfolios because doing so jointly maximizes their 5th percentile. And this is how those allocation sizes were chosen for each safe haven cartoon throughout this analysis.**

This is very similar to the fractional Kelly bet discussed in Chapter 3, which effectively maximizes lower percentile outcomes than the 50th percentile (the one maximized by Kelly), as very often they are not both maximized together. (It should be quite clear that no results for the store-of-value or alpha portfolios are sensitive to our choice of 4.8% as the 5th percentile, as their median outcomes decrease with higher allocation sizes.)

Note that the insurance portfolio has a much larger allocation to the SPX than the other two do (98% compared to the others' 64% and 72%), while all three have the same exposure to the bad paths (or the same 5th percentile path). **As we can see, cost-effective risk mitigation doesn't just slash risk or systematic exposure; it actually lets you take on more exposure (as evidenced by a larger SPX allocation) at the same time.**

And note that this is a sizable increase to the SPX's 5th percentile CAGR for all three safe haven portfolios—from a 2.7% 5th percentile CAGR for the SPX to a 4.8% 5th percentile CAGR for the risk-mitigated portfolios. **We have set each safe haven's allocation size so that each risk-mitigated portfolio has the same improved precision for its range of possible outcomes—for an apples-to-apples comparison. Then we can see the differences in their 50th percentile CAGRs, or their accuracy, to determine which is the William Tell shot.**

The difference in CAGRs among the different risk-mitigated portfolios thus appear as visible *explicit costs* rather than as hidden *implicit costs* because we are tracking the compound growth of each entire portfolio—sized for the same risk—against one

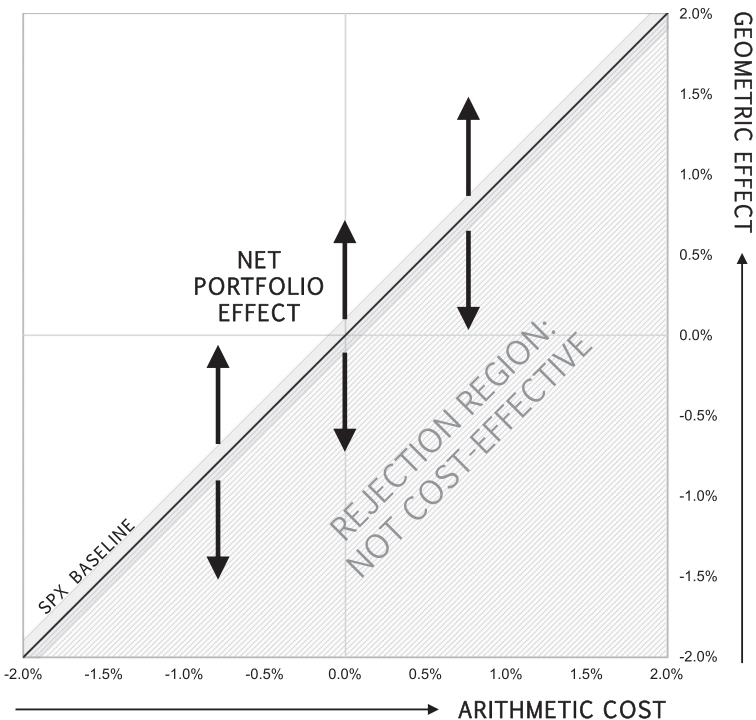
another. **Without this apples-to-apples comparison, the implicit costs from the higher allocations to the store-of-value and the alpha safe havens (when compared to instead allocating that to the SPX) would be exceedingly difficult to see relative to the conspicuous explicit costs of the insurance payoff most of the time; both costs are equally economically relevant.**

There is only one scoreboard, and that is the rate at which we compound capital on this *path*—the one that happened. And so we need to get *this* path right (Nietzsche’s existential imperative)—whether it is the 50th percentile or the 5th percentile or whatever. It’s not about getting the *expected* path right. We are pursuing strategic dominance, improving every percentile path, and thus building robustness to every percentile path—to help make our one and only path a good one. And, lest we forget, our *N* always equals 1.

THE COST-AND-EFFECT RELATIONSHIP

Cost-effectiveness analysis (CEA) is a method of evaluating the relative costs and outcomes—or effects—from among different choices of treatments or other interventions. The point is to provide a decision-making process that weighs the tradeoff between those costs and effects among these different intervention choices. (It is most often used in health care.) Does the magnitude of the effects justify the magnitude of the costs? That tradeoff in a CEA is best visible in a simple two-dimensional plot, often called the *cost-effectiveness plane*, where the costs and effects can be easily viewed and compared along each respective axis. The baseline case (such as the standard of care) is the point at the origin on the graph (0,0) and the line $y = x$ represents where incremental costs equal incremental effects; thus, different scenarios are expressed as ratios of cost-to-effects. But in our case, we will swap the axes (so cost becomes the *x*-axis). **We can**

The Cost-Effectiveness Plane



represent any given risk-mitigated portfolio as a point on the cost-effectiveness plane; that point's deviation from the SPX baseline at $y = x$ represents that portfolio's median CAGR outperformance.

The *arithmetic cost* along the x -axis in our analysis is simply the change in the arithmetic average return from adding each cartoon safe haven payoff to the SPX, or the cells labeled “COST” at the bottom of our Xs and Os profile graph (though the sign is flipped, since a negative number in the Xs and Os profile graph is a *positive cost* here). The cells labeled “NET” at the bottom of our Xs and Os profile graph—or the median CAGR outperformance from adding each cartoon safe haven payoff to the SPX—is represented as the magnitude of any

point above the diagonal SPX baseline, what we will call the *net portfolio effect*. Lastly, the *geometric effect* along the y -axis is the x -axis arithmetic cost plus the net portfolio effect.

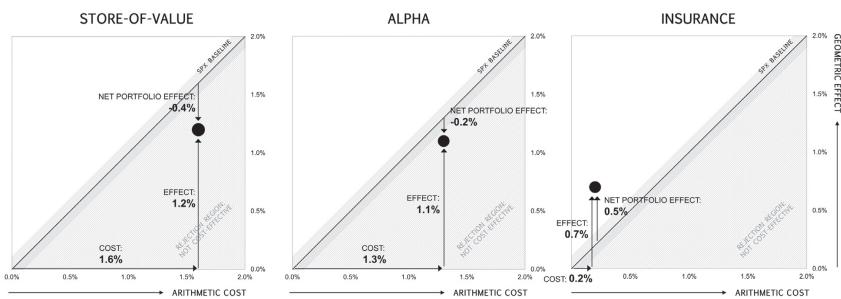
Thus, when the arithmetic cost equals the geometric effect, the risk-mitigated portfolio's median CAGR is the same as the median CAGR of the SPX portfolio without risk mitigation, and the point will reside somewhere on the diagonal line on the graph for that portfolio (depending on the magnitude of the cost and effect). Therefore, the further above the diagonal line a risk-mitigated portfolio lands the more cost-effective it is, and the further below, the more cost-ineffective.

The diagonal SPX baseline contains that same 95% confidence interval for the median CAGR of the SPX. The area below the diagonal—or more specifically below the rejection boundary, or lower confidence band on the diagonal—is the *rejection region* for our null hypothesis tests. If a point on the plot for a risk-mitigated portfolio falls below the rejection boundary line, it doesn't make the cut, because adding that safe haven payoff to the SPX did *not* raise that portfolio's geometric average return or median CAGR over time.

Most investors add a risk-mitigation strategy for its effect, but don't properly account for the cost paid to gain that effect—and thus don't account for the *net portfolio effect*. The chart lets us visually dig deeper, both into that cost, but also into the source of a safe haven's degree of cost-effectiveness, or CAGR outperformance (or, more likely, lack thereof). Is it coming from low arithmetic cost, high geometric effect, or some combination? Is a safe haven even effective at all? Any data point at or below the x -axis, meaning negative effectiveness, regardless of where it is relative to the diagonal, really isn't even a safe haven at all. Without this pictorial framework, that would not be so obvious.

On the following page is a close-up of the CE plane for each individual cartoon safe haven portfolio, zoomed in to show each arithmetic cost, geometric effect, and net portfolio effect (or median CAGR outperformance).

Geometric Effect – Arithmetic Cost = Net Portfolio Effect



The simple elegance in these cost-effectiveness planes is that the two formerly hidden contrary forces at the very heart of safe haven investing, and which are always acting on our distribution of returns and actual performance, now become entirely visible and even quite intuitive.

The pattern that emerges in these three graphs, moving from left to right, is that risk-mitigation costs diminish somewhat along with the effects. But importantly, the costs diminish *more* than the effects, and so the cost-effectiveness increases as we move from left to right.

There is always this risk-mitigation tension or tradeoff between these two contrary forces of cost and effectiveness—or arithmetic cost and geometric effect. That tradeoff is between lower arithmetic returns (the cost) as payment for that geometric pickup that by now we know so well (the effect). There is no free lunch. But if you can tilt that tradeoff in your favor, with an effect that outpaces the cost resulting in a positive net portfolio effect, then risk mitigation *on net* raises compounding and, consequently, wealth. Then, voilà—you have *cost-effective* risk mitigation. That's how adding a safe haven can lower the sum (or average), and yet raise the geometric whole (or a range across percentiles). Here we find our risk-mitigation creed and our buried treasure.

Visibly, the advantage to the insurance comes from its very low cost to the portfolio in the form of an arithmetic average return that is lowered *by less*—and this despite the insurance having the lowest arithmetic return on its own by far among the three safe haven payoffs. This is because its 2% allocation size is so low relative to the others. But the geometric effect remains high, thanks to its explosive crash-bang-for-the-buck, tenbagger payoff. The insurance payoff is very *efficient* in its effectiveness.

Recall from Chapter 3 that this double whammy of arithmetic cost savings plus a greater net portfolio effect is what's referred to in the CEA framework as an *economically dominant* strategy, and the store-of-value and alpha cartoons are thus called *dominated* strategies. And as we can now clearly see, the

lower arithmetic cost of the insurance strategy, or its efficiency, is the very driver of this economic dominance.

The more explosive and efficient a risk-mitigation payoff is—the more crash-bang-for-the-buck—the less of it we need to provide a given geometric effect. And the less we need, the less impactful its arithmetic cost, visible in a lower arithmetic return. It really just comes down to that simple economic exchange.

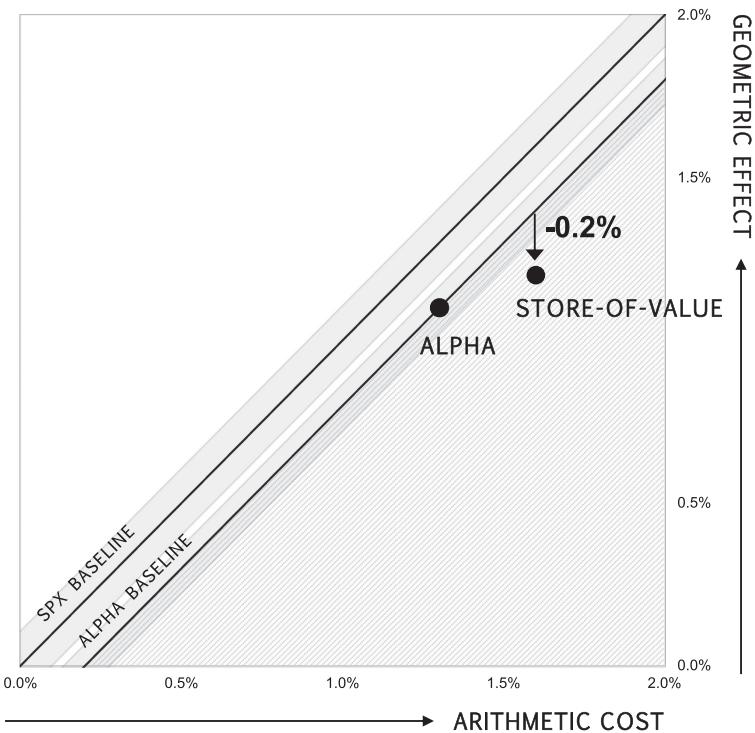
In the technical framework of modern quantitative finance's geometric Brownian motion, these two elements of cost and effect which net to the change in CAGR are represented in the calculation of the geometric return as $\mu - \frac{\sigma^2}{2}$, with changes in the arithmetic average return μ representing the arithmetic cost, and changes in the term $\frac{\sigma^2}{2}$ representing the geometric effect; but these specifically assume a lognormal distribution—what everyone knows has been a frivolous assumption in reality. Our cost term is the same change in μ , but our effect term is only approximated by $\frac{\sigma^2}{2}$. (Our analytical framework makes no distributional assumptions.) The mathematical details here are unimportant. But modern finance clearly gets it, and the implications are present in its basic models; it just can't afford to redirect its entire mathematical apparatus toward something (the geometric mean or the median, for instance) that affords less clean mathematical solutions.

So I hope you have noticed that we have just managed to reproduce the Petersburg merchant trade in actual, real-world stock market returns. Best of all, you now know exactly how it happened.

As we eventually start placing real-world safe haven datapoints all over the cost-effectiveness plane in the next chapter, we will find that CEA can be very useful in making *incremental* improvements to an existing risk-mitigation program based on *relative* cost-effectiveness, rather than just as a blunt disqualifier based on *absolute* cost-effectiveness. This might even be its primary function. For instance, while the alpha safe haven creates a net portfolio effect of -0.2% , that net portfolio effect

is still 0.2% better than the -0.4% net portfolio effect created by the store-of-value safe haven (with over 95% statistical significance)—for the same degree of risk mitigation provided (a 5th percentile portfolio CAGR of 4.8%). We are basically creating a new baseline case (or new standard of care) for our rejection region; rather than the SPX baseline, we can create the *alpha risk-mitigated portfolio baseline* to test CAGR outperformance against, as in the following CE plane:

Relative CEA: Moving the Baseline



As the store-of-value risk-mitigated portfolio point lands in this rejection region, it would then be economically beneficial to move from the store-of-value to the alpha safe haven

in order to accomplish this desired degree of risk mitigation. **Cost-effectiveness in risk mitigation should thus be thought of as both an absolute and a relative measure.** This will be particularly important to keep in mind should we find that truly absolute cost-effective safe havens are scarce in the real world. The best need not be the enemy of the good.

RESHUFFLING

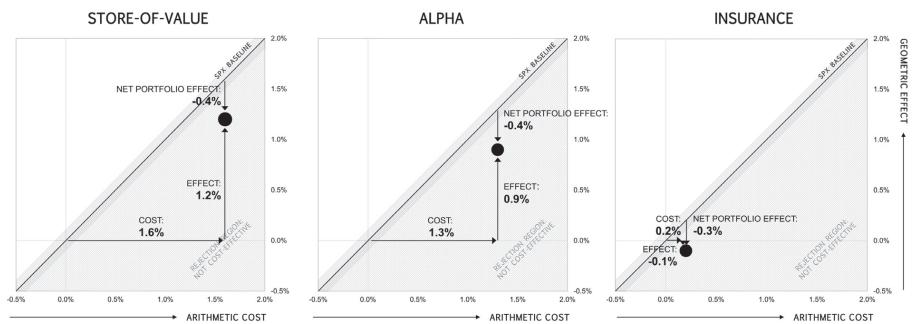
Here's one final illustration to prove to you that the shape of the safe haven payoff matters to the net portfolio effect at least as much as (and often far more than) its expected arithmetic return.

Let's say we recreate a new bootstrap such that, for each 25-year path that we create by rolling the d120 die, we take the 25 SPX returns and the 25 corresponding safe haven returns and randomly *reshuffle* the order in which these returns occur. To be clear, we still have all the same 25 SPX returns and 25 safe haven returns from the original rolling of our d120 die, but they are now combined randomly each year, rather than aligned according to the safe haven payoff; this means the payoff and frequency of each safe haven return remains the same, but the specific year that you experience each return is no longer conditional on the return of the SPX.

How would that change their cost-effectiveness as risk-mitigation strategies in this bootstrap? Any guesses?

The net portfolio effect for the store-of-value risk-mitigated portfolio is the same, naturally, since its return is always the same, reshuffled or not. For the other two, the net portfolio effect is lowered—by 0.2% to a net portfolio effect of -0.4% for the alpha risk-mitigated portfolio, and by 0.8% for a net portfolio effect of -0.3% for the insurance risk-mitigated portfolio. Now, all three points land in the rejection region, and all three are cost-ineffective—a complete strikeout. Again, the expected value of their sum is equal to the sum of their expected values.

The Net Portfolio Effect When Reshuffling



So it shouldn't matter how those returns happen, the sum (or the arithmetic average) of the parts is the same as before. So the arithmetic costs of these safe havens are exactly the same as they were originally, visible in the cost coordinate for all three points on the plot. The geometric effect, however, has been reduced for the alpha and, most dramatically, for the insurance risk-mitigated portfolios, now that their safe haven payoff profiles are decoupled from the SPX.

Because we have torn apart the interacting gears of our safe haven mechanisms (or the coordinated payoff profiles that mitigate a portfolio's big losses), the whole (or the median CAGR) is no longer greater for the insurance cartoon. All that remains is meager diversification (as the random reshuffling creates uncorrelated pairs of returns) which, visibly, is not nearly enough to provide cost-effective risk mitigation.

If it makes you feel any better, I have found that very few professional investors or allocators would have guessed this right, either.

The value of the interacting parts is only visible from within the whole, and that means it is the *shape* of the safe haven payoff that really matters.

As I mentioned while we were fawning over the Kelly criterion and the insurance risk-mitigation strategies in the demonic dice games—specifically the way they added so much wealth by lowering risk—this is not so easy in the real world, where the risk-mitigation tradeoff is a more precarious balancing act. Cost-effective risk mitigation is a nuanced and even pretty hard proposition to evaluate, let alone implement. And this is why modern finance and most practitioners shy away from it—content to instead live with the great dilemma of risk. (It is better to die with the herd than to take a risk on your own, as I've been told countless times in meetings with underfunded pensions.)

AGNOSTICISM

In our experiment thus far, we have compared the median (or geometric average) wealth or CAGR of all our 10,000 bootstrapped 25-year paths, and we have affixed the results to our scoreboard. We have also set the allocations of each cartoon safe haven such that each risk-mitigated portfolio's 5th percentile path is the same (apples-to-apples). As we saw, each risk-mitigated portfolio has a 5th percentile path that is much higher than the 5th percentile path of the SPX alone—by 78% in the case of their CAGR and by 66% in the case of their 25-year ending wealth. We fixed this higher 5th percentile path and then observed how the three risk-mitigated portfolios differ in their median paths.

Remember, any punter can devise something that does well in a crash and raise that 5th percentile; the trick is to do it while also raising the median (or better yet, all percentiles). This, in a nutshell, is cost-effective risk mitigation.

Despite the thoroughness of what we have done here, it's always good to step back for a moment and ask if, perhaps, we could be missing some blind spot in our approach. We are sampling 10,000 paths, and life is not 10,000 paths. Life is just one path. Raising our 5th percentile path raises our precision in not ending up regretting the one path we get—as that one path could happen to be that 5th percentile path. On the other hand, maximizing our 50th percentile path raises our accuracy to get it right most of the time and gets us away from maximizing a path (the average path, like in the Saint Petersburg paradox) that we likely would never see anyways. We are fighting the good fight against luck. But maybe we could still do more.

We don't want to care all that much about what the future SPX distribution of returns actually looks like, or what d120 die shape feeds our bootstrap analysis. If we did, we would be back to that internal contradiction, where cost-effective safe

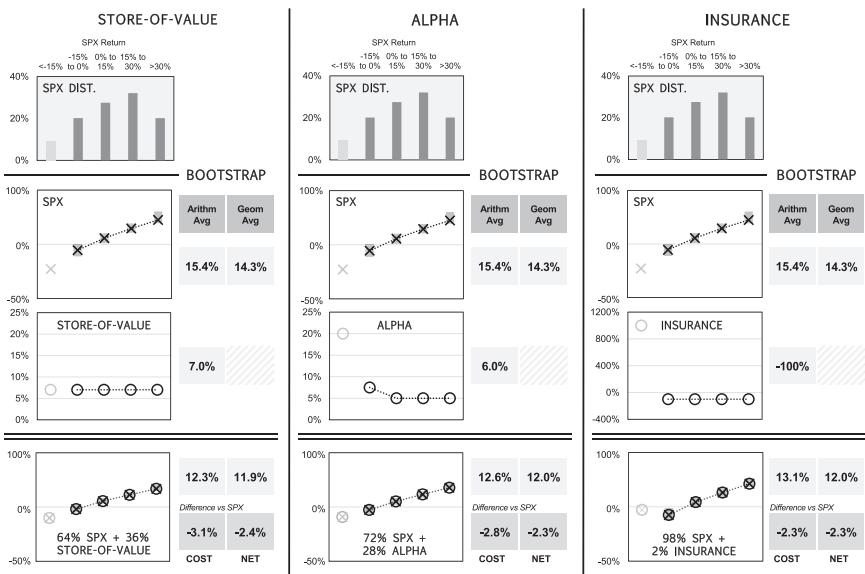
haven investing requires a magic crystal ball. Rather, cost-effective safe haven investing needs to be *agnostic investing*. We truly don't want to roll the dice on whether the market will go up or down. The market will do whatever the market will do, and we don't want to be required to predict that.

Let's say there is no "crash," or specifically *no occurrence of an SPX return in the lowest bin*—down 15% or worse in any given year. Which of these safe havens would be optimal over those restricted paths? Intuitively, you wouldn't expect any safe haven to have much value, as we've just removed the crashes! But let's answer this question methodically by simply restricting any d120 die outcomes corresponding to an SPX return of -15% or less while running our same bootstrap. On the following page are the results.

We might expect that the insurance, which will deterministically lose 100% each year in this scenario since the SPX is never down 15% or more, would have a severe disadvantage compared to the other two. **After all, the store-of-value and alpha safe havens always have a positive return; that's risk mitigation at a low cost, right? As it turns out, even with no SPX returns of -15% or lower, the insurance and the alpha safe haven cartoon portfolios have the same median CAGR—or the same relative cost-effectiveness—while the store-of-value cartoon portfolio's median CAGR is 0.1% below that.**

As surprising as that might be, it is clear that the -2.3% arithmetic cost to the insurance risk-mitigated portfolio is less than the -2.8% arithmetic cost to the alpha portfolio and less than the -3.1% arithmetic cost to the store-of-value risk-mitigated portfolio. This is due to a much lower 2% allocation size to the insurance safe haven compared to the 28% allocation size to the alpha and 36% allocation to the store-of-value safe havens. In this restricted case, the insurance portfolio gets zero positive effect in exchange for that cost (since it never receives any positive payoff from an SPX return of -15% or less)—visible in its net portfolio

No-Crash Bootstrap: Is the Optimal Safe Haven Agnostic to a Crash?



effect that is the same as its arithmetic cost—while the alpha portfolio manages to receive a +0.5% effect and the store-of-value portfolio a +0.7% effect; both the insurance and the alpha risk-mitigated portfolio's costs and effects net to a median CAGR (or geometric average return) of 12.0%, or an underperformance to that of the SPX of 2.3%, while the store-of-value risk-mitigated portfolio's cost and effect net to a median CAGR of 11.9%.

We know we have no ability to predict such a crash-restrictive, low-risk scenario. We want to avoid thinking about risk mitigation in such *tactical* terms, which would require us to haul out that magic crystal ball. But this restricted bootstrap shows another surprising insight: **Any skill in predicting crashes (perceived or otherwise) should not impact the decision between these payoffs.** While tactically waiting for that crash, both the alpha and the insurance risk-mitigated portfolios have the same median CAGR for a given level of crash protection (once it arrives); your cost of using those two safe havens as you wait for the proverbial “bell to ring” are the same. Therefore, your optimal choice would default back to what is most cost-effective *strategically*, given no skill (or perhaps worse) in predicting crashes.

This surprising result makes the *tactical* risk-mitigation decision-making process so much easier, by showing that its reasoning is a *virtuous form of circularity*: When employing safe havens tactically by switching between different varieties (such as the store-of-value, alpha, and insurance payoffs) in order to save costs while awaiting a crash, the least costly choice when there is no crash is the same as the most cost-effective choice with a crash (that is, the insurance)—thus removing the necessity for tactical skill.

We also want to be extremely mindful of the many different ways that our one path can happen. When there is no crash, it stands to reason that you would of course be better off with no risk mitigation at all (or, in this case, with only the SPX portfolio). But that's not the point. **The point is the non-crash**

paths do not favor one safe haven payoff over the other (at least between the alpha and the insurance payoffs); our choice of safe haven is surprisingly agnostic—no matter which path we take.

However, if we decide to have no risk mitigation at all (meaning only the SPX alone), we no longer have an apples-to-apples comparison between strategies. (Central bank interventions notwithstanding, we can't just assume away crashes.) If ever we compare portfolios with very different risk properties, then we are committing the logical fallacy of false equivalence. If you really desire to hold something like the SPX on its own, with a 5th percentile CAGR of 2.7% (and you're going to congratulate yourself when your no-risk mitigation works out well while following a benign path), then you should compare that to our three risk-mitigated strategies adjusted to lower their 5th percentile CAGR of 4.8% down to 2.7%.

In order to make that adjustment (without, of course, just removing the risk mitigation), we need only add more SPX exposure (by utilizing portfolio leverage) to each of those risk-mitigated portfolios until each of their 5th percentile CAGRs goes down from 4.8% to 2.7%. What we find when we do that is we end up requiring SPX allocations of 179% paired with the 36% store-of-value allocation, 187% paired with the 28% alpha allocation, and 225% paired with the 2% insurance allocation. And when we run the previous bootstrap again (with no SPX returns of -15% or lower) with these new levered SPX allocations, the median CAGRs for the store-of-value, alpha, and insurance risk-mitigated portfolios become 26.9%, 26.9%, and 27.6%, respectively (compared with the similar median CAGR for the SPX alone of 14.3%).

Mind you, I'm certainly not suggesting that anyone should ever do that. My only point is, as you can see, **we should avoid comparing highly restrictive (like no crash) performance of risk-mitigated portfolios with portfolios that have no risk mitigation.**

Ironically, when we are honest about apples-to-apples comparisons of portfolios, the optimal risk-mitigation solutions are robust and indifferent to when—and even if—there is ever a crash again. (*Fat tails* are superfluous.) This is winning the war against luck.

OFFENSIVE DEFENSE

Another question needs to be asked when considering how removed our safe havens are from any requirement of prediction, or how strategic they are rather than tactical. Our Xs and Os profile graphs display how these safe havens protect against an SPX return in the worst bins. **This is the obvious defensive component of risk mitigation. But is there an offensive role played by risk mitigation as well?**

Remember, in our bootstrap we are randomizing the order in which the historical SPX annual returns actually occurred. This completely removes a potential advantage to rebalancing our risk-mitigated portfolios after a crash, buying at presumably cheaper levels, by reallocating between the safe haven and the SPX—essentially purchasing more SPX. The question then becomes: Are subsequent returns on the SPX higher after it experiences a large loss? Let's test the Warren Buffett advice to always buy stocks during (or preferably after) a stock market crash.

It is a simple hypothesis test. The null hypothesis is that the average subsequent 1-, 5-, and 10-year SPX returns following any year when the SPX is down 15% or more is the same as the unconditional average returns over those same 1-, 5-, and 10-year periods. We will use the same 120 years of annual SPX return data that we used to populate our d120 die (only now, of course, we need to keep those returns *in order*).

Regrettably, we cannot reject that null hypothesis with 95% confidence (or, surprisingly, not even with 60% confidence).

Those subsequent returns just aren't any higher, relative to their inherent noisy randomness. (And this is true for our calendar year annual data as well as for monthly overlapped annual data.)

The last decade or so of V-shaped stock market recoveries notwithstanding, there appears to have been no statistically significant benefit to buying stocks after steep stock losses (as opposed to just buying them whenever). In other words, there is no visible *mean reversion* in SPX returns over these periods. This should be very surprising, as buying into crashes has become the folk wisdom of investing. Warren Buffett has his maxim: "Be fearful when others are greedy and be greedy when others are fearful." And before that, John D. Rockefeller purportedly said: "The way to make money is to buy when blood is running in the streets."

Simple logic dictates that we should have been able to reject our null hypothesis: We know that lower stock valuations lead to higher subsequent returns for stocks. And stock market sell-offs should create lower stock valuations. But there's "many a slip," as stock market sell-offs can reflexively lead to lower fundamental values as well; the cause-and-effect relationship is rarely straightforward in investing. And although the economists take the idea way too far, there's something to their "efficient markets" argument that it *can't* be common knowledge that a stock is undervalued (after a crash, say)—otherwise its price wouldn't be there. This is why economists typically push their "random walk down Wall Street" hypothesis, where once a big crash occurs, we have no new information *going forward* about how stocks will perform; bygones are bygones.

Sadly, we are stuck with our null hypothesis that buying the SPX after a crash doesn't make any difference to its subsequent returns. This says nothing about specific idiosyncratic pockets of value that may very likely appear after a crash, mind you; we are just considering systematic exposures in general. But the point is still a significant one.

Whether or not this Warren Buffett-esque purported "value" effect ever existed—and it has been conservatively

and completely removed from our bootstrap—remember that there is still a very offensive component to risk mitigation. Safe havens aren't just about feeling good about safety or sleeping well. As we have by now seen, over and over again, the point of safety is to prevent our wagers from plunging after a steep loss, which would then lower the subsequent base to be compounded. This iterative rebalancing of wager sizes and investments sizes—preventing the costly plunge—what we called the strong emergent property of risk mitigation, *is good offense*.

As the cliché goes, “Offense wins games. Defense wins championships.” (I annoy my two-way hockey forward son to no end with that one.) It is why Graham’s “essence of investment management is the management of risks, not the management of returns.” But the dynamics between offense and defense are a little bit more nuanced than that in investing—there is a subtle synergy between the two. This is even a Napoleonic maxim: “The transition from the defensive to the offensive is one of the most delicate operations in war”—particularly in *war with luck*.

Avoiding the concave Bernoulli Falls during the multiplicative compounding of investing carries its own offensive component to safe haven investing. **It is how, in our cost-effectiveness analysis, the geometric effect from risk mitigation can exceed its arithmetic cost. The geometric effect really is the offense.**

In investing, good defense leads to good offense.

A NARROW, BROKEN WINDOW FRAME

It should be very clear by now: We cannot judge the cost-effectiveness of a given risk-mitigation strategy on its own, in a vacuum, based solely on its attributes. Investing's *theory of relativity* dictates that an investment's value can only be known by the net portfolio effect that it provides and is thus unique and relative to that (and any other) particular portfolio. The whole is often, but not always, much greater than the sum of the parts.

This is a big challenge for most observers. And this is particularly so in investing because the math of the sum—or of arithmetic averaging—is so intuitive, while the math of the whole—or of compounding—is so counterintuitive. Portfolio components thus stick out as line items. They are not perceived as soluble in a portfolio, like (just a pinch of) salt; rather, they are perceived as insoluble, like oil.

The challenge in general even has a formal name in the field of behavioral economics known as *narrow framing*. This is the habit or blind spot that people tend to have when looking at investments as parts rather than as wholes—as line items rather than as overall portfolios. It's a small, harmless error by a wide-eyed little boy seeing the workings of his grandpa's cuckoo clock for the first time; but for investors, it leads to incoherent and costly decisions.

As in many things, our capacity to frame a problem coherently and correctly is what creates our capacity to solve it, not to mention our capacity to monetize that solution.

This is what our Xs and Os payoff profile diagrams and scoreboard are intended to do. It is *highly* counterintuitive that the insurance safe haven payoff that makes exactly 0% on average should be the one that is so cost-effective, while the ones that make 7% on average—sized for the same degree of protection visible in the 5th percentile portfolio path—are not. Moreover, it simply runs contrary to the common perception of insurance as expensive and a net cost, as well as the conventional wisdom that for a risk-mitigation strategy to add value it must have a sufficiently positive expected return on its own—or, at least, some positive return most of the time. What at first appears to gratuitously lower the arithmetic return of the portfolio (and drag on the portfolio as a negative line item in most years) turns out to be a CAGR boon. This is, of course, the Petersburg merchant trade.

All risk-mitigation strategies ultimately require a tradeoff between the degree of loss protection provided—the geometric effect, or the amount of the

portfolio's negative compounding that is avoided—versus the degree of opportunity cost from allocating capital to that protection rather than to the rest of the portfolio—the arithmetic cost, or the amount by which the portfolio's arithmetic average return is lowered.

In allocating capital, where narrow framing means each component of a portfolio is judged on its own standalone merits, the optimal choice would typically be the store-of-value or the alpha strategy, rather than the insurance strategy. **An investor will almost always take, and be able to explain, a strategy in the name of risk reduction that, by itself, has a positive return most of the time—or no explicit cost—even if it lowers the total portfolio returns over that or any time—an implicit cost. This is known as *opportunity cost neglect*, and it's probably the most pernicious yet hidden bias that we face in risk mitigation. Kudos to the entire hedge fund industry for basically capitalizing on that simple perceived disparity between explicit and implicit costs (and, yes, I'm being sarcastic).** Indeed, it is why diversification remains erroneously perceived as “the only free lunch in finance.”

Avoiding this incoherent risk-mitigation decision-making requires a holistic view, comparing the implicit costs of whole portfolio returns with that of alternatives. Easy to say, hard to embrace. This is probably why we succumb so easily, as we aren't on the lookout for it. But maybe we can learn something from a few other areas where it's hard and where it's easier to overcome.

The best instance of this framing problem was presented by the great libertarian French economist Frédéric Bastiat in his 1850 essay “*Ce qu'on voit et ce qu'on ne voit pas*” (“That Which Is Seen and That Which Is Not Seen”), where he was perhaps the first to introduce the concept of opportunity cost. In a thought experiment parable, a mischievous boy breaks a shopkeeper's window, and someone in the assembled crowd then tries to argue that this is actually a good thing, because it means more business for the glazier. As Bastiat points out, the fallacy here

is obvious when you consider that we should all then simply go about smashing windows to increase economic activity and growth. The narrow framing of that fallacious view overlooks the implicit cost to the shopkeeper, who must now spend funds to fix his window, rather than on other possible items such as a new coat for his wife, which would have provided business for the tailor. The shopkeeper's wealth is lowered (relative to what it otherwise would have been, had the boy not smashed the window), while the income in the community is merely rearranged (from the tailor to the glazier); so destruction carries a net cost—as it must. The lesson is to account not only for certain parts, but rather for the whole; thus, we realize that opportunity costs are actual—though unseen—costs. We need an honest apples-to-apples comparison of alternatives to create the frame that reveals those actual opportunity costs.

Errors of omission are unseen and easy to ignore; errors of commission are the ones we notice. Ignoring the former for the latter is a fallacy. Politicians commit this fallacy constantly, like they do the related risk-mitigation irony. It basically comes with the job—exploiting it *is* the job (as every government program involves hidden opportunity costs, with competing interests on either side).

Another instance very close to home for me is the fundamental narrow framing problem in modern chemical industrial agriculture, as already mentioned in Chapter 3. Allan Savory references this so wonderfully in his aptly named *holistic management* of rotational herbivore grazing practices, which amazingly increase topsoil quality and quantity as well as the ability to sequester carbon like nothing else can. (The mid-western US became the most fertile land in the world—as well as an enormous carbon sink—because of its grazing, roaming herds of tens of millions of bison.) This holistic view is lost on those with a narrowly framed view that herbivores (one of the parts) are the ecological problem, and a meatless diet is, therefore, the ecological solution. Herbivores removed from pastures (another one of the parts) and fed from endless miles of tilled,

industrially farmed annual monoculture crops is indeed a huge ecological problem; but feeding humans instead of herbivores in this way still leaves us with the same huge ecological problem: tillaged, industrially farmed annual monoculture crops. Herbivores managed on perennial pastures, where they were meant to live, is a huge solution—the whole is greater when these *interacting parts* are back together. (Missing that is an enormous opportunity cost, in exchange for another enormous explicit cost in the form of more tillaged, industrially farmed annual monoculture crops.) Reductively separating the two parts has contributed more to our ecological disaster than we can comprehend, more than anything else by some estimations. (The amount of atmospheric carbon that our pastured goat herds sequester in our soil at Idyll Farms would blow your mind.)

Narrow framing can often even look like a short-term versus long-term disparity, in addition to the parts versus whole disparity. Overcoming one often precludes getting ensnared by the other.

LOOKING DOWN THE TRACK

Curiously, in the best potential narrow framing case that I can think of, the problem does not even exist: the pit stops of auto racing. Think of this simplified auto racing decision involving changing tires in a pit stop. Tire degradation and performance are key to race strategy—truly where the rubber meets the road. The tires are where the power from the engine is transferred into speed and, at least as important, they are what keeps the car from skidding off the track. The great Formula 1 driver Mika Häkkinen (“The Flying Finn”) once very perceptively called tires his life insurance policy.

In circumnavigating the track, we have two basic options:

1. Stay with one set of tires the entire race and drive like a grandpa with his blinker on around the track in order to preserve the tires and stay on the track—and perhaps

even gun it here and there and deal with the risk of occasionally wiping out or even crashing and exiting the race. We can select a harder, longer-lasting though less grippy rubber compound to minimize this tradeoff, but we're still driving much more cautiously to stay on the track.

2. Pull into the pit stop mid-race and—while waiting for what feels like an eternity, but ends up being about 10 seconds—swap our tires for new ones. Now we can use softer, shorter-lived, and grippier tires throughout the race (since they don't need to last as long), and thus we can safely tear around the course. We give up those precious seconds during the pit stop, with the intention of making up the time by driving (safely) with reckless abandon for the rest of the race.

As Häkkinen said, it's insurance (and it's a most roundabout strategy). But it isn't a given that this is the winning strategy; if we take too long in the pit stop, and if the tires aren't grippy enough to make up for that lost time, then the math won't add up, and the grandpas puttering around the track on their harder and worn-out tires will beat us.

We can achieve safety by simply driving slower, or we can achieve safety another way such that we can drive faster.

The decision ultimately comes down to the cost-effectiveness tradeoff of the pit stop—between the implicit costs of the alternatives. But it never comes down to the explicit cost of what it feels like to be in the pit stop and not moving for those 10 seconds, while watching the competition fly by. The long term never succumbs to the short term, and we never lose sight of the whole of the race by focusing only on the parts of each individual lap through opportunity cost neglect.

Are auto-racing strategists all Spock-like, hyper-logical, big picture Übermenschen? Doubtful.

This coherent framing is simply because we cannot help but look further down the track. In fact, we cannot help but look *all the way down the track*, through the whole race, and to the finish line at the end. That finish line remains always in our sights as the only scoreboard, and thus the *obvious, only goal or purpose*.

Because of this, it is difficult to forget that purpose. As Nietzsche himself once said, “To forget one’s purpose is the commonest form of stupidity.”

THE GREAT PIRATES

All our risk-mitigation tests thus far have led us unwaveringly toward the solution that offers the maximum efficiency for the maximum risk-mitigation cost-effectiveness. The bigger the crash-bang-for-the-buck, the less is needed—and the less its potential drag or cost when it isn’t needed. It just waits in the wings, almost unnoticed, with hardly any appreciable cost burden. But when it kicks in, it produces an explosive return that more than makes up for its small cost—many, many times over.

It’s like that 1960s-era slogan “More with less,” most notably from the futurist Buckminster Fuller (of geodesic dome fame). He called it *ephemeralization* to the limit, as in “more and more with less and less until eventually you can do everything with nothing.” His industrial designs followed this concept as well. (Fuller loved our *disdyakis triacontahedron*, which he employed in his geodesic domes. They make good house shapes, too, apparently.)

He even referenced his “more-with-less” thinking on his gravestone, with the epitaph “Call Me Trimtab.” Airplane pilots *trim* the controls in order to take the pressure off them. Maybe you’re climbing and don’t want to pull back so hard on the yoke; you can set the trim so that you barely need to touch the yoke. (My best flight instructors over the years were always OCD about keeping the plane well-trimmed, freeing up attention for

everything else going on.) The trim tabs are actually mini flight surfaces, like mini-elevators. The mini-elevators do not control the plane itself, but rather they control the elevators themselves. They are the fractal elevators for the elevators (as well as the ailerons for the ailerons and the rudder for the rudder). So, you end up controlling a huge aircraft (or a ship) with a surprisingly tiny flight control. It is the tail wagging the dog—one micro part impacting and indirectly controlling the whole.

Holistic thinking was central to all of Fuller's work. He created his own system that he termed *synergetic*, refining the now commonly used word *synergy*. He illustrated this in a little vignette from his 1969 book, *Operating Manual for Spaceship Earth*, called the "Great Pirates."

Fuller had this idea that we should think of the Earth as a spaceship, and we are all the crew with finite resources. Ideally, we work synergistically, to raise the whole despite these finite parts. The problem is we are doomed to get so caught up in our own little parts that we cannot conceive of the whole.

The root of this evil, in Fuller's mind, was the opposite of holistic synergetics—or the narrow framing of ever-increasing specialization. He saw overspecialization as the modern plight of humanity. And then there was his rather paranoid rant that this trend toward increasingly narrow framing was engineered by those with a more holistic view who aimed to protect their immense competitive advantage. He called these privileged few the *Great Pirates*—outlaws who roamed the high seas and controlled worldwide international trade throughout the history of civilization. These pirates, working entirely in the shadows, manipulated the world's nobility and politicians by forcing them and their subjects into ever-narrower niches while keeping the broad worldview for themselves.

The Great Pirates were juxtaposed with the Navy, in particular; with the latter, training in specialized fields kept them uncompetitive. And localized thinking came especially

naturally to all the landlubbers who couldn't see past the security of their insular shores. The Great Pirates scorned the safety of their ships in harbor, preferring the chaotic risks of the seas and storms as they navigated past boundless foreign lands along their ever-expanding routes. The Great Pirates naturally gained a more holistic perspective on the world, or so Fuller's curious historical theory went.

The Great Pirates saw the big picture, recognized the advantage, and worked to keep their competitive advantage. They could see the world's Xs and Os. Fuller called this advantage their "comprehensive thinking" versus everyone else's "localized thinking."

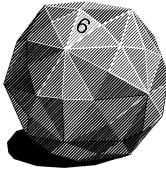
But, sadly, even these Great Pirates were destined for the same mediocrity that they instilled in their hapless, overspecialized lackeys. These seafaring renegades would inevitably lose their edge in their holistic view of the world thanks to encroaching modernity. They are all but extinct.

Fuller's Great Pirates were surely more figurative than literal. Perhaps he was just building a paranoid metaphor or moniker around the multidisciplined, big-picture scientists and artists such as DaVinci and Michelangelo, whom he called out. It doesn't really matter.

These are the very Great Pirates whose buried treasure we pursue, whether or not it even exists. And if it does, their comprehensive thinking is the key to finding it.

They stand for our risk-mitigation creed. The specialists think and live only in terms of the parts, and so can only be pawns in the bigger game. The Great Pirates think and live comprehensively, in wholes, and they master the entire gameboard—indeed, the world.

"Those who stayed on top of the waters and prospered did so because of their comprehensive capability." In a world of narrow-framed, blind specialists, the wide-framed, two-eyed, comprehensive Great Pirate is king.



Bold Conjectures

EPISTEMOLOGY

What started out as friendly and scholarly introspection into various games of dice now takes an irreverent turn. Our sparring has degenerated into an all-out street fight. The game is afoot. It will not be for the faint of heart.

Investing can be viewed as a competition among investment strategies, in which there is rarely a clear winner. Yet it isn't winner take all; in fact, it's pretty good to come in anywhere near the top of the heap. The scientific method also can be viewed as a process used to discriminate between competing hypotheses. But it is far more *severe*. In our case, our testing and our investing both have the same criterion—ending wealth, or equivalently the rate of compound growth in that wealth. If this weren't the case, we would have to ask: What's the point of all this scientific rigor?

And so now it begins: a knock-down, drag-out competition among safe haven strategies. There are some worthy competitors in the arena, and many not so worthy. Our safe havens are battling for their lives, as it were. Those that fail will forever be

exposed and disgraced. Death to them as safe havens (at least in our book).

Our battle is not unlike the blood sport of the gladiators, passed down from the Etruscans to the ancient Romans. They competed for the ultimate stakes—life or death. (It has no modern equivalent, thankfully, as even our most physical and injurious sports have safeguards.) Gladiators fought to maim and injure, and then finally kill with a thrust of a blade or trident—with the approval of the crowd (who occasionally would spare the loser, allowing him to come back and fight another day). Oh, those fun-loving Romans. But what stakes these warriors played for! The gladiators were usually slaves, criminals, or prisoners of war, for whom victory sometimes meant freedom and life. But often, the victorious gladiator could only briefly enjoy the adulation from the crowd, perhaps a nod of approval from the emperor, before going back to his quarters to nurse his wounds—and fight yet again... and again.

In our contest, too, the winners have proven their mettle historically, having been severely tested. But this contest has no victory celebration, no crowning with laurels. It must be seen as always ongoing. Every new return is another lap that continues the race. Without a finish line, the leaderboard is always provisional.

The scientific method, as described and prescribed by Karl Popper, involves posing questions by formulating hypotheses, and then rigorously trying to answer those questions strictly by either rejecting or failing to reject those hypotheses. But we can only answer in the negative, not the positive. Popper showed us that we could know a scientific theory is wrong, but we could never be sure that it was right.

Our null hypothesis, just as with our cartoon safe havens in the last chapter, is that lowering risk in a portfolio with a certain real-world safe haven produces, as a consequence, higher wealth. And recall that, by higher wealth, in the context of our bootstrap methodology, we mean higher geometric average

ending wealth or, equivalently, higher median ending wealth or CAGR (after 25 years); and by lowering risk, we mean raising that portfolio's 5th percentile ending wealth or CAGR. (This, of course, has been our proxy for risk throughout.) So, we can either reject that hypothesis or fail to reject it. We cannot *prove* it—as there are no sure things, neither in investing nor in life. The race goes on, and there will always be someone nipping at each competitor's heels.

Recall that our choice of null hypothesis has epistemological merit. Our experiments are motivated by, and their results anticipated by—and dare I even say predicted by—the deductive theory of Daniel Bernoulli, the Petersburg merchant battling pirates, and our dice games from Part One of this book. They necessarily came first. We are thus able to ask the question: How well did our theory describe what happened? You see, I didn't just need to convince *you* with our million or so rolls of the die in this book—I needed to *justify* our experimental method.

For instance, if some random asset or, worse, some insufferable hot-shot hedge fund manager, happens to outperform the SPX over a period of time in question, can we conclude that this is a superior safe haven? Even with our well-designed bootstrap tests, on those merits alone we certainly cannot! Recall the fallacy of *affirming the consequent*—or crediting my dog Nana when I don't have a groundhog problem, even though she sleeps all day. Without a deductive framework for understanding the what and the why of a cost-effective safe haven, our hypothetical tests lose all seriousness. Instead, they become glorified data mining exercises. (The investment industry is replete with such glorified data mining exercises. And this is probably a big reason why *en vogue* hedge funds, strategies, and *factors* come and go in their performance, like leaves blowing in the wind.) If we do not continue our rigor, we could easily mistake a *speculative* asset or strategy for a safe haven.

As Popper taught us, science cannot verify a theory, only falsify it, through subjecting it to systematic tests by comparing

it with observations. **Failing to reject would not mean that we have definitively found our buried treasure, of course, only that we cannot say that it isn't out there. And perhaps we get a clue that we are getting warmer.**

This is the difference between science and pseudoscience. Scientific knowledge is highly provisional. Like investing, the scientific method is about making probing bets, exposing them to falsification and, when warranted, falsifying them in order to learn from mistakes and correct accordingly. Science and investing are both composed of as-yet unrejected theories or theses; and their histories are a graveyard of these rejected theories and theses.

So, you see why I warned against definitive answers in this book. Definitive answers come from pseudoscientific hucksters.

All of that said, remember that cost-effectiveness analysis doesn't have to be all about absolute cost-effectiveness. It can be about relative cost-effectiveness just as well. We can adjust our SPX baseline such that we have less stringent thresholds for rejection.

Any safe haven that may survive this falsification process does so only *provisionally*. (The victorious gladiator must fight another day.) After all, there's nothing permanent about any of this. These tests are backward looking, not forward looking. For instance, their payoffs can change over time such that they will not pass future tests, making them lose their *cost-effective safe haven* status when we are in a position to confidently reject them. (And, in fact, this is exactly what we will see in some cases.) We should expect that to happen to all of them—not as an inevitability, but rather, as a paranoid precaution. Until that happens, as Popper wrote, “we may say that it has ‘proved its mettle’ or that it is ‘corroborated’ by past experience.” And as we will see, falsification, too, is provisional. In other words, it’s possible that we erroneously come to believe that a *true* theory has been falsified, either because we made a mistake in the test, or because we missed something when we designed the test.

Popper was curiously one of the several things that brought Nassim Taleb and me together as colleagues over 20 years ago. (The other two were our Chicago pit trading roots and a deep and almost fanatical affinity for *positively skewed, explosive payoffs*. And it was a bonus that he also happened to appreciate Mahler.) We both found Popper mostly through trading, and specifically by reading George Soros. (As a kid, I would alternately listen to the books of Soros and Ludwig von Mises on my early morning train commutes to the Chicago Board of Trade—and this was not nearly the contradiction back then that it would be today.)

Popper's philosophy of science is an ideal BS filter. It is the epistemological and analytical framework that we have been using all along, starting with Feynman's directions in Chapter 1, step by step. This may seem ironic when considering Feynman's notable quip that "the philosophy of science is about as useful to scientists as ornithology is to birds." But his actual science spoke much more loudly than his witty repartee.

From Feynman's directive, we made our "guess" in Part One. We computed the "consequences of the guess" in Part Two. Now, lastly, we will "compare the computation results to experiment or experience, compare it directly with observations to see if it works." **That is, will the performance of our three cartoon safe haven prototypes translate into real-world safe havens? By plugging real-world safe havens into our bootstrap methodology—replacing the cartoon payoffs with the payoffs of the real thing—will we recognize their portfolio effects? And will we discover cost-effective risk mitigation the same way we did in those cartoons?**

And in Feynman's conclusion, "If it disagrees with experiment, it's wrong. In that simple statement is the key to science."

These payoffs will be constructed simply by bucketing each safe haven's historical returns in the same way we combined SPX returns for visualization purposes back in Chapter 4. For

each annual calendar return for a given safe haven, we will place it into one of the same five bins, segregated by different ranges of annual SPX returns over the very same period. This creates an empirical payoff profile for each real-world safe haven, just like the cartoon payoff profiles that we have been using, only now these empirical payoffs include a *range* of return data in each SPX return bin, rather than just one single point return. So, we will be drawing randomly from one of those bins—coinciding with whatever the current d120 SPX roll reveals—to determine what the corresponding safe haven return will be for that roll. This means that we now must actually calculate the geometric average return by rolling our d120 die.

Importantly, the allocation size for each safe haven, just as in the previous chapter, was found such that each risk-mitigated portfolio has the same 5th percentile CAGR in our bootstrap—still 4.8%, as we used for the cartoon safe havens. (Recall that this is an improvement from the 5th percentile CAGR of 2.7% for the un-risk-mitigated SPX in our bootstraps.) This means that for each safe haven, the proportion of it in each hypothetical portfolio will be different, depending on the safe haven, in order to make the comparison apples-to-apples. For a given safe haven, if *no* allocation provides a 4.8% 5th percentile CAGR, we will cap that allocation at 50% of the overall portfolio.

The amount of historical data we use, or how far back in time we go, to construct each safe haven's payoff profile will depend on the safe haven. For some, like certain actively managed strategies, the data go back to the 1990s (and we wouldn't want to go back further anyway, as the properties of such strategies and their trading dynamics have changed too much over the years), so that's what we'll use. For other assets, such as gold, the data go back much further. In gold's case, for instance, we will start in 1973, appropriate for when gold started freely floating. And we'll use that same start period for other assets such as bonds.

In the following sections, we will look closely at a handful of the most canonical real-world safe havens, each a mini case study of sorts. While each is worthy of a book on its own, in this book our focus remains on strategic, agnostic, cost-effective risk mitigation—the only kind. My tactical opinions about each must be constrained (as I wouldn’t want to distract you). The culmination of all of this will be throwing the gamut of recognized safe havens (about 40 in all) onto our cost-effectiveness plane—the gladiator’s arena.

NEPTUNE OR VULCAN?

Before we enter the viewing stands of the arena, where our safe havens will battle it out, we need to acknowledge one little problem with this whole falsification thing. We can myopically and overzealously take it too far. This is known as *naïve falsificationism*, of which Popper was very aware.

Case in point: After the planet Uranus was discovered in 1781, astrophysicists noticed that its orbit differed from what Newtonian physics predicted. But rather than falsify Newton’s law of universal gravitation, as it might seem that Popper would have prescribed, it led to the speculative conjecture of the existence of another yet-unseen planet interacting with Uranus. That was the only way to reconcile Uranus’s warped orbit with Newton (other than to jettison poor Newton). As it turned out, with the prediction and discovery in 1846 by the French astrophysicist Urbain Le Verrier, that speculative conjecture was exactly right—Neptune! But this new conjecture didn’t have to be right, as evidenced by Le Verrier’s attempt to repeat this performance with another speculative conjecture that there was a planet Vulcan similarly warping the orbit of Mercury. (Win some, lose some. But, fortunately, Einstein came along later and solved the Mercury puzzle for us—and in this case, Newtonian mechanics really was falsified, and was tentatively replaced by

general relativity.) While formerly accepted theories are always exposed to falsification, their presumed falsification can also provide hints about changing parameters and previously unknown degrees of freedom that can even reinforce the theory. Often, falsificationism is about adjusting a theory rather than dropping it. While we know that as-yet unfalsified theories are provisional, as it turns out, so too are falsified theories. Experimental conditions can change. It's a tricky business, this falsificationism.

As we will see, we have our own Neptune and Vulcan problem. We will observe it in the warping of various safe havens' payoff profiles with time, under different regimes or environments. There are perhaps other bodies acting on those payoffs; or, perhaps, we were wrong about the shape of a payoff profile in the first place. Neptune or Vulcan? These unseen economic or market forces that may or may not be doing the warping are even harder to anticipate than the existence of unseen planets. But the impact on the cost-effectiveness, and even on just the effectiveness, of these safe havens is enormous. We need to be aware of this vulnerability to *higher-order* changes in a safe haven's risk-mitigation performance.

All we can do is, first, try to recognize these effects in the historical data. And furthermore, we need to try to understand the degree to which any safe haven payoff is *mechanical* versus *statistical*. A mechanical payoff is one that happens as a direct, intrinsic consequence, which would present an arbitrage opportunity (or an opportunity for free money) if it weren't so. This would be like an option going in-the-money: it must go up in value. (Or think of the insurance contract that our Petersburg merchant considered for his shipments across the Baltic.)

In contrast to a mechanical payoff, a statistical payoff is one that only *tends* to be so, based on observed history, but it *needn't* be so. It is more extrinsic, and thus noisier. This would be like the flight-to-quality effect that we see in Treasuries and safe havens in general, for instance. The mechanical versus statistical

payoff is really about *basis risk* (or the degree to which a payoff tracks the systematic exposure that is being mitigated—like the SPX). But we could also think about other possibilities for payoff warping, like counterparty risk (or the risk of not getting paid when the risk mitigation really needs to get paid, such as in a crash).

Our cartoon payoffs were all entirely mechanical; real-world payoffs tend to be much less so. The question to *always* ask with regard to mechanical versus statistical safe haven payoffs is: Do you need a lot of things to go right for a safe haven to be *effective*? Is their history a good guide to their future, or is everything always different?

Popper also had his similar “propensity interpretation of probability,” as we first saw in Chapter 1, whereby we need to think about an event as “the result of a single experiment, with respect to its *conditions*, rather than the frequency of results in a sequence of experiments.” (That is, as we know from Nietzsche, our $N = 1$.) He used the example of a loaded die under the pull of different gravitational environments, or the “propensities of the experimental arrangements.”

As in all things safe haven, they tend to fall somewhere as a point on a spectrum or a line—in this case defined by these extremes of mechanical versus statistical payoffs. And we can never be certain how accurate our estimate is of any point on that spectrum.

As we will see, a safe haven’s susceptibility to having its payoff warped can often be even more important than the shape of the payoff itself. Susceptibility is a primary line of demarcation between safe havens and safe haven impostors, like hopeful havens or even unsafe havens.

Here’s the rub: Variability or warping in a safe haven’s payoff profile can make you think you see a Neptune or a Vulcan. And you won’t know which it is. **Warping can make us jettison a risk-mitigation strategy that we shouldn’t—because we don’t know about the planet Neptune: a type I error**

(also called a **false positive**). And warping can make us *not jettison one that we should*—because we think there's a planet Vulcan: a **type II error** (also called a **false negative**).

The first, in our context, is an error of *omission*; we may not even notice that we missed it. The second, like jumping out of an airplane with an uncertain parachute, is an error of commission; we will feel the error when it happens. Both can be very costly.

Given the choice, best of all is a safe haven payoff that is as mechanical as possible (though sometimes that means not very mechanical at all). I never claimed that falsificationism is automatic or easy. Sometimes, it requires some judgment.

CASH IS KING

First, we arrive at our store-of-value safe haven. They are the ones intended to be fixed in time and space. We know how challenging it was for our cartoon store-of-value safe haven payoff with a 7% fixed return to work strategically and cost-effectively. So, our expectations are very low at the start for the real-world store-of-value safe havens as well.

The most canonical example of the store-of-value safe haven is cash. And recall that this happens to be how we first arrived at it in Chapters 2 and 3 (when we set aside a portion of our wagers in the safety of cash, such as in the Kelly criterion), so it makes sense to start here in the real world as well.

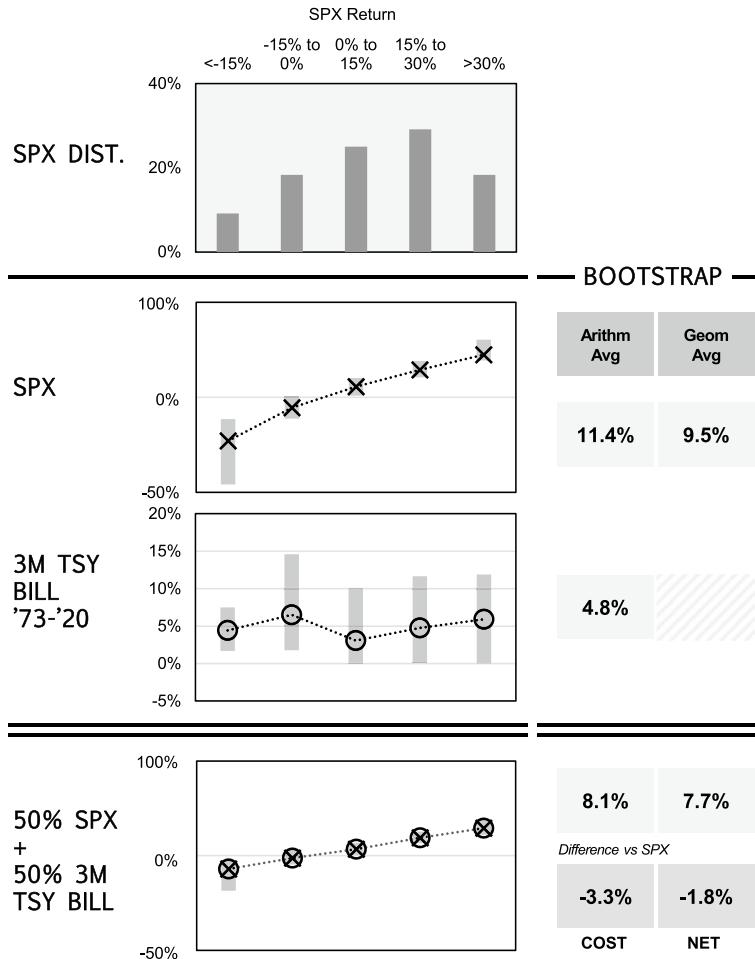
The best example of cash is certainly the three-month US Treasury bill. Its short duration means no interest rate risk beyond the reinvestment risk, as we can simply reinvest that allocation three times for each of our annual data points.

We are using three-month Treasury bill return data going back to 1973 to construct our payoff profile. The allocation size required for the 4.8% 5th percentile CAGR in our bootstrap

was our 50% maximum (as, sadly, its effectiveness never quite got us there).

Here is our familiar Xs and Os profile graph for the three-month Treasury bill:

Xs and Os Profile: Three-month US Treasury Bills



Everything is exactly the same as our cartoon Xs and Os profile graphs from the previous chapter (other than using the range of safe haven returns in each bin, rather than a single return), so this requires no further explanation.

One thing to note: The top two rows of information will *never change* from case to case throughout these mini case studies—as all use the exact same 10,000 runs of 25-year paths of the SPX bootstrapped from our d120 die containing 120 years of SPX annual returns. So this will be the first and only time that I will bother to show it. Henceforth, I will dispense with the top two rows and only show the bottom two rows of information.

Visibly, the shape of the three-month Treasury bill’s payoff profile has been very flat, as we expect for a store-of-value. And as its standalone arithmetic average return has been 4.8%—lower than the 7% of our cartoon store-of-value safe haven—it really has its work cut out for it. As expected, its net portfolio effect has been negative, with a geometric average return, or median CAGR in our bootstrap, of 7.7%, representing a lower CAGR than the SPX alone of 9.5%—resulting in a net portfolio effect of -1.8%. Keeping to our methodology, this net portfolio effect is in the 95% rejection region—or below the SPX’s 9.4% rejection boundary, the lower bound of its 95% confidence interval for its geometric average return.

Thus, our null hypothesis that the three-month Treasury bill is a cost-effective safe haven must be rejected, as we deny its consequent: that adding the three-month Treasury bill to our SPX portfolio raises that portfolio’s CAGR over time (and which we’ve just seen, it doesn’t).

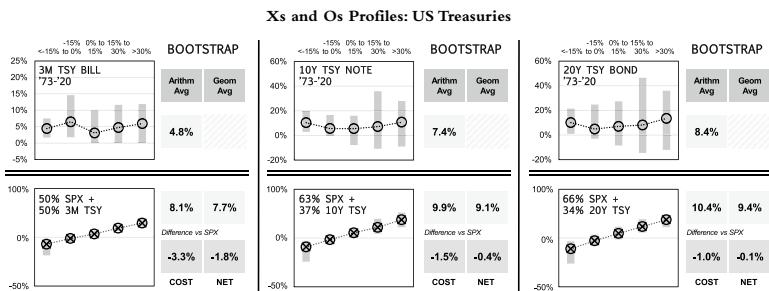
As a next step, we can move further out along the yield curve, from 3 months to 10 and 20 years. This becomes more representative of the bonds in the “stocks/bonds” portfolio that is *the* “balanced portfolio” in investing. We might even think of it as the *standard* in diversified portfolios.

As we move out along the yield curve, we also move out along the safe haven spectrum as defined by our three cartoons. And as we move from the three-month to the 10- and 20-year Treasury maturity, we move from the store-of-value toward a more presumably negatively correlated payoff—a hybrid between the two.

Of course, the price of the shorter maturity three-month bill has less sensitivity to movements in interest rates, and its interest rate itself is more attached to monetary interventions. The valuation of longer-maturity Treasury securities is far more sensitive to movements in their rates, and those rates tend to be more of a function of expectations of economic growth or contraction, and inflation or deflation. Moreover, as mentioned previously, these longer-dated US Treasury securities are a classic flight-to-quality asset—meaning investors tend to scoop them up for safety when things turn bad for stock markets and the economy. On the following page, we can see some evidence of that effect in the following (highly statistical, rather than mechanical) payoff profiles (where the allocations to the 10-year notes and 20-year bonds are 37% and 34%, respectively).

This time, they look a bit better than the three-month bill, though there is still either no or only marginal cost-effectiveness from these 10-year and 20-year Treasuries as safe havens. In addition to the negative net portfolio effect of the three-month Treasury (-1.8%), the 10-year Treasury note (-0.4%) and 20-year bond (-0.1%) are also drags on portfolio performance.

This isn't all terrible, mind you, but I needn't even mention the obvious transformations over the years that have left their safe haven status even more unreliable—specifically the exceedingly low Treasury yields with little room left to fall (though lots to rise). While true and interesting, some may expect these US interest rates to head to negative territory, so this is



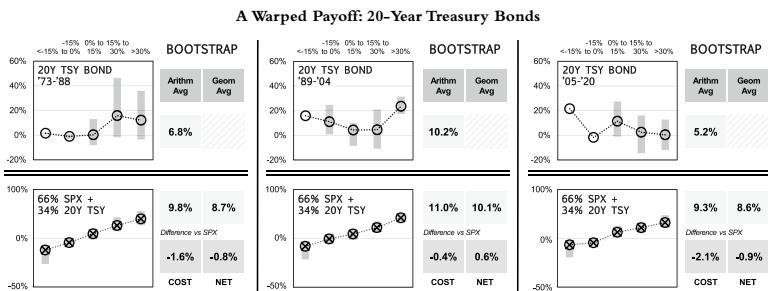
an unconvincing warning to them. Nonetheless, a glimpse at this chart shows that the 10-year note does not pass the cost-effectiveness test, while the 20-year bond just barely does (as it is right at the SPX's rejection boundary).

A closer inspection of the payoff profile of the 20-year bond, however, shows a range of returns that should make us question the reliability of that cost-effectiveness. Treasuries have a statistical element to their payoff (the flight to quality), and they also have a mechanical element to their payoff (real economic growth rates, inflation, and deflation). How have they varied?

We will investigate this question by breaking up the period of time that we used to construct the 20-year Treasury bond's payoff profile into three distinct 16-year periods: 1973–1988, 1989–2004, and 2005–2020. (The choice of three was arbitrary.) Then we can reconstruct the bond's payoff profile for each of those periods. After doing that, we can then run three separate bootstraps, in exactly the same way, with the same d120 SPX die. This means that we are not breaking up our SPX returns into these three separate time chunks; rather we are only separating the data that we use to build the safe haven's payoff profile into these three separate time chunks. We are thus focusing on the *higher-order* changes in our risk mitigation properties, isolating changes in a safe haven payoff as a *function* of the SPX from any changes in the distribution of the SPX *itself*.

On the following page is what we see when we do this.

As we move from one interval of time to the next, we see a lot of variability in the net portfolio effect of the 20-year Treasury bond, from -0.8% to $+0.6\%$ to -0.9% . And this is using the same d120 distribution of SPX returns. And what's driving this is similarly enormous variability in the shape of the payoff. Either the bond's payoff profile is just extremely noisy from moment to moment and decade to decade, or something is acting on it to warp it. Is it an unseen Neptune, that perhaps we



can discover and use tactically, or is it a Vulcan, meaning a presumption that leads us to the wrong conclusion? If it's a Vulcan effect, the 20-year Treasury bond is essentially what we earlier described in our taxonomy as a hopeful haven—with so much noise that the payoff loses much of its meaning and economic effectiveness. It can be worse than nothing even.

Neptune or Vulcan—Treasuries look an awful lot like a hopeful haven or a diworsifier haven.

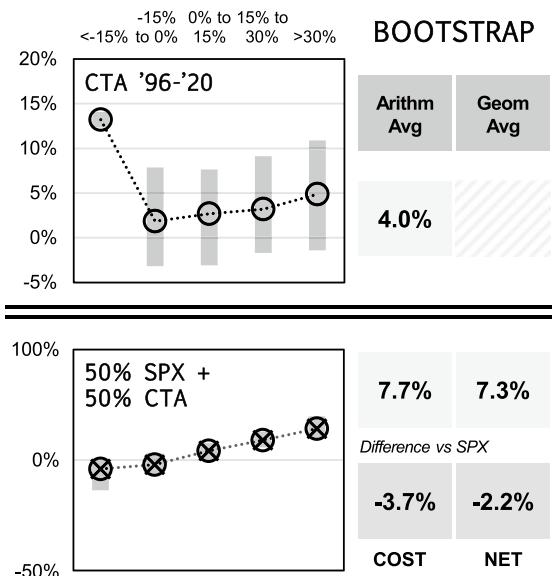
GO WITH THE FLOW

As we move further down the spectrum of safe haven payoffs and mechanisms, we arrive at the alpha safe haven. Recall that this was so named to look very much like the idealized case of a CTA strategy. CTAs (or commodity trading advisors) are generally a *trend-following* strategy: Once a security has moved in a certain direction (up or down) for a certain amount of time, a trend has been established and the CTA would go long or short that security as long as the trend remains. They thus tend to be momentum, go-with-the-flow strategies that rely on persistence in price movements—a sort of long-option-replicating strategy. The time windows and other inputs can vary by CTA firm, and positions are typically scaled by their various measures of volatility.

The CTA is important within the range of actively managed strategies (most notably hedge funds, for instance) because it is an overt attempt at risk mitigation through a *return-seeking* strategy with a presumed *edge* or *alpha*—and this presumption has even been idealistically dubbed *crisis alpha*. For this reason, trend-following strategies are in many ways the darlings of risk mitigation, and the great hope for that holy grail.

Here is our Xs and Os payoff profile of an index of CTA returns, with a maxed-out 50% allocation within the SPX portfolio):

Xs and Os Profile: CTAs



As in the real-world store-of-value-like three-month Treasury bill, this real-world alpha-like CTA index has a similar payoff shape to its namesake, with a lower standalone arithmetic average return of 4% (rather than the alpha cartoon's 7%); this creates a much higher arithmetic cost to the portfolio (of -3.7%).

And just like the alpha cartoon, the CTA's degree of downside protection is insufficient to provide cost-effective risk mitigation. (What's more, it is even insufficient to raise the portfolio's 5th percentile CAGR to 4.8%.) There's no darling here. (Fans of these strategies ostensibly have their own more theoretical than practical scoreboard.)

Note that hedge fund strategies do not typically have this negative correlation or sensitivity in the crash bins—another reason to use CTAs rather than more traditional hedge fund strategies as the canonical alpha safe haven. (The “hedge” in hedge fund has become

very much a misnomer.) **But there are other derivatives-based strategies that aim to do similar things, such as long volatility and tail hedging strategies.** Two indices representative of these two strategies have very similar payoff profiles as CTAs. And like CTAs—and consistent with academic research that rightfully criticizes generic tail hedging—*these indices, too, must be rejected for not being cost-effective.* As we know from the alpha cartoon, this level of negative correlation, even with an arithmetic average return of 7%, has had a negative net portfolio effect.

ALL THAT GLITTERS

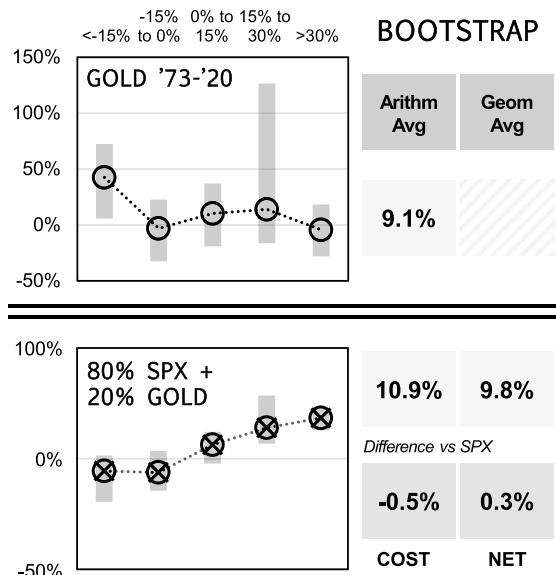
The safe haven body count is slowly piling up as we keep moving down the spectrum toward the far extreme of insurance. The cartoon insurance payoff, you will recall, is marked by an explosive crash payoff, relative to the losses expected to be experienced the rest of the time.

In the general folk wisdom of safe havens, gold is often considered to be an insurance-like hedge against broad market losses. It is the talisman of fear, and even thought of as protection against banking system collapse, as it is a means to extract savings from the fractional reserve banking system. Of course, gold is perhaps first and foremost thought of as a hedge against inflation.

However, it's actually a very noisy hedge against inflation. It is mostly (even almost entirely) tied to movements in real interest rates. (When inflation goes up faster than nominal interest rates, real rates go down, pushing up gold prices. But was it inflation or real rates? It's a chicken or the egg thing.) And you can think of low real rates as lessening the opportunity cost burden of the zero yield of gold.

Here is the Xs and Os payoff profile of gold (with a 20% allocation to an SPX portfolio):

Xs and Os Profile: Gold



Gold's mildly explosive crash payoff, compared to that of CTAs and certainly to Treasuries, is quite apparent and impressive. Now, this is no tenbagger, mind you, but we're making great progress. Consequently, the net portfolio effect of gold is positive (+0.3%). **So, in the case of gold, we cannot reject the null hypothesis that it is cost-effective as a safe haven.**

Gold is appearing worthy of its reputation, so far. However, notice that, since 1973, when we started building gold's payoff profile here, whenever stocks were down by 15% or more in any given year, gold returns ranged from about +70% to +5%, with an average of just over +40%. In all other years, its returns ranged from +125% to -30%, with an average of under 7%. While these are pretty good insurance-like returns, especially the average returns by bin, the problem is the wide ranges around those averages—particularly considering the 20% allocation needed for gold.

We know that gold is all about investors' *expectations* of its value. It has no yield and is completely unproductive in its role as a financial asset. As such, it has no *intrinsic economic value*. It is for that reason

impossible to fundamentally value. The economist Ludwig von Mises—whom I mentioned earlier—famously developed a theory linking today’s price of gold back to its early history as a mere commodity, but that *explains* where gold prices come from; Mises would be the first to admit he wasn’t giving us a formula by which we could *predict* the fair price of an ounce of gold next week. Therefore, despite the mechanical low real interest effect on the opportunity cost of holding gold, we should conclude that its payoff profile is largely statistical—and we would be correct in doing so. Thus, we need to dig a little deeper, as we did with the 20-year Treasury bond, to see how that payoff profile may have moved around over the years.

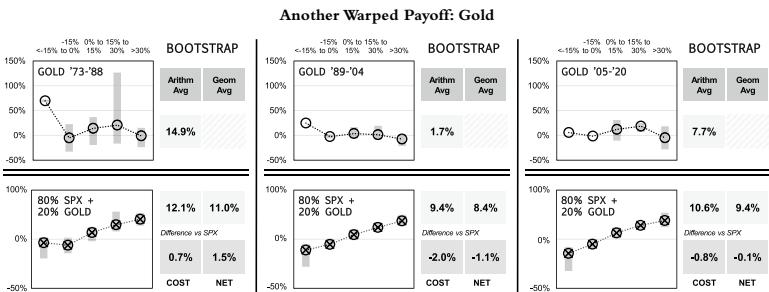
On the following page, as before, are gold’s Xs and Os profiles separated into the same three 16-year time intervals: 1973–1988, 1989–2004, and 2005–2020. As with the prior such example, something seems to be warping the shape of our safe haven’s payoff.

Remember, these are *higher-order effects*. They are not caused by anything the SPX is doing differently over these three distinct periods, as the SPX bootstrap is the same in each. They’re from how the shape of the safe haven’s payoff profile has changed.

Visibly, something has warped gold’s payoff since the late 1980s, at least. Or maybe it warped prior to that, and now gold’s payoff profile has bounced back to its natural shape. **In either case, gold’s payoff has become increasingly flattened over time, or more alpha-like or even store-of-value-like; this has resulted in lower standalone arithmetic average returns for gold, which have in turn resulted in lower net portfolio effects: from +1.5% in the first period to -1.1% in the second, and to -0.1% in the third.**

While gold’s geometric effects have been somewhat stable, its arithmetic costs to the portfolio have gone up.

Anyone using gold as a safe haven to mitigate against systematic risk in their portfolio needs to understand that there may be an unseen Neptune out there warping gold’s payoff. Or, alternatively, there may be a Vulcan, meaning nothing at all—their safe haven hypothesis and classification for gold was just wrong in the first place, and thus gold is, in fact, only a hopeful haven.



Here's what we know: When inflation was higher in the 1970s, gold's payoff profile made it very cost-effective as a safe haven protecting against crashes. Outside of that, gold has been much less cost-effective. Gold has required a tactical call regarding these regimes—be they inflation, or real rates regimes—in order to be a cost-effective safe haven.

It means that we need certain things to go right for gold to even be *effective* in mitigating systematic risk (of a crash), much less *cost-effective*. And this is an internal contradiction, and a problem for gold as a strategic safe haven.

Does gold even have a unique place as this monetary-like insurance against crashes? Some would say that cryptocurrencies, like bitcoin, are taking gold's place in that function. But are these modern inventions really safe havens?

Cryptocurrencies' safe haven payoff profiles are currently too sparse and too noisy to even evaluate intelligently (though the early indication is that they look more like unsafe havens). By that alone, they are hopeful havens at best. (Lazy Nana, posing as a groundhog killer!) Time will tell.

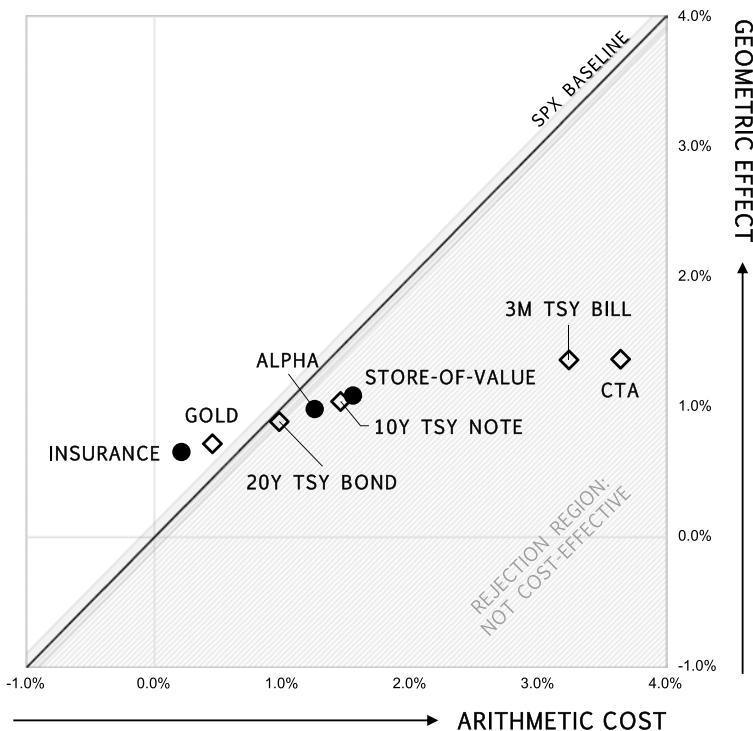
But cryptocurrency enthusiasts have their heads in the right place. Cryptocurrencies are thought of as insurance policies against the failure of central bankers. This, by extension, has also given them the presumed role of being an insurance policy against economic crises—since, at this point, that would entail the failure of current monetary policy.

Cryptocurrencies are a most significant technology platform (the blockchain). They are like secure, virtual safety deposit boxes that only you can access. The box is the thing that's so cool and impressive, and worthy of our respect. It will change the world. But the stuff inside those boxes, just by virtue of the secure, convenient, cool boxes, is now presumed to have value—by decree or, dare I say, by *fiat*. (The economist Robert Murphy has even argued that in Mises's framework, we have no choice but to call crypto *fiat currencies*.)

Moreover, bitcoin isn't even ultimately anonymous; the technical term is that it's *pseudonymous*, meaning that the owner of each bitcoin is public knowledge at any moment, although it's not obvious which *human* is tied to each address. But it's quite traceable, nonetheless. Worst of all, as a highly speculative vehicle, it is a symptom of (and, I would argue, even inseparable from) the liquidity-fueled environment that created it. All that glitters isn't gold.

THE SAFE HAVEN FRONTIER

After a closer look at three of the big safe havens of Treasuries, CTAs (or hedge funds), and gold, here they are on our cost-effectiveness plane, along with our original three cartoons:



As we saw, our safe haven species problem isn't going away any time soon. We will have to keep wrestling with these fuzzy lines of demarcation between safe havens and safe haven impostors. Our cartoons are called cartoons for a reason.

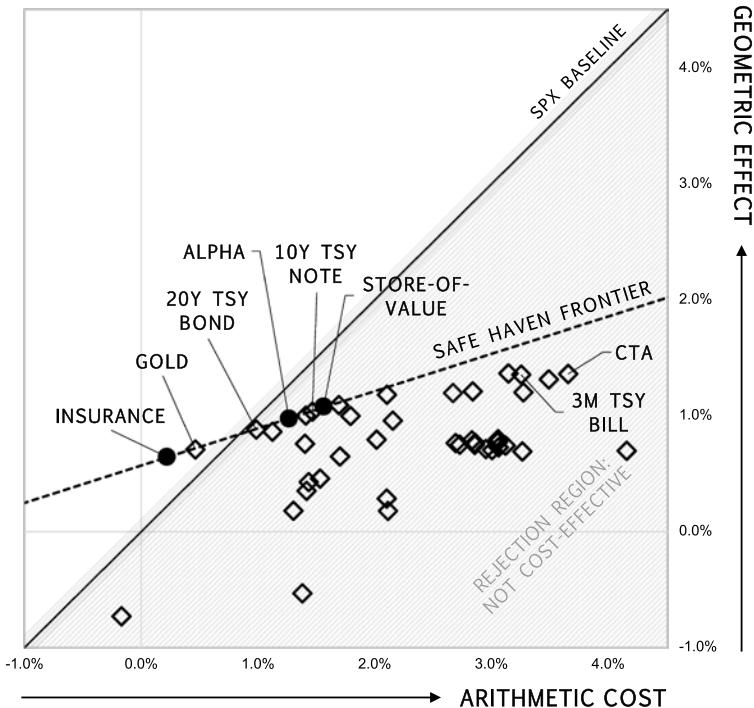
But these cartoons remain ideal prototypes. Think of them as preliminary models from which to explore and develop other real-world safe havens. In fact, this is precisely what we have done and continue to do at Universa: improve and refine the insurance cartoon payoff. Universa's realized standalone safe haven payoff profile has been much more explosive than a ten-bagger, and this has resulted in our cost-effectiveness as a risk mitigation strategy (as well as our decade-plus life-to-date and audited average annual return on capital of over 100%, rather than the insurance cartoon's 0%). **People think of risk mitigation as a tradeoff against wealth creation, because it usually is. It shouldn't be.**

On the following page, we will now throw the gamut of about 40 canonical safe havens onto our cost-effectiveness plane. These data points will include everything from our handful of already covered to also include other hedge fund strategies; currencies like the Swiss franc, Japanese yen, and the US dollar; private equity; value strategies; momentum strategies; risk parity; min-vol and managed-vol strategies; long vol; VXX; high yield indices; art; farmland; commodities; goats (well, maybe not goats).

This plane would appear to represent, with a couple of exceptions already covered, a veritable graveyard of safe havens that fall within the rejection region of their cost-effectiveness. Despite so much movement among these safe havens, there is so little action.

But much more than that, it represents a continuum—a safe haven spectrum, not unlike the one defined by our three prototypical cartoons. **We can draw a line that intersects our three cartoon safe havens on the chart and extend that line in both directions. What is immediately clear is that this line has significant meaning.**

The Safe Haven Frontier



In fact, this line tracks the safe havens whose allocation raises the 5th percentile CAGR of their risk-mitigated portfolio to our predesignated 4.8% (from an un-risk-mitigated 2.7%). The points below that line raise that 5th percentile by less, and the further below the line, the lesser they raise it.

This line is our *safe haven frontier*.

Every similar, lower line that we could draw intersects safe havens that provide less risk mitigation. The level playing field, apples-to-apples comparison between safe havens is along *one such line*.

The safe haven frontier is the spectrum of performance to which I have alluded throughout this

book. It delineates the payoff and cost characteristics of the safe haven universe.

Think about how we sized the allocations within each of these risk-mitigated portfolios in order to raise each portfolio's 5th percentile CAGR in our bootstrap. The more explosive the crash payoff in general, the smaller the safe haven allocation needed to prevent plunging over Bernoulli Falls. And the smaller the safe haven allocation, the less arithmetic cost to the portfolio from the low standalone arithmetic average returns of that safe haven.

The net portfolio effect—or the cost-effectiveness of a safe haven—is thus driven by *how little of that safe haven is needed* for a given level of risk mitigation. When little is needed, it drives down the safe haven's arithmetic average cost relative to its geometric effect. The more the plunge over Bernoulli Falls is mitigated with less cost, the further down this safe haven frontier we travel—and the greater the cost-effectiveness.

Traveling down the safe haven frontier line in this way captures that double whammy of arithmetic cost savings plus greater net portfolio effect—an *economically dominant strategy*. We saw this *same double whammy* in our insured dice game, and we saw it again in our insurance cartoon.

Our deductive and computational results from our many games with dice seem to have conformed with the messy observations of all these diverse safe havens. That is to say, the spectrum defined by our cartoon safe havens seems to have empirical merit. While we tragically must falsify the vast majority of these diverse safe havens, happily, the broader safe haven hypothesis—our “guess”—*still stands*: that the mitigation of risk can be done cost-effectively.

The point of our few case studies wasn't to figure out every messy detail of those dots on our graph. Their particulars are almost incidental. The takeaway was what determined the locations of these dots, and thus all the others, and why they are

where they are. The cost-effectiveness plane is the scoreboard of our gladiatorial fight. The question to always ask, then, is: What moves the scoreboard?

There is a beautiful order to this safe haven frontier line: Mitigating the worst paths gets a safe haven onto this highest line—*on the frontier*; and then mitigating those worst paths with less cost is what slides that safe haven to the left along that frontier line. The ability to raise that 5th percentile path—to be more precise in our William Tell shot—with less cost, *in turn* raises the median path—the accuracy of our shot.

The message from this is that you don't raise your geometric average or median wealth by taking greater risk. You raise it specifically by lowering risk—the right risk, the worst outcomes. *They are actually connected.* The cartoon safe havens anticipated this, and before that, so did Bernoulli's concavity of curve—and the safe haven frontier line corroborates it with all the messy, real-world safe havens.

Therefore, mitigating the losses along the *worst paths in a cost-effective way* accomplishes what modern finance says cannot be done: raise wealth by lowering risk.

WHISTLING PAST THE GRAVEYARD

There are three main conclusions to be drawn from these hypothesis tests:

One, as expected, cost-effective risk mitigation is hard. The canonical safe havens have not been particularly cost effective—in many cases quite the opposite. These exist largely as tactical strategies only, not as strategic risk mitigation strategies.

Two, where such safe havens have existed in a cost-effective form, they have tended to be inconsistent, and even ephemeral. They are hybrid tactical and strategic safe havens. Their payoff profiles have been warped, either by Neptune or Vulcan. Over

long periods of time, the payoff shape of gold has been that rare cost-effective safe haven, even though that cost-effectiveness seems to have required a level of inflation not seen since the 1970s. It has not been cost-effective through the crashes since then, when using gold as a systematic risk mitigation strategy proved costly. (It has been good in total only because of how great it was in the 1970s.) As such, gold is a tactical hedge (during heightened inflation), not a strategic safe haven.

And three, there is some good news in all this: **There exists a real and meaningful safe haven frontier that we can use; it defines and explains the edge of the envelope along which we can push. There exists a spectrum of real safe haven payoff shapes that can (and actually do) move us down that frontier and thus provide increasing cost-effectiveness. What's more, a lowly cartoon—our insurance cartoon—making a 0% arithmetic average return, has done what none of the powerhouse and sophisticated studies and investment vehicles could: raise wealth by lowering risk. But it shouldn't be surprising, after all—it is the Petersburg merchant trade.**

It feels like we have done little except criticize and quash all of our big ideas and high hopes. We would now appear to be the defeatist nihilists of investing.

This would be thinking about it altogether wrong. Knowledge progresses through the body count of refuted theories. It must relish in that gruesome specter. It must whistle past the graveyard of *bold* conjectures.

And as Popper said, the bolder the conjectures, the better—the easier to kill them. The bolder they are the harder they fall. That easy kill is what makes them all the more scientific. **The zombie ideas are the pseudoscientific ideas.**

Many of the conjectures about specific safe havens that we have endeavored to kill in this chapter have been untouchable from a risk-mitigation standpoint. This is because modern finance's framework cannot even consider our conjectures. It shoots at a

different target altogether and can't consider our scoreboard of ending wealth and rates of compounding. It uses a different scoreboard such that its approach isn't even wrong. It isn't even falsifiable. By definition, then, modern finance is a pseudoscience.

In denying the consequents of observable portfolio effects throughout this chapter, we refute a basic hypothesis about these safe havens' cost-effectiveness. And this fundamental goal of lowering risk deliberately in order to do better, with a higher rate of compounding over time, is the very "essence of investment management" itself.

And yet this essence is a radical idea. It is the bold, easily felled conjecture so celebrated by Popper. Perhaps it is the boldest conjecture that we can pose as investors. And until it is refuted, it is accepted only tentatively.

We shouldn't feel bad in being so quick to judge. When we jettison a safe haven for its cost-ineffectiveness, all is not lost. What we are really doing instead is setting new baselines from which to measure them all *relative to each other*.

It isn't just who crosses the finish line first that matters; this isn't winner take all, and the tentative leaderboard matters just as much. The race never ends, and investing is about incremental adjustments and improvements. As we learn, we get closer and closer to the bullseye. As the cost-effectiveness baseline advances, so too does our investing. The best need not be the enemy of the good.

What's more, as Feynman said, "Being wrong isn't a bad thing, it's an opportunity."

The groundwork laid in these exercises gets us thinking rigorously and constructively about that great dilemma, the most important problem in all of investing, that was the very reason for this book. It got us thinking about and even finding a spectrum of safe havens and the safe haven frontier that can get us to its solution, one incremental risk mitigation improvement at a time.

Our investing makes progress by correcting our errors; these are the errors of current financial dogma, but they are also the errors of trying to apply our safe haven hypothesis in the real world. This is retreating in order to advance, seeming to go backward in order to go forward, moving away from the truth through refutation, and thus moving closer to the truth that will help you solve that great dilemma by finding your own cost-effective safe haven, and your buried treasure.

AFTERWORD

Amor Fati



LOOKING BACK

When I was about 11 years old, I decided I wanted to be a professional orchestral horn player when I grew up. (Yes, I was a total stud.) I immersed myself in all the repertoire and practiced multiple hours every day. (One of those hours was before school—and imagine my parents' annoyance getting awakened by blasts of Mahler each morning, bless their hearts.) I got very, very good at it.

It might even have been preordained as, unbeknownst to me at the time, my birthday falls on what is known as the “Horn Duumvirate Date”—the shared birthday of the two most pre-eminent horn players in the world. But it was not to become the “Triumvirate Date.”

One day, at the age of 14 or so, it hit me like a ton of bricks: There were only three horn positions out there that I determinedly and obsessively wanted: principal horn of either the Chicago Symphony, the New York Philharmonic, or the Berlin Philharmonic. That was it! Anything else, and I would regret ever committing to this.

It didn’t matter what other paths might also have been available: second chair at these orchestras, principal at another, or performing in subway stations. All were unacceptable to me. And those three principal horn positions that I so obsessively wanted opened up perhaps once a generation. And so, while I loved my expectation, I hated my probability of ever seeing it (Duumvirate Date or not).

I faced my own Saint Petersburg paradox: My expected outcome, the one in which I would love my fate, was far, far less likely than my median outcome. And if my outcome fell short of that expectation, I knew I would curse my fate. My professional life was too high a price to pay for that expectation.

Needless to say, I threw in the towel—and I never looked back. I haven’t so much as touched a horn since those years (though I still blast Mahler, now to my wife’s annoyance, bless

her heart). It was the right decision based on my internal valuation metric then, which is the very same as the one I've been touting in this book.

THE ONE, AND ONLY ONE, PATH

Before we end, let us look back on how far we have come in our delightful time together. We've played dice games while contemplating all the possible diverging, twisting, and turning paths. (I hope you have enjoyed it as much as I have.) Would that we could traverse all those countless paths, sending out our doppelgänger along each and every one, and taking every new fork in every new path. Such a journey would take us across the breadth of the multiverse.

Wondrous to contemplate, but to us they are mere Dickensian ghosts, the ghosts of what could have been. All except for one, that is—the one that *was*, the one that got us *here*.

We saw in our many dice games, from the splintered six-sided to the implausible 120, what is sometimes hard to remember from our experience traversing our own one path: Some of those other potential paths would have been very pleasant, but some of those potential paths wouldn't have been. They all would have brought us to someplace different than where we are now.

So, what happens now—or, more precisely, what happens when we come to the end of our one twisted path, as we will some day? Will we look back fondly, grateful for our experiences, content with the outcome? Will we, indeed, love the path we chose—enough to desire it once more and innumerable times more? **When Nietzsche's demon steals after us into our loneliest loneliness, will we curse or kiss the demon?**

In the same way, what would we say about our investing path, our foray as investors, with choices and decisions that impact us not only in the moment, but long after? Love it or curse it?

Hindsight is always obvious in showing how we could have taken or not taken certain risks in order to have loved our path. This is the ubiquitous retrospective safe haven fallacy. But what might we say—what we should or could have done—without being a know-it-all (or specifically a “knew-it-all-along”), and all because we gained perspective from looking back from our lofty perch at the end of it all?

The answer to this question reveals how we should think about risk mitigation *now*, before we get to the end when it is too late.

Are we likely to say that we wish we had hidden away more, divorsified more, and kept our ship in harbor more? Are we likely to say that we should have made even more grandiose forecasts and rolled the dice on their outcomes? Are we likely to say that we should have raised the arithmetic average of all our paths more, pretending that we are like a casino—or even tried to raise that average more relative to our paths’ volatility? I hazard to say that we aren’t likely to say any of those defeatist and nihilistic things.

We are most likely to say that we should have focused more on raising and tightening our grouping of outcomes wherever possible (especially the worst of them) toward paths that we can say we love. In other words, we should have focused more on the geometric mean of our outcomes. After all, that grouping would likely include a better place where we would be *now*. We would have a better shot grouping within which our arrow landed. Perhaps only by looking back from our lofty perch can we really see that.

We are most likely to say that we should have considered *cost-effectiveness* as the main criterion in our decisions to take or not take risks. Of course, the degree of safety is part in parcel to this criterion: being very safe and very unsafe can both be very costly.

As we look back from our lofty perch, we gain a perspective that was so challenging while we were in the thick of it,

traversing our unknown path. From here, we have a broad and clear view, all the way down the track, as it were. And we can perhaps even see better that our N equals 1.

What if Babe Ruth had been given just one at bat for his entire career (rather than his 10,617 career plate appearances—among the 50 highest in baseball history)? His optimal strategy would no longer have been his home run–maximizing, King of Strikeouts strategy. After all, it would be very unlikely that he would ever get to realize that home run expectation with only one at-bat. With one at-bat, that expectation becomes meaningless. Ruth would need a new valuation metric: His optimal strategy would have been something more like the on-base-percentage-maximizing strategy of Billy Beane and *Moneyball* fame. (In fact, Ruth actually—and very impressively—looks much more like a contact hitter by today’s strikeout standards.)

This is the same perspective that, hopefully, we have already adopted, thanks to the teachings of our two denizens of the Free City and safe haven of Basel—Bernoulli and Nietzsche. Theirs was an admonition and an imperative for us to arrange our affairs with an appreciation for and a high valuation of the *one* and *only* path that we will traverse—and thus, most importantly, to get it right.

THE WILLIAM TELL SHOT

Choosing my path as a teenager meant abandoning the horn and my dreams of orchestral glory and taking a far different road. I decided instead, at about the age of 16 when I met Everett (“Babe Ruth”) Klipp, to obsessively pursue what would become explosive payoffs on once-a-century stock market crashes. Fate loves irony.

But as it turns out, once-a-century stock market crashes have happened quite often. I would need both hands to count their occurrences in my quarter-century-long career so far. And

I will likely need both again to count them for the rest of it.
(But who's counting?)

Even more importantly, as we now know from this book's conclusive solution to the great dilemma of risk, when those explosive crash payoffs are added to a portfolio to mitigate its systematic risk—like just a pinch of salt becomes the most important ingredient to the dish—they can raise not only the worst outcomes but also the *median* wealth or CAGR outcome of that portfolio. We're not talking some pie-in-the-sky expected wealth, but the median. And they raise it in a way that nothing else has. (And that is just how things have played out at Universa.)

This doesn't mean we shouldn't aim high. Nor does it mean don't take risks. On the contrary! Aiming high and taking risks is exactly what it *does* mean. It means rethinking all the defeatist, nihilistic approaches that keep you aiming low. And it means exposing yourself to risk deliberately, not gratuitously. **You aim high in a way that, even if you don't hit your target, you will also love the other things you're likely to hit instead—your alternative potential outcomes.**

Aim high and aim small; miss high and miss small.

You get one shot at the bullseye. **From the dichotomy of control in investing, you control what you can control when taking that one shot; and once the arrow has left your bow, it's out of your control.** Your risk mitigation strategy should help you with both accuracy *and* precision so that you love that shot—the William Tell shot—whatever it is. It should help you fight—and *win*—the war against luck.

It is unsettling to think about randomly drawing our fate from a vast distribution of possible fates. But thinking about it any other way is an illusion. Of course, we cannot always influence this vast distribution as much as we would like, as I tried as a boy and as we have been doing throughout this book. Sometimes it's only fate. For instance, think of your life as selected for you at random from the population of the world

(as, indeed, it was). How about across time going back millennia (as it also was)?

When our N equals 1, we need to *make* it a good one, whether it was or not.

PIRATE TREASURE

Sadly, our Petersburg merchant never managed to solve that risk dilemma he faced. He so misunderstood it. Instead, he stared wistfully at his framed “*A ship in harbor is safe*” motto on the wall behind his desk piled high with tattered navigation charts from over the years, scribbled with illegible notes and markings plotting his roundabout routes evading Captain Jack of the Baltic. And he would daydream as he stared at the engraving of a ship in that same frame. Then one day he saw what he never noticed before: it was a pirate ship—not a merchant ship, as he always assumed. As he stared in disbelief, that image became the *Sudden Death*, the flagship of his archnemesis.

He had experienced a handful of sudden deaths over the years because of that ship. Those losses had really set him back financially; afterward, because of his much-diminished capital, he’d had to reduce the sizes of his subsequent cargos for what seemed like an eternity. Slowly, with enough successful shipments—barely outrunning that dreaded Captain Jack and the stormy seas to get his cargo safely to market in Saint Petersburg—he managed to claw his way back to where he’d been. All that work just to get back to even. Alas, all along he could not see the real picture.

Nietzsche held a curious belief that “merchant and pirate were for a long period one and the same person,” as “mercantile morality is really nothing but a refinement of piratical morality.” If only our merchant had a little more of Nietzsche’s piratical morality—better yet of Buckminster Fuller’s. Then he would have seen that the solution was right under his nose

all along. **But it wasn't his elaborate navigational charts that were his treasure map; rather, it was Bernoulli's logarithmic map.**

Our merchant lived through enough of the agony and the ecstasy, the costly lost cargos, and the profitable successful ones. He lived through the geometric progression of their compounding from one to the next. He ran the machine of compounding through time—in real time and the real world, not with dice. He should have figured it out—and, even if he had, he would have saved himself so much time and expense by instead simply charting his shipments along the “concavity of curve” of Bernoulli's logarithmic map (just as we did in Chapter 2). He could have tracked his poor, seized merchant vessels as they plunged down that curve into the abyss of the sea. That is, he could have calculated the expected log return (or the *emolumentum medium*) of his next shipment. Thus, he could have found the geometric average return from parlaying that same shipment forever.

What an eye-opener that could have been! He could have seen how a large loss disproportionately lowered his geometric average return because it left him with a much lower stake to reinvest and compound on his next shipment. And if he would have recalculated the geometric average return both with and without that *ochen' dorogo* 800-ruble insurance policy, then, like a Great Pirate, he could have seen the whole, instead of just the parts. **He could have even seen that the whole was so much greater than the sum of the parts.**

Bernoulli's logarithmic map—nature's admonition to either avoid or *insure* the dice—really is a map. As it turns out, it is *the map* to the buried treasure that we and the Petersburg merchant have been looking for all along. It shows us exactly where to dig.

Multiplicative compounding is a *most powerful force* (*the most powerful force*, as some would say). It is to be harnessed and used. But when it throws you over Bernoulli Falls, then it becomes the *most destructive force*. It can make you stronger, just as long as it doesn't kill you—or,

turned around in Nietzsche's famous saying, "What doesn't kill you makes you stronger."

A FORMULA FOR GREATNESS

But of all Nietzsche's wisdom, here we follow most closely his fundamental doctrine of the eternal return—what we reap once and again, over and over. He took his existential imperative another step further: We mustn't merely appreciate our one and only path—we must love it!

This is *Amor fati*—the “love of one’s fate.” Like the eternal return, it is another ancient idea co-opted by Nietzsche, originating at least as far back as the Stoics such as Epictetus and Marcus Aurelius. As the latter wrote in his *Meditations*, “Love the hand that fate deals you and play it as your own, for what could be more fitting?” (Marcus Aurelius wasn’t playing poker, but this has Sklansky’s theory of poker all over it.)

But it was Nietzsche who really owned this idea of loving your fate. *Amor fati* was the logical extension to his fundamental doctrine, such that out of his “highest formula of affirmation” came another, new and improved formula:

My formula for greatness in a human being is amor fati: that one wants nothing to be different, not forward, not backward, not in all eternity. Not merely bear what is necessary, still less conceal it ... but love it.

Nietzsche is so often misunderstood as being a nihilist (mostly thanks to his misunderstood exclamation that “God is dead!”). Nietzsche was no nihilist. *Amor fati* was, in many ways, his stand against nihilism. It’s so easy to respond to the indeterminism of “the great dice game of existence” by retrenching with blind resignation, such as in a safe haven. Rather, to Nietzsche, *amor fati* was tweaking your payoff from those rolls of the dice such that you will love whatever you get.

To love any fate, however the die lands, is not resignation. No, this is a call to *alter* that fate—not the die itself, but its effect—such that we can declare, “Thus I willed it!”

We need to get *this* path right. And in order get *this* path right, we need to have gotten pretty much every possible path right. We need to be robust to the realized path.

The eternal return of the same return forces us to focus on what matters in investing. It makes us get our sights right and understand the nature of the game. We are not a casino, or a portfolio of our distribution of possible simultaneous returns. Rather, we are one wager compounded through time. We only get one chance, and, if we shine a bright light on that, we will avoid many mistakes—start thinking about the right things, with a better internal valuation metric: making sure this chance maximizes its chance. Tighten the potential outcomes while maximizing the most likely.

This is what cost-effective risk mitigation is all about. It is about getting your fate right, whatever it is. Not your average expected fate, and not just your bad fates. But *all of them*—whichever one of them you get.

The hypothesis that we will relive every moment of our life again and again gives each moment the greatest weight. It is perhaps an unbearable weight. (This was the very theme behind Milan Kundera’s 1984 novel, *The Unbearable Lightness of Being*.)

Every moment, every return, doesn’t just happen and then, like that, it’s gone. It is a mathematical fact: it stays with you *forever*. That’s the nature of this most powerful and destructive multiplicative compounding, where each subsequent return is multiplied by the next—and the unfortunate commutative property of multiplication. As we saw in Chapter 3, a big loss today will impact your ending wealth decades from now, just as if it happened decades from now (affecting a much higher wealth). It doesn’t matter when it actually happens, it reverberates like ripples on the water, and for eternity.

Moments are no longer fleeting; rather, each moment becomes a weighty, permanent structure that shapes not only the present, but the future as far as you can see.

This is why we need to evaluate every one-period investment as if we were to parlay that investment over and over, compounded many times—for an eternity even—whether we actually will or not. Effectively—and mathematically—we will. This was the message of Bernoulli's logarithmic objective function (or taking the geometric average of all potential outcomes of a wager). And that's *amor fati* for investing!

Nietzsche's formula for greatness in a human being is also our formula for greatness in investing. And it is the same formula etched in stone along the banks at the crashing Rhine Falls. Far more important than any particular investment strategy is the disposition of *amor fati*. Get it, and you're way ahead of the game.

But this formula is easily forgotten in our runaway lives, so here's another trade secret: Get something to remind yourself of it, if you can (like a phone reminder, a tattoo, or a fuzzy *disdyakis triacontahedron* hanging from your rearview mirror).

And let's always remember that great twist of safe haven investing, that a cost-effective safe haven is not about *slashing* risk. To the contrary, we mitigate risk deliberately so that we can do more, not do less. We can find ourselves in the position of our great stoic Marcus Aurelius when he said, “It is not death that a man should fear, but he should fear never beginning to live.”

“I HAVE FORGOTTEN MY UMBRELLA.”

We are wired to compound our capital and to mitigate the risks accordingly. Surely we get it instinctively in our bones. All that our ancestors went through, their toil, hardships, hunger, and

pain, wasn't to make it through the next day, the next quarter, or even another year. It was for survival and thriving and multiplicative replication to the end. That's human evolution. That's the very progress of civilization. But that hasn't kept the finance and investing industry from completely turning their backs on it. To find evidence of it, we need to look elsewhere.

Merchant marine insurance was really the world's first formal insurance underwriting, going back to the Babylonians—as recorded in the Code of Hammurabi around 1750 BCE. Over the millennia, as civilization was increasingly on the move and pushing the frontiers, ventures were undertaken by swashbuckling merchants ready to roll the dice on their financial fate. More formalized risk-mitigation options were thus born of necessity. How sardonic that it wasn't until Bernoulli examined a dice game in the eighteenth century that we finally got a rigorous, scientific, nongambling basis for the insurance industry, specifically, and for risk mitigation in general.

And yet today, so much of risk mitigation in investing has become mere theater, superficial irony, or a punt. In that sense, while the science of probability finally broke itself free from the reactionary views of humanity on fate, risk mitigation seems to be headed back toward this nihilism of where it started. Modern finance has given up on safe haven investing as *the source* of greater investment value. It has left Bernoulli behind, to its followers' great disadvantage.

As we have seen quite conclusively in our various tests of risk mitigation payoffs, the key is *efficiency*. This is how arithmetic costs can be surpassed by geometric portfolio effects to move down the safe haven frontier and create a cost-effective safe haven. It must be able to lie quietly in wait, unobtrusively, such that we barely even notice it—until it is needed, when it explodes onto the scene. In its essence, the cost-effective safe haven would seem to need to fold up neatly out of the way and *forgotten*, like an umbrella in hand, ready to deploy at a moment's notice—a shelter from the sudden storm.

Weather and market predictions being what they are, our umbrella allows us to accept—and even love—whatever sides of the weather and market gods' dice come up. Like Schrödinger's cat and a splintered die, we can be both safely under cover in the rain and under sunny skies, at the same time.

We already know this physical advantage intuitively, of course. Like a wise old mountain guide exclaimed to me one foul day in the Engadine (echoing my and likely everyone else's wise grandma): "There's no such thing as bad weather, only bad gear." And then there is this shrewd platitude, almost tailor made for our safe haven investing:

*Life isn't about waiting for the storm to pass.
It's about learning to dance in the rain.*

Though we may know, like Dylan, that "it's a hard rain's a-gonna fall" (and it is!), we should act as if we don't. Otherwise, we may find ourselves holed up safely indoors whenever dark clouds gather—and somehow, they always seem to gather—or even paying the higher price for an umbrella in the rain.

Hidden within Nietzsche's piles of unpublished manuscripts, found only after his death, was a cryptic aphorism, without any context and scribbled in bracketed quotes:

<< I have forgotten my umbrella. >>

Though it spawned torturous decoding exercises by philosophers ever since, like so much of Nietzsche it can mean whatever you want it to mean. For us, it means that **our safe haven should let us forget that it is even there. It should let us go about our business, rain or shine, no matter what financial storms loom, allowing us to safely enjoy what remains of a beautiful day. It should allow us to weather any storm—including, just as importantly, none at all.**

I hope I have accomplished at least some of what I set out to do in this book. The one-eighth of the iceberg above the water that I have covered here can do more for you than the submerged rest.

You have a logical and practical analytical framework for approaching risk mitigation, specifically from the standpoint that, to be worthwhile, a safe haven should be accretive to wealth—our first principle. Whenever you encounter another such safe haven beast in the wild of the investment landscape, I hope your first reaction is to think about classifying that creature by more than its superficial traits or the superficial narratives surrounding it. Rather, I hope you will think about it from the specific perspective of what it can do for you along the one and only one path that you get. Think about how it can help you avoid the logarithmic plunge that transforms that entire path, and what that safe haven might look like in our cost-effectiveness analysis and along the safe haven frontier. If you are walking away from this book armed with this perspective—a more realistic premise of safe haven investing, its mechanisms, and a more coherent, holistic framing to look all the way down the track—then you are better equipped to avoid its traps than almost every highly experienced, well-schooled, and well-mannered professional investor out there.

And you are even equipped to solve our great dilemma.

You will be telling this with a sigh, somewhere ages and ages hence: Your big losses would have determined your rate of compounding and put you on a path that made you wish for a different one. But because you removed those losses cost-effectively, that has made all the difference.

We need to fight and win this war against luck.

So, good luck. Or bad luck. *Amor fati.*

-MS



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