

Given that procrastination has not been sufficiently pathologized yet, some associate it with the condition of *akrasia* discussed in Plato, a form of lack of self-control or weakness of will; others with *aboulia*, lack of will. And pharmaceutical companies might one day come up with a pill for it.

The benefits of procrastination apply similarly to medical procedures: we saw that procrastination protects you from error as it gives nature a chance to do its job, given the inconvenient fact that nature is less error-prone than scientists. Psychologists and economists who study “irrationality” do not realize that humans may have an instinct to procrastinate only when no life is in danger. I do not procrastinate when I see a lion entering my bedroom or fire in my neighbor’s library. I do not procrastinate after a severe injury. I do so with unnatural duties and procedures. I once procrastinated and kept delaying a spinal cord operation as a response to a back injury—and was completely cured of the back problem after a hiking vacation in the Alps, followed by weight-lifting sessions. These psychologists and economists want me to kill my naturalistic instinct (the inner b****t detector) that allowed me to delay the elective operation and minimize the risks—an insult to the antifragility of our bodies. Since procrastination is a message from our natural willpower via low motivation, the cure is changing the environment, or one’s profession, by selecting one in which one does not have to fight one’s impulses. Few can grasp the logical consequence that, instead, one should lead a life in which procrastination is good, as a naturalistic-risk-based form of decision making.

Actually I select the writing of the passages of this book by means of procrastination. If I defer writing a section, it must be eliminated. This is simple ethics: Why should I try to fool people by writing about a subject for which I feel no natural drive?*

Using my ecological reasoning, someone who procrastinates is not irrational; it is his environment that is irrational. And the psychologist or economist calling him irrational is the one who is beyond irrational.

In fact we humans are very bad at filtering information, particularly short-term information, and procrastination can be a way for us to filter

* A friend who writes books remarked that painters like painting but authors like “having written.” I suggested he stop writing, for his sake and the sake of his readers.

better, to resist the consequences of jumping on information, as we discuss next.

This idea of “naturalistic” has led to confusion. Philosophers refer to an error called the *naturalistic fallacy*, implying that what is natural is not necessarily morally right—something I subscribe to, as we saw in Chapter 4 in the discussion of the problem of applying Darwinian selection to modern society and the need to protect those who fail, something counter to nature. (The problem is that some people misuse the naturalistic fallacy outside the moral domain and misapply it to this idea of reliance on naturalistic instinct when one is in doubt.) However one slices it, it is not a fallacy when it comes to risk considerations. Time is the best test of fragility—it encompasses high doses of disorder—and nature is the only system that has been stamped “robust” by time. But some philosophasters fail to understand the primacy of risk and survival over philosophizing, and those should eventually exit the gene pool—true philosophers would agree with my statement. There is a worse fallacy: people making the opposite mistake and considering that *what is naturalistic is a fallacy*.

NEUROTICISM IN INDUSTRIAL PROPORTIONS

Imagine someone of the type we call neurotic in common parlance. He is wiry, looks contorted, and speaks with an uneven voice. His neck moves around when he tries to express himself. When he has a small pimple, his first reaction is to assume that it is cancerous, that the cancer is of the lethal type, and that it has already spread to his lymph nodes. His hypochondria is not limited to the medical department: he incurs a small setback in business and reacts as if bankruptcy were both near and certain. In the office, he is tuned to every single possible detail, systematically transforming every molehill into a mountain. The last thing you want in life is to be stuck in traffic with him on your way to an important appointment. The verb “overreact” was designed with him in mind: he does not have reactions, just overreactions.

Compare him to someone imperturbable, with the ability to be calm under fire that is considered necessary to become a leader, military commander, or mafia godfather. Usually unruffled and immune to small information, he can impress you with his self-control in difficult circumstances. For a sample of a composed, calm, and pondered voice, listen to

interviews with “Sammy the Bull,” Salvatore Gravano, who was involved in the murder of nineteen people (all competing mobsters). He speaks with minimal effort, as if what he is discussing is “not a big deal.” This second type sometimes reacts when necessary; in the rare situations when he is angry, unlike with the neurotic fellow, everyone knows it and takes it seriously.

The supply of information to which we are exposed thanks to modernity is transforming humans from the equable second fellow into the neurotic first one. For the purpose of our discussion, the second fellow only reacts to real information, the first largely to noise. The difference between the two fellows will show us the difference between *noise* and *signal*. Noise is what you are supposed to ignore, signal what you need to heed.

Indeed, we have loosely mentioned “noise” earlier in the book; time to be precise about it. In science, noise is a generalization beyond the actual sound to describe random information that is totally useless for any purpose, and that you need to clean up to make sense of what you are listening to. Consider, for example, elements in an encrypted message that have absolutely no meaning, just randomized letters to confuse the spies, or the hiss you hear on a telephone line that you try to ignore in order to focus on the voice of your interlocutor.

And this personal or intellectual inability to distinguish noise from signal is behind overintervention.

A Legal Way to Kill People

If you want to accelerate someone’s death, give him a personal doctor. I don’t mean provide him with a bad doctor: just pay for him to choose his own. Any doctor will do.

This may be the only possible way to murder someone while staying squarely within the law. We can see from the tonsillectomy story that access to data increases intervention, causing us to behave like the neurotic fellow. Rory Sutherland signaled to me that someone with a personal doctor on staff should be particularly vulnerable to naive interventionism, hence iatrogenics; doctors need to justify their salaries and prove to themselves that they have a modicum of work ethic, something that “doing nothing” doesn’t satisfy. Indeed, Michael Jackson’s personal doctor has been sued for something equivalent to overintervention-to-stifle-antifragility (but it will take the law courts a

while to become directly familiar with the concept). Did you ever wonder why heads of state and very rich people with access to all this medical care die just as easily as regular persons? Well, it looks like this is because of overmedication and excessive medical care.

Likewise, those in corporations or in policy making (like Fragilista Greenspan) who are endowed with a sophisticated data-gathering department and are therefore getting a lot of “timely” statistics are capable of overreacting and mistaking noise for information—Greenspan kept an eye on such fluctuations as the sales of vacuum cleaners in Cleveland to, as they say, “get a precise idea about where the economy is going,” and of course he micromanaged us into chaos.

In business and economic decision making, reliance on data causes severe side effects—data is now plentiful thanks to connectivity, and the proportion of spuriousness in the data increases as one gets more immersed in it. A very rarely discussed property of data: it is toxic in large quantities—even in moderate quantities.

The previous two chapters showed how you can use and take advantage of noise and randomness; but noise and randomness can also use and take advantage of you, particularly when totally unnatural, as with the data you get on the Web or through the media.

The more frequently you look at data, the more noise you are disproportionately likely to get (rather than the valuable part, called the signal); hence the higher the noise-to-signal ratio. And there is a confusion which is not psychological at all, but inherent in the data itself. Say you look at information on a yearly basis, for stock prices, or the fertilizer sales of your father-in-law’s factory, or inflation numbers in Vladivostok. Assume further that for what you are observing, at a yearly frequency, the ratio of signal to noise is about one to one (half noise, half signal)—this means that about half the changes are real improvements or degradations, the other half come from randomness. This ratio is what you get from yearly observations. But if you look at the very same data on a daily basis, the composition would change to 95 percent noise, 5 percent signal. And if you observe data on an hourly basis, as people immersed in the news and market price variations do, the split becomes 99.5 percent noise to 0.5 percent signal. That is two hundred times more noise than signal—which is why anyone who listens to news (except when very, very significant events take place) is one step below sucker.

Consider the iatrogenics of newspapers. They need to fill their pages every day with a set of news items—particularly those news items also

dealt with by other newspapers. But to do things right, they ought to learn to keep silent in the absence of news of significance. Newspapers should be of two-line length on some days, two hundred pages on others—in proportion with the intensity of the signal. But of course they want to make money and need to sell us junk food. And junk food is iatrogenic.

There is a biological dimension to this story. I have been repeating that in a natural environment, a stressor is information. Too much information would thus be too much stress, exceeding the threshold of anti-fragility. In medicine, we are discovering the healing powers of fasting, as the avoidance of the hormonal rushes that come with the ingestion of food. Hormones convey information to the different parts of our system, and too much of them confuses our biology. Here again, as with news received at too high a frequency, too much information becomes harmful—daily news and sugar confuse our system in the same manner. And in Chapter 24 (on ethics) I will show how too much data (particularly when it is sterile) causes statistics to be completely meaningless.

Now let's add the psychological to this: we are not made to understand the point, so we overreact emotionally to noise. The best solution is to *only* look at very large changes in data or conditions, never at small ones.

Just as we are not likely to mistake a bear for a stone (but likely to mistake a stone for a bear), it is almost impossible for someone rational, with a clear, uninfected mind, someone who is not drowning in data, to mistake a vital signal, one that matters for his survival, for noise—unless he is overanxious, oversensitive, and neurotic, hence distracted and confused by other messages. Significant signals have a way to reach you. In the tonsillectomies story, the best filter would have been to only consider the children who were very ill, those with periodically recurring throat inflammation.

Media-Driven Neuroticism

There is so much noise coming from the media's glorification of the anecdote. Thanks to this, we are living more and more in virtual reality, separated from the real world, a little bit more every day while realizing it less and less. Consider that every day, 6,200 persons die in the United States, many of preventable causes. But the media only report the most anecdotal and sensational cases (hurricanes, freak accidents, small plane

crashes), giving us a more and more distorted map of real risks. In an ancestral environment, the anecdote, the “interesting,” is information; today, no longer. Likewise, by presenting us with explanations and theories, the media induce an illusion of understanding the world.

And the understanding of events (and risks) on the part of members of the press is so retrospective that they would put the security checks after the plane ride, or what the ancients call *post bellum auxilium*, sending troops after the battle. Owing to domain dependence, we forget the need to check our map of the world against reality. So we are living in a more and more fragile world, while thinking it is more and more understandable.

To conclude, the best way to mitigate interventionism is to ration the supply of information, as naturalistically as possible. This is hard to accept in the age of the Internet. It has been very hard for me to explain that the more data you get, the less you know what’s going on, and the more iatrogenics you will cause. People are still under the illusion that “science” means more data.

THE STATE CAN HELP—WHEN INCOMPETENT

The famine in China that killed 30 million people between 1959 and 1961 can enlighten us about the effect of the state “trying hard.” Xin Meng, Nancy Qian, and Pierre Yared examined its variations *between* areas, looking into how the famine was distributed. They discovered that famine was more severe in areas with higher food production in the period before the famine began, meaning that it was government policy of food distribution that was behind much of the problem, owing to the inflexibility in the procurement system. And indeed, a larger than expected share of famine over the past century has occurred in economies with central planning.

But often it is the state’s incompetence that can help save us from the grip of statism and modernity—inverse iatrogenics. The insightful author Dmitri Orlov showed how calamities were avoided after the breakdown of the Soviet state because food production was inefficient and full of unintentional redundancies, which ended up working in favor of stability. Stalin played with agriculture, causing his share of famine. But he and his successors never managed to get agriculture to become “efficient,” that is, centralized and optimized as it is today in America, so every town had the staples growing around it. This was costlier, as they

did not get the benefits of specialization, but this local lack of specialization allowed people to have access to all varieties of food in spite of the severe breakdown of the institutions. In the United States, we burn twelve calories in transportation for every calorie of nutrition; in Soviet Russia, it was one to one. One can imagine what could happen to the United States (or Europe) in the event of food disruptions. Further, because of the inefficiency of housing in the Soviet state, people had been living in close quarters for three generations, and had tight bonds that ensured—as in the Lebanese war—that they stayed close to each other and lent to each other. People had real links, unlike in social networks, and fed their hungry friends, expecting that some friend (most likely another one) would help them should they get in dire circumstances.

And the top-down state is not necessarily the one that has the reputation of being so.

France Is Messier than You Think

Next we will debunk the narrative that France works well because it is a Cartesian rationalizing-rationalist top-down state. As with the Russians, the French were lucky that it was for a long time a failed aim.

I spent the past two decades wondering why France, as a country managed in a top-down manner by an oversized state, could fare so well in so many fields. It is the country of Jean-Baptiste Colbert, after all, the grand dreamer of a state that infiltrates everything. Indeed the current culture is ultra-interventionist, sort of “if it ain’t broke, fix it.” For things work—somewhat—in France, often better than elsewhere; so can France be used as evidence that central bureaucracies that repress municipal mess are favorable for growth, happiness, good science and literature, excellent weather, diversified flora with Mediterranean varieties, tall mountains, excellent transportation, attractive women, and good cuisine? Then I discovered, reading Graham Robb’s *The Discovery of France*, a major fact that led me to see the place with completely new eyes and search the literature for a revision of the story of the country.

The story was actually staring us in the face: the nation-state in France was largely nominal, in spite of attempts by Louis XIV, Napoleon, and the national education program of Jules Ferry to own the place. France in 1863 did not speak French (only one in five persons could), but rather a variety of languages and dialects (a surprising fact: the Nobel Prize in Literature in 1904 went to the Frenchman Frédéric

Mistral, who wrote in Provençal, a language of southern France no longer spoken). The lack of linguistic integration—like the variety in cheese (of which there are about four hundred different types)—expresses the difficulties in centralizing the country. There was nothing ethnic or linguistic to bind the place—it was just the property of a king and a weak aristocracy. Roads were horrible and most of the country was inaccessible to travelers. Tax collection was a dangerous profession, requiring tenacity and sagacity. Indeed, the country was progressively “discovered” by Paris, in many cases after its colonies in North Africa and elsewhere. In a thick and captivating book, *La rébellion française*, the historian Jean Nicolas shows how the culture of rioting was extremely sophisticated—historically, it counts as the true French national sport.

Paris itself was barely controlled by France—no more than the Rio slums called *favelas* are currently ruled by the Brazilian central state. Louis XIV, the Sun King, had moved the government to Versailles to escape the Parisian crowd. Paris only became controllable after Haussmann in the 1860s removed the tenements and narrow streets to make large avenues that allowed for police to control the crowds. Effectively France was still Paris and “the desert,” as Paris didn’t care much about the rest of France. The country was only centralized after long programs and “Five Year Plans” of roads, rail systems, public schools, and the spread of television—a Napoleonic dream of integration that, begun by De Gaulle after the war, was only completed during the reign of Valéry Giscard d’Estaing in the late 1970s, at which point the decentralization started taking place.* France might have benefited from its two decades or so under a large centralized state—but the argument could equally be that it benefited from the happy condition that the large state spurred growth and did not overstay its welcome.

* Another discovery—the control of that most organic, most disorderly of things, language. France, through the institution of the French academy, has an official stamp on what can and cannot be considered proper French and written by a pupil in a document or in a letter to the local mayor complaining about the noisy garbage pickup schedules. The result is obvious: a convoluted, difficult, and narrow formal vocabulary compared to English—but an expanded spoken French misdefined as “slang” that is just as rich as English. There are even writers like Céline or Dard who write in parallel literary vocabulary mixed with exquisitely precise and rich slang, a unique brand of colloquial-literary style.

Sweden and the Large State

Aside from France, I was baffled by the puzzle of Sweden and other Nordic states, which are often offered as paragons of the large state “that works”—the government represents a large portion of the total economy. How could we have the happiest nation in the world, Denmark (assuming “happiness” is both measurable and desirable), and a monstrously large state? Is it that these countries are all smaller than the New York metropolitan area? Until my coauthor, the political scientist Mark Blyth, showed me that there, too, was a false narrative: it was almost the same story as in Switzerland (but with a worse climate and no good ski resorts). The state exists as a tax collector, but the money is spent in the communes themselves, directed by the communes—for, say, skills training locally determined as deemed necessary by the community themselves, to respond to private demand for workers. The economic elites have more freedom than in most other democracies—this is far from the statism one can assume from the outside. And, most of all, these nations are the size of city-states.

Further, illustrating a case of gaining from disorder, Sweden and other Nordic countries experienced a severe recession at the end of the cold war, around 1990, to which they responded admirably with a policy of fiscal toughness, thus effectively shielding them from the severe financial crisis that took place about two decades later.

CATALYST-AS-CAUSE CONFUSION

When constrained systems, those hungry for natural disorder, collapse, as they are eventually bound to, since they are fragile, failure is never seen as the result of fragility. Rather, such failure is interpreted as the product of poor forecasting. As with a crumbling sand pile, it would be unintelligent to attribute the collapse of a fragile bridge to the last truck that crossed it, and even more foolish to try to predict in advance which truck might bring it down. Yet it is done all too often.

In 2011, U.S. president Barack Obama blamed an intelligence failure for the government’s not foreseeing the revolution in Egypt that took place that spring (just as former U.S. president Jimmy Carter blamed an intelligence failure for his administration’s not foreseeing the 1979 Islamic Revolution in Iran), missing the point that it is the suppressed risk

in the statistical “tails” that matters—not the failure to see the last grain of sand. One analogy to economics: after the inception of the financial crisis in 2007–2008, many people thought that predicting the subprime meltdown (which seemed in their mind to have triggered it) would have helped. It would not have, for Baal’s sake, since it was a symptom of the crisis, not its underlying cause. Likewise, Obama’s blaming “bad intelligence” for his administration’s failure to predict the uprising that took place in Egypt is symptomatic of both the misunderstanding of complex systems and the bad policies involved. And superpowers are plain turkeys in that story.

Obama’s mistake illustrates the illusion of local causal chains—that is, confusing catalysts for causes and assuming that one can know which catalyst will produce which effect. The final episode of the upheaval in Egypt was unpredictable for all observers, especially those involved. As such, blaming the CIA or some other intelligence agency is as injudicious as funding it to forecast such events. Governments are wasting billions of dollars on attempting to predict events that are produced by interdependent systems and are therefore not statistically understandable at the individual level.

Most explanations that are offered for episodes of turmoil follow the catalysts-as-causes confusion. Take the “Arab Spring” of 2011. The riots in Tunisia and Egypt were initially attributed to rising commodity prices, not to stifling and unpopular dictatorships. But Bahrain and Libya were wealthy countries that could afford to import grain and other commodities. Further, we had had considerably higher commodity prices a few years earlier without any uprising at all. Again, the focus is wrong even if the logic is comforting. It is the system and its fragility, not events, that must be studied—what physicists call “percolation theory,” in which the properties of the randomness of the terrain are studied, rather than those of a single element of the terrain.

As Mark Abdollahian of Sentia Group, one of the contractors who sell predictive analytics to the U.S. government (those that failed to warn), noted regarding Egypt, policy makers should “think of this like Las Vegas. In blackjack, if you can do four percent better than the average, you’re making real money.” But the analogy is spurious—pretty much everything I stand against. There is no “four percent better” on Egypt. This was not just money wasted but the construction of a false confidence based on an erroneous focus. It is telling that the intelligence

analysts made the same mistake as the risk-management systems that failed to predict the economic crisis—and offered the exact same excuses when they failed. Political and economic “tail events” are unpredictable, and their probabilities are not scientifically measurable. No matter how many dollars are spent on research, predicting revolutions is not the same as counting cards; humans will never be able to turn politics and economics into the tractable randomness of blackjack.

Prediction as a Child of Modernity

Never shout in French—Ms. Bré gains in respect—Black Swan territory

In the fall of 2009, I found myself in Korea with a collection of suit-and-tie-wearing hotshots. On a panel sat one Takatoshi Kato, then the deputy managing director of a powerful international institution. Before the panel discussion, he gave us a rapid PowerPoint presentation showing his and his department's economic projections for 2010, 2011, 2012, 2013, and 2014.

These were the days before I decided to climb up the mountain, speak slowly and in a priestly tone, and try shaming people rather than insulting them. Listening to Kato's presentation, I could not control myself and flew into a rage in front of two thousand Koreans—I was so angry that I almost started shouting in French, forgetting that I was in Korea. I ran to the podium and told the audience that the next time someone in a suit and tie gave them projections for some dates in the future, they should ask him to show what he had projected in the past—in this case, what he had been forecasting for 2008 and 2009 (the crisis years) two to five years earlier, in 2004, 2005, 2006, and 2007. They would then verify that Highly Venerable Kato-san and his colleagues are, to put it mildly, not very good at this predictionizing business. And it is not just Mr. Kato: our track record in figuring out significant rare events in politics and economics is not close to zero; it is *zero*. I im-

provised, on the spot, my solution. We can't put all false predictors in jail; we can't stop people from asking for predictions; we can't tell people not to hire the next person who makes promises about the future. "All I want is to live in a world in which predictions such as those by Mr. Kato do not harm you. And such a world has unique attributes: robustness."

The idea of proposing the Triad was born there and then as an answer to my frustration: Fragility-Robustness-Antifragility as a replacement for predictive methods.

Ms. Bré Has Competitors

What was getting me in that state of anger was my realization that forecasting was not neutral. It is all in the iatrogenics. Forecasting can be downright injurious to risk-takers—no different from giving people snake oil medicine in place of cancer treatment, or bleeding, as in the story of George Washington. And there was evidence. Danny Kahneman—rightfully—kept admonishing me for my fits of anger and outbursts at respectable members of the establishment (respectable for now), deeming such behavior to be unbecoming of the wise member of the intelligentsia I was supposed to be. Yet he stoked my frustration and sense of outrage the most by showing me the evidence of iatrogenics. There are ample empirical findings to the effect that providing someone with a random numerical forecast increases his risk taking, even if the person *knows* the projections are random.

All I hear is complaints about forecasters, when the next step is obvious yet rarely taken: avoidance of iatrogenics from forecasting. We understand childproofing, but not forecaster-hubris-proofing.

The Predictive

What makes life simple is that the robust and antifragile don't have to have as accurate a comprehension of the world as the fragile—and they do not need forecasting. To see how redundancy is a nonpredictive, or rather a less predictive, mode of action, let us use the argument of Chapter 2: if you have extra cash in the bank (in addition to stockpiles of tradable goods such as cans of Spam and hummus and gold bars in the basement), you don't need to know with precision which event will

cause potential difficulties.* It could be a war, a revolution, an earthquake, a recession, an epidemic, a terrorist attack, the secession of the state of New Jersey, anything—you do not need to predict much, unlike those who are in the opposite situation, namely, in debt. Those, because of their fragility, need to predict with more, a lot more, accuracy.

Plus or Minus Bad Teeth

You can control fragility a lot more than you think. So let us refine in three points:

- (i) Since detecting (anti)fragility—or, actually, smelling it, as Fat Tony will show us in the next few chapters—is easier, much easier, than prediction and understanding the dynamics of events, the entire mission reduces to the central principle of what to do to minimize harm (and maximize gain) from forecasting errors, that is, to have things that don’t fall apart, or even benefit, when we make a mistake.
- (ii) We do not want to change the world for now (leave that to the Soviet-Harvard utopists and other fragilistas); we should first make things more robust to defects and forecast errors, or even exploit these errors, making lemonade out of the lemons.
- (iii) As for the lemonade, it looks as if history is in the business of making it out of lemons; antifragility is necessarily how things move forward under the mother of all stressors, called time.

Further, after the occurrence of an event, we need to switch the blame from the inability to see an event coming (say a tsunami, an Arabo-Semitic spring or similar riots, an earthquake, a war, or a financial crisis) to the failure to understand (anti)fragility, namely, “why did we build something so fragile to these types of events?” Not seeing a tsunami or an economic event coming is excusable; building something fragile to them is not.

Also, as to the naive type of utopianism, that is, blindness to history, we cannot afford to rely on the rationalistic elimination of greed and other human defects that fragilize society. Humanity has been trying to

* From my experiences of the Lebanese war and a couple of storms with power outages in Westchester County, New York, I suggest stocking up on novels, as we tend to underestimate the boredom of these long hours waiting for the trouble to dissipate. And books, being robust, are immune to power outages.

do so for thousands of years and humans remain the same, plus or minus bad teeth, so the last thing we need is even more dangerous moralizers (those who look in a permanent state of gastrointestinal distress). Rather, the more intelligent (and practical) action is to make the world greed-proof, or even hopefully make society benefit from the greed and other perceived defects of the human race.

In spite of their bad press, some people in the nuclear industry seem to be among the rare ones to have gotten the point and taken it to its logical consequence. In the wake of the Fukushima disaster, instead of predicting failure and the probabilities of disaster, these intelligent nuclear firms are now aware that they should instead focus on *exposure to failure*—making the prediction or nonprediction of failure quite irrelevant. This approach leads to building small enough reactors and embedding them deep enough in the ground with enough layers of protection around them that a failure would not affect us much should it happen—costly, but still better than nothing.

Another illustration, this time in economics, is the Swedish government's focus on total fiscal responsibility after their budget troubles in 1991—it makes them much less dependent on economic forecasts. This allowed them to shrug off later crises.*

The Idea of Becoming a Non-Turkey

It is obvious to anyone before drinking time that we can put a man, a family, a village with a mini town hall on the moon, and predict the trajectory of planets or the most minute effect in quantum physics, yet governments with equally sophisticated models cannot forecast revolutions, crises, budget deficits, or climate change. Or even the closing prices of the stock market a few hours from now.

There are two different domains, one in which we can predict (to some extent), the other—the Black Swan domain—in which we should only let turkeys and turkified people operate. And the demarcation is as visible (to non-turkeys) as the one between the cat and the washing machine.

Social, economic, and cultural life lie in the Black Swan domain,

* A related idea is expressed in a (perhaps apocryphal) statement by the financier Warren Buffett that he tries to invest in businesses that are “so wonderful that an idiot can run them. Because sooner or later, one will.”

physical life much less so. Further, the idea is to separate domains into those in which these Black Swans are both unpredictable and consequential, and those in which rare events are of no serious concern, either because they are predictable or because they are inconsequential.

I mentioned in the Prologue that randomness in the Black Swan domain is intractable. I will repeat it till I get hoarse. The limit is mathematical, period, and there is no way around it on this planet. What is nonmeasurable and nonpredictable will remain nonmeasurable and nonpredictable, no matter how many PhDs with Russian and Indian names you put on the job—and no matter how much hate mail I get. There is, in the Black Swan zone, a limit to knowledge that can never be reached, no matter how sophisticated statistical and risk management science ever gets.

The involvement of this author has not been so much in asserting this impossibility to ever know anything about these matters—the general skeptical problem has been raised throughout history by a long tradition of philosophers, including Sextus Empiricus, Algazel, Hume, and many more skeptics and skeptical empiricists—as in formalizing and modernizing as a background and footnote to my anti-turkey argument. So my work is about *where* one should be skeptical, and where one should not be so. In other words, focus on getting out of the f*** Fourth Quadrant—the Fourth Quadrant is the scientific name I gave to the Black Swan domain, the one in which we have a high exposure to rare, “tail” events and these events are incomputable.*

Now, what is worse, because of modernity, the share of Extremistan is increasing. Winner-take-all effects are worsening: success for an author, a company, an idea, a musician, an athlete is planetary, or nothing. These worsen predictability since almost everything in socioeconomic life now is dominated by Black Swans. Our sophistication continuously puts us ahead of ourselves, creating things we are less and less capable of understanding.

* A technical footnote (to skip): What are the Quadrants? Combining exposures and types of randomness we get four combinations: Mediocristan randomness, low exposure to extreme events (First Quadrant); Mediocristan randomness, high exposure to extreme events (Second Quadrant); Extremistan randomness, low exposure to extreme events (Third Quadrant); Extremistan randomness, high exposure to extreme events (Fourth Quadrant). The first three quadrants are ones in which knowledge or lack of it bring inconsequential errors. “Robustification” is the modification of exposures to make a switch from the fourth to the third quadrant.

No More Black Swans

Meanwhile, over the past few years, the world has also gone the other way, upon the discovery of the Black Swan idea. Opportunists are now into predicting, predictioning, and predictionizing Black Swans with even more complicated models coming from chaos-complexity-catastrophe-fractal theory. Yet, again, the answer is simple: *less is more*; move the discourse to (anti)fragility.

BOOK III

A Nonpredictive View of the World

Welcome, reader, to the nonpredictive view of the world.

Chapter 10 presents Seneca's stoicism as a starting point for understanding antifragility, with applications from philosophy and religion to engineering. Chapter 11 introduces the barbell strategy and explains why the dual strategy of mixing high risks and highly conservative actions is preferable to just a simple medium-risk approach to things.

But first, we open Book III with the story of our two friends who derive some great entertainment from, and make a living by, detecting fragility and playing with the ills of fragilistas.

CHAPTER 9

Fat Tony and the Fragilistas

Olfactory methods with the perception of fragility—The difficulties of lunch—Quickly open the envelope—A certain redivision of the world, as seen from New Jersey—The sea gets deeper and deeper

INDOLENT FELLOW TRAVELERS

Before the economic crisis of 2008, the association between Nero Tulip and Tony DiBenedetto, also known as “Fat Tony” or the more politically acceptable “Tony Horizontal,” would have been hard to explain to an outsider.

Nero’s principal activity in life is reading books, with a few auxiliary activities in between. As to Fat Tony, he reads so little that, one day when he mentioned he wanted to write his memoirs, Nero joked that “Fat Tony would have written exactly one more book than he had read”—to which Fat Tony, always a few steps ahead of him, quoted Nero back: “You once said that if you felt like reading a novel, you would write one.” (Nero had one day cited the British prime minister and novelist Benjamin Disraeli, who wrote novels but didn’t like reading them.)

Tony grew up in Brooklyn and moved to New Jersey, and he has exactly the accent you would expect him to have. So, unburdened with time-consuming (and, to him, “useless”) reading activities, and highly allergic to structured office work, Fat Tony spent a lot of his time doing

nothing, with occasional commercial transactions in between. And, of course, a lot of eating.

The Importance of Lunch

While most people around them were running around fighting the different varieties of unsuccess, Nero and Fat Tony had this in common: they were terrified of boredom, particularly the prospect of waking up early with an empty day ahead. So the proximate reason for their getting together before that crisis was, as Fat Tony would say, “doing lunch.” If you live in an active city, say, New York, and have a friendly personality, you will have no trouble finding good dinner partners, people who can hold a conversation of some interest in an almost relaxed way. Lunch, however, is a severe difficulty, particularly during phases of high employment. It is easy to find lunch partners among resident office inmates but trust me, you don’t want to get near them. They will have liquefied stress hormones dripping from their pores, they will exhibit anxiety if they discuss anything that may divert them from what they think is in the course of their “work,” and when in the process of picking their brain you hit on a less uninteresting mine, they will cut you short with a “I have to run” or “I have a two-fifteen.”

Moreover, Fat Tony got respect in exactly the right places. Unlike Nero, whose ruminating philosophical episodes erased his social presence, making him invisible to waiters, Tony elicited warm and enthusiastic responses when he showed up in an Italian restaurant. His arrival triggered a small parade among the waiters and staff; he was theatrically hugged by the restaurant owner, and his departure after the meal was a long procedure with the owner and, sometimes, his mother seeing him outside, with some gift, like perhaps homemade grappa (or some strange liquid in an unmarked bottle), more hugs, and promises to come for the Wednesday special meal.

Accordingly, Nero, when he was in the New York area, could reduce his anxiety about lunchtime, as he could always count on Tony. He would meet Tony at the health club; there our horizontal hero did his triathlon (sauna, Jacuzzi, and steam bath), and from there they would go get some worship from restaurant owners. So Tony once explained to Nero that he had no use for him in the evenings—he could get better, more humorous, more Italian–New Jersey friends, who, unlike Nero, could give him ideas for “something useful.”

The Antifragility of Libraries

Nero lived a life of mixed (and transient) asceticism, going to bed as close to nine o'clock as he could, sometimes even earlier in the winter. He tried to leave parties when the effect of alcohol made people start talking to strangers about their personal lives or, worse, turn metaphysical. Nero preferred to conduct his activities by daylight, trying to wake up in the morning with the sun's rays gently penetrating his bedroom, leaving stripes on the walls.

He spent his time ordering books from booksellers on the Web, and very often read them. Having terminated his turbulent, extremely turbulent, adventures, like Sindbad the sailor and Marco Polo the Venetian traveler, he ended up settling for a quiet and sedate life of post-adventure.

Nero was the victim of an aesthetic ailment that brings revulsion, even phobia, toward: people wearing flip-flops, television, bankers, politicians (right-wing, left-wing, centrists), New Jersey, rich persons from New Jersey (like Fat Tony), rich persons who take cruises (and stop in Venice wearing flip-flops), university administrators, grammatical sticklers, name droppers, elevator music, and well-dressed salespersons and businessmen. As for Fat Tony, he had different allergies: the *empty suit*, which we speculate is someone who has a command of all the superfluous and administrative details of things but misses the essential (and isn't even aware of it), so his conversation becomes mere chitchat around the point, never getting to the central idea.

And Fat Tony was a smeller of fragility. Literally. He claimed that he could figure out a person from seeing him just walk into a restaurant, which was almost true. But Nero had noticed that Fat Tony, when talking to people for the first time, got very close to them and sniffed them, just like a dog, a habit of which Fat Tony wasn't even aware.

Nero belonged to a society of sixty volunteer translators collaborating on previously unpublished ancient texts in Greek, Latin, or Aramaic (Syriac) for the French publishing house Les Belles Lettres. The group is organized along libertarian lines, and one of their rules is that university titles and prestige give no seniority in disputes. Another rule is mandatory attendance at two "dignified" commemorations in Paris, every November 7, the death of Plato, and every April 7, the birth of Apollo. His other membership is in a local club of weight lifters that meets on Saturdays in a converted garage. The club is mostly composed of New York

doormen, janitors, and mobster-looking fellows who walk around in the summer wearing sleeveless “wife-beater” shirts.

Alas, men of leisure become slaves to inner feelings of dissatisfaction and interests over which they have little control. The freer Nero’s time, the more compelled he felt to compensate for lost time in filling gaps in his natural interests, things that he wanted to know a bit deeper. And, as he discovered, the worst thing one can do to feel one knows things a bit deeper is to try to go into them a bit deeper. *The sea gets deeper as you go further into it*, according to a Venetian proverb.

Curiosity is antifragile, like an addiction, and is magnified by attempts to satisfy it—books have a secret mission and ability to multiply, as everyone who has wall-to-wall bookshelves knows well. Nero lived, at the time of writing, among fifteen thousand books, with the stress of how to discard the empty boxes and wrapping material after the arrival of his daily shipment from the bookstore. One subject Nero read for pleasure, rather than the strange duty-to-read-to-become-more-learned, was medical texts, for which he had a natural curiosity. The curiosity came from having had two brushes with death, the first from a cancer and the second from a helicopter crash that alerted him to both the fragility of technology and the self-healing powers of the human body. So he spent a bit of his time reading textbooks (not papers—textbooks) in medicine, or professional texts.

Nero’s formal training was in statistics and probability, which he approached as a special branch of philosophy. He had been spending all his adult life writing a philosophical-technical book called *Probability and Metaprobability*. His tendency was to abandon the project every two years and take it up again two years later. He felt that the concept of probability as used was too narrow and incomplete to express the true nature of decisions in the ecology of the real world.

Nero enjoyed taking long walks in old cities, without a map. He used the following method to detouristify his traveling: he tried to inject some randomness into his schedule by never deciding on the next destination until he had spent some time in the first one, driving his travel agent crazy—when he was in Zagreb, his next destination would be determined by his state of mind while in Zagreb. Largely, it was the smell of places that drew him to them; smell cannot be conveyed in a catalogue.

Mostly, when in New York, Nero sat in his study with his writing desk set against the window, occasionally looking dreamily at the New Jersey shore across the Hudson River and reminding himself how happy

he was to not live there. So he conveyed to Fat Tony that the “I have no use for you” was reciprocal (in equally nondiplomatic terms), which, as we will see, was not true.

ON SUCKERS AND NONSUCKERS

After the crisis of 2008, it became clear what the two fellows had in common: they were predicting a sucker’s fragility crisis. What had gotten them together was that they had both been convinced that a crisis of such magnitude, with a snowballing destruction of the modern economic system in a way and on a scale never seen before, was bound to happen, simply because there were suckers. But our two characters came from two entirely different schools of thought.

Fat Tony believed that nerds, administrators, and, mostly, bankers were the ultimate suckers (that was when everyone still thought they were geniuses). And, what’s more, he believed that collectively they were even bigger suckers than they were individually. And he had a natural ability to detect these suckers before they fell apart. Fat Tony derived his income from that activity while leading, as we saw, a life of leisure.

Nero’s interests were similar to Tony’s, except dressed up in intellectual traditions. To Nero, a system built on illusions of understanding probability is bound to collapse.

By betting against fragility, they were antifragile.

So Tony made a bundle from the crisis, in the high eight to low nine figures—everything other than a bundle for Tony is “tawk.” Nero made a bit, though much less than Tony, but he was satisfied that he had won—as we said, he had already been financially independent and he saw money as a waste of time. To put it bluntly, Nero’s family’s wealth had peaked in 1804, so he did not have the social insecurity of other adventurers, and money to him could not possibly be a social statement—only erudition for now, and perhaps wisdom in old age. Excess wealth, if you don’t need it, is a heavy burden. Nothing was more hideous in his eyes than excessive refinement—in clothes, food, lifestyle, manners—and wealth was nonlinear. Beyond some level it forces people into endless complications of their lives, creating worries about whether the housekeeper in one of the country houses is scamming them while doing a poor job and similar headaches that multiply with money.

The ethics of betting against suckers will be discussed in Book VII, but there are two schools of thought. To Nero one should first warn

people that they are suckers, while Tony was against the very notion of warning. "You will be ridiculed," he said; "words are for sissies." A system based on verbal warnings will be dominated by non-risk-taking-babblers. These people won't give you and your ideas respect unless you take their money.

Further, Fat Tony insisted that Nero take a ritual look at the physical embodiments of the spoils, such as a bank account statement—as we said, it had nothing to do with the financial value, nor even the purchasing power, of the items, just their symbolic value. He could understand why Julius Caesar needed to incur the cost of having Vercingetorix, the leader of the Gaul rebellion, brought to Rome and paraded in chains, just so he could exhibit victory in the flesh.

There is another dimension to the need to focus on actions and avoid words: the health-eroding dependence on external recognition. People are cruel and unfair in the way they confer recognition, so it is best to stay out of that game. Stay robust to how others treat you. Nero at some stage befriended a scientist of legendary status, a giant for whom he had immense respect. Although the fellow was about as prominent as one could get in his field (in the eyes of others), he spent his time focused on the status he had that week in the scientific community. He would become enraged at authors who did not cite him or at some committee granting a medal he had never received to someone he judged inferior, that impostor!

Nero learned that no matter how satisfied they could be with their work, these hotshots-who-depended-on-words were deprived of Tony's serenity; they remained fragile to the emotional toll from the compliments they did *not* get, the ones others got, and from what someone of lower intellect stole from them. So Nero promised himself to escape all of this with his small ritual—just in case he should fall prone to the hot-shot's temptation. Nero's spoils from what he called the "Fat Tony bet," after deducting the cost of a new car (a Mini) and a new \$60 Swatch watch, amounted to a dizzyingly large amount sitting in a portfolio, the summary of which was mailed to him monthly from (of all places) a New Jersey address, with three other statements from overseas countries. Again, it is not the amount but the tangibility of his action that counted—the quantities could have been a tenth, even a hundredth as much and the effect would remain the same. So he would cure himself of the game of recognition by opening the envelope containing the state-

ment and then going on with his day, oblivious to the presence of those cruel and unfair users of words.

But to follow ethics to their natural conclusion, Nero should have felt just as proud—and satisfied—had the envelope contained statements of losses. A man is honorable in proportion to the personal risks he takes for his opinion—in other words, the amount of downside he is exposed to. To sum him up, Nero believed in erudition, aesthetics, and risk taking—little else.

As to the funds, to avoid the charity trap, Nero followed Fat Tony's rule of systematically making donations, but not to those who directly asked for gifts. And he never, never gave a penny to any charitable organization, with the possible exception of those in which not a single person earned a salary.

Loneliness

A word on Nero's loneliness. For Nero, in the dark days before the economic crisis of 2008, it sometimes caused him pain to be alone with his ideas—wondering at times, typically Sunday nights, if there was something particularly wrong with him or if there was something wrong with the world. Lunch with Fat Tony was like drinking water after an episode of thirst; it brought immediate relief to realize that he was either not crazy, or at least not *alone* in being crazy. Things out there *did not make sense*, and it was impossible to convey it to others, particularly people deemed intelligent.

Consider that of the close to a million professionals employed in economic activities, whether in government (from Cameroon to Washington, D.C.), academia, media, banking, corporations, or doing their own private homework for economic and investment decisions, fewer than a handful saw it coming—furthermore, an even smaller handful managed to foresee the full extent of the damage.

And of those who saw it coming, not a single one realized that the crisis was a product of modernity.

Nero could stand near the former World Trade Center site in downtown New York, across from the colossal buildings housing mostly banks and brokerage houses, with hundreds of people running around inside them, expending gigawatts of energy just moving and commuting from New Jersey, consuming millions of bagels with cream cheese, with

insulin response inflaming their arteries, producing gigabytes of information just by talking and corresponding and writing articles.

But noise it was: wasted effort, cacophony, unaesthetic behavior, increased entropy, production of energy that causes a local warming up of the New York area ecozone, and a large-scale delusion of this thing called “wealth” that was bound to evaporate somehow.

You could stack the books and they would constitute an entire mountain. Alas, to Nero anything in them that deals with probability, statistics, or mathematical models is just *air*, in spite of evidence that and evidence this. And you learn more in a few lunches with Fat Tony than from the social science sections of the Harvard libraries,* with close to two million books and research papers, for a total of 33 million hours of reading, close to nine thousand years’ worth of reading as a full-time activity.

Talk about a major sucker problem.

What the Nonpredictor Can Predict

Fat Tony did not believe in predictions. But he made big bucks predicting that some people—the predictors—would go bust.

Isn’t that paradoxical? At conferences, Nero used to meet physicists from the Santa Fe Institute who believed in predictions and used fancy prediction models while their business ventures based on predictions did not do that well—while Fat Tony, who did not believe in predictions, got rich from prediction.

You can’t predict in general, but you can predict that those who rely on predictions are taking more risks, will have some trouble, perhaps even go bust. Why? Someone who predicts will be fragile to prediction errors. An overconfident pilot will eventually crash the plane. And numerical prediction leads people to take more risks.

Fat Tony is antifragile because he takes a mirror image of his fragile prey.

Fat Tony’s model is quite simple. He identifies fragilities, makes a bet on the collapse of the fragile unit, lectures Nero and trades insults with him about sociocultural matters, reacts to Nero’s jabs at New Jersey life, collects big after the collapse. Then he has lunch.

* The only exception in that social science library is a few small sections in the cognitive science literature—some of it works.

CHAPTER 10

Seneca's Upside and Downside

How to survive advice—To lose nothing or gain nothing—What to do on your next shipwreck

A couple of millennia before Fat Tony, another child of the Italian peninsula solved the problem of antifragility. Except that, more intellectual than our horizontal friend, he spoke in a more distinguished prose. In addition, he was no less successful in the real world—actually he was vastly more successful in business than Fat Tony, and no less intellectual than Nero. The fellow was the stoic philosopher Seneca, whom we mentioned earlier was the alleged lover of Nero's mother (he was not).

And he solved the problem of antifragility—what connects the elements of the Triad—using Stoic philosophy.

Is This Really Serious?

Lucius Annaeus Seneca was a philosopher who happened to be the wealthiest person in the Roman Empire, partly owing to his trading acumen, partly for having served as the tutor of the colorful Emperor Nero, the one who tried to whack his mother a few chapters ago. Seneca subscribed to, and was a prominent expositor of, the philosophical school of Stoicism, which advanced a certain indifference to fate. His work has seduced people like me and most of the friends to whom I introduced his books, because he speaks to us; he walked the walk, and he focused on

the practical aspect of Stoicism, down to how to take a trip, how to handle oneself while committing suicide (which he was ordered to do), or, mostly, how to handle adversity and poverty and, even more critically, wealth.

Because Seneca was into practical decision making, he has been described—by academics—as not theoretical or philosophical enough. Yet not a single one of his commentators detected in Seneca the ideas about asymmetry that are central to this book, and to life, the key to robustness and antifragility. Not one. My point is that wisdom in decision making is vastly more important—not just practically, but philosophically—than knowledge.

Other philosophers, when they did things, came to practice from theory. Aristotle, when he attempted to provide practical advice, and a few decades earlier Plato, with his ideas of the state and advice to rulers, particularly the ruler of Syracuse, were either ineffectual or caused debacles. To become a successful philosopher king, it is much better to start as a king than as a philosopher, as illustrated in the following contemporary story.

Modern members of the discipline of decision theory, alas, travel a one-way road from theory to practice. They characteristically gravitate to the most complicated but most inapplicable problems, calling the process “doing science.” There is an anecdote about one Professor Triffat (I am changing the name because the story might be apocryphal, though from what I have witnessed, it is very characteristic). He is one of the highly cited academics of the field of decision theory, wrote the main textbook and helped develop something grand and useless called “rational decision making,” loaded with grand and useless axioms and shmaxioms, grand and even more useless probabilities and shmobabilities. Triffat, then at Columbia University, was agonizing over the decision to accept an appointment at Harvard—many people who talk about risk can spend their lives without encountering more difficult risk taking than this type of decision. A colleague suggested he use some of his Very Highly Respected and Grandly Honored and Decorated academic techniques with something like “maximum expected utility,” as, he told him, “you always write about this.” Triffat angrily responded, “Come on, this is serious!”

By contrast, Seneca is nothing but “this is serious.” He once survived a shipwreck in which other family members perished, and he wrote letters of practical and less practical advice to his friends. In the end, when

he took his own life, he followed excellently and in a dignified way the principles he preached in his writings. So while the Harvard economist is only read by people trying to write papers, who in turn are read by people trying to write papers, and will be (hopefully) swallowed by the inexorable b***t detector of history, Lucius Annaeus, known as Seneca the Younger, is still read by real people two millennia after his passing.

Let us get into his message.

Less Downside from Life

We start with the following conflict. We introduced Seneca as the wealthiest person in the Roman Empire. His fortune was three hundred million denarii (for a sense of its equivalence, at about the same period in time, Judas got thirty denarii, the equivalent of a month's salary, to betray Jesus). Admittedly it is certainly not very convincing to read denigrations of material wealth from a fellow writing the lines on one of his several hundred tables (with ivory legs).

The traditional understanding of Stoicism in the literature is of some *indifference* to fate—among other ideas of harmony with the cosmos that I will skip here. It is about continuously degrading the value of earthly possessions. When Zeno of Kition, the founder of the school of Stoicism, suffered a shipwreck (a lot of shipwrecks in ancient texts), he declared himself lucky to be unburdened so he could now do philosophy. And the key phrase reverberating in Seneca's oeuvre is *nihil perdit*, “I lost nothing,” after an adverse event. Stoicism makes you desire the challenge of a calamity. And Stoics look down on luxury: about a fellow who led a lavish life, Seneca wrote: “He is in debt, whether he borrowed from another person or from fortune.”*

Stoicism, seen this way, becomes pure robustness—for the attainment of a state of immunity from one's external circumstances, good or bad, and an absence of fragility to decisions made by fate, is robustness. Random events won't affect us either way (we are too strong to lose, and not greedy to enjoy the upside), so we stay in the middle column of the Triad.

What we learn from reading Seneca directly, rather than through the

* For those readers who wonder about the difference between Buddhism and Stoicism, I have a simple answer. A Stoic is a Buddhist with attitude, one who says “f*** you” to fate.

commentators, is a different story. Seneca's version of that Stoicism is antifragility from fate. No downside from Lady Fortuna, plenty of upside.

True, Seneca's aim on paper was philosophical, trying to stick to the Stoic tradition as described above: Stoicism was not supposed to be about gains and benefits, so on paper it was not at the level of antifragility, just about a sense of control over one's fate and the reduction of psychological fragility. But there is something that commentators have completely missed. If wealth is so much of a burden, while unnecessary, what's the point of having it? Why did Seneca keep it?

As I said concerning the psychologists who in Chapter 2 ignore post-traumatic growth but focus on post-traumatic harm, intellectuals have this thing against antifragility—for them the world tends to stop at robustness. I don't know what it is, but they don't like it. This made them avoid considering that Seneca wanted the upside from fate, and there is nothing wrong with it.

Let us first learn from the great master how he advocated the mitigation of downside, the standard message of the Stoics—robustness, protection against harm from emotions, how to move away from the first column of the Triad, that sort of thing. Second step, we will show how he truly proposed antifragility. And, third step, we will generalize his trick into a general method of detection of antifragility in Chapters 18 and 19.

Stoicism's Emotional Robustification

Success brings an asymmetry: you now have a lot more to lose than to gain. You are hence fragile. Let us return to the story of Damocles' sword. There is no good news in store, just plenty of bad news in the pipeline. When you become rich, the pain of losing your fortune exceeds the emotional gain of getting additional wealth, so you start living under continuous emotional threat. A rich person becomes trapped by belongings that take control of him, degrading his sleep at night, raising the serum concentration of his stress hormones, diminishing his sense of humor, perhaps even causing hair to grow on the tip of his nose and similar ailments. Seneca fathomed that possessions make us worry about downside, thus acting as a punishment as we depend on them. All downside, no upside. Even more: dependence on circumstances—rather, the emotions that arise from circumstances—induces a form of slavery.

This asymmetry between the effects of good and bad, benefit and harm, had to be familiar to the ancients—I found an earlier exposition in Livy: “Men feel the good less intensely than the bad” (*segnius homines bona quam mala sentiunt*), he wrote half a generation before Seneca. Ancients—mostly thanks to Seneca—stay way ahead of modern psychologists and Triffat-style decision theorists who have developed theories around the notion of “risk (or loss) aversion,” the ancients remain deeper, more practical, while transcending vulgar therapy.

Let me rephrase it in modern terms. Take the situation in which you have a lot to lose and little to gain. If an additional quantity of wealth, say, a thousand Phoenician shekels, would not benefit you, but you would feel great harm from the loss of an equivalent amount, you have an asymmetry. And it is not a good asymmetry: you are fragile.

Seneca’s practical method to counter such fragility was to go through mental exercises to write off possessions, so when losses occurred he would not feel the sting—a way to wrest one’s freedom from circumstances. It is similar to buying an insurance contract against losses. For instance, Seneca often started his journeys with almost the same belongings he would have if he were shipwrecked, which included a blanket to sleep on the ground, as inns were sparse at the time (though I need to qualify, to set things in the context of the day, that he had accompanying him “only one or two slaves”).

To show how eminently modern this is, I will next reveal how I’ve applied this brand of Stoicism to wrest back psychological control of the randomness of life. I have always hated employment and the associated dependence on someone else’s arbitrary opinion, particularly when much of what’s done inside large corporations violates my sense of ethics. So I have, accordingly, except for eight years, been self-employed. But, before that, for my last job, I wrote my resignation letter before starting the new position, locked it up in a drawer, and felt free while I was there. Likewise, when I was a trader, a profession rife with a high dose of randomness, with continuous psychological harm that drills deep into one’s soul, I would go through the mental exercise of assuming every morning that the worst possible thing had actually happened—the rest of the day would be a bonus. Actually the method of mentally adjusting “to the worst” had advantages way beyond the therapeutic, as it made me take a certain class of risks for which the worst case is clear and unambiguous, with limited and known downside. It is hard to stick to a good discipline of mental write-off when things are going well, yet

that's when one needs the discipline the most. Moreover, once in a while, I travel, Seneca-style, in uncomfortable circumstances (though unlike him I am not accompanied by "one or two" slaves).

An intelligent life is all about such emotional positioning to eliminate the sting of harm, which as we saw is done by mentally writing off belongings so one does not feel any pain from losses. The volatility of the world no longer affects you negatively.

The Domestication of Emotions

Seen this way, Stoicism is about the domestication, not necessarily the elimination, of emotions. It is not about turning humans into vegetables. My idea of the modern Stoic sage is *someone who transforms fear into prudence, pain into information, mistakes into initiation, and desire into undertaking*.

Seneca proposes a complete training program to handle life and use emotions properly—thanks to small but effective tricks. One trick, for instance, that a Roman Stoic would use to separate anger from rightful action and avoid committing harm he would regret later would be to wait at least a day before beating up a servant who committed a violation. We moderns might not see this as particularly righteous, but just compare it to the otherwise thoughtful Emperor Hadrian's act of stabbing a slave in the eye during an episode of uncontrolled anger. When Hadrian's anger abated, and he felt the grip of remorse, the damage was irreversible.

Seneca also provides us a catalogue of social deeds: invest in good actions. Things can be taken away from us—not good deeds and acts of virtue.

How to Become the Master

So far, that story is well known, and we have learned to move from the left of the Triad (fragile) to the center (robust). But Seneca went beyond.

He said that wealth is the slave of the wise man and master of the fool. Thus he broke a bit with the purported Stoic habit: *he kept the upside*. In my opinion, if previous Stoics claimed to prefer poverty to wealth, we need to be suspicious of their attitude, as it may be just all talk. Since most were poor, they might have fit a narrative to the circumstances (we will see with the story of Thales of Miletus the notion of

sour grapes—cognitive games to make yourself believe that the grapes that you can't reach taste sour). Seneca was all deeds, and we cannot ignore the fact that he kept the wealth. It is central that he showed his preference of wealth *without harm from wealth* to poverty.

Seneca even outlined his strategy in *De beneficiis*, explicitly calling it a cost-benefit analysis by using the word “bookkeeping”: “The book-keeping of benefits is simple: it is all expenditure; if any one returns it, that is clear *gain* (my emphasis); if he does not return it, it is not lost, I gave it for the sake of giving.” Moral bookkeeping, but bookkeeping nevertheless.

So he played a trick on fate: kept the good and ditched the bad; cut the downside and kept the upside. Self-servingly, that is, by eliminating the harm from fate and un-philosophically keeping the upside. This cost-benefit analysis is not quite Stoicism in the way people understand the meaning of Stoicism (people who study Stoicism seem to want Seneca and other Stoics to think like those who study Stoicism). There is an upside-downside asymmetry.

That's antifragility in its purest form.*

The Foundational Asymmetry

Let us put together Seneca's asymmetry in a single rule.

The concept I used earlier is *more to lose* from adversity. If you have more to lose than to benefit from events of fate, there is an asymmetry, and not a good one. And such asymmetry is universal. Let us see how it brings us to fragility.

Consider the package in Chapter 1: it does not like to be shaken, and it hates the members of the disorder family—hence it is fragile (very fragile because it has absolutely nothing to gain, hence it is very asymmetric). The antifragile package has more to gain than to lose from being shaken. Simple test: if I have “nothing to lose” then it is all gain and I am antifragile.

The entire Table 1 with triads across fields and domains can be explained in these terms. Everything.

To see why asymmetric payoffs like volatility, just consider that if

* And for those who believe that Zeno, the founder of Stoicism, was completely against material wealth, I have some news: I accidentally found a mention of his activities in maritime financing, where he was an involved investor, not exactly an activity for the anti-wealth utopian.

you have less to lose than to gain, more upside than downside, then you like volatility (it will, on balance, bring benefits), and you are also antifragile.

So the job falling upon this author is to make the link between the four elements as follows with the foundational asymmetry.

Fragility implies more to lose than to gain, equals more downside than upside, equals (unfavorable) asymmetry

and

Antifragility implies more to gain than to lose, equals more upside than downside, equals (favorable) asymmetry

You are antifragile for a source of volatility if potential gains exceed potential losses (and vice versa).

Further, if you have more upside than downside, then you may be harmed by lack of volatility and stressors.

Now, how do we put this idea—reduction of downside, increase in upside—into practice? By the method of the barbell in the next chapter.

Never Marry the Rock Star

A precise protocol on how and with whom to cheat on one's husband—Introduction to barbell strategies—Transforming diplomats into writers, and vice versa

The barbell (or bimodal) strategy is a way to achieve antifragility and move to the right side of the Triad. Monogamous birds put it into practice by cheating with the local rock star and writers do better by having as a day job a sinecure devoid of writing activities.

ON THE IRREVERSIBILITY OF BROKEN PACKAGES

The first step toward antifragility consists in first decreasing downside, rather than increasing upside; that is, by lowering exposure to negative Black Swans and letting natural antifragility work by itself.

Mitigating fragility is not an option but a requirement. It may sound obvious but the point seems to be missed. For fragility is very punishing, like a terminal disease. A package doesn't break under adverse conditions, then manage to fix itself when proper conditions are restored. Fragility has a ratchetlike property, the irreversibility of damage. What matters is the route taken, the order of events, not just the destination—what scientists call a *path-dependent* property. Path dependence can be illustrated as follows: your experience in getting a kidney stone operation first and anesthesia later is different from having the

procedures done in the opposite sequence. Or your enjoyment of a meal with coffee and dessert first and tomato soup last would not be the same as the inverse order. The consideration of path dependence makes our approach simple: it is easy to identify the fragile and put it in the left column of the Triad, regardless of upside potential—since the broken will tend to stay permanently broken.

This fragility that comes from path dependence is often ignored by businessmen who, trained in static thinking, tend to believe that generating profits is their principal mission, with survival and risk control something to perhaps consider—they miss the strong logical precedence of survival over success. To make profits and buy a BMW, it would be a good idea to, first, survive.

Notions such as speed and growth—anything related to movement—are empty and meaningless when presented without accounting for fragility. Consider that someone driving two hundred and fifty miles per hour in New York City is quite certain to never get anywhere—the effective speed will be exactly zero miles per hour. While it is obvious that one needs to focus on the effective, not the nominal, speed, something in the sociopolitical discourse masks such an elementary point.

Under path dependence, one can no longer separate growth in the economy from risks of recession, financial returns from risks of terminal losses, and “efficiency” from danger of accident. The notion of efficiency becomes quite meaningless on its own. If a gambler has a risk of terminal blowup (losing back everything), the “potential returns” of his strategy are totally inconsequential. A few years ago, a university fellow boasted to me that their endowment fund was earning 20 percent or so, not realizing that these returns were associated with fragilities that would easily turn into catastrophic losses—sure enough, a bad year wiped out all these returns and endangered the university.

In other words, if something is fragile, its risk of breaking makes anything you do to improve it or make it “efficient” inconsequential unless you first reduce that risk of breaking. As Publilius Syrus wrote, nothing can be done both hastily and safely—almost nothing.

As to growth in GDP (gross domestic product), it can be obtained very easily by loading future generations with debt—and the future economy may collapse upon the need to repay such debt. GDP growth, like cholesterol, seems to be a Procrustean bed reduction that has been used to game systems. So just as, for a plane that has a high risk of crashing, the notion of “speed” is irrelevant, since we know it may not get to

its destination, economic growth with fragilities is not to be called growth, something that has not yet been understood by governments. Indeed, growth was very modest, less than 1 percent per head, throughout the golden years surrounding the Industrial Revolution, the period that propelled Europe into domination. But as low as it was, it was robust growth—unlike the current fools’ race of states shooting for growth like teenage drivers infatuated with speed.

SENECA’S BARBELL

This brings us to the solution in the form of a barbell—about all solutions to uncertainty are in the form of barbells.

What do we mean by barbell? The barbell (a bar with weights on both ends that weight lifters use) is meant to illustrate the idea of a combination of extremes kept separate, with avoidance of the middle. In our context it is not necessarily symmetric: it is just composed of two extremes, with nothing in the center. One can also call it, more technically, a bimodal strategy, as it has two distinct modes rather than a single, central one.

I initially used the image of the barbell to describe a dual attitude of playing it safe in some areas (robust to negative Black Swans) and taking a lot of small risks in others (open to positive Black Swans), hence achieving antifragility. That is extreme risk aversion on one side and extreme risk loving on the other, rather than just the “medium” or the beastly “moderate” risk attitude that in fact is a sucker game (because medium risks can be subjected to huge measurement errors). But the barbell also results, because of its construction, in the reduction of downside risk—the elimination of the risk of ruin.

Let us use an example from vulgar finance, where it is easiest to explain, but misunderstood the most. If you put 90 percent of your funds in boring cash (assuming you are protected from inflation) or something called a “numeraire repository of value,” and 10 percent in very risky, maximally risky, securities, you cannot possibly lose more than 10 percent, while you are exposed to massive upside. Someone with 100 percent in so-called “medium” risk securities has a risk of total ruin from the miscomputation of risks. This barbell technique remedies the problem that risks of rare events are incomputable and fragile to estimation error; here the financial barbell has a maximum known loss.

For antifragility is the combination *aggressiveness plus paranoia*—clip

your downside, protect yourself from extreme harm, and let the upside, the positive Black Swans, take care of itself. We saw Seneca's asymmetry: more upside than downside can come simply from the reduction of extreme downside (emotional harm) rather than improving things in the middle.

A barbell can be any dual strategy composed of extremes, without the corruption of the middle—somehow they all result in favorable asymmetries.

Again, to see the difference between barbells and nonbarbells, consider that restaurants present the main course, say, grass-fed minute steak cooked rare and salad (with Malbec wine), then, separately, after you are done with the meat, bring you the goat cheese cake (with Muscat wine). Restaurants do not take your order, then cut the cake and the steak in small pieces and mix the whole thing together with those machines that produce a lot of noise. Activities “in the middle” are like such mashing. Recall Nero in Chapter 9 hanging around with janitors and scholars, rarely with middlebrows.

In risky matters, instead of having all members of the staff on an airplane be “cautiously optimistic,” or something in the middle, I prefer the flight attendants to be maximally optimistic and the pilot to be maximally pessimistic or, better, paranoid.

The Accountant and the Rock Star

Biological systems are replete with barbell strategies. Take the following mating approach, which we call the 90 percent accountant, 10 percent rock star. (I am just reporting, not condoning.) Females in the animal kingdom, in some monogamous species (which include humans), tend to marry the equivalent of the accountant, or, even more colorless, the economist, someone stable who can provide, and once in a while they cheat with the aggressive alpha, the rock star, as part of a dual strategy. They limit their downside while using extrapair copulation to get the genetic upside, or some great fun, or both. Even the timing of the cheating seems nonrandom, as it corresponds to periods with high likelihood of pregnancy. We see evidence of such a strategy with the so-called monogamous birds: they enjoy cheating, with more than a tenth of the broods coming from males other than the putative father. The phenomenon is real, but the theories around it vary. Evolutionary theorists claim

that females want both economic-social stability and good genes for their children. Both cannot be always obtained from someone in the middle with all these virtues (though good gene providers, those alpha males aren't likely to be stable, and vice versa). Why not have the pie and eat it too? Stable life and good genes. But an alternative theory may be that they just want to have pleasure—or stable life and good fun.*

Also recall from Chapter 2 that overcompensation, to work, requires some harm and stressors as tools of discovery. It means letting children play a little bit, not much more than a little bit, with fire and learn from injuries, for the sake of their own future safety.

It also means letting people experience some, not too much, stress, to wake them up a bit. But, at the same time, they need to be protected from high danger—ignore small dangers, invest your energy in protecting them from consequential harm. And only consequential harm. This can visibly be translated into social policy, health care, and many more matters.

One finds similar ideas in ancestral lore: it is explained in a Yiddish proverb that says “Provide for the worst; the best can take care of itself.” This may sound like a platitude, but it is not: just observe how people tend to provide for the best and hope that the worst will take care of itself. We have ample evidence that people are averse to small losses, but not so much toward very large Black Swan risks (which they underestimate), since they tend to insure for small probable losses, but not large infrequent ones. Exactly backwards.

Away from the Golden Middle

Now let us continue our exploration of barbells. There are so many fields in which the middle is no “golden middle” and where the bimodal strategy (maximally safe plus maximally speculative) applies.

Take literature, that most uncompromising, most speculative, most demanding, and riskiest of all careers. There is a tradition with French and other European literary writers to look for a sinecure, say, the

* There is evidence of such a barbell strategy but no clarity about the theory behind it—evolutionary theorists enjoy narratives but I prefer evidence. We are not sure if the strategy of extrapair copulation in the animal domain actually enhances fitness. So the barbell—accountant plus cheating—while it exists, might not be aiming at the improvement of the species; it can be just be for “fun” at low risk.

anxiety-free profession of civil servant, with few intellectual demands and high job security, the kind of low-risk job that ceases to exist when you leave the office, then spend their spare time writing, free to write whatever they want, under their own standards. There is a shockingly small number of academics among French authors. American writers, on the other hand, tend to become members of the media or academics, which makes them prisoners of a system and corrupts their writing, and, in the case of research academics, makes them live under continuous anxiety, pressures, and indeed, severe bastardization of the soul. Every line you write under someone else's standards, like prostitution, kills a corresponding segment deep inside. On the other hand, sinecure-cum-writing is a quite soothing model, next best to having financial independence, or perhaps even better than financial independence. For instance, the great French poets Paul Claudel and Saint-John Perse and the novelist Stendhal were diplomats; a large segment of English writers were civil servants (Trollope was a post office worker); Kafka was employed by an insurance company. Best of all, Spinoza worked as a lens maker, which left his philosophy completely immune to any form of academic corruption. As a teenager, I thought that the natural way to have a real literary or philosophical career was to enter the lazy, pleasant, and undemanding profession of diplomat, like many members of my family. There was an Ottoman tradition of using Orthodox Christians as emissaries and ambassadors, even ministers of foreign affairs, which was retained by the states of the Levant (my grandfather and great-grandfather had been ministers of foreign affairs). Except that I worried about the wind turning against the Christian minority, and was proved right. But I became a trader and did my writing on my own time, and, as the reader can see, on my own terms. The barbell businessman-scholar situation was ideal; after three or four in the afternoon, when I left the office, my day job ceased to exist until the next day and I was completely free to pursue what I found most valuable and interesting. When I tried to become an academic I felt like a prisoner, forced to follow others' less rigorous, self-promotional programs.

And professions can be serial: something very safe, then something speculative. A friend of mine built himself a very secure profession as a book editor, in which he was known to be very good. Then, after a decade or so, he left completely for something speculative and highly risky. This is a true barbell in every sense of the word: he can fall back on his previous profession should the speculation fail, or fail to bring the ex-

pected satisfaction. This is what Seneca elected to do: he initially had a very active, adventurous life, followed by a philosophical withdrawal to write and meditate, rather than a “middle” combination of both. Many of the “doers” turned “thinkers” like Montaigne have done a serial barbell: pure action, then pure reflection.

Or, if I have to work, I find it preferable (and less painful) to work intensely for very short hours, then do nothing for the rest of the time (assuming doing nothing is really doing nothing), until I recover completely and look forward to a repetition, rather than being subjected to the tedium of Japanese style low-intensity interminable office hours with sleep deprivation. Main course and dessert are separate.

Indeed, Georges Simenon, one of the most prolific writers of the twentieth century, only wrote sixty days a year, with three hundred days spent “doing nothing.” He published more than two hundred novels.

The Domestication of Uncertainty

We will see many barbells in the rest of this book that share exactly the same asymmetry and somehow, when it comes to risk, produce the same type of protection and help in the harnessing of antifragility. They all look remarkably similar.

Let us take a peek at a few domains. With personal risks, you can easily barbell yourself by removing the chances of ruin in any area. I am personally completely paranoid about certain risks, then very aggressive with others. The rules are: no smoking, no sugar (particularly fructose), no motorcycles, no bicycles in town or more generally outside a traffic-free area such as the Sahara desert, no mixing with the Eastern European mafias, and no getting on a plane not flown by a professional pilot (unless there is a co-pilot). Outside of these I can take all manner of professional and personal risks, particularly those in which there is no risk of terminal injury.

In social policy, it consists in protecting the very weak and letting the strong do their job, rather than helping the middle class to consolidate its privileges, thus blocking evolution and bringing all manner of economic problems that tend to hurt the poor the most.

Before the United Kingdom became a bureaucratic state, it was barbelled into adventurers (both economically and physically) and an aristocracy. The aristocracy didn’t really have a major role except to help keep some sense of caution while the adventurers roamed the planet in

search of trading opportunities, or stayed home and tinkered with machinery. Now the City of London is composed of bourgeois bohemian bonus earners.

My writing approach is as follows: on one hand a literary essay that can be grasped by anyone and on the other technical papers, nothing in between—such as interviews with journalists or newspaper articles or op-ed pieces, outside of the requirements of publishers.

The reader may remember the exercise regimen of Chapter 2, which consists in going for the maximum weight one can lift, then nothing, compared to other alternatives that entail less intense but very long hours in the gym. This, supplemented with effortless long walks, constitutes an exercise barbell.

More barbells. Do crazy things (break furniture once in a while), like the Greeks during the later stages of a drinking symposium, and stay “rational” in larger decisions. Trashy gossip magazines and classics or sophisticated works; never middlebrow stuff. Talk to either undergraduate students, cab drivers, and gardeners or the highest caliber scholars; never to middling-but-career-conscious academics. If you dislike someone, leave him alone or eliminate him; don’t attack him verbally.*

So take for now that a barbell strategy with respect to randomness results in achieving antifragility thanks to the mitigation of fragility, the clipping of downside risks of harm—reduced pain from adverse events, while keeping the benefits of potential gains.

To return to finance, the barbell does not need to be in the form of investment in inflation-protected cash and the rest in speculative securities. Anything that removes the risk of ruin will get us to such a barbell. The legendary investor Ray Dalio has a rule for someone making speculative bets: “Make sure that the probability of the unacceptable (i.e., the risk of ruin) is nil.” Such a rule gets one straight to the barbell.†

* In finance, I stood in 2008 for banks to be nationalized rather than bailed out, and other forms of speculation not entailing taxpayers left free. Nobody was getting my barbell idea—some hated the libertarian aspect, others hated the nationalization part. Why? Because the halfway—here, the regulation of both—doesn’t work, as it can be gamed by a good lawyer. Hedge funds need to be unregulated and banks nationalized, as a barbell, rather than the horror we now have.

† Domain dependence again. People find insuring their house a necessity, not something to be judged against a financial strategy, but when it comes to their portfolios, because of the way things are framed in the press, they don’t look at them in the same way. They think that my barbell idea is a strategy that needs to be examined for its *potential return* as an investment. That’s not the point. The barbell is simply an idea of insurance of survival; it is a necessity, not an option.

Another idea from Rory Sutherland: the U.K. guidelines for patients with mild problems coming from alcohol are to reduce the daily consumption to under a certain number of grams of alcohol per day. But the optimal policy is to avoid alcohol three times a week (hence give the liver a lengthy vacation) then drink liberally the remaining four. The mathematics behind this and other barbell ideas are outlined with the later discussion of Jensen's inequality.

Most items on the right of the Triad have a barbell component, necessary, but not sufficient.

So just as Stoicism is the domestication, not the elimination, of emotions, so is the barbell a domestication, not the elimination, of uncertainty.

BOOK IV

Optionality, Technology, and the Intelligence of Antifragility

Now we get into innovation, the concept of options and optionality. How to enter the impenetrable and completely dominate it, conquer it.

DO YOU REALLY KNOW WHERE YOU ARE GOING?

Summa Theologiae by Saint Thomas Aquinas is the kind of book that no longer exists, the book-as-monument, a *summa* being the comprehensive treatment of a given discipline, while freeing it from the structure the authorities had given it before—the antitextbook. In this case its subject matter is theology, meaning everything philosophical, and it comments on every body of knowledge as it relates to his arguments. And it reflects—and largely directs—the thought of the Middle Ages.

Quite a departure from the book with a simple closed-end subject matter.

The erudite mind's denigration of antifragility is best seen in a sentence that dominates the *Summa*, being repeated in many places, one variant of which is as follows: "An agent does not move except out of intention for an end," *agen autem non movet nisi ex intentione finis*. In other words, agents are supposed to know where they are going, a teleological argument (from *telos*, "based on the end") that originates with Aristotle. Everyone, including the Stoics, but excluding the skeptics, fell

for such teleological arguments intellectually, but certainly not in action. Incidentally, it is not Aristotle whom Aquinas is quoting—he calls him the Philosopher—but the Arab synthesizer of Aristotle’s thinking, Ibn Rushd, also known as Averroes, whom Aquinas calls the Commentator. And the Commentator has caused a great deal of damage. For Western thought is vastly more Arabian than is recognized, while post-Medieval Arabs have managed to escape medieval rationalism.

This entire heritage of thinking, grounded in the sentence “An agent does not move except out of intention for an end,” is where the most pervasive human error lies, compounded by two or more centuries of the illusion of unconditional scientific understanding. This error is also the most fragilizing one.

The Teleological Fallacy

So let us call here the teleological fallacy the illusion that you know exactly where you are going, and that you knew exactly where you were going in the past, and that others have succeeded in the past by knowing where they were going.

The rational flâneur is someone who, unlike a tourist, makes a decision at every step to revise his schedule, so he can imbibe things based on new information, what Nero was trying to practice in his travels, often guided by his sense of smell. The flâneur is not a prisoner of a plan. Tourism, actual or figurative, is imbued with the teleological illusion; it assumes completeness of vision and gets one locked into a hard-to-revise program, while the flâneur continuously—and, what is crucial, rationally—modifies his targets as he acquires information.

Now a warning: the opportunism of the flâneur is great in life and business—but not in personal life and matters that involve others. The opposite of opportunism in human relations is loyalty, a noble sentiment—but one that needs to be invested in the right places, that is, in human relations and moral commitments.

The error of thinking you know exactly where you are going and assuming that you know *today* what your preferences will be *tomorrow* has an associated one. It is the illusion of thinking that *others*, too, know where they are going, and that they would tell you what they want if you just asked them.

Never ask people what they want, or where they want to go, or where they think they should go, or, worse, what they think they will

desire tomorrow. The strength of the computer entrepreneur Steve Jobs was precisely in distrusting market research and focus groups—those based on asking people what they want—and following his own imagination. His modus was that people don't know what they want until you provide them with it.

This ability to switch from a course of action is an *option* to change. Options—and optionality, the character of the option—are the topic of Book IV. Optionality will take us many places, but at the core, an option is what makes you antifragile and allows you to benefit from the positive side of uncertainty, without a corresponding serious harm from the negative side.

America's Principal Asset

And it is optionality that makes things work and grow—but it takes a certain type of person for that. Many people keep deplored the low level of formal education in the United States (as defined by, say, math grades). Yet these people fail to realize that the *new* comes from here and gets imitated elsewhere. And it is not thanks to universities, which obviously claim a lot more credit than their accomplishments warrant.

Like Britain in the Industrial Revolution, America's asset is, simply, risk taking and the use of optionality, this remarkable ability to engage in rational forms of trial and error, with no comparative shame in failing, starting again, and repeating failure. In modern Japan, by contrast, shame comes with failure, which causes people to hide risks under the rug, financial or nuclear, making small benefits while sitting on dynamite, an attitude that strangely contrasts with their traditional respect for fallen heroes and the so-called nobility of failure.

Book IV will take this idea to its natural conclusion and will show evidence (ranging from medieval architecture to medicine, engineering, and innovation) that, perhaps, our greatest asset is the one we distrust the most: the built-in antifragility of certain risk-taking systems.

CHAPTER 12

Thales' Sweet Grapes

Where we discuss the idea of doing instead of walking the Great Walk—The idea of a free option—Can a philosopher be called nouveau riche?

An anecdote appears in Aristotle's *Politics* concerning the pre-Socratic philosopher and mathematician Thales of Miletus. This story, barely covering half a page, expresses both antifragility and its denigration and introduces us to optionality. The remarkable aspect of this story is that Aristotle, arguably the most influential thinker of all time, got the central point of his own anecdote exactly backward. So did his followers, particularly after the Enlightenment and the scientific revolution. I am not saying this to denigrate the great Aristotle, but to show that intelligence makes you discount antifragility and ignore the power of optionality.

Thales was a philosopher, a Greek-speaking Ionian of Phoenician stock from the coastal town of Miletus in Asia Minor, and like some philosophers, he enjoyed what he was doing. Miletus was a trading post and had the mercantile spirit usually attributed to Phoenician settlements. But Thales, as a philosopher, was characteristically impecunious. He got tired of his buddies with more transactional lives hinting at him that “those who can, do, and others philosophize.” He performed the following prowess: he put a down payment on the seasonal use of every olive press in the vicinity of Miletus and Chios, which he got at low rent.

The harvest turned out to be extremely bountiful and there was demand for olive presses, so he released the owners of olive presses on his own terms, building a substantial fortune in the process. Then he went back to philosophizing.

What he collected was large, perhaps not enough to make him massively wealthy, but enough to make the point—to others but also, I suspect, to himself—that he talked the talk and was truly above, not below, wealth. This kind of sum I've called in my vernacular “f*** you money”—a sum large enough to get most, if not all, of the advantages of wealth (the most important one being independence and the ability to only occupy your mind with matters that interest you) but not its side effects, such as having to attend a black-tie charity event and being forced to listen to a polite exposition of the details of a marble-rich house renovation. The worst side effect of wealth is the social associations it forces on its victims, as people with big houses tend to end up socializing with other people with big houses. Beyond a certain level of opulence and independence, gents tend to be less and less personable and their conversation less and less interesting.

The story of Thales has many morals, all of them linked to asymmetry (and the construction of an antifragile payoff). The central one is related to the following account by Aristotle: *“But from his knowledge of astronomy he had observed while it was still winter that there was going to be a large crop of olives . . .”* So for Aristotle, clearly, the stated reason was Thales' superior knowledge.

Superior knowledge?

Thales put himself in a position to take advantage of his *lack* of knowledge—and the secret property of the asymmetry. The key to our message about this upside-downside asymmetry is that he did not need to understand too much the messages from the stars.

Simply, he had a contract that is the archetype of what an asymmetry is, perhaps the only explicit asymmetry you can find in its purest form. It is an option, “the right but not the obligation” for the buyer and, of course, “the obligation but not the right” for the other party, called the seller. Thales had the right—but not the obligation—to use the olive presses in case there would be a surge in demand; the other party had the obligation, not the right. Thales paid a small price for that privilege, with a limited loss and large possible outcome. That was the very first option on record.

The option is an agent of antifragility.

OPTION AND ASYMMETRY

The olive press episode took place about six hundred years before Seneca's writings on his tables with ivory legs, and three hundred years before Aristotle.

The formula in Chapter 10 was: *antifragility equals more to gain than to lose equals more upside than downside equals asymmetry (favorable) equals likes volatility*. And if you make more when you are right than you are hurt when you are wrong, then you will benefit, in the long run, from volatility (and the reverse). You are only harmed if you repeatedly pay too much for the option. But in this case Thales patently got a good deal—and we will see in the rest of Book IV that we don't pay for the options given to us by nature and technological innovation. Financial options may be expensive because people know they are options and *someone* is selling them and charging a price—but most interesting options are free, or at the worst, cheap.

Centrally, we just don't need to *know* what's going on when we buy cheaply—when we have the asymmetry working for us. But this property goes beyond buying cheaply: we do not need to understand things when we have some edge. And the edge from optionality is in the larger payoff when you are right, which makes it unnecessary to be right too often.

The Options of Sweet Grapes

The option I am talking about is no different from what we call options in daily life—the vacation resort with the most options is more likely to provide you with the activity that satisfies your tastes, and the one with the narrowest choices is likely to fail. So you need *less information*, that is, less knowledge, about the resort with broader options.

There are other hidden options in our story of Thales. Financial independence, when used intelligently, can make you robust; it gives you options and allows you to make the right choices. Freedom is the ultimate option.

Further, you will never get to know yourself—your real preferences—unless you face options and choices. Recall that the volatility of life helps provide information to us about others, but also about ourselves. Plenty of people are poor against their initial wish and only become robust by spinning a story that it was their choice to be poor—as if they had the

option. Some are genuine; many don't really have the option—they constructed it. Sour grapes—as in Aesop's fable—is when someone convinces himself that the grapes he cannot reach are sour. The essayist Michel de Montaigne sees the Thales episode as a story of immunity to sour grapes: you need to know whether you *do not like* the pursuit of money and wealth because you genuinely do not like it, or because you are rationalizing your inability to be successful at it with the argument that wealth is not a good thing because it is bad for one's digestive system or disturbing for one's sleep or other such arguments. So the episode enlightened Thales about his own choices in life—how genuine his pursuit of philosophy was. He had other *options*. And, it is worth repeating, options, any options, by allowing you more upside than downside, are vectors of antifragility.*

Thales, by funding his own philosophy, became his own Maecenas, perhaps the highest rank one can attain: being both independent and intellectually productive. He now had even more *options*. He did not have to tell others—those funding him—where he was going, because he himself perhaps didn't even know where he was heading. Thanks to the power of options, he didn't have to.

The next few vignettes will help us go deeper into the notion of *optionality*—the property of option-like payoffs and option-like situations.

Saturday Evening in London

It is Saturday afternoon in London. I am coping with a major source of stress: where to go tonight. I am fond of the brand of the unexpected one finds at parties (going to parties has optionality, perhaps the best advice for someone who wants to benefit from uncertainty with low downside). My fear of eating alone in a restaurant while rereading the same passage of Cicero's *Tusculan Discussions* that, thanks to its pocket-fitting size, I have been carrying for a decade (and reading about three and a half pages per year) was alleviated by a telephone call. Someone, not a close friend, upon hearing that I was in town, invited me to a gathering in

* I suppose that the main benefit of being rich (over just being independent) is to be able to despise rich people (a good concentration of whom you find in glitzy ski resorts) without any sour grapes. It is even sweeter when these farts don't know that you are richer than they are.

Kensington, but somehow did not ask me to commit, with “drop by if you want.” Going to the party is better than eating alone with Cicero’s *Tusculan Discussions*, but these are not very interesting people (many are involved in the City, and people employed in financial institutions are rarely interesting and even more rarely likable) and I know I can do better, but I am not certain to be able to do so. So I can call around: if I can do better than the Kensington party, with, say, a dinner with any of my real friends, I would do that. Otherwise I would take a black taxi to Kensington. I have an *option*, not an obligation. It came at no cost since I did not even solicit it. So I have a small, nay, nonexistent, downside, a big upside.

This is a free option because there is no real cost to the privilege.

Your Rent

Second example: assume you are the official tenant of a rent-controlled apartment in New York City, with, of course, wall-to-wall bookshelves. You have the *option* of staying in it as long as you wish, but no obligation to do so. Should you decide to move to Ulan Bator, Mongolia, and start a new life there, you can simply notify the landlord a certain number of days in advance, and thank you goodbye. Otherwise, the landlord is obligated to let you live there somewhat permanently, at a predictable rent. Should rents in town increase enormously, and real estate experience a bubble-like explosion, you are largely protected. On the other hand, should rents collapse, you can easily switch apartments and reduce your monthly payments—or even buy a new apartment and get a mortgage with lower monthly payments.

So consider the asymmetry. You benefit from lower rents, but are not hurt by higher ones. How? Because here again, you have an option, not an obligation. In a way, uncertainty increases the worth of such privilege. Should you face a high degree of uncertainty about future outcomes, with possible huge decreases in real estate value, or huge possible increases in them, your option would become more valuable. The more uncertainty, the more valuable the option.

Again, this is an embedded option, hidden as there is no cost to the privilege.

Asymmetry

Let us examine once again the asymmetry of Thales—along with that of any option. In Figure 5, the horizontal axis represents the rent, the vertical axis the corresponding profits in thekels. Figure 5 shows the asymmetry: in this situation, the payoff is larger one way (if you are right, you “earn big time”) than the other (if you are wrong, you “lose small”).

Profits in Stater (Thekel)

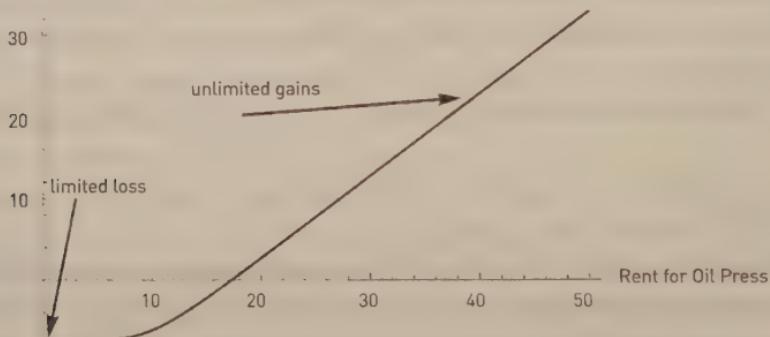


FIGURE 5. Thales’ antifragility. He pays little to get a huge potential. We can see the asymmetry between upside and downside.

The vertical axis in Figure 5 represents a function of the rent for oil presses (the payoff from the option). All the reader needs to note from the picture is the nonlinearity (that is, the asymmetry, with more upside than downside; asymmetry is a form of nonlinearity).

Things That Like Dispersion

One property of the option: it does not care about the average outcome, only the favorable ones (since the downside doesn’t count beyond a certain point). Authors, artists, and even philosophers are much better off having a very small number of fanatics behind them than a large number of people who appreciate their work. The number of persons who dislike the work don’t count—there is no such thing as the *opposite* of buying your book, or the equivalent of losing points in a soccer game, and this absence of negative domain for book sales provides the author with a measure of optionality.

Further, it helps when supporters are both enthusiastic and influen-

tial. Wittgenstein, for instance, was largely considered a lunatic, a strange bird, or just a b****t operator by those whose opinion didn't count (he had almost no publications to his name). But he had a small number of cultlike followers, and some, such as Bertrand Russell and J. M. Keynes, were massively influential.

Beyond books, consider this simple heuristic: your work and ideas, whether in politics, the arts, or other domains, are antifragile if, instead of having one hundred percent of the people finding your mission acceptable or mildly commendable, you are better off having a high percentage of people disliking you and your message (even intensely), combined with a low percentage of extremely loyal and enthusiastic supporters. Options like dispersion of outcomes and don't care about the average too much.

Another business that does not care about the average but rather the dispersion around the average is the luxury goods industry—jewelry, watches, art, expensive apartments in fancy locations, expensive collector wines, gourmet farm-raised probiotic dog food, etc. Such businesses only care about the pool of funds available to the very rich. If the population in the Western world had an average income of fifty thousand dollars, with no inequality at all, luxury goods sellers would not survive. But if the average stays the same but with a high degree of inequality, with some incomes higher than two million dollars, and potentially some incomes higher than ten million, then the business has plenty of customers—even if such high incomes are offset by masses of people with lower incomes. The “tails” of the distribution on the higher end of the income brackets, the extreme, are much more determined by changes in inequality than changes in the average. It gains from dispersion, hence is antifragile. This explains the bubble in real estate prices in Central London, determined by inequality in Russia and the Arabian Gulf and totally independent of the real estate dynamics in Britain. Some apartments, those for the very rich, sell for twenty times the average per square foot of a building a few blocks away.

Harvard's former president Larry Summers got in trouble (clumsily) explaining a version of the point and lost his job in the aftermath of the uproar. He was trying to say that males and females have equal intelligence, but the male population has more variations and dispersion (hence volatility), with more highly unintelligent men, and more highly intelligent ones. For Summers, this explained why men were overrepresented in science and technology fields.

sented in the scientific and intellectual community (and also why men were overrepresented in jails or failures). The number of successful scientists depends on the “tails,” the extremes, rather than the average. Just as an option does not care about the adverse outcomes, or an author does not care about the haters.

No one at present dares to state the obvious: growth in society may not come from raising the average the Asian way, but from increasing the number of people in the “tails,” that small, very small number of risk takers crazy enough to have ideas of their own, those endowed with that very rare ability called imagination, that rarer quality called courage, and who make things happen.

THE THALESIAN AND THE ARISTOTELIAN

Now some philosophy. As we saw with the exposition of the Black Swan problem earlier in Chapter 8, the decision maker focuses on the payoff, the consequence of the actions (hence includes asymmetries and nonlinear effects). The Aristotelian focuses on being right and wrong—in other words, raw logic. They intersect less often than you think.

Aristotle made the mistake of thinking that knowledge about the event (future crop, or price of the rent for oil presses, what we showed on the horizontal axis) and making profits out of it (vertical) are the same thing. And here, because of asymmetry, the two are not, as is obvious in the graph. As Fat Tony will assert in Chapter 14, “they are not the same thing” (pronounced “ting”).

How to Be Stupid

If you “have optionality,” you don’t have much need for what is commonly called intelligence, knowledge, insight, skills, and these complicated things that take place in our brain cells. For you don’t have to be right that often. All you need is the wisdom to *not do* unintelligent things to hurt yourself (some acts of omission) and recognize favorable outcomes when they occur. (The key is that your assessment doesn’t need to be made beforehand, only after the outcome.)

This property allowing us to be stupid, or, alternatively, allowing us to get more results than the knowledge may warrant, I will call the “philosopher’s stone” for now, or “convexity bias,” the result of a mathe-

matical property called Jensen's inequality. The mechanics will be explained later, in Book V when we wax technical, but take for now that evolution can produce astonishingly sophisticated objects without intelligence, simply thanks to a combination of optionality and some type of a selection filter, plus some randomness, as we see next.

Nature and Options

The great French biologist François Jacob introduced into science the notion of options (or option-like characteristics) in natural systems, thanks to trial and error, under a variant called *bricolage* in French. Bricolage is a form of trial and error close to *tweaking*, trying to make do with what you've got by recycling pieces that would be otherwise wasted.

Jacob argued that even within the womb, nature knows how to select: about half of all embryos undergo a spontaneous abortion—easier to do so than design the perfect baby by blueprint. Nature simply keeps what it likes if it meets its standards or does a California-style “fail early”—it has an option and uses it. Nature understands optionality effects vastly better than humans, and certainly better than Aristotle.

Nature is all about the exploitation of optionality; it illustrates how optionality is a substitute for intelligence.*

Let us call trial and error *tinkering* when it presents small errors and large gains. Convexity, a more precise description of such positive asymmetry, will be explained in a bit of depth in Chapter 18.†

The graph in Figure 7 best illustrates the idea present in California, and voiced by Steve Jobs at a famous speech: “Stay hungry, stay foolish.” He probably meant “Be crazy but retain the rationality of choosing the upper bound when you see it.” Any trial and error can be seen as the expression of an option, so long as one is capable of identifying a favorable result and exploiting it, as we see next.

* We will use nature as a model to show how its operational outperformance arises from optionality rather than intelligence—but let us not fall for the naturalistic fallacy: ethical rules do not have to spring from optionality.

† Everyone talks about luck and about trial and error, but it has led to so little difference. Why? Because it is not about luck, but about optionality. By definition luck cannot be exploited; trial and error can lead to errors. Optionality is about getting the upper half of luck.

Changes in Value

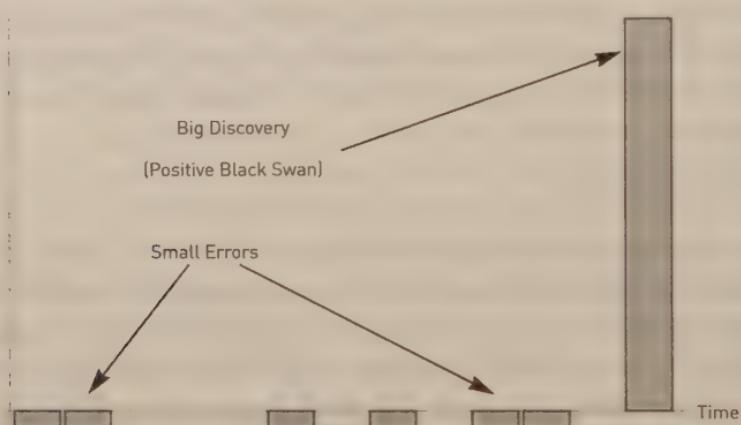


FIGURE 6. The mechanism of optionlike trial and error [the fail-fast model], a.k.a. convex tinkering. Low-cost mistakes, with known maximum losses, and large potential payoff [unbounded]. A central feature of positive Black Swans: the gains are unbounded (unlike a lottery ticket), or, rather, with an unknown limit; but the losses from errors are limited and known

Changes in Value

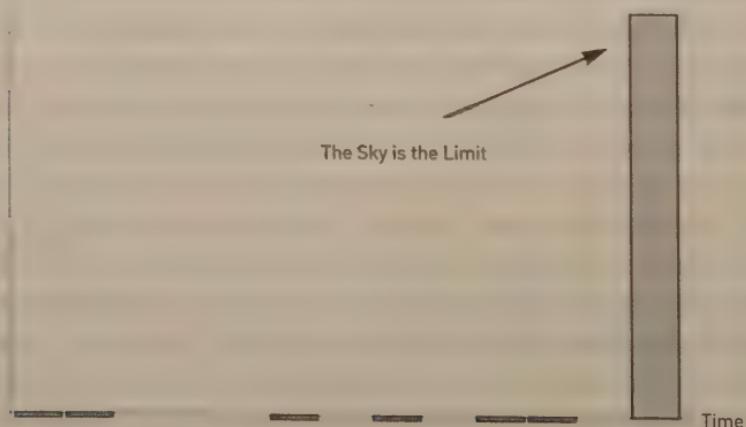


FIGURE 7. Same situation as in Figure 6, but in Extremistan the payoff can be monstrous.

The Rationality

To crystallize, take this description of an option:

$$\text{Option} = \text{asymmetry} + \text{rationality}$$

The rationality part lies in keeping what is good and ditching the bad, knowing to take the profits. As we saw, nature has a filter to keep the good baby and get rid of the bad. The difference between the antifragile and the fragile lies there. The fragile has no option. But the antifragile needs to select what's best—the best option.

It is worth insisting that the most wonderful attribute of nature is the rationality with which it selects its options and picks the best for itself—thanks to the testing process involved in evolution. Unlike the researcher afraid of doing something different, it sees an option—the asymmetry—when there is one. So it ratchets up—biological systems get locked in a state that is better than the previous one, the path-dependent property I mentioned earlier. In trial and error, the rationality consists in not rejecting something that is markedly better than what you had before.

As I said, in business, people pay for the option when it is identified and mapped in a contract, so explicit options tend to be expensive to purchase, much like insurance contracts. They are often overhyped. But because of the domain dependence of our minds, we don't recognize it in other places, where these options tend to remain underpriced or not priced at all.

I learned about the asymmetry of the option in class at the Wharton School, in the lecture on financial options that determined my career, and immediately realized that the professor did not himself see the implications. Simply, he did not understand nonlinearities and the fact that the optionality came from some asymmetry! Domain dependence: he missed it in places where the textbook did not point to the asymmetry—he understood optionality mathematically, but not really outside the equation. He did not think of trial and error as options. He did not think of model error as negative options. And, thirty years later, little has changed in the understanding of the asymmetries by many who, ironically, teach the subject of options.*

* I usually hesitate to discuss my career in options, as I worry that the reader will associate the idea with finance rather than the more scientific applications. I go ballistic when I use technical insights derived from derivatives and people mistake it for a financial discussion—these are only techniques, portable techniques, very portable techniques, for Baal's sake!

An option hides where we don't want it to hide. I will repeat that options benefit from variability, but also from situations in which errors carry small costs. So these errors are like options—in the long run, happy errors bring gains, unhappy errors bring losses. That is exactly what Fat Tony was taking advantage of: certain models can have only unhappy errors, particularly derivatives models and other fragilizing situations.

What also struck me was the option blindness of us humans and intellectuals. These options were, as we will see in the next chapter, out there in plain sight.

Life Is Long Gamma

Indeed, in plain sight.

One day, my friend Anthony Glickman, a rabbi and Talmudic scholar turned option trader, then turned again rabbi and Talmudic scholar (so far), after one of these conversations about how this optionality applies to everything around us, perhaps after one of my tirades on Stoicism, calmly announced: “Life is long gamma.” (To repeat, in the jargon, “long” means “benefits from” and “short” “hurt by,” and “gamma” is a name for the nonlinearity of options, so “long gamma” means “benefits from volatility and variability.” Anthony even had as his mail address “@longgamma.com.”)

There is an ample academic literature trying to convince us that options are not rational to own because *some* options are overpriced, and they are deemed overpriced according to business school methods of computing risks that do not take into account the possibility of rare events. Further, researchers invoke something called the “long shot bias” or lottery effects by which people stretch themselves and overpay for these long shots in casinos and in gambling situations. These results, of course, are charlatanism dressed in the garb of science, with non-risk takers who, Triffat-style, when they want to think about risk, only think of casinos. As in other treatments of uncertainty by economists, these are marred with mistaking the randomness of life for the well-tractable one of the casinos, what I call the “ludic fallacy” (after *ludes*, which means “games” in Latin)—the mistake we saw made by the blackjack fellow of Chapter 7. In fact, criticizing all bets on rare events based on the fact that lottery tickets are overpriced is as foolish as criticizing all risk taking on grounds that casinos make money in the long run from

gamblers, forgetting that we are here because of risk taking *outside* the casinos. Further, casino bets and lottery tickets also have a known maximum upside—in real life, the sky is often the limit, and the difference between the two cases can be significant.

Risk taking *ain't* gambling, and optionality *ain't* lottery tickets.

In addition, these arguments about “long shots” are ludicrously cherry-picked. If you list the businesses that have generated the most wealth in history, you would see that they all have optionality. There is unfortunately the optionality of people stealing options from others and from the taxpayer (as we will see in the ethical section in Book VII), such as CEOs of companies with upside and no downside to themselves. But the largest generators of wealth in America historically have been, first, real estate (investors have the option at the expense of the banks), and, second, technology (which relies almost completely on trial and error). Further, businesses with negative optionality (that is, the opposite of having optionality) such as banking have had a horrible performance through history: banks lose periodically every penny made in their history thanks to blowups.

But these are all dwarfed by the role of optionality in the two evolutions: natural and scientific-technological, the latter of which we will examine in Book IV.

Roman Politics Likes Optionality

Even political systems follow a form of rational tinkering, when people are rational hence take the better option: the Romans got their political system by tinkering, not by “reason.” Polybius in his *Histories* compares the Greek legislator Lycurgus, who constructed his political system while “untaught by adversity,” to the more experiential Romans, who, a few centuries later, “have not reached it by *any process of reasoning* [emphasis mine], but by the discipline of many struggles and troubles, and always choosing the best by the light of the experience gained in disaster.”

Next

Let me summarize. In Chapter 10 we saw the foundational asymmetry as embedded in Seneca’s ideas: more upside than downside and vice versa. This chapter refined the point and presented a manifestation of

such asymmetry in the form of an option, by which one can take the upside if one likes, but without the downside. An option is the weapon of antifragility.

The other point of the chapter and Book IV is that the option is a substitute for knowledge—actually I don’t quite understand what sterile knowledge is, since it is necessarily vague and sterile. So I make the bold speculation that many things we think are derived by skill come largely from options, but well-used options, much like Thales’ situation—and much like nature—rather than from what we claim to be understanding.

The implication is nontrivial. For if you think that education causes wealth, rather than being a result of wealth, or that intelligent actions and discoveries are the result of intelligent ideas, you will be in for a surprise. Let us see what kind of surprise.

Lecturing Birds on How to Fly

Finally, the wheel—Proto-Fat Tony thinking—The central problem is that birds rarely write more than ornithologists—Combining stupidity with wisdom rather than the opposite

Consider the story of the wheeled suitcase.

I carry a large wheeled suitcase mostly filled with books on almost all my travels. It is heavy (books that interest me when I travel always happen to be in hardcover).

In June 2012, I was rolling that generic, heavy, book-filled suitcase outside the JFK international terminal and, looking at the small wheels at the bottom of the case and the metal handle that helps pull it, I suddenly remembered the days when I had to haul my book-stuffed luggage through the very same terminal, with regular stops to rest and let the lactic acid flow out of my sore arms. I could not afford a porter, and even if I could, I would not have felt comfortable doing it. I have been going through the same terminal for three decades, with and without wheels, and the contrast was eerie. It struck me how lacking in imagination we are: we had been putting our suitcases on top of a cart with wheels, but nobody thought of putting tiny wheels directly under the suitcase.

Can you imagine that it took close to six thousand years between the invention of the wheel (by, we assume, the Mesopotamians) and this brilliant implementation (by some luggage maker in a drab industrial

suburb)? And billions of hours spent by travelers like myself schlepping luggage through corridors full of rude customs officers.

Worse, this took place three decades or so after we put a man on the moon. And consider all this sophistication used in sending someone into space, and its totally negligible impact on my life, and compare it to this lactic acid in my arms, pain in my lower back, soreness in the palms of my hands, and sense of helplessness in front of a long corridor. Indeed, though extremely consequential, we are talking about something trivial: a very simple technology.

But the technology is only trivial retrospectively—not prospectively. All those brilliant minds, usually disheveled and rumpled, who go to faraway conferences to discuss Gödel, Shmodel, Riemann's Conjecture, quarks, shmarks, had to carry their suitcases through airport terminals, without thinking about applying their brain to such an insignificant transportation problem. (We said that the intellectual society rewards “difficult” derivations, compared to practice in which there is no penalty for simplicity.) And even if these brilliant minds had applied their supposedly overdeveloped brains to such an obvious and trivial problem, they probably would not have gotten anywhere.

This tells us something about the way we map the future. We humans lack imagination, to the point of not even knowing what tomorrow's important things look like. We use randomness to spoon-feed us with discoveries—which is why antifragility is necessary.

The story of the wheel itself is even more humbling than that of the suitcase: we keep being reminded that the Mesoamericans did not invent the wheel. They did. They had wheels. But the wheels were on small toys for children. It was just like the story of the suitcase: the Mayans and Zapotecs did not make the leap to the application. They used vast quantities of human labor, corn maize, and lactic acid to move gigantic slabs of stone in the flat spaces ideal for pushcarts and chariots where they built their pyramids. They even rolled them on logs of wood. Meanwhile, their small children were rolling their toys on the stucco floors (or perhaps not even doing that, as the toys might have been solely used for mortuary purposes).

The same story holds for the steam engine: the Greeks had an operating version of it, for amusement, of course: the aeolipyle, a turbine that spins when heated, as described by Hero of Alexandria. But it took the Industrial Revolution for us to discover this earlier discovery.

Just as great geniuses invent their predecessors, practical innovations create their theoretical ancestry.

There is something sneaky in the process of discovery and implementation—something people usually call evolution. We are managed by small (or large) accidental changes, more accidental than we admit. We talk big but hardly have any imagination, except for a few visionaries who seem to recognize the optionality of things. We need some randomness to help us out—with a double dose of antifragility. For randomness plays a role at two levels: the invention and the implementation. The first point is not overly surprising, though we play down the role of chance, especially when it comes to our own discoveries.

But it took me a lifetime to figure out the second point: implementation does not necessarily proceed from invention. It, too, requires luck and circumstances. The history of medicine is littered with the strange sequence of discovery of a cure followed, much later, by the implementation—as if the two were completely separate ventures, the second harder, much harder, than the first. Just taking something to market requires struggling against a collection of naysayers, administrators, empty suits, formalists, mountains of details that invite you to drown, and one's own discouraged mood on occasion. In other words, to identify the option (again, there is this option blindness). This is where all you need is the wisdom to realize what you have on your hands.

The Half-Invented. For there is a category of things that we can call half-invented, and taking the half-invented into the invented is often the real breakthrough. Sometimes you need a visionary to figure out what to do with a discovery, a vision that he and only he can have. For instance, take the computer mouse, or what is called the graphical interface: it took Steve Jobs to put it on your desk, then laptop—only he had a vision of the dialectic between images and humans—later adding sounds to a trilectic. The things, as they say, that are “staring at us.”

Further, the simplest “technologies,” or perhaps not even technologies but tools, such as the wheel, are the ones that seem to run the world. In spite of the hype, what we call technologies have a very high mortality rate, as I will show in Chapter 20. Just consider that of all the means of transportation that have been designed in the past three thousand years or more since the attack weapons of the Hyksos and the drawings of Hero of Alexandria, individual transportation today is limited to bicy-

cles and cars (and a few variants in between the two). Even then, technologies seem to go backward and forward, with the more natural and less fragile superseding the technological. The wheel, born in the Middle East, seems to have disappeared after the Arab invasion introduced to the Levant a more generalized use of the camel and the inhabitants figured out that the camel was more robust—hence more efficient in the long run—than the fragile technology of the wheel. In addition, since one person could control six camels but only one carriage, the regression away from technology proved more economically sound.

Once More, Less Is More

This story of the suitcase came to tease me when I realized, looking at a porcelain coffee cup, that there existed a simple definition of fragility, hence a straightforward and practical testing heuristic: the simpler and more obvious the discovery, the less equipped we are to figure it out by complicated methods. The key is that the significant can only be revealed through practice. How many of these simple, trivially simple heuristics are currently looking and laughing at us?

The story of the wheel also illustrates the point of this chapter: both governments and universities have done very, very little for innovation and discovery, precisely because, in addition to their blinding rationalism, they look for the complicated, the lurid, the newsworthy, the narrated, the scientific, and the grandiose, rarely for the wheel on the suitcase. Simplicity, I realized, does not lead to laurels.

Mind the Gaps

As we saw with the stories of Thales and the wheel, antifragility (thanks to the asymmetry effects of trial and error) supersedes intelligence. But *some* intelligence is needed. From our discussion on rationality, we see that all we need is the ability to accept that what we have on our hands is better than what we had before—in other words, to recognize the existence of the option (or “exercise the option” as people say in the business, that is, take advantage of a valuable alternative that is superior to what precedes it, with a certain gain from switching from one into the other, the only part of the process where rationality is required). And from the history of technology, this ability to use the option given to us by antifragility is not guaranteed: things can be looking at us for

a long time. We saw the gap between the wheel and its use. Medical researchers call such lag the “translational gap,” the time difference between formal discovery and first implementation, which, if anything, owing to excessive noise and academic interests, has been shown by Contopoulos-Ioannidis and her peers to be lengthening in modern times.

The historian David Wooton relates a gap of two centuries between the discovery of germs and the acceptance of germs as a cause of disease, a delay of thirty years between the germ theory of putrefaction and the development of antisepsis, and a delay of sixty years between antisepsis and drug therapy.

But things can get bad. In the dark ages of medicine, doctors used to rely on the naive rationalistic idea of a balance of humors in the body, and disease was assumed to originate with some imbalance, leading to a series of treatments that were perceived as needed to restore such balance. In her book on humors, Noga Arikha shows that after William Harvey demonstrated the mechanism of blood circulation in the 1620s, one would have expected that such theories and related practices should have disappeared. Yet people continued to refer to spirit and humors, and doctors continued to prescribe, for centuries more, phlebotomies (bloodletting), enemas (I prefer to not explain), and cataplasms (application of a moist piece of bread or cereal on inflamed tissue). This continued even after Pasteur’s evidence that germs were the cause of these infectious diseases.

Now, as a skeptical empiricist, I do not consider that resisting new technology is *necessarily* irrational: waiting for time to operate its testing might be a valid approach if one holds that we have an incomplete picture of things. This is what naturalistic risk management is about. However, it is downright irrational if one holds on to an old technology that is not naturalistic at all yet visibly harmful, or when the switch to a new technology (like the wheel on the suitcase) is obviously free of possible side effects that did not exist with the previous one. And resisting removal is downright incompetent and criminal (as I keep saying, removal of something non-natural does not carry long-term side effects; it is typically iatrogenics-free).

In other words, I do not give the resistance to the implementation of such discoveries any intellectual credit, or explain it by some hidden wisdom and risk management attitude: this is plainly mistaken. It partakes of the chronic lack of heroism and cowardice on the part of profes-

sionals: few want to jeopardize their jobs and reputation for the sake of change.

Search and How Errors Can Be Investments

Trial and error has one overriding value people fail to understand: it is not really random, rather, thanks to optionality, it requires some rationality. One needs to be intelligent in recognizing the favorable outcome and knowing what to discard.

And one needs to be rational in not making trial and error completely random. If you are looking for your misplaced wallet in your living room, in a trial and error mode, you exercise rationality by not looking in the same place twice. In many pursuits, every trial, every failure provides additional information, each more valuable than the previous one—if you know what does not work, or where the wallet is not located. With every trial one gets closer to something, assuming an environment in which one knows exactly what one is looking for. We can, from the trial that fails to deliver, figure out progressively *where* to go.

I can illustrate it best with the modus operandi of Greg Stemm, who specializes in pulling long-lost shipwrecks from the bottom of the sea. In 2007, he called his (then) biggest find “the Black Swan” after the idea of looking for positive extreme payoffs. The find was quite sizable, a treasure with precious metals now worth a billion dollars. His Black Swan is a Spanish frigate called *Nuestra Señora de las Mercedes*, which was sunk by the British off the southern coast of Portugal in 1804. Stemm proved to be a representative hunter of positive Black Swans, and someone who can illustrate that such a search is a highly controlled form of randomness.

I met him and shared ideas with him: his investors (like mine at the time, as I was still involved in that business) were for the most part not programmed to understand that for a treasure hunter, a “bad” quarter (meaning expenses of searching but no finds) was not indicative of distress, as it would be with a steady cash flow business like that of a dentist or prostitute. By some mental domain dependence, people can spend money on, say, office furniture and not call it a “loss,” rather an investment, but would treat cost of search as “loss.”

Stemm’s method is as follows. He does an extensive analysis of the general area where the ship could be. That data is synthesized into a map

drawn with squares of probability. A search area is then designed, taking into account that they must have certainty that the shipwreck is not in a specific area before moving on to a lower probability area. It looks random but it is not. It is the equivalent of looking for a treasure in your house: every search has incrementally a higher probability of yielding a result, but only if you can be certain that the area you have searched does not hold the treasure.

Some readers might not be too excited about the morality of shipwreck-hunting, and could consider that these treasures are national, not private, property. So let us change domain. The method used by Stemm applies to oil and gas exploration, particularly at the bottom of the unexplored oceans, with a difference: in a shipwreck, the upside is limited to the value of the treasure, whereas oil fields and other natural resources are nearly unlimited (or have a very high limit).

Finally, recall my discussion of random drilling in Chapter 6 and how it seemed superior to more directed techniques. This optionality-driven method of search is not foolishly random. Thanks to optionality, it becomes tamed and harvested randomness.

Creative and Uncreative Destructions

Someone who got a (minor) version of the point that generalized trial and error has, well, *errors*, but without much grasp of asymmetry (or what, since Chapter 12, we have been calling optionality), is the economist Joseph Schumpeter. He realized that some things need to break for the system to improve—what is labeled *creative destruction*—a notion developed, among so many other ones, by the philosopher Karl Marx and a concept discovered, we will show in Chapter 17, by Nietzsche. But a reading of Schumpeter shows that he did not think in terms of uncertainty and opacity; he was completely smoked by interventionism, under the illusion that governments could innovate by fiat, something that we will contradict in a few pages. Nor did he grasp the notion of layering of evolutionary tensions. More crucially, both he and his detractors (Harvard economists who thought that he did not know mathematics) missed the notion of antifragility as asymmetry (optionality) effects, hence the philosopher's stone—on which, later—as the agent of growth. That is, they missed half of life.

THE SOVIET-HARVARD DEPARTMENT OF ORNITHOLOGY

Now, since a very large share of technological know-how comes from the antifragility, the optionality, of trial and error, some people and some institutions want to hide the fact from us (and themselves), or downplay its role.

Consider two types of knowledge. The first type is not exactly “knowledge”; its ambiguous character prevents us from associating it with the strict definitions of knowledge. It is a way of doing things that we cannot really express in clear and direct language—it is sometimes called *apophasic*—but that we do nevertheless, and do well. The second type is more like what we call “knowledge”; it is what you acquire in school, can get grades for, can codify, what is explainable, academizable, rationalizable, formalizable, theoretizable, codifiable, Sovietizable, bureaucratizable, Harvardifiable, provable, etc.

The error of naive rationalism leads to overestimating the role and necessity of the second type, academic knowledge, in human affairs—and degrading the uncodifiable, more complex, intuitive, or experience-based type.

There is no proof against the statement that the role such explainable knowledge plays in life is so minor that it is not even funny.

We are very likely to believe that skills and ideas that we actually acquired by antifragile *doing*, or that came naturally to us (from our innate biological instinct), came from books, ideas, and reasoning. We get blinded by it; there may even be something in our brains that makes us suckers for the point. Let us see how.

I recently looked for definitions of technology. Most texts define it as *the application of scientific knowledge to practical projects*—leading us to believe in a flow of knowledge going chiefly, even exclusively, from lofty “science” (organized around a priestly group of persons with titles before their names) to lowly practice (exercised by uninitiated people without the intellectual attainments to gain membership into the priestly group).

So, in the corpus, knowledge is presented as derived in the following manner: basic research yields scientific knowledge, which in turn generates technologies, which in turn lead to practical applications, which in turn lead to economic growth and other seemingly interesting matters. The payoff from the “investment” in basic research will be partly directed to more investments in basic research, and the citizens will pros-

per and enjoy the benefits of such knowledge-derived wealth with Volvo cars, ski vacations, Mediterranean diets, and long summer hikes in beautifully maintained public parks.

This is called the Baconian linear model, after the philosopher of science Francis Bacon; I am adapting its representation by the scientist Terence Kealey (who, crucially, as a biochemist, is a practicing scientist, not a historian of science) as follows:

Academia → Applied Science and Technology → Practice

While this model may be valid in some very narrow (but highly advertised instances), such as building the atomic bomb, the exact reverse seems to be true in most of the domains I've examined. Or, at least, this model is not guaranteed to be true and, what is shocking, we have no rigorous evidence that it is true. It may be that academia helps science and technology, which in turn help practice, but in unintended, non-teleological ways, as we will see later (in other words, it is *directed research* that may well be an illusion).

Let us return to the metaphor of the birds. Think of the following event: A collection of hieratic persons (from Harvard or some such place) lecture birds on how to fly. Imagine bald males in their sixties, dressed in black robes, officiating in a form of English that is full of jargon, with equations here and there for good measure. The bird flies. Wonderful confirmation! They rush to the department of ornithology to write books, articles, and reports stating that the bird has obeyed them, an impeccable causal inference. The Harvard Department of Ornithology is now indispensable for bird flying. It will get government research funds for its contribution.

Mathematics → Ornithological navigation and wing-flapping technologies → (ungrateful) birds fly

It also happens that birds write no such papers and books, conceivably because they are just birds, so we never get their side of the story. Meanwhile, the priests keep broadcasting theirs to the new generation of humans who are completely unaware of the conditions of the pre-Harvard lecturing days. Nobody discusses the possibility of the birds' not needing lectures—and nobody has any incentive to look at the number of birds that fly without such help from the great scientific establishment.

The problem is that what I wrote above looks ridiculous, but a change of domain makes it look reasonable. Clearly, we never think that it is thanks to ornithologists that birds learn to fly—and if some people do hold such a belief, it would be hard for them to convince the birds. But why is it that when we anthropomorphize and replace “birds” with “men,” the idea that people learn to do things thanks to lectures becomes plausible? When it comes to human agency, matters suddenly become confusing to us.

So the illusion grows and grows, with government funding, tax dollars, swelling (and self-feeding) bureaucracies in Washington all devoted to helping birds fly better. Problems occur when people start cutting such funding—with a spate of accusations of killing birds by not helping them fly.

As per the Yiddish saying: “If the student is smart, the teacher takes the credit.” These illusions of contribution result largely from confirmation fallacies: in addition to the sad fact that history belongs to those who can write about it (whether winners or losers), a second bias appears, as those who write the accounts can deliver confirmatory facts (what has worked) but not a complete picture of what has worked and what has failed. For instance, directed research would tell you what has worked from funding (like AIDS drugs or some modern designer drugs), not what has failed—so you may have the impression that it fares better than random.

And of course iatrogenics is never part of the discourse. They never tell you if education hurt you in some places.

So we are blind to the possibility of the alternative process, or the role of such a process, a loop:

Random Tinkering (antifragile) → Heuristics (technology) → Practice and Apprenticeship → Random Tinkering (antifragile) → Heuristics (technology) → Practice and Apprenticeship . . .

In parallel to the above loop,

Practice → Academic Theories → Academic Theories → Academic Theories → Academic Theories . . . (with of course . . . some exceptions, some accidental leaks, though these are indeed rare and overhyped and grossly generalized).

Now, crucially, one can detect the scam in the so-called Baconian model by looking at events in the days that preceded the Harvard lectures on flying and examining the birds. This is what I accidentally found (indeed, accidentally) in my own career as practitioner turned researcher in volatility, thanks to some lucky turn of events. But before that, let me explain epiphenomena and the arrow of education.

EPIPHENOMENA

The Soviet-Harvard illusion (lecturing birds on flying and believing that the lecture is the cause of these wonderful skills) belongs to a class of causal illusions called *epiphenomena*. What are these illusions? When you spend time on the bridge of a ship or in the coxswain's station with a large compass in front, you can easily develop the impression that the compass is directing the ship rather than merely reflecting its direction.

The lecturing-birds-how-to-fly effect is an example of epiphenomenal belief: we see a high degree of academic research in countries that are wealthy and developed, leading us to think uncritically that research is the generator of wealth. In an epiphenomenon, you don't usually observe A without observing B with it, so you are likely to think that A causes B, or that B causes A, depending on the cultural framework or what seems plausible to the local journalist.

One rarely has the illusion that, given that so many boys have short hair, short hair determines gender, or that wearing a tie causes one to become a businessman. But it is easy to fall into other epiphenomena, particularly when one is immersed in a news-driven culture.

And one can easily see the trap of having these epiphenomena fuel action, then justify it retrospectively. A dictator—just like a government—will feel indispensable because the alternative is not easily visible, or is hidden by special interest groups. The Federal Reserve Bank of the United States, for instance, can wreak havoc on the economy yet feel convinced of its effectiveness. People are scared of the alternative.

Greed as a Cause

Whenever an economic crisis occurs, greed is pointed to as the cause, which leaves us with the impression that if we could go to the root of greed and extract it from life, crises would be eliminated. Further, we

tend to believe that greed is new, since these wild economic crises are new. This is an epiphenomenon: greed is much older than systemic fragility. It existed as far back as the eye can go into history. From Virgil's mention of *greed of gold* and the expression *radix malorum est cupiditas* (from the Latin version of the New Testament), both expressed more than twenty centuries ago, we know that the same problems of greed have been propounded through the centuries, with no cure, of course, in spite of the variety of political systems we have developed since then. Trollope's novel *The Way We Live Now*, published close to a century and a half ago, shows the exact same complaint of a resurgence of greed and con operators that I heard in 1988 with cries over of the "greed decade," or in 2008 with denunciations of the "greed of capitalism." With astonishing regularity, greed is seen as something (a) new and (b) curable. A Procrustean bed approach; we cannot change humans as easily as we can build greed-proof systems, and nobody thinks of simple solutions.*

Likewise "lack of vigilance" is often proposed as the cause of an error (as we will see with the Société Générale story in Book V, the cause was size and fragility). But lack of vigilance is not the cause of the death of a mafia don; the cause of death is making enemies, and the cure is making friends.

Debunking Epiphenomena

We can dig out epiphenomena in the cultural discourse and consciousness by looking at the sequence of events and checking whether one always precedes the other. This is a method refined by the late Clive Granger (himself a refined gentleman), a well-deserved "Nobel" in Economics, that Bank of Sweden (Sveriges Riksbank) prize in honor of Alfred Nobel that has been given to a large number of fragilistas. It is the only rigorously scientific technique that philosophers of science can use to establish causation, as they can now extract, if not measure, the

* Is democracy epiphenomenal? Supposedly, democracy works because of this hallowed rational decision making on the part of voters. But consider that democracy may be something completely accidental to something else, the side effect of people liking to cast ballots for completely obscure reasons, just as people enjoy expressing themselves just to express themselves. (I once put this question at a political science conference and got absolutely nothing beyond blank nerdy faces, not even a smile.)

so-called “Granger cause” by looking at sequences. In epiphenomenal situations, you end up seeing A and B together. But if you refine your analysis by considering the sequence, thus introducing a time dimension—which takes place first, A or B?—and analyze evidence, then you will see if truly A causes B.

Further, Granger had the great idea of studying differences, that is, *changes* in A and B, not just levels of A and B. While I do not believe that Granger’s method can lead me to believe that “A causes B” with certainty, it can most certainly help me debunk fake causation, and allow me to make the claim that “the statement that B causes A is wrong” or has insufficient evidence from the sequence.

The important difference between theory and practice lies precisely in the detection of the sequence of events and retaining the sequence in memory. If life is lived forward but remembered backward, as Kierkegaard observed, then books exacerbate this effect—our own memories, learning, and instinct have sequences in them. Someone standing today looking at events *without having lived them* would be inclined to develop illusions of causality, mostly from being mixed-up by the sequence of events. In real life, in spite of all the biases, we do not have the same number of asynchronies that appear to the student of history. Nasty history, full of lies, full of biases!

For one example of a trick for debunking causality: I am not even dead yet, but am already seeing distortions about my work. Authors theorize about some ancestry of my ideas, as if people read books then developed ideas, not wondering whether perhaps it is the other way around; people look for books that support their mental program. So one journalist (Anatole Kaletsky) saw the influence of Benoît Mandelbrot on my book *Fooled by Randomness*, published in 2001 when I did not know who Mandelbrot was. It is simple: the journalist noticed similarities of thought in one type of domain, and seniority of age, and immediately drew the false inference. He did not consider that like-minded people are inclined to hang together and that such intellectual similarity caused the relationship rather than the reverse. This makes me suspicious of the master-pupil relationships we read about in cultural history: about all the people that have been called my pupils have been my pupils because we were like-minded.

Cherry-picking (or the Fallacy of Confirmation)

Consider the tourist brochures used by countries to advertise their wares: you can expect that the pictures presented to you will look much, much better than anything you will encounter in the place. And the bias, the difference (for which humans correct, thanks to common sense), can be measured as *the country shown in the tourist brochure minus the country seen with your naked eyes*. That difference can be small, or large. We also make such corrections with commercial products, not overly trusting advertising.

But we don't correct for the difference in science, medicine, and mathematics, for the same reasons we didn't pay attention to iatrogenics. We are suckers for the sophisticated.

In institutional research, one can selectively report facts that confirm one's story, without revealing facts that disprove it or don't apply to it—so the public perception of science is biased into believing in the necessity of the highly conceptualized, crisp, and purified Harvardized methods. And statistical research tends to be marred with this one-sidedness. Another reason one should trust the disconfirmatory more than the confirmatory.

Academia is well equipped to tell us what it did for us, not what it did not—hence how indispensable its methods are. This ranges across many things in life. Traders talk about their successes, so one is led to believe that they are intelligent—not looking at the hidden failures. As to academic science: a few years ago, the great Anglo-Lebanese mathematician Michael Atiyah of string theory fame came to New York to raise funds for a research center in mathematics based in Lebanon. In his speech, he enumerated applications in which mathematics turned out to be useful for society and modern life, such as traffic signaling. Fine. But what about areas where mathematics led us to disaster (as in, say, economics or finance, where it blew up the system)? And how about areas out of the reach of mathematics? I thought right there of a different project: a catalog of where mathematics fails to produce results, hence causes harm.

Cherry-picking has optionality: the one telling the story (and publishing it) has the advantage of being able to show the confirmatory examples and completely ignore the rest—and the more volatility and dispersion, the rosier the best story will be (and the darker the worst story). Someone with optionality—the right to pick and choose his

story—is only reporting on what suits his purpose. You take the upside of your story and hide the downside, so only the sensational seems to count.

The real world relies on the intelligence of antifragility, but no university would swallow that—just as interventionists don't accept that things can improve without their intervention. Let us return to the idea that universities generate wealth and the growth of useful knowledge in society. There is a causal illusion here; time to bust it.

When Two Things Are Not the “Same Thing”

*Green lumber another “blue”—Where we look for the arrow of discovery—
Putting Iraq in the middle of Pakistan—Prometheus never looked back*

I am writing these lines in an appropriate place to think about the arrow of knowledge: Abu Dhabi, a city that sprang out of the desert, as if watered by oil.

It makes me queasy to see the building of these huge universities, funded by the oil revenues of governments, under the postulation that oil reserves can be turned into knowledge by hiring professors from prestigious universities and putting their kids through school (or, as is the case, waiting for their kids to feel the desire to go to school, as many students in Abu Dhabi are from Bulgaria, Serbia, or Macedonia getting a free education). Even better, they can, with a single check, import an entire school from overseas, such as the Sorbonne and New York University (among many more). So, in a few years, members of this society will be reaping the benefits of a great technological improvement.

It would seem a reasonable investment if one accepts the notion that *university knowledge generates economic wealth*. But this is a belief that comes more from superstition than empiricism. Remember the story of Switzerland in Chapter 5—a place with a very low level of formal edu-

cation.* I wonder if my nausea comes from the feeling that these desert tribes are being separated from their money by the establishment that has been sucking dry their resources and diverting them to administrators from Western universities. Their wealth came from oil, not from some vocational know-how, so I am certain that their spending on education is completely sterile and a great transfer of resources (rather than milking antifragility by forcing their citizens to make money naturally, through circumstances).

Where Are the Stressors?

There is something that escapes the Abu Dhabi model. Where are the stressors?

Recall the quote by Seneca and Ovid to the effect that sophistication is born of need, and success of difficulties—in fact many such variations, sourced in medieval days (such as *necessitas magistra* in Erasmus), found their way into our daily vernaculars, as in “necessity is the mother of invention.” The best is, as usual, from the master aphorist Publilius Syrus: “poverty makes experiences” (*hominem experiri multa paupertas iubet*). But the expression and idea appear in one form or another in so many classical writers, including Euripides, Pseudo-Theoctitus, Plautus, Apuleius, Zenobius, Juvenal, and of course it is now labeled “post-traumatic growth.”

I saw ancient wisdom at work in the exact opposite of the situation in Abu Dhabi. My Levantine village of origin, Amioun, was pillaged and evacuated during the war, sending its inhabitants into exile across the planet. Twenty-five years later, it became opulent, having bounced back with a vengeance: my own house, dynamited, is now *bigger* than the previous version. My father, showing me the multiplication of villas in the countryside while bemoaning these nouveaux riches, calmly told me, “You, too, had you stayed here, would have become a beach bum. People from Amioun only do well when shaken.” That’s antifragility.

* Switzerland's education system has traditionally been apprenticeship-based. But it is now more and more oriented toward formal education, and might lose its edge. Success and wealth bring transformations that end up bringing fragilities.

L'Art pour l'Art, to Learn for Learning's Sake

Now let's look at evidence of the direction of the causal arrow, that is, whether it is true that lecture-driven knowledge leads to prosperity. Serious empirical investigation (largely thanks to one Lant Pritchett, then a World Bank economist) shows no evidence that raising the general level of education raises income at the level of a country. But we know the opposite is true, that wealth leads to the rise of education—not an optical illusion. We don't need to resort to the World Bank figures, we could derive this from an armchair. Let us figure out the direction of the arrow:

Education → Wealth and Economic Growth

or

Wealth and Economic Growth → Education

And the evidence is so easy to check, just lying out there in front of us. It can be obtained by looking at countries that are both wealthy and have some level of education and considering which condition preceded the other. Take the following potent and *less-is-more*-style argument by the rogue economist Ha-Joon Chang. In 1960 Taiwan had a much lower literacy rate than the Philippines and half the income per person; today Taiwan has ten times the income. At the same time, Korea had a much lower literacy rate than Argentina (which had one of the highest in the world) and about one-fifth the income per person; today it has three times as much. Further, over the same period, sub-Saharan Africa saw markedly increasing literacy rates, accompanied with a decrease in their standard of living. We can multiply the examples (Pritchett's study is quite thorough), but I wonder why people don't realize the simple truism, that is, the *fooled by randomness* effect: mistaking the merely associative for the causal, that is, if rich countries are educated, immediately inferring that education makes a country rich, without even checking. Epiphenomenon here again. (The error in reasoning is a bit from wishful thinking, because education is considered "good"; I wonder why people don't make the epiphenomenal association between the wealth of a country and something "bad," say, decadence, and infer that decadence, or some other disease of wealth like a high suicide rate, also generates wealth.)

I am not saying that for an individual, education is useless: it builds helpful credentials for one's own career—but such effect washes out at the country level. Education stabilizes the income of families across generations. A merchant makes money, then his children go to the Sorbonne, they become doctors and magistrates. The family retains wealth because the diplomas allow members to remain in the middle class long after the ancestral wealth is depleted. But these effects don't count for countries.

Further, Alison Wolf debunks the flaw in logic in going from the point that it is hard to imagine Microsoft or British Aerospace without advanced knowledge to the idea that more education means more wealth. "The simple one-way relationship which so entrances our politicians and commentators—education spending in, economic growth out—simply doesn't exist. Moreover, the larger and more complex the education sector, the less obvious any links to productivity become." And, similar to Pritchett, she looks at countries such as, say, Egypt, and shows how the giant leap in education it underwent did not translate into the Highly Cherished Golden GDP Growth That Makes Countries Important or Unimportant on the Ranking Tables.

This argument is not against adopting governmental educational policies for noble aims such as reducing inequality in the population, allowing the poor to access good literature and read Dickens, Victor Hugo, or Julien Gracq, or increasing the freedom of women in poor countries, which happens to decrease the birth rate. But then one should not use the excuses of "growth" or "wealth" in such matters.

I once ran into Alison Wolf at a party (parties are great for optional-ity). As I got her to explain to other people her evidence about the lack of effectiveness of funding formal education, one person got frustrated with our skepticism. Wolf's answer to him was "real education is this," pointing at the room full of people chatting. Accordingly, I am not saying that knowledge is not important; the skepticism in this discussion applies to the brand of commoditized, prepackaged, and pink-coated knowledge, stuff one can buy in the open market and use for self-promotion. Further, let me remind the reader that scholarship and organized education are not the same.

Another party story. Once, at a formal fancy dinner, a fellow in a quick speech deplored the education level in the United States—falling for low-math-grades alarmism. Although I agreed with all his other views, I felt compelled to intervene. I interrupted him to state the point

that America's values were "convex" risk taking and that I am glad that we are not like these helicopter-mom cultures—the kind of thing I am writing here. Everyone was shocked, either confused or in heavy but passive disagreement, except for one person who came to lend her support to me. It turned out that she was the head of the New York City school system.

Also, note that I am not saying that universities do not generate knowledge at all and do not help growth (outside, of course, of most standard economics and other superstitions that set us back); all I am saying is that their role is overly hyped-up and that their members seem to exploit some of our gullibility in establishing wrong causal links, mostly on superficial impressions.

Polished Dinner Partners

Education has benefits aside from stabilizing family incomes. Education makes individuals more polished dinner partners, for instance, something non-negligible. But the idea of educating people to improve the economy is rather novel. The British government documents, as early as fifty years ago, an aim for education other than the one we have today: raising values, making good citizens, and "learning," not economic growth (they were not suckers at the time)—a point also made by Alison Wolf.

Likewise, in ancient times, learning was for learning's sake, to make someone a good person, worth talking to, not to increase the stock of gold in the city's heavily guarded coffers. Entrepreneurs, particularly those in technical jobs, are not necessarily the best people to have dinner with. I recall a heuristic I used in my previous profession when hiring people (called "separate those who, when they go to a museum, look at the Cézanne on the wall from those who focus on the contents of the trash can"): the more interesting their conversation, the more cultured they are, the more they will be trapped into thinking that they are effective at what they are doing in real business (something psychologists call the *halo effect*, the mistake of thinking that skills in, say, skiing translate unfailingly into skills in managing a pottery workshop or a bank department, or that a good chess player would be a good strategist in real life).*

* The halo effect is largely the opposite of domain dependence.

Clearly, it is unrigorous to equate *skills at doing* with *skills at talking*. My experience of good practitioners is that they can be totally incomprehensible—they do not have to put much energy into turning their insights and internal coherence into elegant style and narratives. Entrepreneurs are selected to be just doers, not thinkers, and doers do, they don't talk, and it would be unfair, wrong, and downright insulting to measure them in the talk department. The same with artisans: the quality lies in their product, not their conversation—in fact they can easily have false beliefs that, as a side effect (inverse iatrogenics), lead them to make better products, so what? Bureaucrats, on the other hand, because of the lack of an objective metric of success and the absence of market forces, are selected on the “halo effects” of shallow looks and elegance. The side effect is to make them better at conversation. I am quite certain a dinner with a United Nations employee would cover more interesting subjects than one with some of Fat Tony's cousins or a computer entrepreneur obsessed with circuits.

Let us look deeper at this flaw in thinking.

THE GREEN LUMBER FALLACY

In one of the rare noncharlatanic books in finance, descriptively called *What I Learned Losing a Million Dollars*, the protagonist makes a big discovery. He remarks that a fellow named Joe Siegel, one of the most successful traders in a commodity called “green lumber,” actually thought that it was lumber painted green (rather than freshly cut lumber, called green because it had not been dried). And he made it his profession to trade the stuff! Meanwhile the narrator was into grand intellectual theories and narratives of what caused the price of commodities to move, and went bust.

It is not just that the successful expert on lumber was ignorant of central matters like the designation “green.” He also knew things about lumber that nonexperts think are unimportant. People we call ignorant might not be ignorant.

The fact is that predicting the order flow in lumber and the usual narrative had little to do with the details one would assume from the outside are important. People who do things in the field are not subjected to a set exam; they are selected in the most non-narrative manner—nice arguments don't make much difference. Evolution does not rely on narratives, humans do. Evolution does not need a word for the color blue.

So let us call the *green lumber fallacy* the situation in which one mistakes a source of necessary knowledge—the greenness of lumber—for another, less visible from the outside, less tractable, less narratable.

My intellectual world was shattered as if everything I had studied was not just useless but a well-organized scam—as follows. When I first became a derivatives or “volatility” professional (I specialized in nonlinearities), I focused on exchange rates, a field in which I was embedded for several years. I had to cohabit with foreign exchange traders—people who were not involved in technical instruments as I was; their job simply consisted of buying and selling currencies. Money changing is a very old profession with a long tradition and craft; recall the story of Jesus Christ and the money changers. Coming to this from a highly polished Ivy League environment, I was in for a bit of a shock. You would think that the people who specialized in foreign exchange understood economics, geopolitics, mathematics, the future price of currencies, differentials between prices in countries. Or that they read assiduously the economics reports published in glossy papers by various institutes. You might also imagine cosmopolitan fellows who wear ascots at the opera on Saturday night, make wine sommeliers nervous, and take tango lessons on Wednesday afternoons. Or spoke intelligible English. None of that.

My first day on the job was an astounding discovery of the real world. The population in foreign exchange was at the time mostly composed of New Jersey/Brooklyn Italian fellows. Those were street, very street people who had started in the back office of banks doing wire transfers, and when the market expanded, even exploded, with the growth of commerce and the free-floating of currencies, they developed into traders and became prominent in the business. And prosperous.

My first conversation with an expert was with a fellow called B. Something-that-ends-with-a-vowel dressed in a handmade Brioni suit. I was told that he was the biggest Swiss franc trader in the world, a legend in his day—he had predicted the big dollar collapse in the 1980s and controlled huge positions. But a short conversation with him revealed that he could not place Switzerland on the map—foolish as I was, I thought he was Swiss Italian, yet he did not know there were Italian-speaking people in Switzerland. He had never been there. When I saw that he was not the exception, I started freaking out watching all

these years of education evaporating in front of my eyes. That very same day I stopped reading economic reports. I felt nauseous for a while during this enterprise of "deintellectualization"—in fact I may not have recovered yet.

If New York was blue collar in origin, London was sub-blue collar, and even more successful. The players were entirely cockney, even more separated from sentence-forming society. They were East Londoners, street people (extremely street) with a distinctive accent, using their own numbering system. Five is "Lady Godiva" or "ching," fifteen is a "commodore," twenty-five is a "pony," etc. I had to learn cockney just to communicate, and mostly to go drinking, with my colleagues during my visits there; at the time, London traders got drunk almost every day at lunch, especially on Friday before New York opened. "Beer turns you into a lion," one fellow told me as he hurried to finish his drink before the New York open.

The most hilarious scenes were hearing on loudspeakers transatlantic conversations between New York Bensonhurst folks and cockney brokers, particularly when the Brooklyn fellow tried to put on a little bit of a cockney pronunciation to be understood (these cockneys sometimes spoke *no* standard English).

So that is how I learned the lesson that price and reality as seen by economists *are not the same thing*. One may be a function of the other but the function is too complex to map mathematically. The relation may have optionality in places, something that these non-sentence-savvy people knew deep inside.*

* At first I thought that economic theories were not necessary to understand short-term movements in exchange rates, but it turned out that the same limitation applied to long-term movements as well. Many economists toying with foreign exchange have used the notion of "purchasing power parity" to try to predict exchange rates on the basis that in the long run "equilibrium" prices cannot diverge too much and currency rates need to adjust so a pound of ham will eventually need to carry a similar price in London and Newark, New Jersey. Put under scrutiny, there seems to be no operational validity to this theory—currencies that get expensive tend to get even more expensive, and most Fat Tonys in fact made fortunes following the inverse rule. But theoreticians would tell you that "in the long run" it should work. Which long run? It is impossible to make a decision based on such a theory, yet they still teach it to students, because being academics, lacking heuristics, and needing something complicated, they never found anything better to teach.

How Fat Tony Got Rich (and Fat)

Fat Tony got to become (literally) Fat Tony, rich and heavier, in the aftermath of the Kuwait war (the sequence was conventional, that is, first rich, then fat). It was in January 1991, on the day the United States attacked Baghdad to restitute Kuwait, which Iraq had invaded.

Every intelligent person in socioeconomic had his theory, probabilities, scenarios, and all that. Except Fat Tony. He didn't even know where Iraq was, whether it was a province in Morocco or some emirate with spicy food east of Pakistan—he didn't know the food, so the place did not exist for him.

All he knew is that suckers exist.

If you asked any intelligent “analyst” or journalist at the time, he would have predicted a rise in the price of oil *in the event* of war. But that causal link was precisely what Tony could not take for granted. So he bet against it: they are all prepared for a rise in oil from war, so the price must have adjusted to it. War could cause a rise in oil prices, but not *scheduled* war—since prices adjust to expectations. It has to be “in the price,” as he said.

Indeed, on the news of war, oil collapsed from around \$39 a barrel to almost half that value, and Tony turned his investment of three hundred thousand into eighteen million dollars. “There are so few occasions in one’s life, you can’t miss them,” he later told Nero during one of their lunches as he was convincing his non-New Jersey friend to bet on a collapse of the financial system. “Good speculative bets come to you, you don’t get them by just staying focused on the news.”

And note the main Fat Tony statement: “Kuwait and oil are not the same *ting* [thing].” This will be a platform for our notion of conflation. Tony had greater upside than downside, and for him, that was it.

Indeed many people lost their shirt from the drop of oil—while *correctly predicting* war. They just thought it was the same *ting*. But there had been too much hoarding, too much inventory. I remember going around that time into the office of a large fund manager who had a map of Iraq on the wall in a war-room-like setting. Members of the team knew every possible thing about Kuwait, Iraq, Washington, the United Nations. Except for the very simple fact that it had nothing to do with oil—not the same “*ting*.” All these analyses were nice, but not too connected to anything. Of course the fellow got subsequently shellacked by the drop in oil price, and, from what I heard, went to law school.

Aside from the non-narrative view of things, another lesson. People with too much smoke and complicated tricks and methods in their brains start missing elementary, very elementary things. Persons in the real world can't afford to miss these things; otherwise they crash the plane. Unlike researchers, they were selected for survival, not complications. So I saw the less is more in action: the more studies, the less obvious elementary but fundamental things become; activity, on the other hand, strips things to their simplest possible model.

CONFLATION

Of course, so many things are *not the same* "ting" in life. Let us generalize the conflation.

This lesson "not the same thing" is quite general. When you have optionality, or some antifragility, and can identify betting opportunities with big upside and small downside, what you do is only remotely connected to what Aristotle thinks you do.

There is *something* (here, perception, ideas, theories) and a *function of something* (here, a price or reality, or something real). The conflation problem is to mistake one for the other, forgetting that there is a "function" and that such function has different properties.

Now, the more asymmetries there are between the *something* and the *function of something*, then the more difference there is between the two. They may end up having nothing to do with each other.

This seems trivial, but there are big-time implications. As usual science—not "social" science, but smart science—gets it. Someone who escaped the conflation problem is Jim Simons, the great mathematician who made a fortune building a huge machine to transact across markets. It replicates the buying and selling methods of these sub-blue collar people and has more statistical significance than anyone on planet Earth. He claims to never hire economists and finance people, just physicists and mathematicians, those involved in pattern recognition accessing the internal logic of things, without theorizing. Nor does he ever listen to economists or read their reports.

The great economist Ariel Rubinstein gets the green lumber fallacy—it requires a great deal of intellect and honesty to see things that way. Rubinstein is one of the leaders in the field of game theory, which consists in thought experiments; he is also the greatest expert in cafés for think-

ing and writing across the planet. Rubinstein refuses to claim that his knowledge of theoretical matters can be translated—by him—into anything directly practical. To him, economics is like a fable—a fable writer is there to stimulate ideas, indirectly inspire practice perhaps, but certainly not to direct or determine practice. Theory should stay independent from practice and vice versa—and we should not extract academic economists from their campuses and put them in positions of decision making. Economics is not a science and should not be there to advise policy.

In his intellectual memoirs, Rubinstein recounts how he tried to get a Levantine vendor in the souk to apply ideas from game theory to his bargaining in place of ancestral mechanisms. The suggested method failed to produce a price acceptable to both parties. Then the fellow told him: “For generations, we have bargained in our way and you come and try to change it?” Rubinstein concluded: “I parted from him shame-faced.” All we need is another two people like Rubinstein in that profession and things will be better on planet Earth.

Sometimes, even when an economic theory makes sense, its application cannot be imposed from a model, in a top-down manner, so one needs the organic self-driven trial and error to get us to it. For instance, the concept of specialization that has obsessed economists since Ricardo (and before) blows up countries when imposed by policy makers, as it makes the economies error-prone; but it works well when reached progressively by evolutionary means, with the right buffers and layers of redundancies. Another case where economists may inspire us but should never tell us what to do—more on that in the discussion of Ricardian comparative advantage and model fragility in the Appendix.

The difference between a narrative and practice—the important things that cannot be easily narrated—lies mainly in optionality, the missed optionality of things. The “right thing” here is typically an antifragile payoff. And my argument is that you don’t go to school to learn optionality, but the reverse: to become blind to it.

PROMETHEUS AND EPIMETHEUS

In Greek legend, there were two Titan brothers, Prometheus and Epimetheus. Prometheus means “fore-thinker” while Epimetheus means “after-thinker,” equivalent to someone who falls for the retrospective

distortion of fitting theories to past events in an *ex post* narrative manner. Prometheus gave us fire and represents the progress of civilization, while Epimetheus represents backward thinking, staleness, and lack of intelligence. It was Epimetheus who accepted Pandora's gift, the large jar, with irreversible consequences.

Optionality is Promethean, narratives are Epimethean—one has reversible and benign mistakes, the other symbolizes the gravity and irreversibility of the consequences of opening Pandora's box.

You make forays into the future by opportunism and optionality. So far in Book IV we have seen the power of optionality as an alternative way of doing things, opportunistically, with some large edge coming from asymmetry with large benefits and benign harm. It is a way—the only way—to domesticate uncertainty, to work rationally without understanding the future, while reliance on narratives is the exact opposite: one is domesticated by uncertainty, and ironically set back. You cannot look at the future by naive projection of the past.

This brings us to the difference between doing and thinking. The point is hard to understand from the vantage point of intellectuals. As Yogi Berra said, "In theory there is no difference between theory and practice; in practice there is." So far we have seen arguments that intellect is associated with fragility and instills methods that conflict with tinkering. So far we saw the option as the expression of antifragility. We separated knowledge into two categories, the formal and the Fat Tonyish, heavily grounded in the antifragility of trial and error and risk taking with less downside, barbell-style—a de-intellectualized form of risk taking (or, rather, intellectual in its own way). In an opaque world, that is the only way to go.

Table 4 summarizes the different aspects of the opposition between narrating and tinkering, the subject of the next three chapters.

TABLE 4 • THE DIFFERENCE BETWEEN THE TELEOLOGICAL AND OPTIONALITY

NARRATIVE KNOWLEDGE	ANTIFRAGILE: OPTIONALITY-DRIVEN TINKERING, TRIAL AND ERROR
Hates uncertainty (fragile to change, or turkey-style misunderstanding of the past)	Domesticates uncertainty (antifragile to the unknown)
Looks at the past, subject to overfitting to past	Looks at the future
Epimetheus	Prometheus
Teleological action	Opportunistic action
Tourist-style	Flâneur-style
Fragile, naive rationality	Robust rationality
Psychologically comfortable	Psychologically uncomfortable, but sense of thrill and adventure
Concave (visible known gains, unknown errors)	Convex (small known errors, large possible gains)
Subject to turkey problems (mistaking evidence of absence for absence of evidence)	Can benefit from suckers and turkey problems
Subject to epiphenomena and the green lumber fallacy	Escapes the green lumber fallacy
Academia's sole mechanism outside laboratory and physical science	Practice's main mechanism
Narrative is epistemological	Narrative is instrumental
Trapped into a story	No meaningful dependence on a story—the narrative can be just for motivation
Narrow domain, closed space of action	Broad domain, open space of action
Needs to understand logic of things	Little understanding is necessary, just rationality in comparing two outcomes (exercising the better option)
Doesn't benefit from the philosopher's stone (a.k.a. convexity bias; see Chapter 19)	Relies on the philosopher's stone

All this does not mean that tinkering and trial and error are devoid of narrative: they are just not overly dependent on the narrative being true—the narrative is not epistemological but instrumental. For instance, religious stories might have no value as narratives, but they may get you to do something convex and antifragile you otherwise would not do, like mitigate risks. English parents controlled children with the false narrative that if they didn't behave or eat their dinner, Boney (Napoleon Bonaparte) or some wild animal might come and take them away. Religions often use the equivalent method to help adults get out of trouble, or avoid debt. But intellectuals tend to believe their own b****t and take their ideas too literally, and that is vastly dangerous.

Consider the role of heuristic (rule-of-thumb) knowledge embedded in traditions. Simply, just as evolution operates on individuals, so does it act on these tacit, unexplainable rules of thumb transmitted through generations—what Karl Popper has called evolutionary epistemology. But let me change Popper's idea ever so slightly (actually quite a bit): my take is that this evolution is not a competition between ideas, but between humans and systems based on such ideas. An idea does not survive because it is better than the competition, but rather because the person who holds it has survived! Accordingly, wisdom you learn from your grandmother should be vastly superior (empirically, hence scientifically) to what you get from a class in business school (and, of course, considerably cheaper). My sadness is that we have been moving farther and farther away from grandmothers.

Expert problems (in which the expert knows a lot but less than he thinks he does) often bring fragilities, and acceptance of ignorance the reverse.* Expert problems put you on the wrong side of asymmetry. Let us examine the point with respect to risk. When you are fragile you need to know a lot more than when you are antifragile. Conversely, when you think you know more than you do, you are fragile (to error).

We showed earlier the evidence that classroom education does not

* Overconfidence leads to reliance on forecasts, which causes borrowing, then to the fragility of leverage. Further, there is convincing evidence that a PhD in economics or finance causes people to build vastly more fragile portfolios. George Martin and I listed all the major financial economists who were involved with funds, calculated the blowups by funds, and observed a far higher proportional incidence of such blowups on the part of finance professors—the most famous one being Long Term Capital Management, which employed Fragilistas Robert Merton, Myron Scholes, Chi-Fu Huang, and others.

lead to wealth as much as it comes from wealth (an epiphenomenon). Next let us see how, similarly, antifragile risk taking—not education and formal, organized research—is largely responsible for innovation and growth, while the story is dressed up by textbook writers. It does not mean that theories and research play no role; it is that just as we are fooled by randomness, so we are fooled into overestimating the role of good-sounding ideas. We will look at the confabulations committed by historians of economic thought, medicine, technology, and other fields that tend to systematically downgrade practitioners and fall into the green lumber fallacy.

History Written by the Losers

The birds may perhaps listen—Combining stupidity with wisdom rather than the opposite—Where we look for the arrow of discovery—A vindication of trial and error

Because of a spate of biases, historians are prone to epiphenomena and other illusions of cause and effect. To understand the history of technology, you need accounts by nonhistorians, or historians with the right frame of mind who developed their ideas by watching the formation of technologies, instead of just reading accounts concerning it. I mentioned earlier Terence Kealey's debunking of the so-called linear model and that he was a practicing scientist.* A practicing laboratory scientist, or an engineer, can witness the real-life production of, say, pharmacological innovations or the jet engine and can thus avoid falling for epiphenomena, unless he was brainwashed prior to starting practice.

I have seen evidence—as an eyewitness—of results that owe *nothing* to academizing science, rather evolutionary tinkering that was dressed up and claimed to have come from academia.

* According to David Edgerton, the so-called linear model was not believed in much in the early twentieth century; it is just that we believe *now* that we believed *then* in the supremacy of teleological science.

**TABLE 5 • THE LECTURING-BIRDS-HOW-TO-FLY EFFECT ACROSS DOMAINS:
EXAMPLE OF MISATTRIBUTION OF RESULTS IN TEXTBOOKS**

FIELD	ORIGINATION AND DEVELOPMENT AS MARKETED BY BIRDS LECTURERS	REAL ORIGINATION AND DEVELOPMENT
Jet Engine	Physicists (busted by Scranton)	Tinkering engineers with no understanding of "why it works"
Architecture	Euclidian geometry, mathematics (busted by Beaujouan)	Heuristics and secret recipes (guilds)
Cybernetics	Norbert Wiener (busted by Mindell)	Programmers "wiki-style"
Derivatives formulas	Black, Scholes, and Fragilista Merton (busted by Haug and Taleb)	Traders and practitioners, Regnault, Bachelier, Thorp
Medicine	Biological understanding (busted by a long series of doctors)	Luck, trial and error, side effects of other medicines, or sometimes poisoning (mustard gas)
Industrial Revolution	Growth in knowledge, Scientific Revolution (busted by Kealey)	Adventurers, hobbyists
Technology	Formal science	Technology, businesses

Long before I knew of the results in Table 5, of other scholars debunking the lecturing-birds-how-to-fly effect, the problem started screaming at me, as follows, around 1998. I was sitting in a Chicago restaurant with the late Fred A., an economist, though a true, thoughtful gentleman. He was the chief economist of one of the local exchanges and had to advise them on new, complicated financial products and wanted my opinion on these, as I specialized in and had published a textbook of sorts on the so-called very complicated "exotic options." He recognized that the demand for these products was going to be very large, but he wondered "how traders could handle these complicated exotics if they do not understand the Girsanov theorem." The Girsanov theorem is something mathematically complicated that at the time was only known by a very small number of persons. And we were talking about pit traders who—as we saw in the last chapter—would most certainly mistake

Girsanov for a vodka brand. Traders, usually uneducated, were considered overeducated if they could spell their street address correctly, while the professor was truly under the epiphenomenal impression that traders studied mathematics to produce an option price. I for myself had figured out by trial and error and picking the brains of experienced people how to play with these complicated payoffs before I heard of these theorems.

Something hit me then. Nobody worries that a child ignorant of the various theorems of aerodynamics and incapable of solving an equation of motion would be unable to ride a bicycle. So why didn't he transfer the point from one domain to another? Didn't he realize that these Chicago pit traders respond to supply and demand, little more, in competing to make a buck, with no need for the Girsanov theorem, any more than a trader of pistachios in the Souk of Damascus needs to solve general equilibrium equations to set the price of his product?

For a minute I wondered if I was living on another planet or if the gentleman's PhD and research career had led to this blindness and his strange loss of common sense—or if people without practical sense usually manage to get the energy and interest to acquire a PhD in the fictional world of equation economics. Is there a selection bias?

I smelled a rat and got extremely excited but realized that for someone to be able to help me, he had to be both a practitioner and a researcher, with practice coming before research. I knew of only one other person, a trader turned researcher, Espen Haug, who had to have observed the same mechanism. Like me, he got his doctorate *after* spending time in trading rooms. So we immediately embarked on an investigation about the source of the option pricing formula that we were using: what did people use before? Is it thanks to the academically derived formula that we are able to operate, or did the formula come through some anti-fragile evolutionary discovery process based on trial and error, now expropriated by academics? I already had a hint, as I had worked as a pit trader in Chicago and had observed veteran traders who refused to touch mathematical formulas, using simple heuristics and saying "real men don't use sheets," the "sheets" being the printouts of output from the complex formulas that came out of computers. Yet these people had survived. Their prices were sophisticated and more efficient than those produced by the formula, and it was obvious what came first. For instance, the prices accounted for Extremistan and "fat tails," which the standard formulas ignored.

Haug has some interests that diverge from mine: he was into the sub-

ject of finance and eager to collect historical papers by practitioners. He called himself “the collector,” even used it as a signature, as he went to assemble and collect books and articles on option theory written before the Great War, and from there we built a very precise image of what had taken place. To our great excitement, we had proof after proof that traders had vastly, vastly more sophistication than the formula. And their sophistication preceded the formula by at least a century. It was of course picked up through natural selection, survivorship, apprenticeship to experienced practitioners, and one’s own experience.

*Traders trade → traders figure out techniques and products → academic economists find formulas and claim traders are using them → new traders believe academics → blowups
(from theory-induced fragility)*

Our paper sat for close to seven years before publication by an academic economics journal—until then, a strange phenomenon: it became one the most downloaded papers in the history of economics, but was not cited at all during its first few years. Nobody wanted to stir the pot.*

Practitioners don’t write; they do. Birds fly and those who lecture them are the ones who write their story. So it is easy to see that history is truly written by losers with time on their hands and a protected academic position.

The greatest irony is that we watched firsthand how narratives of thought are made, as we were lucky enough to face another episode of blatant intellectual expropriation. We received an invitation to publish our side of the story—being option practitioners—in the honorable *Wiley Encyclopedia of Quantitative Finance*. So we wrote a version of the previous paper mixed with our own experiences. Shock: we caught the editor of the historical section, one Barnard College professor, red-handed trying to modify our account. A historian of economic thought, he proceeded to rewrite our story to play down, if not reverse, its message and change the arrow of the formation of knowledge. This was scientific history in the making. The fellow sitting in his office in

* We also figured out that two fragilistas, Myron Scholes and Robert Merton, got the Memorial Prize in Economics called “Nobel” for the packaging of a formula that other people discovered in much more sophisticated form before them. Furthermore, they used fictional mathematics. It is quite unsettling.

Barnard College was now dictating to us what we saw as traders—we were supposed to override what we saw with our own eyes with his logic.

I came to notice a few similar inversions of the formation of knowledge. For instance, in his book written in the late 1990s, the Berkeley professor Highly Certified Fragilista Mark Rubinstein attributed to publications by finance professors techniques and heuristics that we practitioners had been extremely familiar with (often in more sophisticated forms) since the 1980s, when I got involved in the business.

No, we don't put theories into practice. We create theories out of practice. That was our story, and it is easy to infer from it—and from similar stories—that the confusion is generalized. The theory is the child of the cure, not the opposite—*ex cura theoria nascitur*.

The Evidence Staring at Us

It turned out that engineers, too, get sandbagged by historians.

Right after the previous nauseating episode I presented the joint paper I had written with Haug on the idea of lecturing birds on how to fly in finance at the London School of Economics, in their sociology of science seminar. I was, of course, heckled (but was by then very well trained at being heckled by economists). Then, surprise. At the conclusion of the session, the organizers informed me that, exactly a week earlier, Phil Scranton, a professor from Rutgers, had delivered the exact same story. But it was not about the option formula; it was about the jet engine.

Scranton showed that we have been building and using jet engines in a completely trial-and-error experiential manner, without anyone truly understanding the theory. Builders needed the original engineers who knew how to twist things to make the engine work. *Theory came later*, in a lame way, to satisfy the intellectual bean counter. But that's not what you tend to read in standard histories of technology: my son, who studies aerospace engineering, was not aware of this. Scranton was polite and focused on situations in which innovation is messy, “distinguished from more familiar analytic and synthetic innovation approaches,” as if the latter were the norm, which it is obviously not.

I looked for more stories, and the historian of technology David Edgerton presented me with a quite shocking one. We think of cybernetics—

which led to the “cyber” in cyberspace—as invented by Norbert Wiener in 1948. The historian of engineering David Mindell debunked the story; he showed that Wiener was articulating ideas about feedback control and digital computing that had long been in practice in the engineering world. Yet people—even today’s engineers—have the illusion that we owe the field to Wiener’s mathematical thinking.

Then I was hit with the following idea. We all learn geometry from textbooks based on axioms, like, say, Euclid’s *Book of Elements*, and tend to think that it is thanks to such learning that we today have these beautiful geometric shapes in buildings, from houses to cathedrals; to think the opposite would be anathema. So I speculated immediately that the ancients developed an interest in Euclid’s geometry and other mathematics because they were already using these methods, derived by tinkering and experiential knowledge, otherwise they would not have bothered at all. This is similar to the story of the wheel: recall that the steam engine had been discovered and developed by the Greeks some two millennia before the Industrial Revolution. It is just that things that are implemented tend to want to be born from practice, not theory.

Now take a look at architectural objects around us: they appear so geometrically sophisticated, from the pyramids to the beautiful cathedrals of Europe. So a sucker problem would make us tend to believe that mathematics led to these beautiful objects, with exceptions here and there such as the pyramids, as these preceded the more formal mathematics we had after Euclid and other Greek theorists. Some facts: architects (or what were then called Masters of Works) relied on heuristics, empirical methods, and tools, and almost nobody knew any mathematics—according to the medieval science historian Guy Beaujouan, before the thirteenth century no more than five persons in the whole of Europe knew how to perform a division. No theorem, shmeorem. But builders could figure out the resistance of materials without the equations we have today—buildings that are, for the most part, still standing. The thirteenth-century French architect Villard de Honnecourt documents with his series of drawings and notebooks in Picard (the language of the Picardie region in France) how cathedrals were built: experimental heuristics, small tricks and rules, later tabulated by Philibert de l’Orme in his architectural treatises. For instance, a triangle was visualized as the head of a horse. Experimentation can make people much more careful than theories.

Further, we are quite certain that the Romans, admirable engineers, built aqueducts without mathematics (Roman numerals did not make quantitative analysis very easy). Otherwise, I believe, these would not be here, as a patent side effect of mathematics is making people over-optimize and cut corners, causing fragility. Just look how the new is increasingly more perishable than the old.

And take a look at Vitruvius' manual, *De architectura*, the bible of architects, written about three hundred years after Euclid's *Elements*. There is little formal geometry in it, and, of course, no mention of Euclid, mostly heuristics, the kind of knowledge that comes out of a master guiding his apprentices. (Tellingly, the main mathematical result he mentions is Pythagoras's theorem, amazed that the right angle could be formed "without the contrivances of the artisan.") Mathematics had to have been limited to mental puzzles until the Renaissance.

Now I am not saying that theories or academic science are not behind some practical technologies at all, directly derived from science for their final use (not for some tangential use)—what the researcher Joel Mokyr calls an "epistemic base," or propositional knowledge, a sort of repository of formal "knowledge" that embeds the theoretical and empirical discoveries and becomes a rulebook of sorts, used to generate more knowledge and (he thinks) more applications. In other words, a body of theories from which further theories can be directly derived.

But let's not be suckers: following Mr. Mokyr would make one want to study economic geography to predict foreign exchange prices (I would have loved to introduce him to the expert in green lumber). While I accept the notion of epistemic base, what I question is the role it has really played in the history of technology. The evidence of a strong effect is not there, and I am waiting for someone to show it to me. Mokyr and the advocates of such view provide no evidence that it is not epiphenomenal—nor do they appear to understand the implications of asymmetric effects. Where is the role of optionality in this?

There is a body of know-how that was transmitted from master to apprentice, and transmitted *only* in such a manner—with degrees necessary as a selection process or to make the profession more respectable, or to help here and there, but not systematically. And the role of such formal knowledge will be overappreciated precisely because it is highly visible.

Is It Like Cooking?

Cooking seems to be the perfect business that depends on optionality. You add an ingredient and have the option of keeping the result if it is in agreement with Fat Tony's taste buds, or fuhgetaboudit if it's not. We also have wiki-style collaborative experimentation leading to a certain body of recipes. These recipes are derived entirely without conjectures about the chemistry of taste buds, with no role for any "epistemic base" to generate theories out of theories. Nobody is fooled so far by the process. As Dan Ariely once observed, we cannot reverse engineer the taste of food from looking at the nutritional label. And we can observe ancestral heuristics at work: generations of collective tinkering resulting in the evolution of recipes. These food recipes are embedded in cultures. Cooking schools are entirely apprenticeship based.

On the other side, we have pure physics, with theories used to generate theories with some empirical validation. There the "epistemic base" can play a role. The discovery of the Higgs Boson is a modern case of a particle entirely expected from theoretical derivations. So was Einstein's relativity. (Prior to the Higgs Boson, one spectacular case of a discovery with a small number of existing external data is that of the French astronomer Le Verrier's derivation of the existence of the planet Neptune. He did that on the basis of solitary computation, from the behavior of the surrounding planets. When the planet was actually sighted he refused to look at it, so comfortable was he with his result. These are exceptions, and tend to take place in physics and other places I call "linear," where errors are from Mediocristan, not from Extremistan.)

Now use this idea of cooking as a platform to grasp other pursuits: do other activities resemble it? If we put technologies through scrutiny, we would see that most do in fact resemble cooking a lot more than physics, particularly those in the complex domain.

Even medicine today remains an apprenticeship model with some theoretical science in the background, but made to look entirely like science. And if it leaves the apprenticeship model, it would be for the "evidence-based" method that relies less on biological theories and more on the cataloging of empirical regularities, the phenomenology I explained in Chapter 7. Why is it that science comes and goes and technologies remain stable?

Now, one can see a possible role for basic science, but not in the way

it is intended to be.* For an example of a chain of unintended uses, let us start with Phase One, the computer. The mathematical discipline of combinatorics, here basic science, derived from propositional knowledge, led to the building of computers, or so the story goes. (And, of course, to remind the reader of cherry-picking, we need to take into account the body of theoretical knowledge that went nowhere.) But at first, nobody had an idea what to do with these enormous boxes full of circuits as they were cumbersome, expensive, and their applications were not too widespread, outside of database management, only good to process quantities of data. It is as if one needed to invent an application for the thrill of technology. Baby boomers will remember those mysterious punch cards. Then someone introduced the console to input with the aid of a screen monitor, using a keyboard. This led, of course, to word processing, and the computer took off because of its fitness to word processing, particularly with the microcomputer in the early 1980s. It was convenient, but not much more than that until some other unintended consequence came to be mixed into it. Now Phase Two, the Internet. It had been set up as a resilient military communication network device, developed by a research unit of the Department of Defense called DARPA and got a boost in the days when Ronald Reagan was obsessed with the Soviets. It was meant to allow the United States to survive a generalized military attack. Great idea, but add the personal computer *plus* Internet and we get social networks, broken marriages, a rise in nerdiness, the ability for a post-Soviet person with social difficulties to find a matching spouse. All that thanks to initial U.S. tax dollars (or rather budget deficit) during Reagan's anti-Soviet crusade.

So for now we are looking at the forward arrow and at no point, although science was of *some* use along the way since computer technology relies on science in most of its aspects; at no point did academic science serve in setting its direction, rather it served as a slave to chance discoveries in an opaque environment, with almost no one but college dropouts and overgrown high school students benefiting along the way. The process remained self-directed and unpredictable at every step. And the great fallacy is to make it sound irrational—the irrational resides in not seeing a free option when it is handed to us.

* I remind the reader that the bone in Book IV is teleology and sense of direction, and while this is largely skeptical of formal academia (i.e. anti-universities), this is staunchly anti-pseudoscience (or cosmetic science) and ultra-pro-science. It is just that what many call science is highly unscientific. Science is an anti-sucker problem.

China might be a quite convincing story, through the works of a genius observer, Joseph Needham, who debunked quite a few Western beliefs and figured out the powers of Chinese science. As China became a top-down mandarinate (that is, a state managed by Soviet-Harvard centralized scribes, as Egypt had been before), the players somehow lost the zest for bricolage, the hunger for trial and error. Needham's biographer Simon Winchester cites the sinologist Mark Elvin's description of the problem, as the Chinese did not have, or, rather, no longer had, what he called the "European mania for tinkering and improving." They had all the means to develop a spinning machine, but "nobody tried"—another example of knowledge hampering optionality. They probably needed someone like Steve Jobs—blessed with an absence of college education and the right aggressiveness of temperament—to take the elements to their natural conclusion. As we will see in the next section, it is precisely this type of uninhibited doer who made the Industrial Revolution happen.

We will next examine two cases, first, the Industrial Revolution, and second, medicine. So let us start by debunking a causal myth about the Industrial Revolution, the overstatement of the role of science in it.

The Industrial Revolution

Knowledge formation, even when theoretical, takes time, some boredom, and the freedom that comes from having another occupation, therefore allowing one to escape the journalistic-style pressure of modern publish-and-perish academia to produce cosmetic knowledge, much like the counterfeit watches one buys in Chinatown in New York City, the type that you know is counterfeit although it looks like the real thing. There were two main sources of technical knowledge and innovation in the nineteenth and early twentieth centuries: the hobbyist and the English rector, both of whom were generally in barbell situations.

An extraordinary proportion of work came out of the rector, the English parish priest with no worries, erudition, a large or at least comfortable house, domestic help, a reliable supply of tea and scones with clotted cream, and an abundance of free time. And, of course, optionality. The enlightened amateur, that is. The Reverends Thomas Bayes (as in Bayesian probability) and Thomas Malthus (Malthusian overpopulation) are the most famous. But there are many more surprises, catalogued in Bill Bryson's *Home*, in which the author found ten times

more vicars and clergymen leaving recorded traces for posterity than scientists, physicists, economists, and even inventors. In addition to the previous two giants, I randomly list contributions by country clergymen: Rev. Edmund Cartwright invented the power loom, contributing to the Industrial Revolution; Rev. Jack Russell bred the terrier; Rev. William Buckland was the first authority on dinosaurs; Rev. William Greenwell invented modern archaeology; Rev. Octavius Pickard-Cambridge was the foremost authority on spiders; Rev. George Garrett invented the submarine; Rev. Gilbert White was the most esteemed naturalist of his day; Rev. M. J. Berkeley was the top expert on fungi; Rev. John Michell helped discover Uranus; and many more. Note that, just as with our episode documented with Haug, that organized science tends to skip the “not made here,” so the list of visible contribution by hobbyists and doers is most certainly shorter than the real one, as some academic might have appropriated the innovation by his predecessor.*

Let me get poetic for a moment. Self-directed scholarship has an aesthetic dimension. For a long time I had on the wall of my study the following quote by Jacques Le Goff, the great French medievalist, who believes that the Renaissance came out of independent humanists, not professional scholars. He examined the striking contrast in period paintings, drawings, and renditions that compare medieval university members and humanists:

One is a professor surrounded and besieged by huddled students. The other is a solitary scholar, sitting in the tranquility and privacy of his chambers, at ease in the spacious and comfy room where his thoughts can move freely. Here we encounter the tumult of schools, the dust of classrooms, the indifference to beauty in collective workplaces,

There, it is all order and beauty,

Luxe, calme et volupté

As to the hobbyist in general, evidence shows him (along with the hungry adventurer and the private investor) to be at the source of the Industrial Revolution. Kealey, who we mentioned was not a historian and, thankfully, not an economist, in *The Economic Laws of Scientific*

* Remarkably, Johan Jensen, of Jensen's inequality, which provides the major technical support behind the ideas of this book, was an amateur mathematician who never held any academic position.

Research questions the conventional “linear model” (that is, the belief that academic science leads to technology)—for him, universities prospered as a consequence of national wealth, not the other way around. He even went further and claimed that like naive interventions, these had iatrogenics that provided a negative contribution. He showed that in countries in which the government intervened by funding research with tax money, private investment decreased and moved away. For instance, in Japan, the almighty MITI (Ministry for Technology and Investment) has a horrible record of investment. I am not using his ideas to prop up a political program against science funding, only to debunk causal arrows in the discovery of important things.

The Industrial Revolution, for a refresher, came from “technologists building technology,” or what he calls “hobby science.” Take again the steam engine, the one artifact that more than anything else embodies the Industrial Revolution. As we saw, we had a blueprint of how to build it from Hero of Alexandria. Yet the theory didn’t interest anyone for about two millennia. So practice and rediscovery had to be the cause of the interest in Hero’s blueprint, not the other way around.

Kealey presents a convincing—very convincing—argument that the steam engine emerged from preexisting technology and was created by uneducated, often isolated men who applied practical common sense and intuition to address the mechanical problems that beset them, and whose solutions would yield obvious economic reward.

Now, second, consider textile technologies. Again, the main technologies that led to the jump into the modern world owe, according to Kealey, nothing to science. “In 1733,” he writes, “John Kay invented the flying shuttle, which mechanized weaving, and in 1770 James Hargreaves invented the spinning jenny, which as its name implies, mechanized spinning. These major developments in textile technology, as well as those of Wyatt and Paul (spinning frame, 1758), Arkwright (water frame, 1769), presaged the Industrial Revolution, yet they owed nothing to science; they were empirical developments based on the trial, error, and experimentation of skilled craftsmen who were trying to improve the productivity, and so the profits, of their factories.”

David Edgerton did some work questioning the link between academic science and economic prosperity, along with the idea that people believed in the “linear model” (that is, that academic science was at the source of technology) in the past. People were *no suckers* in the nine-

teenth and twentieth centuries; we believe today that they believed in the said linear model then but they did not. In fact academics were mostly just teachers, not researchers, until well into the twentieth century.

Now, instead of looking into a scholar's writings to see whether he is credible or not, it is always best to consider what his detractors say—they will uncover what's worst in his argument. So I looked for the detractors of Kealey, or people opposing his ideas, to see if they address anything of merit—and to see where they come from. Aside from some comments by Joel Mokyr, who, as I said, has not yet discovered optionality, and an attack by an economist of the type that doesn't count, given the devaluation of the currency of the economics profession, the main critique against Kealey, published in the influential journal *Nature* by a science bureaucrat, was that he uses data from government-sponsored agencies such as the OECD in his argument against tax-funded research. So far, no substantive evidence that Kealey was wrong. But, let us flip the burden of evidence: there is zero evidence that the opposite of his thesis is remotely right. Much of all of this is a religious belief in the *unconditional* power of organized science, one that has replaced unconditional religious belief in organized religion.

Governments Should Spend on Nonteleological Tinkering, Not Research

Note that I do not believe that the argument set forth above should logically lead us to say that *no* money should be spent by government. This reasoning is more against teleology than research in general. There has to be a form of spending that works. By some vicious turn of events, governments have gotten huge payoffs from research, but not as intended—just consider the Internet. And look at the recapture we've had of military expenditures with innovations, and, as we will see, medical cures. It is just that functionaries are too teleological in the way they look for things (particularly the Japanese), and so are large corporations. Most large corporations, such as Big Pharma, are their own enemies.

Consider *blue sky* research, whereby research grants and funding are given to people, not projects, and spread in small amounts across many researchers. The sociologist of science Steve Shapin, who spent time in California observing venture capitalists, reports that investors tend to back entrepreneurs, not ideas. Decisions are largely a matter of opinion strengthened with "who you know" and "who said what," as, to use the venture capitalist's lingo, you bet on the jockey, not the horse. Why?

Because innovations drift, and one needs flâneur-like abilities to keep capturing the opportunities that arise, not stay locked up in a bureaucratic mold. The significant venture capital decisions, Shapin showed, were made without real business plans. So if there was any “analysis,” it had to be of a backup, confirmatory nature. I myself spent some time with venture capitalists in California, with an eye on investing myself, and sure enough, that was the mold.

Visibly the money should go to the tinkerers, the aggressive tinkerers who you trust will milk the option.

Let us use statistical arguments and get technical for a paragraph. Payoffs from research are from Extremistan; they follow a power-law type of statistical distribution, with big, near-unlimited upside but, because of optionality, limited downside. Consequently, payoff from research should necessarily be linear to number of trials, not total funds involved in the trials. Since, as in Figure 7, the winner will have an explosive payoff, uncapped, the right approach requires a certain style of blind funding. It means the right policy would be what is called “one divided by n ” or “ $1/N$ ” style, spreading attempts in as large a number of trials as possible: if you face n options, invest in all of them in equal amounts.* Small amounts per trial, lots of trials, broader than you want. Why? Because in Extremistan, it is more important to be in something in a small amount than to miss it. As one venture capitalist told me: “The payoff can be so large that you can’t afford not to be in everything.”

THE CASE IN MEDICINE

Unlike technology, medicine has a long history of domestication of luck; it now has accepted randomness in its practice. But not quite.

Medical data allow us to assess the performance of teleological research compared to randomly generated discoveries. The U.S. government provides us with the ideal dataset for that: the activities of the National Cancer Institute that came out of the Nixon “war on cancer” in the early 1970s. Morton Meyers, a practicing doctor and researcher, writes in his wonderful *Happy Accidents: Serendipity in Modern Medical Breakthroughs*: “Over a twenty-year period of screening more than

* This is a technical comment. “ $1/N$ ” is the argument Mandelbrot and I used in 2005 to debunk optimized portfolios and modern finance theory on simple mathematical grounds; under Extremistan effects, we favor broad, very broad diversification with small equal allocations rather than what modern financial theory stipulates.

144,000 plant extracts, representing about 15,000 species, not a single plant-based anticancer drug reached approved status. This failure stands in stark contrast to the discovery in the late 1950s of a major group of plant-derived cancer drugs, the Vinca Alcaloids—a discovery that came about by chance, not through directed research.”

John LaMatina, an insider who described what he saw after leaving the pharmaceutical business, shows statistics illustrating the gap between public perception of academic contributions and truth: private industry develops nine drugs out of ten. Even the tax-funded National Institutes of Health found that out of forty-six drugs on the market with significant sales, about three had anything to do with federal funding.

We have not digested the fact that cures for cancer had been coming from other branches of research. You search for noncancer drugs (or noncancer nondrugs) and find something you were not looking for (and vice versa). But the interesting constant is that when a result is initially discovered by an academic researcher, he is likely to disregard the consequences because it is not what he wanted to find—an academic has a script to follow. So, to put it in option terms, he does not exercise his option in spite of its value, a strict violation of rationality (no matter how you define rationality), like someone who both is greedy and does not pick up a large sum of money found in his garden. Meyers also shows the lecturing-birds-how-to-fly effect as discoveries are ex post narrated back to some academic research, contributing to our illusion.

In some cases, because the source of the discovery is military, we don’t know exactly what’s going on. Take for instance chemotherapy for cancer, as discussed in Meyers’s book. An American ship carrying mustard gas off Bari in Italy was bombed by the Germans in 1942. It helped develop chemotherapy owing to the effect of the gas on the condition of the soldiers who had liquid cancers (eradication of white blood cells). But mustard gas was banned by the Geneva Conventions, so the story was kept secret—Churchill purged all mention from U.K. records, and in the United States, the information was stifled, though not the research on the effect of nitrogen mustard.

James Le Fanu, the doctor and writer about medicine, wrote that the therapeutic revolution, or the period in the postwar years that saw a large number of effective therapies, was not ignited by a major scientific insight. It came from the exact opposite, “the realization by doctors and scientists that it was not necessary to understand in any detail what was wrong, but that synthetic chemistry blindly and randomly would deliver

the remedies that had eluded doctors for centuries.” (He uses as a central example the sulfonamides identified by Gerhard Domagk.)

Further, the increase in our theoretical understanding—the “epistemic base,” to use Mokyr’s term—came with a *decrease* in the number of new drugs. This is something Fat Tony or the green lumber fellow could have told us. Now, one can argue that we depleted the low-hanging fruits, but I go further, with more cues from other parts (such as the payoff from the Human Genome Project or the stalling of medical cures of the past two decades in the face of the growing research expenditures)—knowledge, or what is called “knowledge,” in complex domains inhibits research.

Or, another way to see it, studying the chemical composition of ingredients will make you neither a better cook nor a more expert taster—it might even make you worse at both. (Cooking is particularly humbling for teleology-driven fellows.)

One can make a list of medications that came Black Swan–style from serendipity and compare it to the list of medications that came from design. I was about to embark on such a list until I realized that the notable exceptions, that is, drugs that were discovered in a teleological manner, are too few—mostly AZT, AIDS drugs. Designer drugs have a main property—they are designed (and are therefore teleological). But it does not look as if we are capable of designing a drug while taking into account the potential side effects. Hence a problem for the future of designer drugs. The more drugs there are on the market, the more interactions with one another—so we end up with a swelling number of possible interactions with every new drug introduced. If there are twenty unrelated drugs, the twenty-first would need to consider twenty interactions, no big deal. But if there are a thousand, we would need to predict a little less than a thousand. And there are tens of thousands of drugs available today. Further, there is research showing that we may be underestimating the interactions of *current* drugs, those already on the market, by a factor of four so, if anything, the pool of available drugs should be shrinking rather than growing.

There is an obvious drift in that business, as a drug can be invented for something and find new applications, what the economist John Kay calls *obliquity*—aspirin, for instance, changed many times in uses; or the ideas of Judah Folkman about restricting the blood supply of tumors (angiogenesis inhibitors) have led to the treatment of macular degenera-

tion (bevacizumab, known as Avastin), an effect that is more effective than the original intent.

Now, instead of giving my laundry list of drugs here (too inelegant), I refer the reader to, in addition to Meyers's book, Claude Bohuon and Claude Monneret, *Fabuleux hasards, histoire de la découverte des médicaments*, and Jie Jack Li's *Laughing Gas, Viagra and Lipitor*.

Matt Ridley's Anti-Teleological Argument

The great medieval Arabic-language skeptic philosopher Algazel, aka Al-Ghazali, who tried to destroy the teleology of Averroes and his rationalism, came up with the famous metaphor of the pin—now falsely attributed to Adam Smith. The pin doesn't have a single maker, but twenty-five persons involved; these are all collaborating in the absence of a central planner—a collaboration guided by an invisible hand. For not a single one knows how to produce it on his own.

In the eyes of Algazel, a skeptic fideist (i.e., a skeptic with religious faith), knowledge was not in the hands of humans, but in those of God, while Adam Smith calls it the law of the market and some modern theorist presents it as self-organization. If the reader wonders why fideism is epistemologically equivalent to pure skepticism about human knowledge and embracing the hidden logics of things, just replace God with nature, fate, the Invisible, Opaque, and Inaccessible, and you mostly get the same result. The logic of things stands outside of us (in the hands of God or natural or spontaneous forces); and given that nobody these days is in direct communication with God, even in Texas, there is little difference between God and opacity. Not a single individual has a clue about the general process, and that is central.

The author Matt Ridley produces a more potent argument thanks to his background in biology. The difference between humans and animals lies in the ability to collaborate, engage in business, let ideas, pardon the expression, copulate. Collaboration has explosive upside, what is mathematically called a superadditive function, i.e., one plus one equals more than two, and one plus one plus one equals much, much more than three. That is pure nonlinearity with explosive benefits—we will get into details on how it benefits from the philosopher's stone. Crucially, this is an argument for unpredictability and Black Swan effects: since you cannot forecast collaborations and cannot direct them, you cannot see

where the world is going. All you can do is create an environment that facilitates these collaborations, and lay the foundation for prosperity. And, no, you cannot centralize innovations, we tried that in Russia.

Remarkably, to get a bit more philosophical with the ideas of Algazel, one can see religion's effect here in reducing dependence on the fallibility of human theories and agency—so Adam Smith meets Algazel in that sense. For one the invisible hand is the market, for the other it is God. It has been difficult for people to understand that, historically, skepticism has been mostly skepticism of expert knowledge rather than skepticism about abstract entities like God, and that all the great skeptics have been largely either religious or, at least, pro-religion (that is, in favor of *others* being religious).

Corporate Teleology

When I was in business school I rarely attended lectures in something called strategic planning, a required course, and when I showed my face in class, I did not listen for a nanosecond to what was said there; did not even buy the books. There is something about the common sense of student culture; we knew that it was all babble. I passed the required classes in management by confusing the professors, playing with complicated logics, and I felt it intellectually dishonest to enroll in more classes than the strictly necessary.

Corporations are in love with the idea of the strategic plan. They need to pay to figure out where they are going. Yet there is no evidence that strategic planning works—we even seem to have evidence against it. A management scholar, William Starbuck, has published a few papers debunking the effectiveness of planning—it makes the corporation option-blind, as it gets locked into a non-opportunistic course of action.

Almost everything theoretical in management, from Taylorism to all productivity stories, upon empirical testing, has been exposed as pseudoscience—and like most economic theories, lives in a world parallel to the evidence. Matthew Stewart, who, trained as a philosopher, found himself in a management consultant job, gives a pretty revolting, if funny, inside story in *The Management Myth*. It is similar to the self-serving approach of bankers. Abrahamson and Friedman, in their beautiful book *A Perfect Mess*, also debunk many of these neat, crisp,

teleological approaches. It turns out, strategic planning is just superstitious babble.

For an illustration of business drift, rational and opportunistic business drift, take the following. Coca-Cola began as a pharmaceutical product. Tiffany & Co., the fancy jewelry store company, started life as a stationery store. The last two examples are close, perhaps, but consider next: Raytheon, which made the first missile guidance system, was a refrigerator maker (one of the founders was no other than Vannevar Bush, who conceived the teleological linear model of science we saw earlier; go figure). Now, worse: Nokia, who used to be the top mobile phone maker, began as a paper mill (at some stage they were into rubber shoes). DuPont, now famous for Teflon nonstick cooking pans, Corian countertops, and the durable fabric Kevlar, actually started out as an explosives company. Avon, the cosmetics company, started out in door-to-door book sales. And, the strangest of all, Oneida Silversmiths was a community religious cult but for regulatory reasons they needed to use as cover a joint stock company.

THE INVERSE TURKEY PROBLEM

Now some plumbing behind what I am saying—epistemology of statistical statements. The following discussion will show how the unknown, what you don't see, can contain good news in one case and bad news in another. And in Extremistan territory, things get even more accentuated.

To repeat (it is necessary to repeat because intellectuals tend to forget it), absence of evidence is not evidence of absence, a simple point that has the following implications: for the antifragile, good news tends to be absent from past data, and for the fragile it is the bad news that doesn't show easily.

Imagine going to Mexico with a notebook and trying to figure out the average wealth of the population from talking to people you randomly encounter. Odds are that, without Carlos Slim in your sample, you have little information. For out of the hundred or so million Mexicans, Slim would (I estimate) be richer than the bottom seventy to ninety million all taken together. So you may sample fifty million persons and unless you include that "rare event," you may have nothing in your sample and underestimate the total wealth.

Remember the graphs in Figures 6 or 7 illustrating the payoff from

trial and error. When engaging in tinkering, you incur a lot of small losses, then once in a while you find something rather significant. Such methodology will show nasty attributes when seen from the outside—it hides its qualities, not its defects.

In the antifragile case (of positive asymmetries, positive Black Swan businesses), such as trial and error, the sample track record will tend to underestimate the long-term average; it will hide the qualities, not the defects.

(A chart is included in the appendix for those who like to look at the point graphically.)

Recall our mission to “not be a turkey.” The take-home is that, when facing a long sample subjected to turkey problems, one tends to estimate a *lower* number of adverse events—simply, rare events are rare, and tend not to show up in past samples, and given that *the rare is almost always negative*, we get a rosier picture than reality. But here we face the mirror image, the reverse situation. Under positive asymmetries, that is, the antifragile case, the “unseen” is positive. So “empirical evidence” tends to miss positive events and underestimate the total benefits.

As to the classic turkey problem, the rule is as follows.

In the fragile case of negative asymmetries (turkey problems), the sample track record will tend to overestimate the long-term average; it will hide the defects and display the qualities.

The consequences make life simple. But since standard methodologies do not take asymmetries into account, about anyone who studied conventional statistics without getting very deep into the subject (just to theorize in social science or teach students) will get the turkey problem wrong. I have a simple rule, that those who teach at Harvard should be expected to have much less understanding of things than cab drivers or people innocent of canned methods of inference (it is a heuristic, it can be wrong, but it works; it came to my attention as the Harvard Business School used to include Fragilista Robert C. Merton on its staff).

So let us pick on Harvard Business School professors who deserve it quite a bit. When it comes to the first case (the error of ignoring positive asymmetries), one Harvard Business School professor, Gary Pisano,

writing about the potential of biotech, made the elementary inverse-turkey mistake, not realizing that in a business with limited losses and unlimited potential (the exact opposite of banking), what you don't see can be both significant and hidden from the past. He writes: "Despite the commercial success of several companies and the stunning growth in revenues for the industry as a whole, most biotechnology firms earn no profit." This may be correct, but the inference from it is wrong, possibly backward, on two counts, and it helps to repeat the logic owing to the gravity of the consequences. First, "most companies" in Extremistan make no profit—the rare event dominates, and a small number of companies generate all the shekels. And whatever point he may have, in the presence of the kind of asymmetry and optionality we see in Figure 7, it is inconclusive, so it is better to write about another subject, something less harmful that may interest Harvard students, like how to make a convincing PowerPoint presentation or the difference in managerial cultures between the Japanese and the French. Again, he may be right about the pitiful potential of biotech investments, but not on the basis of the data he showed.

Now why is such thinking by the likes of Professor Pisano dangerous? It is not a matter of whether or not he would inhibit research in biotech. The problem is that such a mistake inhibits everything in economic life that has antifragile properties (more technically, "right-skewed"). And it would fragilize by favoring matters that are "sure bets."

Remarkably, another Harvard professor, Kenneth Froot, made the exact same mistake, but in the opposite direction, with the negative asymmetries. Looking at reinsurance companies (those that insure catastrophic events), he thought that he found an aberration. They made too much profit given the risks they took, as catastrophes seemed to occur *less often* than what was reflected in the premia. He missed the point that catastrophic events hit them only negatively, and tend to be absent from past data (again, they are rare). Remember the turkey problem. One single episode, the asbestos liabilities, bankrupted families of Lloyd underwriters, losing income made over generations. One single episode.

We will return to these two distinct payoffs, with "bounded left" (limited losses, like Thales' bet) and "bounded right" (limited gains, like insurance or banking). The distinction is crucial, as most payoffs in life fall in either one or the other category.

To Fail Seven Times, Plus or Minus Two

Let me stop to issue rules based on the chapter so far. (i) Look for optionality; in fact, rank things according to optionality, (ii) preferably with open-ended, not closed-ended, payoffs; (iii) Do not invest in business plans but in people, so look for someone capable of changing six or seven times over his career, or more (an idea that is part of the modus operandi of the venture capitalist Marc Andreessen); one gets immunity from the backfit narratives of the business plan by investing in people. It is simply more robust to do so; (iv) Make sure you are barbelled, whatever that means in your business.

THE CHARLATAN, THE ACADEMIC, AND THE SHOWMAN

I end the chapter on a sad note: our ingratitude toward many who have helped us get here—letting our ancestors survive.

Our misunderstanding of convex tinkering, antifragility, and how to tame randomness is woven into our institutions—though not consciously and explicitly. There is a category of people in medicine called the empirics, or empirical skeptics, the doers, and that is about it—we do not have many names for them as they have not written a lot of books. Many of their works were destroyed or hidden from cultural consciousness, or have naturally dropped out of the archives, and their memory has been treated very badly by history. Formal thinkers and theorizing theorizers tend to write books; seat-of-the-pants people tend to be practitioners who are often content to get the excitement, make or lose the money, and discourse at the pub. Their experiences are often formalized by academics; indeed, history has been written by those who want you to believe that reasoning has a monopoly or near monopoly on the production of knowledge.

So the final point here is about those called charlatans. Some were, others were less so; some were not; and many were borderline. For a long time official medicine had to compete with crowds of flashy showmen, mountebanks, quacks, sorcerers and sorceresses, and all manner of unlicensed practitioners. Some were itinerant, going from town to town carrying out their curative acts in front of large gatherings. They would perform surgery on occasion while repeating incantations.

This category included doctors who did not subscribe to the dominant Graeco-Arabic school of rational medicine, developed in the Hel-

lenistic world of Asia Minor and later grown by the Arabic language school. The Romans were an anti-theoretical pragmatic bunch; the Arabs loved everything philosophical and “scientific” and put Aristotle, about whom nobody seemed to have cared much until then, on a pedestal. For instance we know very, very little of the skeptical empirical school of Menodotus of Nicomedia—we know a lot more about Galen, the rationalist. Medicine, for the Arabs, was a scholarly pursuit and founded on the logic of Aristotle and the methods of Galen; they abhorred experience.* Medical practitioners were the Other.

The regulation of the medical establishment corresponds to worries about the empirics for economic reasons as competition made their incomes drop. So no wonder these were bundled with the thieves, to wit this long title for an Elizabethan treatise: *A short discourse, or, discouery of certaine stratagems, whereby our London-empericks, haue bene obserued strongly to oppugne, and oft times to expugne their poore patients purses.*

“Charlatan” was held to be a synonym for *empirick*. The word “*empiric*” designated someone who relied on experiment and experience to ascertain what was correct. In other words, trial and error and tinkering. That was held to be inferior—professionally, socially, and intellectually. It is still not considered to be very “intelligent.”

But luckily for us, the empirics enjoyed immense popular support and could not be uprooted. You do not see their works, but they left a huge imprint on medicine.

Note the initial peaking of iatrogenics after the academization—and institutionalization—of medicine with the onset of modernity. It has only recently started to reverse. Also, formal academics, seen in the light of history, were not better than those they called charlatans—they just hid their fraud under the weight of more convincing rationalizations. They were just *organized quacks*. My hope is for that to change.

Now, I agree that most nonacademically vetted medical practitioners were scoundrels, mountebanks, quacks, and often even worse than these. But let’s hold off jumping to the wrong conclusions. Formalists, to protect their turf, have always played on the logical fallacy that if quacks are found among nonacademics, nonacademics are all quacks. They keep doing it: the statement *all that is nonrigorous is nonacademic* (as-

* It is not very well noticed that Arabic thought favors abstract thinking and science in the most theoretical sense of the word — violently rationalistic, away from empiricism.

suming one is a sucker and believes it) does not imply that *all that is nonacademic is nonrigorous*. The fight between the “legitimate” doctors and the Others is quite enlightening, particularly when you note that doctors were silently (and reluctantly) copying some of the remedies and cures developed and promoted by the Others. They had to do so for economic reasons. They benefited from the collective trial and error of the Others. And the process led to cures, now integrated into medicine.

Now, reader, let us take a minute and pay some respect. Consider our ingratitude to those who got us here, got our disrespect, and do not even know that they were heroes.

A Lesson In Disorder

*Where is the next street fight?—How to decommoditize, detouristify—
The intelligent student [also in reverse]—Flâneur as options*

Let us continue with teleology and disorder—in private life and individual education. Then an autobiographical vignette.

THE ECOLOGICAL AND THE LUDIC

As we saw with the fellow making the common but false analogy to blackjack in Chapter 7, there are two domains, the ludic, which is set up like a game, with its rules supplied in advance in an explicit way, and the ecological, where we don't know the rules and cannot isolate variables, as in real life. Seeing the nontransferability of skills from one domain to the other led me to skepticism in general about whatever skills are acquired in a classroom, anything in a non-ecological way, as compared to street fights and real-life situations.

It is not well advertised that there is no evidence that abilities in chess lead to better reasoning off the chessboard—even those who play blind chess games with an entire cohort can't remember things outside the board better than a regular person. We accept the domain-specificity of games, the fact that they do not really train you for life, that there are severe losses in translation. But we find it hard to apply this lesson to technical skills acquired in schools, that is, to accept the crucial fact that

what is picked up in the classroom *stays* largely in the classroom. Worse even, the classroom can bring some detectable harm, a measure of iatrogenics hardly ever discussed: Laura Martignon showed me results from her doctoral student Birgit Ulmer demonstrating that children's ability to *count* degrades right after they are taught arithmetic. When you ask children how many intervals there are between fifteen poles, those who don't know arithmetic figure out that there are fourteen of them. Those who studied arithmetic get confused and often make the mistake that there are fifteen.

The Touristification of the Soccer Mom

The biologist and intellectual E. O. Wilson was once asked what represented the most hindrance to the development of children; his answer was the soccer mom. He did not use the notion of the Procrustean bed, but he outlined it perfectly. His argument is that they repress children's natural biophilia, their love of living things. But the problem is more general; soccer moms try to eliminate the trial and error, the antifragility, from children's lives, move them away from the ecological and transform them into nerds working on preexisting (soccer-mom-compatible) maps of reality. Good students, but nerds—that is, they are like computers except slower. Further, they are now totally untrained to handle ambiguity. As a child of civil war, I disbelieve in structured learning—actually I believe that one can be an intellectual without being a nerd, provided one has a private library instead of a classroom, and spends time as an aimless (but rational) flâneur benefiting from what randomness can give us inside and outside the library. Provided we have the right type of rigor, we need randomness, mess, adventures, uncertainty, self-discovery, near-traumatic episodes, all these things that make life worth living, compared to the structured, fake, and ineffective life of an empty-suit CEO with a preset schedule and an alarm clock. Even their leisure is subjected to a clock, squash between four and five, as their life is sandwiched between appointments. It is as if the mission of modernity was to squeeze every drop of variability and randomness out of life—with (as we saw in Chapter 5) the ironic result of making the world a lot more unpredictable, as if the goddesses of chance wanted to have the last word.

Only the autodidacts are free. And not just in school matters—those who decommoditize, detouristify their lives. Sports try to put random-