

tary filmmakers, economic forecasts, news about the stock market, gym “strength training” machines, and many more.*

The Iatrogenics of Money

To understand the outright denial of antifragility in the way we seek wealth, consider that construction laborers seem happier with a ham and cheese baguette than businessmen with a Michelin three-star meal. Food tastes so much better after exertion. The Romans had a strange relation to wealth: anything that “softens” or “mollifies” was seen negatively. Their reputation for decadence is a bit overdone—history likes the lurid; they disliked comfort and understood its side effects. The same with the Semites, split between desert tribes and city dwellers, with city dwellers harboring a certain cross-generational nostalgia for their roots and their original culture; so there is the culture of the desert, full of poetry, chivalry, contemplation, rough episodes, and frugality, plotted against the cities’ comfort, which is associated with physical and moral decay, gossip, and decadence. The city dweller repairs to the desert for purification, as Christ did for forty days in the Judean desert, or Saint Mark in the Egyptian desert, starting a tradition of such asceticism. There was at some point an epidemic of monasticism in the Levant, perhaps the most impressive being Saint Simeon, who spent forty years on top of a column in Northern Syria. The Arabs kept the tradition, shedding possessions to go to silent, barren, empty spaces. And of course, with mandatory fasting, on which a bit later.

Note that medical iatrogenics is the result of wealth and sophistication rather than poverty and artlessness, and of course the product of partial knowledge rather than ignorance. So this idea of shedding possessions to go to the desert can be quite potent as a *via negativa*-style subtractive strategy. Few have considered that money has its own iatrogenics, and that separating some people from their fortune would simplify their lives and bring great benefits in the form of healthy stressors. So being poorer might not be completely devoid of benefits if one does it right. We need modern civilization for many things, such as the legal

* One example of lack of empirical wisdom in the use of “evidence”: in a *New York Times Magazine* article, a doctor who claimed that he stopped eating sugar because of its potential harm was apologetic for doing so “without full evidence.” The best test of empirical wisdom in someone is in where he puts the burden of evidence.

system and emergency room surgery. But just imagine how by the subtractive perspective, *via negativa*, we can be better off by getting tougher: no sunscreen, no sunglasses if you have brown eyes, no air-conditioning, no orange juice (just water), no smooth surfaces, no soft drinks, no complicated pills, no loud music, no elevator, no juicer, no . . . I stop.

When I see pictures of my friend the godfather of the Paleo ancestral lifestyle, Art De Vany, who is extremely fit in his seventies (much more than most people thirty years younger than him), and those of the pear-shaped billionaires Rupert Murdoch or Warren Buffett or others in the same age group, I am invariably hit with the following idea. If true wealth consists in worriless sleeping, clear conscience, reciprocal gratitude, absence of envy, good appetite, muscle strength, physical energy, frequent laughs, no meals alone, no gym class, some physical labor (or hobby), good bowel movements, no meeting rooms, and periodic surprises, then it is largely subtractive (elimination of iatrogenics).

Religion and Naïve Interventionism

Religion has invisible purposes beyond what the literal-minded scientistic-scientifiers identify—one of which is to protect us from scientism, that is, them. We can see in the corpus of inscriptions (on graves) accounts of people erecting fountains or even temples to their favorite gods after these succeeded where doctors failed. Indeed we rarely look at religion's benefits in limiting the intervention bias and its iatrogenics: *in a large set of circumstances (marginal disease), anything that takes you away from the doctor and allows you to do nothing (hence gives nature a chance to do its work) will be beneficial.* So going to church (or the temple of Apollo) for mild cases—say, those devoid of trauma, like a mild discomfort, not injuries from a car accident, those situations in which the risk of iatrogenics exceeds the benefit of cure, to repeat it again, the cases with negative convexity—will certainly help. We have so many inscriptions on temples of the type *Apollo saved me, my doctors tried to kill me*—typically the patient has bequeathed his fortune to the temple.

And it seems to me that human nature does, deep down, know when to resort to the solace of religion, and when to switch to science.*

* I am trying to avoid discussing the placebo effect; I am in the business of nonlinearities and it does not relate to the nonlinearities argument.

IF IT'S WEDNESDAY, I MUST BE VEGAN

Sometimes, for a conference dinner, the organizers send me a form asking me if I have dietary requirements. Some do so close to six months in advance. In the past, my usual answer had been that I avoid eating cats, dogs, rats, and humans (especially economists). Today, after my personal evolution, I truly need to figure out the day of the week to know if I will be vegan then or capable of eating those thick monstrous steaks. How? Just by looking at the Greek Orthodox calendar and its required fasts. This confuses the usual categorizing business-reader-TED-conference modern version of the naive fellow who cannot place me in the “Paleo camp” or the “vegan camp.” (The “Paleo” people are carnivores who try to replicate the supposed ancestral high-meat, high-animal-fat diet of hunter-gatherers; vegans are people who eat no animal product, not even butter). We will see further down why it is a naive rationalistic mistake to be in either category (except for religious or spiritual reasons) except episodically.

I believe in the heuristics of religion and blindly accommodate its rules (as an Orthodox Christian, I can cheat once in a while, as it is part of the game). Among other things the role of religion is to tame the iatrogenics of abundance—fasting makes you lose your sense of entitlement. But there are more subtle aspects.

Convexity Effects and Random Nutrition

Recall from the lung ventilator discussion this practical consequence of Jensen’s inequality: irregularity has its benefits in some areas; regularity has its detriments. Where Jensen’s inequality applies, irregularity might be medicine.

Perhaps what we mostly need to remove is a few meals at random, or at least avoid steadiness in food consumption. The error of missing nonlinearities is found in two places, in the mixture and in the frequency of food intake.

The problem with the mixture is as follows. We humans are said to be omnivorous, compared to more specialized mammals, such as cows and elephants (who eat salads) and lions (who eat prey, generally salad-eating prey). But such ability to be omnivorous had to come in response to more variegated environments with unplanned, haphazard, and, what is key, serial availability of sources—specialization is the re-

sponse to a very stable habitat free of abrupt changes, redundancy of pathways the response to a more variegated one. Diversification of function had to come in response to variety. And a variety of a certain structure.

Note a subtlety in the way we are built: the cow and other herbivores are subjected to much less randomness than the lion in their food intake; they eat steadily but need to work extremely hard in order to metabolize all these nutrients, spending several hours a day just eating. Not to count the boredom of standing there eating salads. The lion, on the other hand, needs to rely on more luck; it succeeds in a small percentage of the kills, less than 20 percent, but when it eats, it gets in a quick and easy way all these nutrients produced thanks to very hard and boring work by the prey. So take the following principles derived from the random structure of the environment: when we are herbivores, we eat steadily; but when we are predators we eat more randomly. Hence our proteins need to be consumed randomly for statistical reasons.

So if you agree that we need “balanced” nutrition of a certain combination, it is wrong to immediately assume that we need such balance *at every meal* rather than serially so. Assuming that we need on average certain quantities of the various nutrients that have been identified, say a certain quantity of carbohydrates, proteins, and fats.* There is a big difference between getting them together, at every meal, with the classical steak, salad, followed by fresh fruits, or having them separately, serially.

Why? Because deprivation is a stressor—and we know what stressors do when allowed adequate recovery. Convexity effects at work here again: getting three times the daily dose of protein in one day and nothing the next two is certainly not biologically equivalent to “steady” moderate consumption if our metabolic reactions are nonlinear. It should have some benefits—at least this is how we are designed to be.

I speculate; in fact I more than speculate: I am convinced (an inevitable result of nonlinearity) that we are antifragile to randomness in food delivery and composition—at least over a certain range, or number of days.

* Some people claim that we need more fat than carbohydrates; others offer the opposite (they all tend to agree on protein, though few realize we need to randomize protein intake). Both sides still advocate nonrandomness in the mixing and ignore the nonlinearities from sequence and composition.

And one blatant denial of convexity bias is the theory about the benefits of the so-called Cretan (or Mediterranean) diet that triggered a change in the eating habits of the U.S. enlightened class, away from steak and potatoes in favor of grilled fish with salad and feta cheese. It happened as follows. Someone looked at the longevity of Cretans, cataloged what they ate, then inferred—naively—that they lived longer because of the types of food they consumed. It could be true, but the second-order effect (the variations in intake) could be dominant, something that went unnoticed by mechanistic researchers. Indeed, it took a while to notice the following: the Greek Orthodox church has, depending on the severity of the local culture, almost two hundred days of fasting per year; and these are harrowing fasts.

Yes, harrowing fasts, as I am feeling it right now. For I am writing these lines during Orthodox Lent, a forty-day period in which almost no animal product can be consumed, no sweets, and, for some sticklers, no olive oil. As there are several gradations, I try to stick to a semistrict level, and life is not very easy, as is meant to be. I just spent a long weekend in Amioun, my ancestral village in Northern Lebanon, in the Greek Orthodox area called the Koura valley. There traditional “ruse” foods are perfected, with great imagination: Levantine kibbeh made with herbs and beans in place of meat, meatballs made of matzoh-style small brown balls in a lentil soup. Remarkably, while fish is banned, most days, shellfish is allowed, probably as it was not considered a luxury item. The compensation for the absence of some nutrients from my daily diet will take place in lumps. I will make up my deprivation of what researchers (for now) call protein with fish on days when it is allowed, and of course I will ravenously eat lamb on Easter Day, then consume disproportionately high quantities of fatty red meat for a while thereafter. I dream of the red steak served in Fat Tony—patronized restaurants in unapologetically monstrous portions.

And there is this antifragility to the stressor of the fast, as it makes the wanted food taste better and can produce euphoria in one’s system. Breaking a fast feels like the exact opposite of a hangover.*

* The principal disease of abundance can be seen in habituation and jadedness (what biologists currently call dulling of receptors); Seneca: “To a sick person, honey tastes better.”

How to Eat Yourself

I wonder how people can accept that the stressors of exercise are good for you, but do not transfer to the point that food deprivation can have the same effect. But scientists are in the process of discovering the effects of episodic deprivation of some, or all, foods. Somehow, evidence shows, we get sharper and fitter in response to the stress of the constraint.

We can look at biological studies not to generalize or use in the rationalistic sense, but to verify the existence of a human response to hunger: that biological mechanisms are activated by food deprivation. And we have experiments on cohorts showing the positive effect of hunger—or deprivation of a food group—on the human body. Researchers rationalize now with the mechanism of *autophagy* (eating oneself): when deprived of external sources, the theories are that your cells start eating themselves, or breaking down proteins and recombining amino acids to provide material for building other cells. It is assumed by some researchers (for now) that the “vacuum cleaner” effect of autophagy is the key to longevity—though my ideas of the natural are impervious to their theories: as I will show further down, occasional starvation produces some health benefits and that’s that.

The response to hunger, our antifragility, has been underestimated. We’ve been telling people to eat a good meal for breakfast so they can face the travails of the day. And it is not a new theory by empirically blind modern-day nutritionists—for instance I was struck by a dialogue in Stendhal’s monumental novel *Le rouge et le noir* in which the protagonist, Julien Sorel, is told “the work for the day will be long and rough, so let us *fortify* ourselves with a breakfast” (which in the French of the period was called “the first lunch”). Indeed, the idea of breakfast as a main meal with cereals and other such materials has been progressively shown to be harming humans—I wonder why it took so long before anyone realized that such an unnatural idea needs to be tested; further, the tests show that harm, or, at least, no benefits are derived from breakfast unless one has worked for it beforehand.

Let us remember that we are not designed to be receiving foods from the delivery person. In nature, we had to expend some energy to eat. Lions hunt to eat, they don’t eat their meal then hunt for pleasure. Giving people food before they expend energy would certainly confuse their signaling process. And we have ample evidence that intermittently (and

only intermittently) depriving organisms of food has been shown to engender beneficial effects on many functions—Valter Longo, for instance, noted that prisoners in concentration camps got less sick in the first phase of food restriction, then broke down later. He tried the result experimentally and found out that mice, in the initial phases of starvation, can withstand high doses of chemotherapy without visible side effects. Scientists use the narrative that starvation causes the expression of a gene coding a protein called SIRT, SIRT1, or sirtuin, which brings longevity and other effects. The antifragility of humans manifests itself in the response with up-regulation of some genes in response to hunger.

So once again, religions with ritual fasts have more answers than assumed by those who look at them too literally. In fact what these ritual fasts do is try to bring nonlinearities in consumption to match biological properties. The Appendix shows graphically the standard dose responses in biology: a little bit of anything seems to harbor positive convexity effects (whether beneficial or harmful); add to it and the effect weakens. Clearly at the upper end, the dose has no additional effect since one reaches saturation.

Walk-Deprived

Another source of harm from naive rationalism. Just as for a long time people tried to shorten their sleep, as it seemed useless to our earthling logic, many people think that walking is useless, so they use mechanical transportation (car, bicycle, etc.) and get their exercise working out at the gym. And when they walk, they do this ignominious “power walk,” sometimes with weights on their arms. They do not realize that for reasons still opaque to them, walking effortlessly, at a pace below the stress level, can have some benefits—or, as I speculate, is necessary for humans, perhaps as necessary as sleep, which at some point modernity could not rationalize and tried to reduce. Now it may or may not be true that walking effortlessly is as necessary as sleep, but since all my ancestors until the advent of the automobile spent much of their time walking around (and sleeping), I try to just follow the logic, even before some medical journal catches up to the idea and produces what referees of medical journals call “evidence.”

I Want to Live Forever

All I hear is how to live longer, richer, and, of course, more laden with electronic gadgets. We are not the first generation to believe that the worst possible thing to befall us is death. But for the ancients, the worst possible outcome was not death, but a dishonorable death, or even just a regular one. For a classical hero, dying in a retirement home with a rude nurse and a network of tubes coming into and out of your nose would not be the attractive *telos* for a life.

And, of course, we have this modern illusion that we should live as long as we can. As if we were each the end product. This idea of the “me” as a unit can be traced to the Enlightenment. And, with it, fragility.

Before that, we were part of the present collective and future progeny. Both present and the future tribes exploited the fragility of individuals to strengthen themselves. People engaged in sacrifices, sought martyrdom, died for the group, and derived pride from doing so; they worked hard for future generations.

Sadly, as I am writing these lines, the economic system is loading future generations with public governmental debt, causing depletion of resources, and environmental blight to satisfy the requirements of the security analysts and the banking establishment (once again, we cannot separate fragility from ethics).

As I wrote in Chapter 4, while the gene is antifragile, since it is information, the carrier of the gene is fragile, and needs to be so for the gene to get stronger. We live to produce information, or improve on it. Nietzsche had the Latin pun *aut liberi, aut libri*—either children or books, both information that carries through the centuries.

I was just reading in John Gray’s wonderful *The Immortalization Commission* about attempts to use science, in a postreligious world, to achieve immortality. I felt some deep disgust—as would any ancient—at the efforts of the “singularity” thinkers (such as Ray Kurzweil) who believe in humans’ potential to live forever. Note that if I had to find the anti-me, the person with diametrically opposite ideas and lifestyle on the planet, it would be that Ray Kurzweil fellow. It is not just neomania. While I propose removing offensive elements from people’s diets (and lives), he works by adding, popping close to two hundred pills daily. Beyond that, these attempts at immortality leave me with deep moral revulsion.

It is the same kind of deep internal disgust that takes hold of me

when I see a rich eighty-two-year-old man surrounded with “babes,” twentysomething mistresses (often Russian or Ukrainian). I am not here to live forever, as a sick animal. Recall that the antifragility of a system comes from the mortality of its components—and I am part of that larger population called humans. I am here to die a heroic death for the sake of the collective, to produce offspring (and prepare them for life and provide for them), or eventually, books—my information, that is, my genes, the antifragile in me, should be the ones seeking immortality, not me.

Then say goodbye, have a nice funeral in St. Sergius (Mar Sarkis) in Amioun, and, as the French say, *place aux autres*—make room for others.

BOOK VII

The Ethics of Fragility and Antifragility

Now, ethics. Under opacity and in the newfound complexity of the world, people can hide risks and hurt others, with the law incapable of catching them. Iatrogenics has both delayed and invisible consequences. It is hard to see causal links, to fully understand what's going on.

Under such epistemic limitations, skin in the game is the only true mitigator of fragility. Hammurabi's code provided a simple solution—close to thirty-seven hundred years ago. This solution has been increasingly abandoned in modern times, as we have developed a fondness for neomanic complication over archaic simplicity. We need to understand the everlasting solidity of such a solution.

Skin in the Game: Antifragility and Optionality at the Expense of Others

Making talk less cheap—Looking at the spoils—Corporations with random acts of pity?—Predict and inverse predict

This chapter will look at what we are getting ourselves into when someone gets the upside, and a different person gets the downside.

The worst problem of modernity lies in the malignant transfer of fragility and antifragility from one party to the other, with one getting the benefits, the other one (unwittingly) getting the harm, with such transfer facilitated by the growing wedge between the ethical and the legal. This state of affairs has existed before, but is acute today—modernity hides it especially well.

It is, of course, an agency problem.

And the agency problem, is of course, an asymmetry.

We are witnessing a fundamental change. Consider older societies—those societies that have survived. The main difference between us and them is the disappearance of a sense of heroism; a shift away from a certain respect—and power—to those who take downside risks for others. For heroism is the exact inverse of the agency problem: someone elects to bear the disadvantage (risks his own life, or harm to himself, or, in milder forms, accepts to deprive himself of some benefits) for the sake of others. What we have currently is the opposite: power seems to go to

those, like bankers, corporate executives (nonentrepreneurs), and politicians, who steal a free option from society.

And heroism is not just about riots and wars. An example of an inverse agency problem: as a child I was most impressed with the story of a nanny who died in order to save a child from being hit by a car. I find nothing more honorable than accepting death in someone else's place.

In other words, what is called sacrifice. And the word “sacrifice” is related to *sacred*, the domain of the holy that is separate from that of the profane.

In traditional societies, a person is only as respectable and as worthy as the downside he (or, more, a lot more, than expected, *she*) is willing to face for the sake of others. The most courageous, or valorous, occupy the highest rank in their society: knights, generals, commanders. Even mafia dons accept that such rank in the hierarchy makes them the most exposed to be whacked by competitors and the most penalized by the authorities. The same applies to saints, those who abdicate, devote their lives to serve others—to help the weak, the deprived, and the dispossessed.

So Table 7 presents another Triad: there are those with no skin in the game but who benefit from others, those who neither benefit from nor harm others, and, finally, the grand category of those sacrificial ones who take the harm for the sake of others.

TABLE 7 • ETHICS AND THE FOUNDATIONAL ASYMMETRY

NO SKIN IN THE GAME	SKIN IN THE GAME	SKIN IN THE GAME FOR THE SAKE OF OTHERS, OR SOUL IN THE GAME
{Keeps upside, transfers downside to others, owns a hidden option at someone else's expense}	{Keeps his own downside, takes his own risk}	{Takes the downside on behalf of others, or universal values}
Bureaucrats	Citizens	Saints, knights, warriors, soldiers
Cheap talk ("tawk" in Fat Tony's lingo)	Actions, no tawk	Expensive talk
Consultants, sophists	Merchants, businessmen	Prophets, philosophers (in the pre-modern sense)
Businesses	Artisans	Artists, some artisans
Corporate executives (with suit)	Entrepreneurs	Entrepreneurs/Innovators
Theoreticians, data miners, observational studies	Laboratory and field experimenters	Maverick scientists
Centralized government	Government of city-states	Municipal government
Editors	Writers	Great writers
Journalists who "analyze" and predict	Speculators	Journalists who take risks and expose frauds (powerful regimes, corporations)
Politicians	Activists	Rebels, dissidents, revolutionaries
Bankers	Traders	(They would not engage in vulgar commerce)
Fragilista Prof. Dr. Joseph Stiglitz	Fat Tony	Nero Tulip
Risk vendors		Taxpayers (not quite voluntarily soul in the game, but they are victims)

Let me follow my emotions and start with the third column, on the far right, the one about heroes and people of courage. The robustness—even antifragility—of society depends on them; if we are here today, it is because someone, at some stage, took some risks for us. But courage and heroism do not mean blind risk taking—it is not necessarily recklessness. There is a pseudocourage that comes from risk blindness, in which people underestimate the odds of failure. We have ample evidence that the very same people become chicken and overreact in the face of real risks; the exact opposite. For the Stoics, prudence is connatural to courage—the courage to fight your own impulses (in an aphorism by—who else—Publilius Syrus, prudence was deemed the courage of the general).

Heroism has evolved through civilization from the martial arena to that of ideas. Initially, in preclassical times, the Homeric hero was someone principally endowed with physical courage—since everything was physical. In later classical times, for such people as the great Lacedaemonian king Agiselaus, a truly happy life was one crowned by the privilege of death in battle, little else, perhaps even nothing else. But for Agiselaus, courage had already evolved from purely martial prowess into something greater. Courage was often seen in acts of renunciation, as when one is ready to sacrifice himself for the benefit of others, of the collective, something altruistic.

Finally, a new form of courage was born, that of the Socratic Plato, which is the very definition of the modern man: the courage to stand up for an idea, and enjoy death in a state of thrill, simply because the privilege of dying for truth, or standing up for one's values, had become the highest form of honor. And no one has had more prestige in history than two thinkers who overtly and defiantly sacrificed their lives for their ideas—two Eastern Mediterraneans; one Greek and one Semite.

We should pause a little when we hear *happiness* defined as an economic or otherwise puny materialistic condition. You can imagine how distraught I feel when I hear about the glorified heroism-free “middle class values,” which, thanks to globalization and the Internet, have spread to any place easily reached by British Air, enshrining the usual opiates of the deified classes: “hard work” for a bank or a tobacco company, diligent newspaper reading, obedience to most, but not all, traffic laws, captivity in some corporate structure, dependence on the opinion of a boss (with one's job records filed in the personnel department), good legal compliance, reliance on stock market investments, tropical vacations, and a suburban life (under some mortgage) with a nice-looking

dog and Saturday night wine tasting. Those who meet with some success enter the gallery of the annual billionaire list, where they will hope to spend some time before their fertilizer sales are challenged by competitors from China. They will be called heroes—rather than lucky. Further, if success is random, a conscious act of heroism is nonrandom. And the “ethical” middle class may work for a tobacco company—and thanks to casuistry call themselves ethical.

I am even more distraught for the future of the human race when I see a nerd behind a computer in a D.C. suburb, walking distance from a Starbucks coffeehouse, or a shopping mall, capable of blowing up an entire battalion in a remote place, say Pakistan, and afterward going to the gym for a “workout” (compare his culture to that of knights or samurai). Cowardice enhanced by technology is all connected: society is fragilized by spineless politicians, draft dodgers afraid of polls, and journalists building narratives, who create explosive deficits and compound agency problems because they want to look good in the short term.

A disclaimer. Table 7 does not imply that those with soul in the game are necessarily right or that dying for one’s ideas makes one necessarily good for the rest of us: many messianic utopians have caused quite a bit of harm. Nor is a grandiose death a necessity: many people fight evil in the patient grind of their daily lives without looking like heroes; they suffer society’s ingratitude even more—while media-friendly pseudo-heroes rise in status. These people will not get a statue from future generations.

A half-man (or, rather, half-person) is not someone who does not have an opinion, just someone who does not take risks for it.

The great historian Paul Veyne has recently shown that it is a big myth that gladiators were forced labor. Most were volunteers who wanted the chance to become heroes by risking their lives and winning, or, when failing, to show in front of the largest crowd in the world how they were able to die honorably, without cowering—when a gladiator loses the fight the crowd decides whether he should be spared or put to death by the opponent. And spectators did not care for nonvolunteers, as these did not have their soul in the fight.

My greatest lesson in courage came from my father—as a child, I had admired him before for his erudition, but was not overly fazed since erudition on its own does not make a man. He had a large ego and immense dignity, and he demanded respect. He was once insulted by a militiaman

at a road check during the Lebanese war. He refused to comply, and got angry at the militiaman for being disrespectful. As he drove away, the gunman shot him in the back. The bullet stayed in his chest for the rest of his life so he had to carry an X-ray image through airport terminals. This set the bar very high for me: dignity is worth nothing unless you earn it, unless you are willing to pay a price for it.

A lesson I learned from this ancient culture is the notion of *megalopsychon* (a term expressed in Aristotle's ethics), a sense of grandeur that was superseded by the Christian value of "humility." There is no word for it in Romance languages; in Arabic it is called *Shhm*—best translated as *nonsmall*. If you take risks and face your fate with dignity, there is nothing you can do that makes you small; if you don't take risks, there is nothing you can do that makes you grand, nothing. And when you take risks, insults by half-men (small men, those who don't risk anything) are similar to barks by nonhuman animals: you can't feel insulted by a dog.

HAMMURABI

Let us now work with the elements of Table 7 and bring the unifying foundational asymmetry (between upside and downside) into our central theme, ethics. Just as only business school professors and similar fragilistas separate robustness and growth, we cannot separate fragility and ethics.

Some people have options, or have optionality, at the expense of others. And the others don't know it.

The effects of transfers of fragility are becoming more acute, as modernity is building up more and more people on the left column—inverse heroes, so to say. So many professions, most arising from modernity, are affected, becoming more antifragile at the expense of our fragility—tenured government employees, academic researchers, journalists (of the non-myth-busting variety), the medical establishment, Big Pharma, and many more. Now how do we solve the problem? As usual, with some great help from the ancients.

Hammurabi's code—now about 3,800 years old—identifies the need to reestablish a symmetry of fragility, spelled out as follows:

If a builder builds a house and the house collapses and causes the death of the owner of the house—the builder shall be put to

death. If it causes the death of the son of the owner of the house, a son of that builder shall be put to death. If it causes the death of a slave of the owner of the house—he shall give to the owner of the house a slave of equal value.

It looks like they were much more advanced 3,800 years ago than we are today. The entire idea is that the builder knows more, a lot more, than any safety inspector, particularly about what lies hidden in the foundations—making it the best risk management rule ever, as the foundation, with delayed collapse, is the best place to hide risk. Hammurabi and his advisors understood small probabilities.

Now, clearly the object here is not to punish retrospectively, but to save lives by providing up-front disincentive in case of harm to others during the fulfillment of one's profession.

These asymmetries are particularly severe when it comes to small-probability extreme events, that is, Black Swans—as these are the most misunderstood and their exposure is easiest to hide.

Fat Tony has two heuristics.

First, never get on a plane if the pilot is not on board.

Second, make sure there is also a copilot.

The first heuristic addresses the asymmetry in rewards and punishment, or transfer of fragility between individuals. Ralph Nader has a simple rule: people voting for war need to have at least one descendant (child or grandchild) exposed to combat. For the Romans, engineers needed to spend some time under the bridge they built—something that should be required of financial engineers today. The English went further and had the families of the engineers spend time with them under the bridge after it was built.

To me, every opinion maker needs to have “skin in the game” in the event of harm caused by reliance on his information or opinion (not having such persons as, say, the people who helped cause the criminal Iraq invasion come out of it completely unscathed). Further, anyone producing a forecast or making an economic analysis needs to have something to lose from it, given that others rely on those forecasts (to repeat, forecasts induce risk taking; they are more toxic to us than any other form of human pollution).

We can derive plenty of sub-heuristics from Fat Tony’s rules, particularly to mitigate the weaknesses of predictive systems. Predicting—any

prediction—without skin in the game can be as dangerous for others as unmanned nuclear plants without the engineer sleeping on the premises. Pilots should be on the plane.

The second heuristic is that we need to build redundancy, a margin of safety, avoiding optimization, mitigating (even removing) asymmetries in our sensitivity to risk.

The rest of this chapter will present a few syndromes, with, of course, some ancient remedies.

THE TALKER'S FREE OPTION

We closed Book I by arguing that we need to put entrepreneurs and risk takers, “failed” or not, on top of the pyramid, and, unless they take personal risks when they expose others, academizing academics, talkers, and political politicians at the bottom. The problem is that society is currently doing the exact opposite, granting mere talkers a free option.

The idea that Fat Tony milked suckers when they ran to the exit door seemed at first quite inelegant to Nero. Benefiting from the misfortune of others—no matter how hideous these are and can be—is not the most graceful approach to life. But Tony had something at risk, and would have been personally harmed by an adverse outcome. Fat Tony had no agency problem. This makes it permissible. For there is an even worse problem associated with the opposite situation: people who just *talk*, prognosticate, theorize.

In fact, speculative risk taking is not just permissible; it is mandatory. No opinion without risk; and, of course, no risk without hope for return. If Fat Tony had an opinion, he felt he needed, for ethical reasons, to have a corresponding exposure. As they say in Bensonhurst, you got to do so if you have an opinion. Otherwise, you do not really have an opinion at all. You need to be earmarked as someone who has no downside for his opinion, with a special status in society, perhaps something below that of ordinary citizen. Commentators need to have a status *below* ordinary citizens. Regular citizens, at least, face the downside of their statements.

So counter to the entire idea of the intellectual and commentator as a detached and protected member of society, I am stating here that I find it profoundly unethical to talk without doing, without exposure to harm, without having one’s skin in the game, without having something

at risk. You express your opinion; it can hurt others (who rely on it), yet you incur no liability. Is this fair?

But this is the information age. This effect of transferring fragility might have been present throughout history, but it is much more acute now, under modernity's connectivity, and the newfound invisibility of causal chains. The intellectual today is vastly more powerful and dangerous than before. The "knowledge world" causes separation of knowing and doing (within the same person) and leads to the fragility of society. How?

In the old days, privilege came with obligations—except for the small class of intellectuals who served a patron or, in some cases, the state. You want to be a feudal lord—you will be first to die. You want war? First in battle. Let us not forget something embedded in the U.S. Constitution: the president is commander in chief. Caesar, Alexander, and Hannibal were on the battlefield—the last, according to Livy, was first-in, last-out of combat zones. George Washington, too, went to battle, unlike Ronald Reagan and George W. Bush, who played video games while threatening the lives of others. Even Napoleon was personally exposed to risks; his showing up during a battle was the equivalent of adding twenty-five thousand troops. Churchill showed an impressive amount of physical courage. They were in it; they believed in it. Status implied you took physical risks.

Note that in traditional societies even those who fail—but have taken risks—have a higher status than those who are not exposed.

Now, again, the idiocy of predictive systems, making me emotional. We may have more social justice today than before the Enlightenment, but we also have more, a lot more transfers of optionality, more than ever—a patent setback. Let me explain. This knowledge shknowledge business necessarily means shifting to talk. Talk by academics, consultants, and journalists, when it comes to predictions, can be just *talk*, devoid of embodiment and stripped of true evidence. As in anything with words, it is not the victory of the most correct, but that of the most charming—or the one who can produce the most academic-sounding material.

We mentioned earlier how the political philosopher Raymond Aron sounded uninteresting in spite of his predictive abilities, while those who were wrong about Stalinism survived beautifully. Aron was about as

colorless as they come: in spite of his prophetic insights he looked, wrote, and lived like a tax accountant while his enemy, say, Jean-Paul Sartre, who led a flamboyant lifestyle, got just about everything wrong and even put up with the occupying Germans in an extremely cowardly manner. Sartre the coward looked radiant, impressive, and, alas, his books survived (please stop calling him a Voltaire; he was no Voltaire).

I got nauseous in Davos making eye contact with the fragilista journalist Thomas Friedman who, thanks to his influential newspaper op-eds, helped cause the Iraq war. He paid no price for the mistake. The real reason for my malaise was perhaps not just that I saw someone I consider vile and harmful. I just get disturbed when I see wrong and do nothing about it; it is biological. It is guilt, for Baal's sake, and guilt is what I do not have to put up with. There is another central element of ancient Mediterranean ethics: *Factum tacendo, crimen facias acrius*: For Publilius Syrus, he who does not stop a crime is an accomplice. (I've stated my own version of this in the prologue, which needs to be reiterated: if you see fraud and don't say fraud, you are a fraud.)

Thomas Friedman was a bit responsible for the Iraq invasion of 2003, and not only paid no penalty for it but continues to write for the op-ed page of *The New York Times*, confusing innocent people. He got—and kept—the upside, others get the downside. A writer with arguments can harm more people than any serial criminal. I am singling him out here because, at the core, the problem is his promotion of the misunderstanding of iatrogenics in complex systems. He promoted the “earth is flat” idea of globalization without realizing that globalization brings fragilities, causes more extreme events as a side effect, and requires a great deal of redundancies to operate properly. And the very same error holds with the Iraq invasion: in such a complex system, the predictability of the consequences is very low, so invading was epistemologically irresponsible.

Natural and ancestral systems work by penalties: no perpetual free option given to anyone. So does society in many things with visible effects. If someone drives a school bus blindfolded, and has an accident, he either exits the gene pool the old-fashioned way, or, if for some reason he is not harmed by the accident, he will incur enough penalties to be prevented from driving other people ever again. The problem is that the journalist Thomas Friedman is still driving the bus. There is no penalty for opinion makers who harm society. And this is a very bad practice.

The Obama administration was after the crisis of 2008 populated with people who drove the bus blindfolded. The iatrogenists got promoted.

Postdicting

Words are dangerous: postdictors, who explain things after the fact—because they are in the business of talking—always look smarter than predictors.

Because of the retrospective distortion, people who of course did not see an event coming will remember some thought to the effect that they did, and will manage to convince themselves that they predicted it, before proceeding to convince others. There will be after every event many more postdictors than true predictors, people who had an idea in the shower without taking it to its logical conclusion, and, given that many people take a lot of showers, say, nearly twice a day (if you include the gym or the episode with the mistress), they will have a large repertoire to draw from. They will not remember the numerous bath-generated ideas they had in the past that were either noise, or that contradicted the observed present—but as humans crave self-consistency, they will retain those elements of what they thought in the past that cohere with their perception of the present.

So opinion makers who were so proudly and professionally providing idle babble will eventually appear to win an argument, since they are the ones writing, and suckers who got in trouble from reading them will again look to them for future guidance, and will again get in trouble.

The past is fluid, marred with selection biases and constantly revised memories. It is a central property of suckers that they will never know they were the suckers because that's how our minds work. (Even so, one is struck with the following fact: the fragilista crisis that started in 2007–2008 had many, many fewer *near-predictors* than random.)

The asymmetry (antifragility of postdictors): postdictors can cherry-pick and produce instances in which their opinions played out and discard mispredictions into the bowels of history. It is like a free option—to them; we pay for it.

Since they have the option, the fragilistas are personally antifragile: volatility tends to benefit them: the more volatility, the higher the illusion of intelligence.

But evidence of whether one has been a sucker or a nonsucker is easy to ferret out by looking at actual records, actions. Actions are symmetric, do not allow cherry-picking, remove the free option. When you look at the actual history of someone's activities, instead of what thoughts he will deliver after the facts, things become crystal clear. The option is gone. Reality removes the uncertainty, the imprecision, the vagueness, the self-serving mental biases that make us appear more intelligent. Mistakes are costly, no longer free, but being right brings actual rewards. Of course, there are other checks one can do to assess the b****t component of life: investigate people's decisions as expressed through their own investments. You would discover that many people who claim to have foreseen the collapse of the financial system had financial companies in their portfolios. Indeed, there was no need to "profit" from events like Tony and Nero to show nonsuckerness: just avoiding being hurt by them would have been sufficient.

I want predictors to have visible scars on their body from prediction errors, not distribute these errors to society.

You cannot sit and moan about the world. You need to come out on top. So Tony was right to insist that Nero take a ritual look at the physical embodiment of the spoils, like a bank account statement—as we said, it had nothing to do with financial value, nor purchasing power, just symbolic value. We saw in Chapter 9 how Julius Caesar needed to incur the cost of having Vercingetorix brought to Rome and paraded. An intangible victory has no value.

Verba volent, words fly. Never have people who talk and don't do been more visible, and played a larger role, than in modern times. This is the product of modernism and division of tasks.

Recall that I said that America's strength was risk taking and harboring risk takers (the right kind, the Thalesian king of high-failure, long-optionality type). Sorry, but we have been moving away from this model.

The Stiglitz Syndrome

There is something more severe than the problem with Thomas Friedman, which can be generalized to represent someone causing action while being completely unaccountable for his words.

The phenomenon I will call the Stiglitz syndrome, after an academic economist of the so-called “intelligent” variety called Joseph Stiglitz, is as follows.

Remember the fragility detection in Chapter 19 and my obsession with Fannie Mae. Luckily, I had some skin in the game for my opinions, be it through exposure to a smear campaign. And, in 2008, no surprise, Fannie Mae went bust, I repeat, costing the U.S. taxpayer hundreds of billions (and counting)—generally, the financial system, with similar risks, exploded. The entire banking system had similar exposures.

But around the same period, Joseph Stiglitz, with two colleagues, the Orszag brothers (Peter and Jonathan), looked at the very same Fannie Mae. They assessed, in a report, that “on the basis of historical experience, the risk to the government from a potential default on GSE debt is effectively zero.”* Supposedly, they ran simulations—but didn’t see the obvious. They also said that the probability of a default was found to be “so small that it is difficult to detect.” It is statements like these and, to me, only statements like these (intellectual hubris and the illusion of understanding of rare events) that caused the buildup of these exposures to rare events in the economy. This is the Black Swan problem that I was fighting. This is Fukushima.

Now the culmination is that Stiglitz writes in 2010 in his *I-told-you-so* book that he claims to have “predicted” the crisis that started in 2007–2008.

Look at this aberrant case of antifragility provided to Stiglitz and his colleagues by society. It turns out that Stiglitz was not just a nonpredicator (by my standards) but was also part of the problem that caused the events, these accumulations of exposures to small probabilities. But he did not notice it! An academic is not designed to remember his opinions because he doesn’t have anything at risk from them.

At the core, people are dangerous when they have that strange skill that allows their papers to be published in journals but decreases their understanding of risk. So the very same economist who caused the problem then postdicted the crisis, and then became a theorist on what happened. No wonder we will have larger crises.

The central point: had Stiglitz been a businessman with his own money on the line, he would have blown up, terminated. Or had he been in nature, his genes would have been made extinct—so people with such

* GSE is Fannie Mae and Freddie Mac—they both blew up.

misunderstanding of probability would eventually disappear from our DNA. What I found nauseating was the government hiring one of his coauthors.*

I am reluctantly calling the syndrome by Stiglitz's name because I find him the smartest of economists, one with the most developed intellect for things *on paper*—except that he has no clue about the fragility of systems. And Stiglitz symbolizes harmful misunderstanding of small probabilities by the economics establishment. It is a severe disease, one that explains why economists will blow us up again.

The Stiglitz syndrome corresponds to a form of cherry-picking, the nastiest variety because the perpetrator is not aware of what he is doing. It is a situation in which someone doesn't just fail to detect a hazard but contributes to its cause while ending up convincing himself—and sometimes others—of the opposite, namely, that he predicted it and warned against it. It corresponds to a combination of remarkable analytical skills, blindness to fragility, selective memory, and absence of skin in the game.

$$\text{Stiglitz Syndrome} = \text{fragilista (with good intentions)} + \text{ex post cherry-picking}$$

There are other lessons here, related to the absence of penalty. This is an illustration of the academics-who-write-papers-and-talk syndrome in its greatest severity (unless, as we will see, they have their soul in it). So many academics propose something in one paper, then the opposite in another paper, without penalty to themselves from having been wrong in the first paper since there is a need only for consistency *within* a single paper, not *across* one's career. This would be fine, as someone may evolve and contradict earlier beliefs, but then the earlier “result” should be withdrawn from circulation and superseded with a new one—with books, the new edition supersedes the preceding one. This absence of penalty makes them antifragile at the expense of the society that accepts the “rigor” of their results. Further, I am not doubting Stiglitz's sincerity, or some weak form of sincerity: I believe he genuinely thinks he predicted the financial crisis, so let me rephrase the problem: the problem

* I find it truly disgusting that one of the Orszag brothers, Peter, after the crisis got a job with the Obama administration—another rehiring of blindfolded bus drivers. Then he became vice chairman of Citibank, which explains why Citibank will blow up again (and we taxpayers will end up subsidizing his high salary).

with people who do not incur harm is that they can cherry-pick from statements they've made in the past, many of them contradictory, and end up convincing themselves of their intellectual lucidity on the way to the World Economic Forum at Davos.

There is the iatrogenics of the medical charlatan and snake oil salesperson causing harm, but he sort of knows it and lies low after he is caught. And there is a far more vicious form of iatrogenics by experts who use their more acceptable status to claim later that they warned of harm. As these did not know they were causing iatrogenics, they cure iatrogenics with iatrogenics. Then things explode.

Finally, the cure to many ethical problems maps to the exact cure for the Stiglitz effect, which I state now.

Never ask anyone for their opinion, forecast, or recommendation. Just ask them what they have—or don't have—in their portfolio.

We now know that many innocent retirees have been harmed by the incompetence of the rating agencies—it was a bit more than incompetence. Many subprime loans were toxic waste dressed as “AAA,” meaning near-government grade in safety. People were innocently led into putting their savings into them—and, further, regulators were forcing portfolio managers to use the assessment of the rating agencies. But rating agencies are protected: they present themselves as press—without the noble mission of the press to expose frauds. And they benefit from the protection of free speech—the “First Amendment” so ingrained in American habits. My humble proposal: one should say whatever he wants, but one's portfolio needs to line up with it. And, of course, regulators should not be fragilistas by giving their stamp to predictive approaches—hence junk science.

The psychologist Gerd Gigerenzer has a simple heuristic. Never ask the doctor what *you* should do. Ask him what *he* would do if he were in your place. You would be surprised at the difference.

The Problem of Frequency, or How to Lose Arguments

Recall that Fat Tony was in favor of just “making a buck” as opposed to being “proven right.” The point has a statistical dimension. Let us return to the distinction between Thalesian and Aristotelian for a minute

and look at evolution from the following point of view. The frequency, i.e., how *often* someone is right is largely irrelevant in the real world, but alas, one needs to be a practitioner, not a talker, to figure it out. On paper, the frequency of being right matters, but only on paper—typically, fragile payoffs have little (sometimes no) upside, and antifragile payoffs have little downside. This means that one makes pennies to lose dollars in the fragile case; makes dollars to lose pennies in the antifragile one. So the antifragile can lose for a long time with impunity, so long as he happens to be right once; for the fragile, a single loss can be terminal.

Accordingly if you were betting on the downfall of, say, a portfolio of financial institutions because of their fragilities, it would have cost you pennies over the years preceding their eventual demise in 2008, as Nero and Tony did. (Note again that taking the other side of fragility makes you antifragile.) You were wrong for years, right for a moment, losing small, winning big, so vastly more successful than the other way (actually the other way would be bust). So you would have made the Thekels like Thales because betting against the fragile is antifragile. But someone who had merely “predicted” the event with just words would have been called by the journalists “wrong for years,” “wrong most of the time,” etc.

Should we keep tally of opinion makers’ “right” and “wrong,” the proportion does not matter, as we need to include consequences. And given that this is impossible, we are now in a quandary.

Look at it again, the way we looked at entrepreneurs. They are usually wrong and make “mistakes”—plenty of mistakes. They are convex. So what counts is the payoff from success.

Let me rephrase again. Decision making in the real world, that is, deeds, are Thalesian, while forecasting *in words* is Aristotelian. As we saw in the discussion in Chapter 12, one side of a decision has larger consequences than the other—we don’t have evidence that people are terrorists but we check them for weapons; we don’t believe the water is poisonous but we avoid drinking it; something that would be absurd for someone narrowly applying Aristotelian logic. To put in Fat Tony terms: suckers try to be right, nonsuckers try to make the buck, or:

Suckers try to win arguments, nonsuckers try to win.

To put it again in other words: it is rather a good thing to lose arguments.

The Right Decision for the Wrong Reason

More generally, for Mother Nature, opinions and predictions don't count; surviving is what matters.

There is an evolutionary argument here. It appears to be the most underestimated argument in favor of free enterprise and a society driven by individual doers, what Adam Smith called "adventurers," not central planners and bureaucratic apparatuses. We saw that bureaucrats (whether in government or large corporations) live in a system of rewards based on narratives, "tawk," and the opinion of others, with job evaluation and peer reviews—in other words, what we call marketing. Aristotelian, that is. Yet the biological world evolves by survival, not opinions and "I predicted" and "I told you so." Evolution dislikes the confirmation fallacy, endemic in society.

The economic world should, too, but institutions mess things up, as suckers may get bigger—*institutions block evolution with bailouts and statism*. Note that, in the long term, social and economic evolution nastily takes place by surprises, discontinuities, and jumps.*

We mentioned earlier Karl Popper's ideas on evolutionary epistemology; not being a decision maker, he was under the illusion that ideas compete with each other, with the least wrong surviving at any point in time. He missed the point that it is not ideas that survive, but people who have the right ones, or societies that have the correct heuristics, or the ones, right or wrong, that lead them to do the good thing. He missed the Thalesian effect, the fact that a wrong idea that is harmless can survive. Those who have wrong heuristics—but with a small harm in the event of error—will survive. Behavior called "irrational" can be good if it is harmless.

Let me give an example of a type of false belief that is helpful for survival. In your opinion, which is more dangerous, to mistake a bear for a stone, or mistake a stone for a bear? It is hard for humans to make the first mistake; our intuitions make us overreact at the smallest probability of harm and fall for a certain class of false patterns—those who

* My suggestion to deter "too big to fail" and prevent employers from taking advantage of the public is as follows. A company that is classified as potentially *bailable out* should it fail should not be able to pay anyone more than a corresponding civil servant. Otherwise people should be free to pay each other what they want since it does not affect the taxpayer. Such limitation would force companies to stay small enough that they would not be considered for a bailout in the event of their failure.

overreact upon seeing what may look like a bear have had a survival advantage, those who made the opposite mistake left the gene pool.

Our mission is to make talk less cheap.

THE ANCIENTS AND THE STIGLITZ SYNDROME

We saw how the ancients understood the Stiglitz syndrome—and associated ones—rather well. In fact they had quite sophisticated mechanisms to counter most aspects of agency problems, whether individual or collective (the circular effect of hiding behind the collective). Earlier, I mentioned the Romans forcing engineers to spend time under the bridge they built. They would have had Stiglitz and Orszag sleep under the bridge of Fannie Mae and exit the gene pool (so they wouldn't harm us again).

The Romans had even more powerful heuristics for situations few today have thought about, solving potent game-theoretic problems. Roman soldiers were forced to sign a *sacramentum* accepting punishment in the event of failure—a kind of pact between the soldier and the army spelling out commitment for upside and downside.

Assume that you and I are facing a small leopard or a wild animal in the jungle. The two of us can possibly overcome it by joining forces—but each one of us is individually weak. Now, if you run away, all you need to be is just faster than me, not faster than the animal. So it would be optimal for the one who can run away the fastest, that is, the most cowardly, to just be a coward and let the other one perish.

The Romans removed the soldiers' incentive to be a coward and hurt others thanks to a process called *decimation*. If a legion loses a battle and there is suspicion of cowardice, 10 percent of the soldiers and commanders are put to death, usually by random lottery. Decimation—meaning eliminating one in ten—has been corrupted by modern language. The magic number is one in ten (or something equivalent): putting more than 10 per cent to death would lead to weakening of the army; too little, and cowardice would be a dominant strategy.

And the mechanism must have worked well as a deterrent against cowardice, since it was not commonly applied.

The English applied a version of it. Admiral John Byng was court-martialed and sentenced to death as he was found guilty of failing to “do his utmost” to prevent Minorca from falling to the French following the Battle of Minorca in 1757.

To Burn One's Vessels

Playing on one's inner agency problem can go beyond symmetry: give soldiers no options and see how antifragile they can get.

On April 29, 711, the armies of the Arab commander Tarek crossed the Strait of Gibraltar from Morocco into Spain with a small army (the name Gibraltar is derived from the Arabic *Jabal Tarek*, meaning “mount of Tarek”). Upon landing, Tarek had his ships put to the fire. He then made a famous speech every schoolchild memorized during my school days that I translate loosely: “Behind you is the sea, before you, the enemy. You are vastly outnumbered. All you have is sword and courage.”

And Tarek and his small army took control of Spain. The same heuristic seems to have played out throughout history, from Cortés in Mexico, eight hundred years later, to Agathocles of Syracuse, eight hundred years earlier—ironically, Agathocles was heading southward, in the opposite direction as Tarek, as he was fighting the Carthaginians and landed in Africa.

Never put your enemy's back to the wall.

How Poetry Can Kill You

Ask a polyglot who knows Arabic who he considers the best poet—in any language—and odds are that he would answer Almutanabbi, who lived about a thousand years ago; his poetry in the original has a hypnotic effect on the reader (listener), rivaled only by the grip of Pushkin on Russian speakers. The problem is that Almutanabbi knew it; his name was literally “He who thinks of himself as a prophet,” on account of his perceived oversized ego. For a taste of his bombast, one of his poems informs us that his poetry is so potent “that blind people can read it” and “deaf people can listen to it.” Well, Almutanabbi was that rare case of a poet with skin in the game, dying for his poetry.

For in the same egotistical poem, Almutanabbi boasts, in a breathtaking display of linguistic magic, that he walks the walk, in addition to being the most unimaginably potent poet—which I insist he was—he knew “the horse, the night, the desert, the pen, the book”—and thanks to his courage he got respect from the lion.

Well, the poem cost him his life. For Almutanabbi had—characteristically—vilified a desert tribe in one of his poems and they

were out to get him. They reached him as he was traveling. As he was outnumbered, he started to do the rational thing and run away, nothing shameful, except that one of his companions started reciting “the horse, the night . . .” back at him. He turned around and confronted the tribe to his certain death. Thus Almutanabbi remains, a thousand years later, the poet who died simply to avoid the dishonor of running away, and when we recite his verses we know they are genuine.

My childhood role model was the French adventurer and writer André Malraux. He imbued his writings with his own risk taking: Malraux was a school dropout—while extremely well read—who became an adventurer in Asia in his twenties. He was an active pilot during the Spanish Civil War and later an active member of the French underground resistance during the Second World War. He turned out to be a bit of a mythomaniac, unnecessarily glorifying his meetings with great men and statesmen. He just could not bear the idea of a writer being an intellectual. But unlike Hemingway, who was mostly into image building, he was the real thing. And he never engaged in small talk—his biographer reports that while other writers were discussing copyrights and royalties, he would steer the conversation to theology (he supposedly said *the twenty-first century will be religious or will not be*). One of my saddest days was when he died.

The Problem of Insulation

The system does not give researchers the incentive to be a Malraux. The great skeptic Hume was said to leave his skeptical angst in the philosophical cabinet, then go party with his friends in Edinburgh (though his idea of partying was rather too . . . Edinburgh). The philosopher Myles Burnyeat called this the “problem of insulation,” particularly with skeptics who are skeptics in one domain but not another. He provides the example of a philosopher who puzzles about the reality of time, but who nonetheless applies for a research grant to work on the philosophical problem of time during next year’s sabbatical—without doubting the reality of next year’s arrival. For Burnyeat, the philosopher “insulates his ordinary first order judgments from the effects of his philosophizing.” Sorry, Professor Doctor Burnyeat; I agree that philosophy is the only field (and its sibling, pure mathematics) that does not need to connect to reality. But then make it a parlor game and give it another name . . .

Likewise, Gerd Gigerenzer reports a more serious violation on the part of Harry Markowitz, who started a method called “portfolio selection” and received the same iatrogenic Swedish Riskbank prize (called “Nobel” in economics) for it, like other fragilistas such as Fragilista Merton and Fragilista Stiglitz. I spent part of my adult life calling it charlatanism, as it has no validity outside of academic endorsements and causes blowups (as explained in the Appendix). Well, Doctor Professor Fragilista Markowitz does not use his method for his own portfolio; he has recourse to more sophisticated (and simpler to implement) cab-drivers’ methodologies, closer to the one Mandelbrot and I have proposed.

I believe that forcing researchers to eat their own cooking whenever possible solves a serious problem in science. Take this simple heuristic—does the scientific researcher whose ideas are applicable to the real world apply his ideas to his daily life? If so, take him seriously. Otherwise, ignore him. (If the fellow is doing pure mathematics or theology, or teaching poetry, then there is no problem. But if he is doing something applicable, then: red flag.)

This brings us to Triffat-type fakeness compared to Seneca, the talker versus the doer. I applied this method of ignoring what an academic writes and focusing on what he does when I met a researcher on happiness who held that *anything one makes beyond \$50,000 does not bring any additional happiness*—he was then earning more than twice that at a university, so according to his metric he was safe. The argument seen through his “experiments” published in “highly cited papers” (that is, by other academics) seemed convincing on paper—although I am not particularly crazy about the notion of “happiness” or the vulgarity of the modern interpretation of “seeking happiness.” So, like an idiot, I believed him. But a year or so later, I heard that he was particularly avid for dollars and spent his time on the road speaking for fees. That, to me, was more sufficient evidence than thousands of citations.

Champagne Socialism

Another blatant case of insulation. Sometimes the divorce between one’s “tawk” and one’s life can be overtly and convincingly visible: take people who want others to live a certain way but don’t really like it for themselves.

Never listen to a leftist who does not give away his fortune or does

not live the exact lifestyle he wants others to follow. What the French call “the caviar left,” *la gauche caviar*, or what Anglo-Saxons call champagne socialists, are people who advocate socialism, sometimes even communism, or some political system with sumptuary limitations, while overtly leading a lavish lifestyle, often financed by inheritance—not realizing the contradiction that they want others to avoid just such a lifestyle. It is not too different from the womanizing popes, such as John XII, or the Borgias. The contradiction can exceed the ludicrous as with French president François Mitterrand of France who, coming in on a socialist platform, emulated the pomp of French monarchs. Even more ironic, his traditional archenemy, the conservative General de Gaulle, led a life of old-style austerity and had his wife sew his socks.

I have witnessed even worse. A former client of mine, a rich fellow with what appeared to be a social mission, tried to pressure me to write a check to a candidate in an election on a platform of higher taxes. I resisted, on ethical grounds. But I thought that the fellow was heroic, for, should the candidate win, his own taxes would increase by a considerable amount. A year later I discovered that the client was being investigated for his involvement in a very large scheme to be shielded from taxes. He wanted to be sure that *others* paid more taxes.

I developed a friendship over the past few years with the activist Ralph Nader and saw contrasting attributes. Aside from an astonishing amount of personal courage and total indifference toward smear campaigns, he exhibits absolutely no divorce between what he preaches and his lifestyle, none. Just like saints who have soul in their game. The man is a secular saint.

Soul in the Game

There is a class of people who escape bureaucrato-journalistic “tawk”: those who have more than their skin in the game. *They have their soul in the game.*

Consider prophets. Prophecy is a pledge of belief, little else. A prophet is not someone who first had an idea; he is the one to first believe in it—and take it to its conclusion.

Chapter 20 discussed prophecy, when done right, as subtraction, and detection of fragility. But if having skin in the game (and accepting downside) is what distinguishes the genuine thinker from ex post “tawk,” there is one step beyond needed to reach the rank of prophet. It

is a matter of commitment, or what philosophers call *doxastic commitment*, a type of belief-pledge that to Fat Tony and Nero needed to be translated into deeds (the reverse-Stiglitz). *Doxa* in Greek used to mean “belief,” but distinguished from “knowledge” (*episteme*); to see how it involves a commitment of sorts beyond just words, consider that in church Greek it took the meaning of *glorification*.

Incidentally, this notion also applies to all manner of ideas and theories: the main person behind a theory, the person to be called the originator, is someone who believed in it, in a doxastic way, with a costly commitment to take it to its natural conclusion; and not necessarily the first person to mention it over dessert wine or in a footnote.

Only he who has true beliefs will avoid eventually contradicting himself and falling into the errors of postdicting.

OPTIONS, ANTIFRAGILITY, AND SOCIAL FAIRNESS

The stock market: the greatest, industrial-sized, transfer of antifragility in history—due to a vicious form of asymmetric skin in the game. I am not talking about investment here—but the current system of packaging investments into shares of “public” corporations, with managers allowed to game the system, and of course, getting more prestige than the real risk takers, the entrepreneurs.

A blatant manifestation of the agency problem is the following. There is a difference between a manager running a company that is not his own and an owner-operated business in which the manager does not need to report numbers to anyone but himself, and for which he has a downside. Corporate managers have incentives without disincentives—something the general public doesn’t quite get, as they have the illusion that managers are properly “incentivized.” Somehow these managers have been given free options by innocent savers and investors. I am concerned here with managers of businesses that are *not* owner-operated.

As I am writing these lines the United States stock market has cost retirees more than three trillion dollars in losses over the past dozen years compared to leaving money in government money market funds (I am being generous, the difference is even higher), while managers of the companies composing the stock market, thanks to the asymmetry of the stock option, are richer by close to four hundred billion dollars. They pulled a Thales on these poor savers. Even more outrageous is the fate of the banking industry: banks have lost more than they ever made in

their history, with their managers being paid billions in compensation—taxpayers take the downside, bankers get the upside. And the policies aiming at correcting the problem are hurting innocent people while bankers are sipping the Rosé de Provence brand of summer wine on their yachts in St. Tropez.

The asymmetry is visibly present: volatility benefits managers since they only get one side of the payoffs. The main point (alas, missed by almost everyone) is that they stand to gain from volatility—the more variations, the more value to this asymmetry. Hence they are antifragile.

To see how transfer of antifragility works, consider two scenarios, in which the market does the same thing on average but following different paths.

Path 1: market goes up 50 percent, then goes back down to erase all gains.

Path 2: market does not move at all.

Visibly Path 1, the more volatile, is more profitable to the managers, who can cash in their stock options. So the more jagged the route, the better it is for them.

And of course society—here the retirees—has the exact opposite payoff since they finance bankers and chief executives. Retirees get less upside than downside. Society pays for the losses of the bankers, but gets no bonuses from them. If you don't see this transfer of antifragility as theft, you certainly have a problem.

What is worse, this system is called “incentive-based” and supposed to correspond to capitalism. Supposedly managers’ interests are aligned with those of the shareholders. What incentive? There is upside and no downside, no disincentive at all.

The Robert Rubin Free Option

Robert Rubin, former treasury secretary, earned \$120 million from Citibank in bonuses over about a decade. The risks taken by the institution were hidden but the numbers looked good . . . until they didn’t look good (upon the turkey’s surprise). Citibank collapsed, but he kept his money—we taxpayers had to compensate him retrospectively since the government took over the banks’ losses and helped them stand on their feet. This type of payoff is very common, thousands of other executives had it.

This is the same story as the one of the architect hiding risks in the

basement for delayed collapse and cashing big checks while protected by the complexities of the legal system.

Some people suggest enforcing a “clawback provision” as a remedy, which consists of making people repay past bonuses in cases of subsequent failure. It would be done as follows: managers cannot cash their bonuses immediately, they can only do so three or five years later if there are no losses. But this does not solve the problem: the managers still have a net upside, and no net downside. At no point is their own net worth endangered. So the system still contains a high degree of optionality and transfer of fragility.

The same applies to the fund manager involved in managing a pension fund—he, too, has no downside.

But bankers used to be subjected to Hammurabi’s rule. The tradition in Catalonia was to behead bankers in front of their own banks (bankers tended to skip town before failure was apparent, but that was the fate of at least one banker, Francesco Castello, in 1360). In modern times, only the mafia executes these types of strategies to remove the free option. In 1980, the “Vatican banker” Roberto Calvi, the chief executive of Banco Ambrosiano that went bust, ran to take refuge in London. There, he supposedly committed suicide—as if Italy was no longer a good place for acts of drama such as taking one’s own life. It was recently discovered that it was not quite suicide; the mafia killed him for losing their money. The same fate befell the Las Vegas pioneer Bugsy Siegel, who ran an unprofitable casino in which the mafia had investments.

And in some countries such as Brazil, even today, top bankers are made unconditionally liable to the extent of their own assets.

Which Adam Smith?

Many right-wingers-in-love-with-large-corporations keep citing Adam Smith, famous patron saint of “capitalism,” a word he never uttered, without reading him, using his ideas in a self-serving selective manner—ideas that he most certainly did not endorse in the form they are presented.*

* I have had the same experience with journalists citing each other about my books without the smallest effort to go to my writings—my experience is that most journalists, professional academics, and others in similar phony professions don’t read original sources, but each other, largely because they need to figure out the consensus before making a pronouncement.

In Book IV of *The Wealth of Nations*, Smith was extremely chary of the idea of giving someone upside without downside and had doubts about the limited liability of joint-stock companies (the ancestor of the modern limited liability corporation). He did not get the idea of transfer of antifragility, but he came close enough. And he detected—sort of—the problem that comes with managing other people's business, the lack of a pilot on the plane:

The directors of such companies, however, being the managers rather of other people's money than of their own, it cannot well be expected, that they should watch over it with the same anxious vigilance with which the partners in a private copartnery frequently watch over their own.

Further, Smith is even suspicious of their economic performance as he writes: "Joint-stock companies for foreign trade have seldom been able to maintain the competition against private adventurers."

Let me make the point clearer: the version of "capitalism" or whatever economic system you need to have is with the minimum number of people in the left column of the Triad. Nobody realizes that the central problem of the Soviet system was that it put everyone in charge of economic life in that nasty fragilizing left column.

THE ANTI-FRAGILITY AND ETHICS OF (LARGE) CORPORATIONS

Have you noticed that while corporations sell you junk drinks, artisans sell you cheese and wine? And there is a transfer of antifragility from the small in favor of the large—until the large goes bust.

The problem of the commercial world is that it only works by addition (*via positiva*), not subtraction (*via negativa*): pharmaceutical companies don't gain if you avoid sugar; the manufacturer of health club machines doesn't benefit from your deciding to lift stones and walk on rocks (without a cell phone); your stockbroker doesn't gain from your decision to limit your investments to what you see with your own eyes, say your cousin's restaurant or an apartment building in your neighborhood; all these firms have to produce "growth in revenues" to satisfy the metric of some slow thinking or, at best, semi-slow thinking MBA analyst sitting in New York. Of course they will eventually self-destruct, but that's another conversation.

Now consider companies like Coke or Pepsi, which I assume are, as the reader is poring over these lines, still in existence—which is unfortunate. What business are they in? Selling you sugary water or substitutes for sugar, putting into your body stuff that messes up your biological signaling system, *causing* diabetes and making diabetes vendors rich thanks to their compensatory drugs. Large corporations certainly can't make money selling you tap water and cannot produce wine (wine seems to be the best argument in favor of the artisanal economy). But they dress their products up with a huge marketing apparatus, with images that fool the drinker and slogans such as “125 years of providing happiness” or some such. I fail to see why the arguments we've used against tobacco firms don't apply—to some extent—to all other large companies that try to sell us things that may make us ill.

The historian Niall Ferguson and I once debated the chairperson of Pepsi-Cola as part of an event at the New York Public Library. It was a great lesson in antifragility, as neither Niall nor I cared about who she was (I did not even bother to know her name). Authors are antifragile. Both of us came totally unprepared (not even a single piece of paper) and she showed up with a staff of aides who, judging from their thick files, had probably studied us down to our shoe sizes (I saw in the speakers' lounge an aide perusing a document with an ugly picture of yours truly in my pre-bone-obsession, pre-weight-lifting days). We could say anything we wanted with total impunity and she had to hew to her party line, lest the security analysts issue a bad report that would cause a drop of two dollars and thirty cents in the stock price before the year-end bonus. In addition, my experience of company executives, as evidenced by their appetite for spending thousands of hours in dull meetings or reading bad memos, is that they cannot possibly be remarkably bright. They are no entrepreneurs—just actors, slick actors (business schools are more like acting schools). Someone intelligent—or free—would likely implode under such a regimen. So Niall immediately detected her weak point and went straight for the jugular: her slogan was that she contributed to employment by having six hundred thousand persons on her staff. He immediately exposed her propaganda with the counterargument—actually developed by Marx and Engels—that large bureaucratic corporations seized control of the state just by being “big employers,” and can then extract benefits at the expense of small businesses. So a company that employs six hundred thousand persons is al-

lowed to wreck the health of citizens with impunity, and to benefit from the implied protection of bailouts (just like American car companies), whereas artisans like hairdressers and cobblers do not get such immunity.

A rule then hit me: with the exception of, say, drug dealers, small companies and artisans tend to sell us healthy products, ones that seem naturally and spontaneously needed; larger ones—including pharmaceutical giants—are likely to be in the business of producing wholesale iatrogenics, taking our money, and then, to add insult to injury, hijacking the state thanks to their army of lobbyists. Further, anything that requires marketing appears to carry such side effects. You certainly need an advertising apparatus to convince people that Coke brings them “happiness”—and it works.

There are, of course, exceptions: corporations with the soul of artisans, some with even the soul of artists. Rohan Silva once remarked that Steve Jobs wanted the inside of the Apple products to look aesthetically appealing, although they are designed to remain unseen by the customer. This is something only a true artisan would do—carpenters with personal pride feel fake when treating the inside of cabinets differently from the outside. Again, this is a form of redundancy, one with an aesthetic and ethical payoff. But Steve Jobs was one of the rare exceptions in the Highly Talked About Completely Misunderstood Said to Be Efficient Corporate Global Economy.

Artisans, Marketing, and the Cheapest to Deliver

Another attribute of the artisanal. There is no product that I particularly like that I have discovered through advertising and marketing: cheeses, wine, meats, eggs, tomatoes, basil leaves, apples, restaurants, barbers, art, books, hotels, shoes, shirts, eyeglasses, pants (my father and I have used three generations of Armenian tailors in Beirut), olives, olive oil, etc. The same applies to cities, museums, art, novels, music, painting, sculpture (I had at some point an obsession with ancient artifacts and Roman heads). These may have been “marketed” in some sense, by making people aware of their existence, but this isn’t how I came to use them—word of mouth is a potent naturalistic filter. Actually, the only filter.

The mechanism of *cheapest-to-deliver-for-a-given-specification* pervades whatever you see on the shelves. Corporations, when they sell

you what they call cheese, have an incentive to provide you with the cheapest-to-produce piece of rubber containing the appropriate ingredients that can still be called cheese—and do their homework by studying how to fool your taste buds. Actually, it is more than just an incentive: they are structurally designed and extremely expert at delivering the cheapest possible product that meets their specifications. The same with, say, business books: publishers and authors want to grab your attention and put in your hands the most perishable journalistic item available that still can be called a book. This is optimization at work, in maximizing (image and packaging) or minimizing (costs and efforts).

I said about marketing by soft drink companies that it is meant to maximally confuse the drinker. Anything one needs to market heavily is necessarily either an inferior product or an evil one. And it is highly unethical to portray something in a more favorable light than it actually is. One may make others aware of the existence of a product, say a new belly dancing belt, but I wonder why people don't realize that, by definition, what is being marketed is necessarily inferior, otherwise it would not be advertised.

Marketing is bad manners—and I rely on my naturalistic and ecological instincts. Say you run into a person during a boat cruise. What would you do if he started boasting of his accomplishments, telling you how great, rich, tall, impressive, skilled, famous, muscular, well educated, efficient, and good in bed he is, plus other attributes? You would certainly run away (or put him in contact with another talkative bore to get rid of both of them). It is clearly much better if others (preferably someone other than his mother) are the ones saying good things about him, and it would be nice if he acted with some personal humility.

Actually this is not at all far-fetched. As I was writing this book, I overheard on a British Air flight a gentleman explain to the flight attendant less than two seconds into the conversation (meant to be about whether he liked cream and sugar in his coffee) that he won the Nobel Prize in Medicine “and Physiology” in addition to being the president of a famous monarchal academy. The flight attendant did not know what the Nobel was, but was polite, so he kept repeating “the Nobel Prize” hoping that she would wake up from her ignorance. I turned around and recognized him, and the character suddenly deflated. As the saying goes, it is hardest to be a great man to one’s chambermaid. And marketing beyond conveying information is insecurity.

We accept that people who boast are boastful and turn people off. How about companies? Why aren't we turned off by companies that advertise how great they are? We have three layers of violations:

First layer, the mild violation: companies are shamelessly self-promotional, like the man on the British Air flight, and it only harms them. Second layer, the more serious violation: companies trying to represent themselves in the most favorable light possible, hiding the defects of their products—still harmless, as we tend to expect it and rely on the opinion of users. Third layer, the even more serious violation: companies trying to misrepresent the product they sell by playing with our cognitive biases, our unconscious associations, and that's sneaky. The latter is done by, say, showing a poetic picture of a sunset with a cowboy smoking and forcing an association between great romantic moments and some given product that, logically, has no possible connection to it. You seek a romantic moment and what you get is cancer.

It seems that the corporate system pushes companies progressively into the third layer. At the core of the problem with capitalism—again, please do not invoke Adam Smith—lies the problem of units that are different from individuals. A corporation does not have natural ethics; it just obeys the balance sheet. The problem is that its sole mission is the satisfaction of some metric imposed by security analysts, themselves (very) prone to charlatanism.

A (publicly listed) corporation does not feel shame. We humans are restrained by some physical, natural inhibition.

A corporation does not feel pity.

A corporation does not have a sense of honor—while, alas, marketing documents mention “pride.”

A corporation does not have generosity. Only self-serving actions are acceptable. Just imagine what would happen to a corporation that decided to unilaterally cancel its receivables—just to be nice. Yet societies function thanks to random acts of generosity between people, even sometimes strangers.

All of these defects are the result of the absence of skin in the game, cultural or biological—an asymmetry that harms others for their benefit.

Now, such systems should tend to implode. And they do. As they say, you can't fool too many people for too long a period of time. But the problem of implosion is that it does not matter to the managers—because of the agency problem, their allegiance is to their own personal cash flow. They will not be harmed by subsequent failures; they will keep

their bonuses, as there is currently no such thing as negative manager compensation.

In sum, corporations are so fragile, long-term, that they eventually collapse under the weight of the agency problem, while managers milk them for bonuses and ditch the bones to taxpayers. They would collapse sooner if not for the lobby machines: they start hijacking the state to help them inject sugary drinks into your esophagus. In the United States large corporations control some members of Congress. All this does is delay the corporation's funeral at our expense.*

Lawrence of Arabia or Meyer Lansky

Finally, if you ever have to choose between a mobster's promise and a civil servant's, go with the mobster. Any time. Institutions do not have a sense of honor, individuals do.

During the Great War, T. E. Lawrence, nicknamed Lawrence of Arabia, struck a deal with the Arab desert tribes to help the British against the Ottoman Empire. His promise: to deliver to them in return an Arab state. As the tribes did not know better, they made good on their side of the bargain. But, it turned out, the French and British governments had made a secret agreement, the Sykes-Picot Agreement, to divide the area in question between themselves. After the war, Lawrence went back to live in the U.K., supposedly in a state of frustration, but, of course, not much more. But he left us with a good lesson: never trust the words of a man who is not free.

Now on the other hand, a mobster's greatest asset is that "his word is gold." It was said that "a handshake from the famous mobster Meyer Lansky was worth more than the strongest contracts that a battery of lawyers could put together." In fact he held in his mind the assets and liabilities of the Sicilian mafia, and was their bank account, without a single record. Just his honor.

As a trader I never trusted transactions with "representatives" of institutions; pit traders are bound by their bonds, and I've never known a single self-employed trader over a two-decade-long career who did not live up to his handshake.

Only a sense of honor can lead to commerce. Any commerce.

* There seems to be a survival advantage to small or medium-sized owner-operated or family-owned companies.

Next

We saw how, thanks to the misunderstanding of antifragility (and asymmetry or convexity), some classes of people use hidden options and harm the collective without anyone realizing. We also saw the solution in forcing skin in the game. Next, we will look at another form of optionality: how people can cherry-pick ethical rules to fit their actions. Or how they use public office as a means to satisfy personal greed.

Fitting Ethics to a Profession

How the slaves can snatch control—Squeezing the sissies—The tantalized class, permanently tantalized

At no time in the history of mankind has the following situation been seen in such an acute form. Say Mr. John Smith Jr., JD, is employed as lobbyist for the tobacco industry in Washington, D.C., which, as we all know, is engaged in the business of killing people for profit (we saw with the powers of subtraction that if we stopped such industries from existing by, say, banning cigarettes, then everything else done by medicine becomes a footnote). Ask any of his relatives (or friends) why they can tolerate it and don't just ostracize him or harass him to tears, avoid him at the next family funeral. The answer is likely to be "everyone needs to make a living"—as they are hedging the possibility of their falling into the same situation some day.

We need to test the direction of the arrow (using the same logic as in our discussion of lecturing birds on flying):

Ethics (and Beliefs) → Profession

or

Profession → Ethics (and Beliefs)

Prior to Fat Tony's debate with Socrates, Nero was curious about the first minute of encounter, since there is a gap of about twenty-five centuries. It is not a simple matter to identify the elements of our physical environment that would surprise Socrates the most. Questioned on the point by Fat Tony, who had some grudging respect for Nero's knowledge of history, Nero's speculative reply was "It would most certainly be the absence of slaves."

"These people never did small domestic things themselves. So imagine Socrates' sorry figure of a bulging belly, spindly legs, wondering *Opou oi douloi?*"

"But, Neeroh Toolip, there are still slaves around," Fat Tony blurted out. "They often distinguish themselves by wearing this intricate device called a necktie."

Nero: "Signore Ingeniere Tony, some of these tie-wearers are very rich, even richer than you."

Tony: "Nero, you sucker. Don't be fooled by money. These are just numbers. Being self-owned is a state of mind."

Wealth Without Independence

There is a phenomenon called the *treadmill effect*, similar to what we saw with neomania: you need to make more and more to stay in the same place. Greed is antifragile—though not its victims.

Back to the sucker problem in believing that wealth makes people more independent. We need no more evidence for it than what is taking place now: recall that we have never been richer in the history of mankind. And we have never been more in debt (for the ancients, someone in debt was not free, he was in bondage). So much for "economic growth."

At the local level, it looks like we get socialized in a certain milieu, hence exposed to a treadmill. You do better, move to Greenwich, Connecticut, then become a pauper next to a twenty-million-dollar mansion and million-dollar birthday parties. And you become more and more dependent on your job, particularly as your neighbors get big tax-sponsored Wall Street bonuses.

This class of persons is like Tantalus, who was subjected to an eternal punishment: he stood in a pool of water underneath a fruit tree and whenever he tried to grab the fruit it moved away and whenever he tried to drink, the water receded.

And such a permanently tantalized class is a modern condition. The Romans circumvented these social treadmill effects: much of social life took place between a patron and his less fortunate clients who benefited from his largesse and ate at his table—and relied on his assistance in times of trouble. There was no welfare at the time, and no church to distribute or recommend charity: everything was private (Seneca's book *De beneficiis* I mentioned earlier was exactly about which obligations one had in such situations). There was little exposure to the other wealthy biggies, just as mafia dons don't socialize with other mafia dons but with their constituents. To a large extent, that's how my grandfather and great-grandfather lived, as they were local landowners and politicians; power was accompanied by a coterie of dependents. Provincial landowners were required to maintain an occasional "open house," with an open table for people to come help themselves to the fruits of the wealth. Court life, on the other hand, leads to corruption—the nobleman comes from the provinces, where he is now brought down to size; he faces more flamboyant, wittier persons and feels pressure to prop up his self-esteem. People who would have lost their status in the cities conserve it in the provinces.

You cannot possibly trust someone on a treadmill.

THE PROFESSIONALS AND THE COLLECTIVE

It is a fact that one can rapidly, after a phase of indoctrination, become enslaved to a profession, to the point of having one's opinions on any subject become self-serving, hence unreliable for the collective. This is the bone the Greeks had to pick with professionals.

One of my first jobs was for a Wall Street firm. After I'd been employed for a few months, the managing director called us up and told us that we needed to contribute to a few politicians' campaigns, with a "recommended" payment of a certain proportion of our income. These politicians were said to be "good." By "good" was meant good for their business of investment banking, as these politicians would help with legislation that would protect their business. Had I done that, I would no longer have been eligible ethically to voice a political opinion "for the sake of the public."

In a story well argued throughout the centuries, Demades the Athenian condemned a man who traded in funeral goods on the grounds that he could only derive profits by the death of the great many people. Mon-

taigne, rephrasing the argument made by Seneca in his *De beneficiis*, argued that we would then be obligated to condemn every single professional. According to him, the merchant only thrives by the debauchery of youth, the farmer by the dearness of grain, the architect by the ruin of buildings, lawyers and officers of justice by the suits and contentions of men. A physician takes no pleasure in the health of even his friends, a soldier does not wish for the peace of his country, etc. And, even worse, should we go into people's inner and private thoughts and motivations, we would see that their wishes and hopes are almost invariably at someone else's expense.

But Montaigne and Seneca were a bit too indulgent toward self-interest and missed something quite central. They clearly got the point that economic life does not necessarily depend on altruistic motives, and that the aggregate works differently from the individual. Remarkably, Seneca was born about eighteen centuries before Adam Smith, and Montaigne about three, so we should be quite impressed with their thinking while retaining a certain abhorrence of the fundamental dishonesty of men. We have known since Adam Smith that the collective does not require the benevolence of individuals, as self-interest can be the driver of growth. But all this does not make people less unreliable *in their personal opinions* about the collective. For they are involving the skin of others, so to speak.

What Montaigne and Seneca missed, in addition to the notion of skin in the game, was that one can draw the line with public affairs. They missed the agency problem—although the problem was known heuristically (Hammurabi, golden rules), it was not part of their consciousness.

The point isn't that making a living in a profession is inherently bad; rather, it's that such a person becomes automatically suspect when dealing with public affairs, matters that involve others. The definition of the *free man*, according to Aristotle, is one who is free with his opinions—as a side effect of being free with his time.

Freedom in this sense is only a matter of sincerity in political opinions.

The Greeks saw the world in three professions. The *banausikai technai*, the artisans; the craft of war, *polemike techne*; and that of farming, *georgia*. The last two professions, war and farming, were worthy of a gentleman—mainly because they were not self-serving and were free of conflicts of interest with the collective. But the Athenians despised the *banausoi*, the artisans who worked for a living in dark rooms making

objects—generally sitting down. For Xenophon, such crafts degraded the craftsmen's bodily strength, softened his spirit, and left him no time for his friends and city. The illiberal arts confine one to the workshop and narrow one's interests *to his own welfare*; the crafts of war and farming give one a wider scope so that he can attend to his friends and city. To Xenophon, farming is the mother and nurse of the other *technai*. (The ancients did not have corporations; if Xenophon were alive today he would transfer his distrust from artisans to corporate employees.)

There are Arabic and Hebrew sayings, *Yad el hurr mizan / Yad ben horin moznayim*—“the hand of the free is a scale.” It is just that the definition of the free is not well understood: he is free who owns his own opinion.

For Metternich, humanity started at the rank of baron; for Aristotle, as well as, though in a separate form, the English up until the twentieth century, it started at the rank of idle freeman, unpreoccupied with work. It never meant *not* working; it just meant not deriving your personal and emotional identity from your work, and viewing work as something optional, more like a hobby. In a way your profession does not identify you so much as other attributes, here your birth (but it could be something else). This is the *f*** you money* that allowed Thales of Miletus to gauge his own sincerity. For the Spartans, it was all about courage. For Fat Tony, humanity started at the level of “self-ownership.”

Now self-ownership for our horizontal friend was vastly more democratic than for his thinking predecessors. It simply meant being the owner of your opinion. And it has nothing to do with wealth, birth, intelligence, looks, shoe size, rather with personal courage.

In other words, for Fat Tony, it was a very, very specific definition of a free person: someone who cannot be squeezed into doing something he would otherwise never do.

Consider this leap in sophistication from Athens to Brooklyn: if for the Greeks, only he who is free with his time is free with his opinion, for our horizontal friend and advisor, only he who has courage is free with his opinion. *Sissies are born, not made. They stay sissies no matter how much independence you give them, no matter how rich they get.*

Another facet of the difference between abstract modernistic nation-states and local government. In an antique city-state, or a modern municipality, shame is the penalty for the violation of ethics—making things more symmetric. Banishment and exile, or, worse, ostracism were severe

penalties—people did not move around voluntarily and considered uprooting a horrible calamity. In larger organisms like the mega holy nation-state, with a smaller role for face-to-face encounters, and social roots, shame ceases to fulfill its duty of disciplinarian. We need to reestablish it.

And aside from shame, there is friendship, socialization in a certain milieu, being part of a group of people that have diverging interests from the collective. Cleon, the hero of the Peloponnesian War, advocated the public renouncement of friends upon taking up public affairs—he paid for it with some revilement by historians.

A simple solution, but quite drastic: anyone who goes into public service should not be allowed to *subsequently* earn more from any commercial activity than the income of the highest paid civil servant. It is like a voluntary cap (it would prevent people from using public office as a credential-building temporary accommodation, then going to Wall Street to earn several million dollars). This would get priestly people into office.

Just as Cleon was reviled, in the modern world, there seems to be an inverse agency problem for those who do the right thing: you pay for your service to the public with smear campaigns and harassment. The activist and advocate Ralph Nader suffered numerous smear campaigns as the auto industry went after him.

THE ETHICAL AND THE LEGAL

I felt ashamed not having exposed the following scam for a long time. (As I said, *if you see fraud . . .*) Let us call it the Alan Blinder problem.

The story is as follows. At Davos, during a private coffee conversation that I thought aimed at saving the world from, among other things, moral hazard and agency problems, I was interrupted by Alan Blinder, a former vice chairman of the Federal Reserve Bank of the United States, who tried to sell me a peculiar investment product that aims at legally hoodwinking taxpayers. It allowed the high net worth investor to get around the regulations limiting deposit insurance (at the time, \$100,000) and benefit from coverage for near-unlimited amounts. The investor would deposit funds in any amount and Prof. Blinder's company would break it up into smaller accounts and invest in banks, thus escaping the limit; it would look like a single account but would be insured in full. In

other words, it would allow the super-rich to scam taxpayers by getting free government-sponsored insurance. Yes, *scam* taxpayers. Legally. With the help of former civil servants who have an insider edge.

I blurted out: “Isn’t this unethical?” I was then told in response “It is perfectly legal,” adding the even more incriminating “we have plenty of former regulators on the staff,” (a) implying that what was legal was ethical and (b) asserting that former regulators have an edge over citizens.

It took a long time, a couple of years, before I reacted to the event and did my public *J'accuse*. Alan Blinder is certainly not the worst violator of my sense of ethics; he probably irritated me because of the prominence of his previous public position, while the Davos conversation was meant to save the world from evil (I was presenting to him my idea of how bankers take risks at the expense of taxpayers). But what we have here is a model of how people use public office to, at some point, legally profit from the public.

Tell me if you understand the problem in its full simplicity: former regulators and public officials who were employed by the citizens to represent their best interests can use the expertise and contacts acquired on the job to benefit from glitches in the system upon joining private employment—law firms, etc.

Think about it a bit further: the more complex the regulation, the more bureaucratic the network, the more a regulator who knows the loops and glitches would benefit from it later, as his regulator edge would be a convex function of his differential knowledge. This is a franchise, an asymmetry one has at the expense of others. (Note that this franchise is spread across the economy; the car company Toyota hired former U.S. regulators and used their “expertise” to handle investigations of its car defects.)

Now stage two—things get worse. Blinder and the dean of Columbia University Business School wrote an op-ed opposing the government’s raising the insurance limit on individuals. The article argued that the public should not have the unlimited insurance that Blinder’s clients benefit from.

A few remarks.

First, the more complicated the regulation, the more prone to arbitrages by insiders. This is another argument in favor of heuristics. Twenty-three hundred pages of regulation—something I can replace

with Hammurabi's rule—will be a gold mine for former regulators. The incentive of a regulator is to have complex regulation. Again, the insiders are the enemies of the *less-is-more* rule.

Second, the difference between the letter and the spirit of regulation is harder to detect in a complex system. The point is technical, but complex environments with nonlinearities are easier to game than linear ones with a small number of variables. The same applies to the gap between the legal and the ethical.

Third, in African countries, government officials get explicit bribes. In the United States they have the implicit, never mentioned, promise to go work for a bank at a later date with a sinecure offering, say \$5 million a year, if they are seen favorably by the industry. And the “regulations” of such activities are easily skirted.

What upset me the most about the Alan Blinder problem is the reactions by those with whom I discussed it: people found it natural that a former official would try to “make money” thanks to his former position—at our expense. *Don't people like to make money?* goes the argument.

Casuistry as Optionality

You can always find an argument or an ethical reason to defend an opinion *ex post*. This is a dicey point, but, as with cherry-picking, one should propose an ethical rule before an action, not after. You want to prevent fitting a narrative to what you are doing—and for a long time “casuistry,” the art of arguing the nuances of decisions, was just that, fitting narratives.

Let me first define a fraudulent opinion. It is simply one with vested interests generalized to the public good—in which, say a hairdresser recommends haircuts “for the health of people,” or a gun lobbyist claims gun ownership is “good for America,” simply making statements that benefit him personally, while the statements are dressed up to look as if they were made for the benefit of the collective. In other words, is he in the left column of Table 7? Likewise, Alan Blinder wrote that he opposed generalized deposit insurance, not because his company would lose business, but *because of the public good*.

But the heuristic is easy to implement, with a simple question. I was in Cyprus at a conference dinner in which another speaker, a Cypriot

professor of petrochemical engineering in an American university, was ranting against the climate activist Lord Nicholas Stern. Stern was part of the conference but absent from the dinner. The Cypriot was extremely animated. I had no idea what the issues were, but saw the notion of “absence of evidence” mixed with “evidence of absence” and pounced on him in defense of Stern, whom I had never met. The petrochemical engineer was saying that we had *no evidence* that fossil fuels caused harm to the planet, turning his point semantically into something equivalent in decision making to the statement that that we had *evidence that fossil fuels did not harm*. He made the mistake of saying that Stern was recommending useless insurance, causing me to jump to ask him if he had car, health, and other insurance for events that did not take place, that sort of argument. I started bringing up the idea that we are doing something new to the planet, that the burden of evidence is on those who disturb natural systems, that Mother Nature knows more than he will ever know, not the other way around. But it was like talking to a defense lawyer—sophistry, and absence of convergence to truth.

Then a heuristic came to mind. I surreptitiously asked a host sitting next to me if the fellow had anything to gain from his argument: it turned out that he was deep into oil companies, as an advisor, an investor, and a consultant. I immediately lost interest in what he had to say and the energy to debate him in front of others—his words were nugatory, just babble.

Note how this fits into the idea of skin in the game. If someone has an opinion, like, say, the banking system is fragile and should collapse, I want him invested in it so he is harmed if the audience for his opinion are harmed—as a token that he is not an empty suit. But when general statements about the collective welfare are made, instead, *absence of investment* is what is required. *Via negativa*.

I have just presented the mechanism of ethical optionality by which *people fit their beliefs to actions rather than fit their actions to their beliefs*. Table 8 compares professions with respect to such ethical back-fitting.

TABLE 8 • COMPARING PROFESSIONS AND ACTIVITIES

<i>INVITED TO BE OPPORTUNIST (IF ITS ETHICS TO PROFESSION)</i>	<i>PROTECTED FROM PLAYING THE PSEUDOETHICS GAME</i>
Gold-digger	Prostitute
Networker	Social person
Compromises	Doesn't compromise
Someone "here to help"	Erudite, dilettante, amateur
Merchant, professional (Classical period)	Landowner (Classical period)
Employee	Artisan
Academic at a research university, researcher depending on "grants"	Lens maker, philosophy teacher in a college or Lycée high school, independent scholar

There exists an inverse Alan Blinder problem, called “evidence against one’s interest.” One should give more weight to witnesses and opinions when they present the opposite of a conflict of interest. A pharmacist or an executive of Big Pharma who advocates starvation and *via negativa* methods to cure diabetes would be more credible than another one who favors the ingestion of drugs.

BIG DATA AND THE RESEARCHER’S OPTION

This is a bit technical, so the reader can skip this section with no loss. But optionality is everywhere, and here is a place to discuss a version of cherry-picking that destroys the entire spirit of research and makes the abundance of data extremely harmful to knowledge. More data means more information, perhaps, but it also means more false information. We are discovering that fewer and fewer papers replicate—textbooks in, say, psychology need to be revised. As to economics, fuhgetaboudit. You can hardly trust many statistically oriented sciences—especially when the researcher is under pressure to publish for his career. Yet the claim will be “to advance knowledge.”

Recall the notion of epiphenomenon as a distinction between real life and libraries. Someone looking at history from the vantage point of a library will necessarily find many more spurious relationships than

one who sees matters in the making, in the usual sequences one observes in real life. He will be duped by more epiphenomena, one of which is the direct result of the excess of data as compared to real signals.

We discussed the rise of noise in Chapter 7. Here it becomes a worse problem, because there is an optionality on the part of the researcher, no different from that of a banker. The researcher gets the upside, truth gets the downside. The researcher's free option is in his ability to pick whatever statistics can confirm his belief—or show a good result—and ditch the rest. He has the *option* to stop once he has the right result. But beyond that, he can find statistical relationships—the spurious rises to the surface. There is a certain property of data: in large data sets, large deviations are vastly more attributable to noise (or variance) than to information (or signal).*

Spurious Correlations

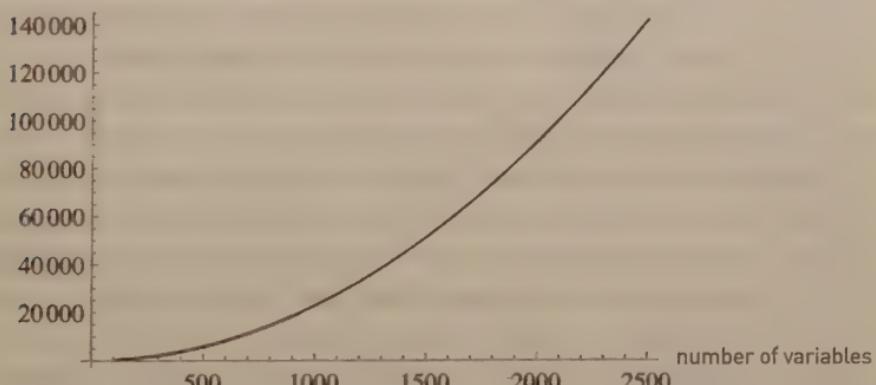


FIGURE 18. The Tragedy of Big Data. The more variables, the more correlations that can show significance in the hands of a "skilled" researcher. Falsity grows faster than information; it is nonlinear (convex) with respect to data.

There is a difference in medical research between (a) observational studies, in which the researcher looks at statistical relationships on his computer, and (b) the double-blind cohort experiments that extract information in a realistic way that mimics real life.

The former, that is, observation from a computer, produces all man-

* It is a property of sampling. In real life, if you are observing things in real time, then large deviations matter a lot. But when a researcher looks for them, then they are likely to be bogus—in real life there is no cherry-picking, but on the researcher's computer, there is.

ner of results that tend to be, as last computed by John Ioannides, now more than eight times out of ten, spurious—yet these observational studies get reported in the papers and in *some* scientific journals. Thankfully, these observational studies are not accepted by the Food and Drug Administration, as the agency's scientists know better. The great Stan Young, an activist against spurious statistics, and I found a genetics-based study in *The New England Journal of Medicine* claiming significance from statistical data—while the results to us were no better than random. We wrote to the journal, to no avail.

Figure 18 shows the swelling number of potential spurious relationships. The idea is as follows. If I have a set of 200 random variables, completely unrelated to each other, then it would be near impossible not to find in it a high correlation of sorts, say 30 percent, but that is entirely spurious. There are techniques to control the cherry-picking (one of which is known as the Bonferroni adjustment), but even then they don't catch the culprits—much as regulation doesn't stop insiders from gaming the system. This explains why in the twelve years or so since we've decoded the human genome, not much of significance has been found. I am not saying that there is no information in the data: the problem is that the needle comes in a haystack.

Even experiments can be marred with bias: the researcher has the incentive to select the experiment that corresponds to what he was looking for, hiding the failed attempts. He can also formulate a hypothesis after the results of the experiment—thus fitting the hypothesis to the experiment. The bias is smaller, though, than in the previous case.

The fooled-by-data effect is accelerating. There is a nasty phenomenon called “Big Data” in which researchers have brought cherry-picking to an industrial level. Modernity provides too many variables (but too little data per variable), and the spurious relationships grow much, much faster than real information, as noise is convex and information is concave.

Increasingly, data can only truly deliver *via negativa*-style knowledge—it can be effectively used to debunk, not confirm.

The tragedy is that it is very hard to get funding to replicate—and reject—existing studies. And even if there were money for it, it would be hard to find takers: trying to replicate studies will not make anyone a hero. So we are crippled with a distrust of empirical results, except for those that are negative. To return to my romantic idea of the amateur and tea-drinking English clergyman: the professional researcher com-

petes to “find” relationships. Science must not be a competition; it must not have rankings—we can see how such a system will end up blowing up. Knowledge must not have an agency problem.

THE TYRANNY OF THE COLLECTIVE

Mistakes made collectively, not individually, are the hallmark of organized knowledge—and the best argument against it. The argument “because everyone is doing it” or “that’s how others do it” abounds. It is not trivial: people who on their own would not do something because they find it silly now engage in the same thing but in groups. And this is where academia in its institutional structure tends to violate science.

One doctoral student at the University of Massachusetts, Chris S., once came to tell me that he believed in my ideas of “fat tails” and my skepticism of current methods of risk management, but that it would not help him get an academic job. “It’s what everybody teaches and uses in papers,” he said. Another student explained that he wanted a job at a good university so he could make money testifying as an expert witness—they would not buy my ideas on robust risk management because “everyone uses these textbooks.” Likewise, I was asked by the administration of a university to teach standard risk methods that I believe are pure charlatanism (I refused). Is my duty as a professor to get students a job at the expense of society, or to fulfill my civic obligations? Well, if the former is the case, then economics and business schools have a severe ethical problem. For the point is generalized and that’s why economics hasn’t collapsed yet in spite of the obvious nonsense in it—and *scientifically proven* nonsense in it. (In my “fourth quadrant” paper—see discussion in the Appendix—I show how these methods are empirically invalid, in addition to being severely mathematically inconsistent, in other words, a scientific swindle). Recall that professors are not penalized when they teach you something that blows up the financial system, which perpetuates the fraud. Departments need to teach *something* so students get jobs, even if they are teaching snake oil—this got us trapped in a circular system in which everyone knows that the material is wrong but nobody is free enough or has enough courage to do anything about it.

The problem is that the last place on the planet where the “other people think so” argument can be used is science: science is precisely about arguments standing on their own legs, and something proven to

be wrong empirically or mathematically is plain wrong, whether a hundred “experts” or three trillion disagree with the statement. And the very use of “other people” to back up one’s claims is indicative that the person—or the entire collective that composes the “other”—is a wimp. The appendix shows what has been busted in economics, and what people keep using because they are not harmed by error, and that’s the optimal strategy for keeping a job or getting a promotion.

But the good news is that I am convinced that a single person with courage can bring down a collective composed of wimps.

And here, once again, we need to go back into history for the cure. The scriptures were quite aware of the problem of the diffusion of responsibility and made it a sin to follow the crowd in doing evil—as well as to give false testimony in order to conform to the multitude.

I close Book VII with a thought. Whenever I hear the phrase “I am ethical” uttered, I get tense. When I hear about classes in ethics, I get even more tense. All I want is to remove the optionality, reduce the antifragility of some at the expense of others. It is simple *via negativa*. The rest will take care of itself.

Conclusion

As usual at the end of the journey, while I was looking at the entire manuscript on a restaurant table, someone from a Semitic culture asked me to explain my book standing on one leg. This time it was Shaiy Pilpel, a probabilist with whom I've had a two-decades-long calm conversation without a single episode of small talk. It is hard to find people knowledgeable and confident enough to like to extract the essence of things, instead of nitpicking.

With the previous book, one of his compatriots asked me the same question, but I had to think about it. This time I did not even have to make an effort.

It was so obvious that Shaiy summed it up himself in the same breath. He actually believes that all real ideas can be distilled down to a central issue that the great majority of people in a given field, by dint of specialization and empty-suitedness, completely miss. Everything in religious law comes down to the refinements, applications, and interpretations of the Golden Rule, “Don’t do unto others what you don’t want them to do to you.” This we saw was the logic behind Hammurabi’s rule. And the Golden Rule was a true distillation, not a Procrustean bed. A central argument is never a summary—it is more like a generator.

Shaiy’s extraction was: *Everything gains or loses from volatility. Fragility is what loses from volatility and uncertainty.* The glass on the table is short volatility.

In the novel *The Plague* by Albert Camus, a character spends part of his life searching for the perfect opening sentence for a novel. Once he

had that sentence, he had the full book as a derivation of the opening. But the reader, to understand and appreciate the first sentence, will have to read the entire book.

I glanced at the manuscript with a feeling of calm elation. Every sentence in the book was a derivation, an application, or an interpretation of the short maxim. Some details and extensions can be counterintuitive and elaborate, particularly when it comes to decision making under opacity, but at the end everything flows from it.

The reader is invited to do the same. Look around you, at your life, at objects, at relationships, at entities. You may replace *volatility* with other members of the disorder cluster here and there for clarity, but it is not even necessary—when formally expressed, it is all the same symbol. Time is volatility. Education, in the sense of the formation of character, personality, and acquisition of true knowledge, likes disorder; label-driven education and educators abhor disorder. Some things break because of error, others don't. Some theories fall apart, not others. Innovation is precisely something that gains from uncertainty: and some people sit around waiting for uncertainty and using it as raw material, just like our ancestral hunters.

Prometheus is long disorder; Epimetheus is short disorder. We can separate people and the quality of their experiences based on exposure to disorder and appetite for it: Spartan hoplites contra bloggers, adventurers contra copy editors, Phoenician traders contra Latin grammarians, and pirates contra tango instructors.

It so happens that everything nonlinear is convex or concave, or both, depending on the intensity of the stressor. We saw the link between convexity and liking volatility. So everything likes or hates volatility up to a point. Everything.

We can detect what likes volatility thanks to convexity or acceleration and higher orders, since convexity is the response by a thing that likes disorder. We can build Black Swan-protected systems thanks to detection of concavity. We can take medical decisions by understanding the convexity of harm and the logic of Mother Nature's tinkering, on which side we face opacity, which error we should risk. Ethics is largely about stolen convexities and optionality.

More technically, we may never get to know x , but we can play with the exposure to x , barbell things to defang them; we can control a function of x , $f(x)$, even if x remains vastly beyond our understanding. We

can keep changing $f(x)$ until we are comfortable with it by a mechanism called *convex transformation*, the fancier name for the barbell.

This short maxim also tells you where fragility supersedes truth, why we lie to children, and why we humans got a bit ahead of ourselves in this large enterprise called modernity.

Distributed randomness (as opposed to the concentrated type) is a necessity, not an option: everything big is short volatility. So is everything fast. Big and fast are abominations. Modern times don't like volatility.

And the Triad gives us some indication of what should be done to live in a world that does not want us to understand it, a world whose charm comes from our inability to truly understand it.

The glass is dead; living things are long volatility. The best way to verify that you are alive is by checking if you like variations. Remember that food would not have a taste if it weren't for hunger; results are meaningless without effort, joy without sadness, convictions without uncertainty, and an ethical life isn't so when stripped of personal risks.

And once again, reader, thank you for reading my book.

EPILOGUE

From Resurrection to Resurrection

It was an aortic aneurism.

Nero was in the Levant for his annual celebration of the death and rebirth of Adonis. It was a period of mourning with wailing women, followed by a celebration of resurrection. He watched nature waking up from the mild Mediterranean winter, when the rivers are full of reddish water, the blood of the Phoenician god wounded by the boar, as the melted snow from the mountains swelled the rivers and rivulets.

Things in nature move ahead from resurrection to resurrection.

That was when Tony's driver called. His name was also Tony, and while identified as Tony-the-driver he pretended he was a bodyguard (when in fact it looked like, given the comparative size, he was the one bodyguarded by Tony). Nero never liked him, always had that strange feeling of distrust, so the moment of sharing the news was odd. During his silence on the line, he felt sympathy for Tony-the-driver.

Nero was designated as the executor of Tony's will, which made him initially nervous. He had somehow a fear that Tony's wisdom would have a gigantic Achilles' heel somewhere. But, it turned out, there was nothing serious, a flawless estate, of course debt-free, conservative, fairly distributed. There were some funds to discreetly provide to a woman likely to be a prostitute, for whom Tony had some antifragile obsessive love, of course helped by the fact that she was both older and much less attractive than Tony's wife, that sort of thing. So nothing serious.

Except for the posthumous prank. Tony bequeathed to Nero a sum of twenty million dollars to spend at his discretion on . . . It was to be a secret mission; noble of course, but secret. And, of course, vague. And dangerous. It was the best compliment Nero ever got from Tony: trusting that Nero would be able to read his mind.

Which he did.

Glossary

Triad: The triplet Antifragility, Robustness, Fragility.

Fundamental Asymmetry (also **Seneca's Asymmetry**): When someone has *more upside than downside* in a certain situation, he is antifragile and tends to gain from (a) volatility, (b) randomness, (c) errors, (d) uncertainty, (e) stressors, (f) time. And the reverse.

Procrustean bed: Procrustes got people to fit perfectly into his bed by cutting or stretching their limbs. Corresponds to situations in which simplifications are not simplifications.

Fragilista: Someone who causes fragility because he thinks he understands what's going on. Also usually lacks sense of humor. See **Iatrogenics**. Often Fragilistas fragilize by depriving variability-loving systems of variability and error-loving systems of errors. They tend to mistake organisms for machines and engineering projects.

Lecturing-Birds-How-to-Fly Effect: Inverting the arrow of knowledge to read academia → practice, or education → wealth, to make it look as though technology owes more to institutional science than it actually does.

Touristification: The attempt to suck randomness out of life. Applies to soccer moms, Washington civil servants, strategic planners, social engineers, “nudge” manipulators, etc. Opposite: **rational flâneur**.

Rational flâneur (or just **flâneur**): Someone who, unlike a tourist, makes a decision opportunistically at every step to revise his schedule (or his

destination) so he can imbibe things based on new information obtained. In research and entrepreneurship, being a flâneur is called “looking for optionality.” A non-narrative approach to life.

Barbell Strategy: A dual strategy, a combination of two extremes, one safe and one speculative, deemed more robust than a “monomodal” strategy; often a necessary condition for antifragility. For instance, in biological systems, the equivalent of marrying an accountant and having an occasional fling with a rock star; for a writer, getting a stable sinecure and writing without the pressures of the market during spare time. Even trial and error are a form of barbell.

Iatrogenics: Harm done by the healer, as when the doctor’s interventions do more harm than good.

Generalized Iatrogenics: By extension, applies to the harmful side effects of actions by policy makers and activities of academics.

Tantalized Class: An economic condition of making more than minimum wage *and* wishing for more wealth. Workers, monks, hippies, some artists, and English aristocrats escape it. The middle class tends to fall into it; so do Russian billionaires, lobbyists, most bankers, and bureaucrats. Members are bribable provided they are given an adequate narrative, mostly with the use of casuistry.

Black Swan Errors

Nonpredictive Approach: Building stuff in a manner immune to perturbations—hence robust to changes in future outcomes.

Thalesian versus Aristotelian: The Thalesian focuses on exposure, payoff from decision; the Aristotelian focuses on logic, the True-False distinction. For Fat Tony, the problem is all about sucker-nonsucker, or risks and rewards. (Also see **nonlinearities, convexity effects**.)

Conflation of Event and Exposure: Mistaking a function of a variable for the variable itself.

Naturalistic Risk Management: The belief that, when it comes to risk management, Mother Nature has a much, much more significant track record than rationalistic humans. It is imperfect, but much better.

Burden of evidence: The burden of evidence falls on those who disrupt the natural, or those who propose *via positiva* policies.

Ludic Fallacy: Mistaking the well-posed problems of mathematics and laboratory experiments for the ecologically complex real world. Includes mistaking the randomness in casinos for that in real life.

Antifragile Tinkering, Bricolage: A certain class of trial and error, with small errors being “the right” kind of mistakes. All equivalent to rational flâneur.

Hormesis: A bit of a harmful substance, or stressor, in the right dose or with the right intensity, stimulates the organism and makes it better, stronger, healthier, and prepared for a stronger dose the next exposure. (Think of bones and karate.)

Naive Interventionism: Intervention with disregard to iatrogenics. The preference, even obligation, to “do something” over doing nothing. While this instinct can be beneficial in emergency rooms or ancestral environments, it hurts in others in which there is an “expert problem.”

Naive Rationalism: Thinking that the reasons for things are, by default, accessible to university buildings. Also called the **Soviet-Harvard illusion**.

Turkey and Inverse Turkey: The turkey is fed by the butcher for a thousand days, and every day the turkey pronounces with increased statistical confidence that the butcher “will never hurt it”—until Thanksgiving, which brings a Black Swan revision of belief for the turkey. The **inverse turkey error** is the mirror confusion, not seeing opportunities—pronouncing that one has evidence that someone digging for gold or searching for cures will “never find” anything.

Doxastic Commitment, or “Soul in the Game”: You must only believe predictions and opinions by those who committed themselves to a cer-

tain belief, and had something to lose, in a way to pay a cost in being wrong.

Heuristics: Simple, practical, easy-to-apply rules of thumb that make life easy. These are necessary (we do not have the mental power to absorb all information and tend to be confused by details) but they can get us in trouble as we do not know we are using them when forming judgments.

Opaque Heuristic: Routine performed by societies that does not seem to make sense yet has been done for a long time and sticks for unknown reasons.

Dionysian: Opaque heuristic seemingly irrational, named after Dionysos (or Bacchus for Romans), the god of wine and revelling. Is contrasted to the Apollonian, which represents order.

Agency Problem: Situation in which the manager of a business is not the true owner, so he follows a strategy that cosmetically seems to be sound, but in a hidden way benefits him and makes him antifragile at the expense (fragility) of the true owners or society. When he is right, he collects large benefits; when he is wrong, others pay the price. Typically this problem leads to fragility, as it is easy to hide risks. It also affects politicians and academics. A major source of fragility.

Hammurabi Risk Management: The idea that a builder has more knowledge than the inspector and can hide risks in the foundations where they can be most invisible; the remedy is to remove the incentive in favor of delayed risk.

Green Lumber Fallacy: Mistaking the source of important or even necessary knowledge—the greenness of lumber—for another, less visible from the outside, less tractable one. How theoreticians impute wrong weights to what one should know in a certain business or, more generally, how many things we call “relevant knowledge” aren’t so much so.

Skin in the Game / Captain and Ship Rule: Every captain goes down with every ship. This removes the agency problem and the lack of doxastic commitment.

Empedocles' Tile: A dog sleeps on the same tile because of a natural, biological, explainable or nonexplainable match, confirmed by long series of recurrent frequentation. We may never know the reason, but the match is there. Example: why we read books.

Cherry-picking: Selecting from the data what serves to prove one's point and ignoring disconfirming elements.

Ethical Problems as Transfers of Asymmetry (fragility): Someone steals antifragility and optionality from others, getting the upside and sticking others with the downside. "Others' skin in the game."

The Robert Rubin violation: Stolen optionality. Getting upside from a strategy without downside for oneself, leaving the harm to society. Rubin got \$120 million in compensation from Citibank; taxpayers are retrospectively paying for his errors.

The Alan Blinder problem: (1) Using privileges of office retrospectively at the expense of citizens. (2) Violating moral rules while complying perfectly with the law; confusion of ethical and legal. (3) The regulator's incentive to make complicated regulations in order to subsequently sell his "expertise" to the private sector.

The Joseph Stiglitz problem: Lack of penalty from bad recommendation causing harm to others. Mental cherry-picking, leading to contributing to the cause of a crisis while being convinced of the opposite—and thinking he predicted it. Applies to people with opinions without skin in the game.

Rational Optionality: Not being locked into a given program, so one can change his mind as he goes along based on discovery or new information. Also applies to **rational flâneur**.

Ethical Inversion: Fitting one's ethics to actions (or profession) rather than the reverse.

Narrative Fallacy: Our need to fit a story, or pattern, to a series of connected or disconnected facts. The statistical application is data mining.

Narrative Discipline: Discipline that consists of fitting a convincing and good-sounding story to the past. Opposed to experimental discipline. A great way to fool people is to use statistics as part of the narrative, by ferreting out “good stories” from the data thanks to cherry picking; in medicine, epidemiological studies tend to be marred with the narrative fallacy, less so controlled experiments. Controlled experiments are more rigorous, less subjected to **cherry-picking**.

Non-narrative action: Does not depend on a narrative for the action to be right—the narrative is just there to motivate, entertain, or prompt action. See **flâneur**.

Robust Narrative: When the narrative does not produce opposite conclusions or recommendations for action under change of assumption or environment. The narrative is otherwise fragile. Similarly, a robust model or mathematical tool does not lead to different policies when you change some parts of the model.

Subtractive Knowledge: You know what is wrong with more certainty than you know anything else. An application of *via negativa*.

Via negativa: In theology and philosophy, the focus on what something is not, an indirect definition. In action, it is a recipe for what to avoid, what not to do—subtraction, not addition, say, in medicine.

Subtractive Prophecy: Predicting the future by removing what is fragile from it rather than naively adding to it. An application of *via negativa*.

Lindy Effect: A technology, or anything nonperishable, increases in life expectancy with every day of its life—unlike perishable items (such as humans, cats, dogs, and tomatoes). So a book that has been a hundred years in print is likely to stay in print another hundred years.

Neomania: A love of change for its own sake, a form of philistinism that does not comply with the **Lindy effect** and understands fragility. Forecasts the future by adding, not subtracting.

Opacity: You do not see the barrel when someone is playing Russian roulette. More generally, some things remain opaque to us, leading to illusions of understanding.

Mediocristan: A process dominated by the mediocre, with few extreme successes or failures (say, income for a dentist). No single observation can meaningfully affect the aggregate. Also called “thin-tailed,” or member of the Gaussian family of distributions.

Extremistan: A process where the total can be conceivably impacted by a single observation (say, income for a writer). Also called “fat-tailed.” Includes the fractal, or power-law, family of distributions.

Nonlinearities, Convexity Effects (smiles and frowns): Nonlinearities can be concave or convex, or a mix of both. The term **convexity effects** is an extension and generalization of the fundamental asymmetry. The technical name for fragility is negative convexity effects and for antifragility is positive convexity effects. Convex is good (a smiley), concave is bad (a frowny).

Philosopher’s Stone, also called Convexity Bias (very technical): The exact measure of benefits derived from nonlinearity or optionality (or, even more technically, the difference between x and a convex function of x). For instance, such bias can quantify the health benefits of variable intensity of pulmonary ventilation over steady pressure, or compute the gains from infrequent feeding. The **Procrustean bed** from the neglect of nonlinearity (to “simplify”) lies in assuming such convexity bias does not exist.

Appendix I: A GRAPHICAL TOUR OF THE BOOK

For those nonliterary folks who like to see things in graphs, rather than words, and those only.

NONLINEARITY AND LESS IS MORE (& PROCRUSTEAN BED)

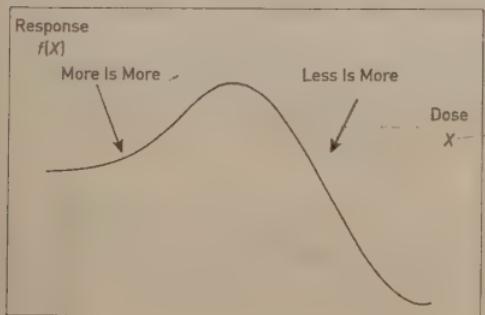


FIGURE 19. This graph explains both the nonlinear response and the “less is more” idea. As the dose increases beyond a certain point, benefits reverse. We saw that everything nonlinear is either convex, concave, or, as in this graph, mixed. Also shows how under nonlinearities, reductions fail: the Procrustean bed of words “good for you” or “bad” is severely distorting.

Also shows why tinkering-derived heuristics matter because they don't take you into the danger zone—words and narratives do. Note how the “more is more” zone is convex, meaning accelerated initial benefits. (In Levantine Arabic, the zone beyond the saturation has a name: *كفرنا مثل قلتنا* “more of it is like less of it.”)

Finally, it shows why competitive “sophistication” (rather, complication masked as sophistication) is harmful, as compared to the practitioner's craving for optimal simplicity.

Fragility Transfer Theorem:

Note that by the Fragility Transfer Theorem,

CONVEX EXPOSURE [OVER SOME RANGE] \leftrightarrow LIKES VOLATILITY [UP TO SOME POINT]

(volatility and other members of the disorder cluster), and

CONCAVE EXPOSURE \leftrightarrow DISLIKES VOLATILITY

MAPPING OF FRAGILITIES

In Time Series Space

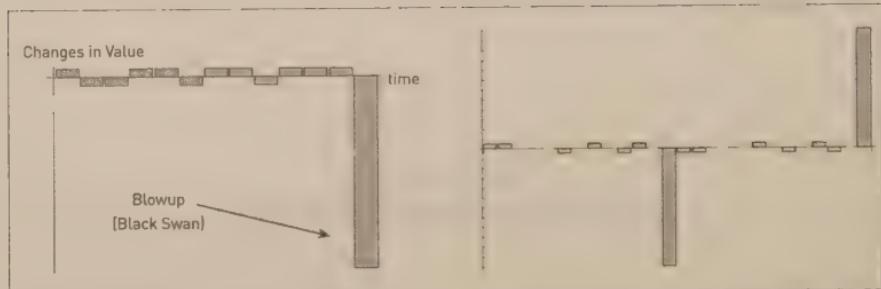


FIGURE 20. *Fragile variations through time, two types of fragilities.* A representative series. The horizontal axis shows time, the vertical one shows variations. This can apply to anything: a health indicator, changes in wealth, your happiness, etc. We can see small (or no) benefits and variations most of the time and occasional large adverse outcomes. Uncertainty can hit in a rather hard way. Notice that the loss can occur at any time and exceed the previous cumulative gains. Type 2 (left) and Type 1 (right) differ in that Type 2 does not experience large positive effects from uncertainty while Type 1 does.

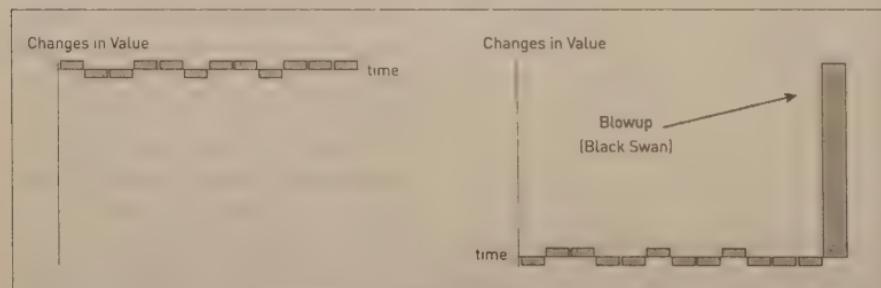
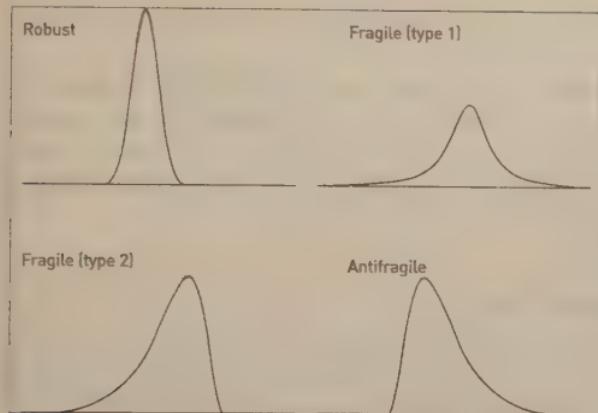


FIGURE 21. *The Just Robust (but not antifragile) (on the left): It experiences small or no variations through time. Never large ones. The Antifragile system (right): Uncertainty benefits a lot more than it hurts—the exact opposite of the first graph in Figure 20.*

Seen in Probabilities

FIGURE 22. The horizontal axis represents outcomes, the vertical their probability (i.e., their frequency). The Robust: Small positive and negative outcomes. The Fragile (Type 1, very rare): Can deliver both large negative and large positive outcomes. Why is it rare? Symmetry is very, very rare empirically yet all statistical distributions tend to simplify by using it. The Fragile (Type 2): We see large improbable downside (often hidden and ignored), small upside. There is a possibility of a se-



vere unfavorable outcome (left), much more than a hugely favorable one, as the left side is thicker than the right one. **The Anti-fragile:** Large upside, small downside. Large favorable outcomes are possible, large unfavorable ones less so (if not impossible). The right “tail,” for favorable outcomes, is larger than the left one.

TABLE 9 • THE FOUR DIFFERENT CLASSES OF PAYOFFS

Left Tail of the Distribution	Right Tail of the Distribution	Condition
Thin	Thick	Antifragile
Thick	Thick	Fragile [Type 1] [Very Rare]
Thick	Thin	Fragile [Type 2]
Thin	Thin	Robust

Fragility has a left tail and, what is crucial, is therefore sensitive to perturbations of the left side of the probability distribution.

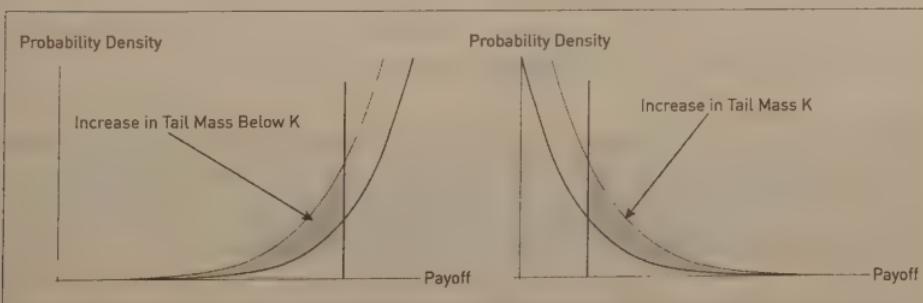


FIGURE 23. **Definition of Fragility** (left graph): Fragility is the shaded area, the increase in the mass in left tail below a certain level K of the target variable in response to any change in parameter of the source variable—mostly the “volatility” or something a bit more tuned. We subsume all these changes in s^2 , about which later in the notes section (where I managed to hide equations).

For a definition of antifragility (right graph), which is not exactly symmetric, the

same mirror image for right tail plus robustness in left tail. The parameter perturbed is s^+ .

It is key that while we may not be able to specify the probability distribution with any precision, we can probe the response through heuristics thanks to the “transfer theorem” in Taleb and Douady (2012). In other words, we do not need to understand the future probability of events, but we can figure out the fragility to these events.

BARBELL TRANSFORMATION IN TIME SERIES

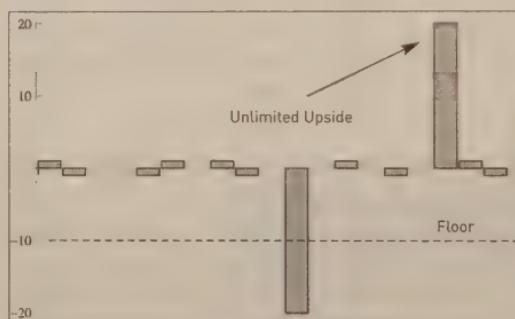
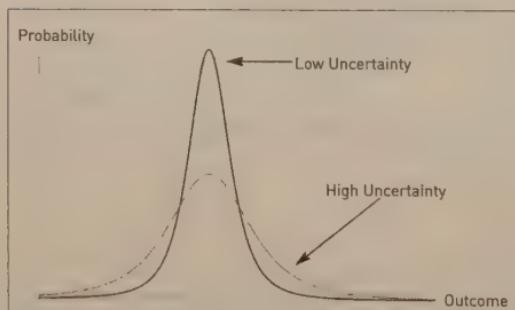


FIGURE 24. Barbell seen in time series space. Flooring payoffs while keeping upside.

BARBELLS (CONVEX TRANSFORMATIONS) AND THEIR PROPERTIES IN PROBABILITY SPACE



A graphical expression of the barbell idea.

FIGURE 25. Case 1, the Symmetric Case. Injecting uncertainty into the system makes us move from one bell shape—the first, with narrow possible slate of outcomes—to the second, a lower peak but more spread out. So it causes an increase of both positive and negative surprises, both positive and negative Black Swans.

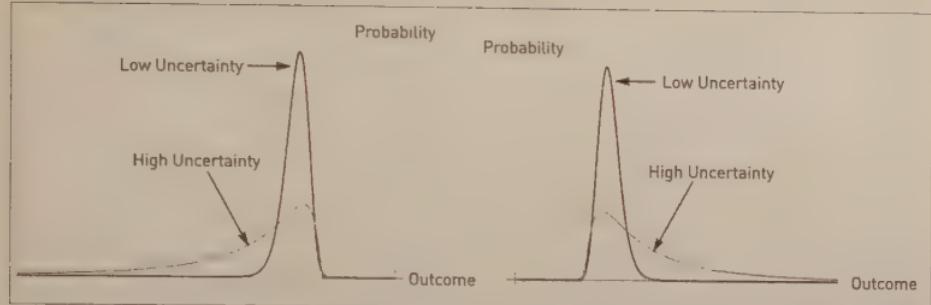


FIGURE 26. Case 2 (left): *Fragile*. Limited gains, larger losses. Increasing uncertainty in the system causes an augmentation of mostly (sometimes only) negative outcomes, just negative Black Swans. Case 3 (right): *Antifragile*. Increasing randomness and uncertainty in the system raises the probability of very favorable outcomes, and accordingly expand the expected payoff. It shows how discovery is, mathematically, exactly like an anti-airplane delay.

TECHNICAL VERSION OF FAT TONY'S "NOT THE SAME 'TING,'" OR THE CONFLATION OF EVENTS AND EXPOSURE TO EVENTS

This note will also explain a “convex transformation.”

$f(x)$ is *exposure* to the variable x . $f(x)$ can equivalently be called “payoff from x ,” “exposure to x ,” even “utility of payoff from x ” where we introduce in f a utility function. x can be anything.

Example: x is the intensity of an earthquake on some scale in some specific area, $f(x)$ is the number of persons dying from it. We can easily see that $f(x)$ can be made more predictable than x (if we force people to stay away from a specific area or build to some standards, etc.).

Example: x is the number of meters of my fall to the ground when someone pushes me from height x , $f(x)$ is a measure of my physical condition from the effect of the fall. Clearly I cannot predict x (who will push me, rather $f(x)$).

Example: x is the number of cars in NYC at noon tomorrow, $f(x)$ is travel time from point A to point B for a certain agent. $f(x)$ can be made more predictable than x (take the subway, or, even better, walk).

Some people talk about $f(x)$ thinking they are talking about x . This is the problem of the **conflation of event and exposure**. This error present in Aristotle is virtually ubiquitous in the philosophy of probability (say, Hacking).

One can become antifragile to x without understanding x , through convexity of $f(x)$.

The answer to the question “what do you do in a world you don’t understand?” is, simply, work on the undesirable states of $f(x)$.

It is often easier to modify $f(x)$ than to get better knowledge of x . (In other words, robustification rather than forecasting Black Swans.)

Example: If I buy an insurance on the market, here x , dropping more than 20 percent, $f(x)$ will be independent of the part of the probability distribution of x that is below 20 percent and impervious to changes in its scale parameter. (This is an example of a barbell.)

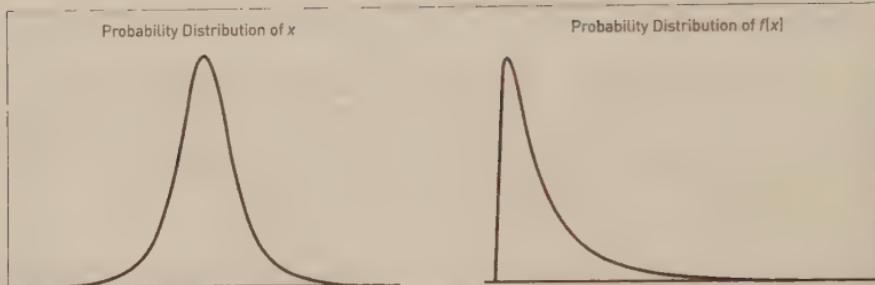


FIGURE 27. Convex Transformation ($f(x)$ is a convex function of x). The difference between x and exposure to x . There is no downside risk in the second graph. The key is to modify $f(x)$ in order to make knowledge of the properties of x on the left side of the distribution as irrelevant as possible. This operation is called convex transformation, nicknamed “barbell” here.

Green lumber fallacy: When one confuses $f(x)$ for another function $g(x)$, one that has different nonlinearities.

More technically: If one is antifragile to x , then the variance (or volatility, or other measures of variation) of x benefit $f(x)$, since distributions that are skewed have their mean depend on the variance and when skewed right, their expectation increases with variance (the lognormal, for instance, has for mean a term that includes $+1/2 \sigma^2$).

Further, the probability distribution of $f(x)$ is markedly different from that of x , particularly in the presence of nonlinearities.

When $f(x)$ is convex (concave) monotonically, $f(x)$ is right (left) skewed.

When $f(x)$ is increasing and convex on the left then concave to the right, the probability distribution of $f(x)$ is thinner-tailed than that of x . For instance, in Kahneman-Tversky's prospect theory, the so-called utility of changes in wealth is more “robust” than that of wealth.

Why payoff matters more than probability (technical): Where $p(x)$ is the density, the expectation, that is $\int f(x)p(x)dx$, will depend increasingly on f rather than p , and the more nonlinear f , the more it will depend on f rather than p .

THE FOURTH QUADRANT (TALEB, 2009)

The idea is that tail events are not computable (in fat-tailed domains), but we can assess our exposure to the problem. Assume $f(x)$ is an increasing function, Table 10 connects the idea to the notion of the Fourth Quadrant.

TABLE 10

	THIN-TAILED DISTRIBUTION FOR X	FAT-TAILED DISTRIBUTION FOR X
$f(x)$ "mitigating" by clipping extreme outcomes, i.e., convex-concave	Very robust outcome	Quite robust outcome
$f(x)$ concave-convex, exacerbates remote outcomes	Robust outcome (sort of)	FOURTH QUADRANT Fragile (if $f(x)$ is concave) or antifragile

LOCAL AND GLOBAL CONVEXITIES (TECHNICAL)

Nothing is open-ended in nature—death is a maximum outcome for a unit. So things end up convex on one end, concave on the other.

In fact, there is maximum harm at some point in things biological. Let us revisit the concave figure of the stone and pebbles in Chapter 18: by widening the range we see that boundedness of harm brings convexities somewhere. Concavity was dominant, but local. Figure 28 looks at the continuation of the story of the stone and pebbles.

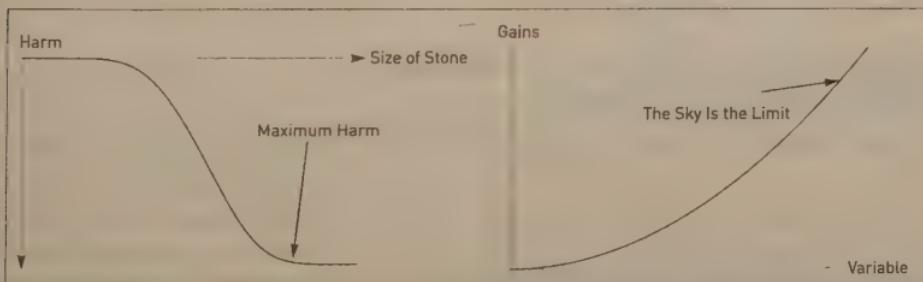


FIGURE 28. The left graph shows a broader range in the story of the stone and pebbles in Chapter 18. At some point, the concave turns convex as we hit maximum harm. The right graph shows strong antifragility, with no known upper limit (leading to Extremistan). These payoffs are only available in economic variables, say, sales of books, or matters unbounded or near-unbounded. I am unable to find such an effect in nature.

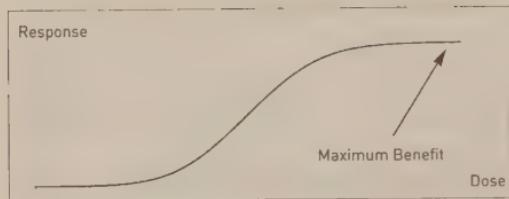


FIGURE 29. Weak Antifragility (Mediocristan), with bounded maximum. Typical in nature.

FREAK NONLINEARITIES (VERY TECHNICAL)

The next two types of nonlinearities are almost never seen outside of economic variables; they are particularly limited to those caused by derivatives.

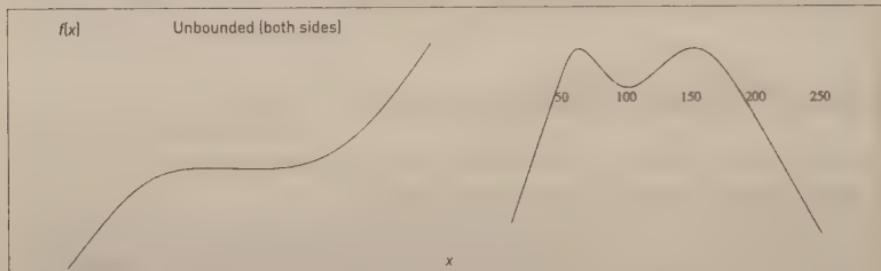


FIGURE 30. The left graph shows a convex-concave increasing function, the opposite of the bounded dose-response functions we see in nature. It leads to Type 2, Fragile (very, very fat tails). The right graph shows the most dangerous of all: pseudoconvexity. Local antifragility, global fragility.

MEDICAL NONLINEARITIES AND THEIR PROBABILITY CORRESPONDENCE (CHAPTERS 21 & 22)

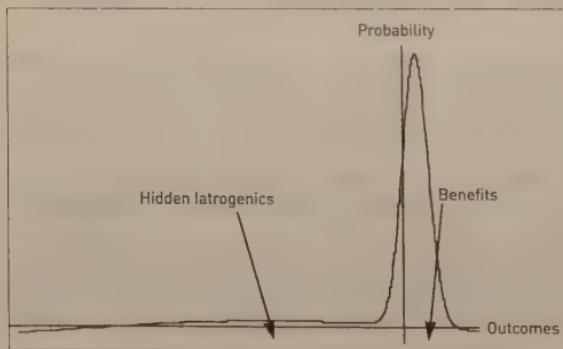
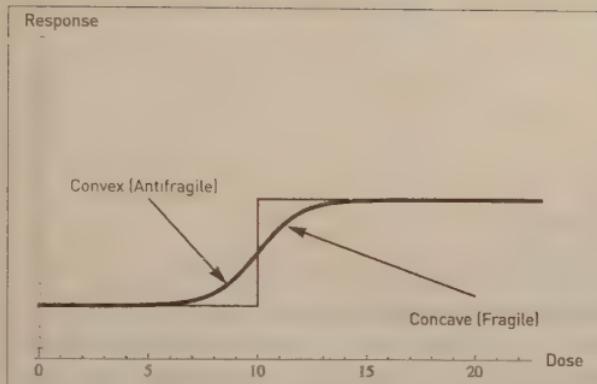


FIGURE 31. Medical Iatrogenics: Case of small benefits and large Black Swan-style losses seen in probability space. Iatrogenics occurs when we have small identifiable gains (say, avoidance of small discomfort or a minor infection) and exposure to Black Swans with delayed invisible large side effects (say, death). These

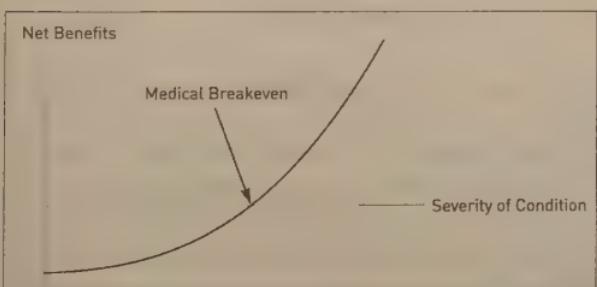
concave benefits from medicine are just like selling a financial option (plenty of risk) against small tiny immediate gains while claiming "evidence of no harm."

In short, for a healthy person, there is a small probability of disastrous outcomes (discounted because unseen and not taken into account), and a high probability of mild benefits.



Additional doses tend to become gradually ineffective or start hurting. The same can apply to anything consumed in too much regularity. This type of graph necessarily applies to any situation bounded on both sides, with a known minimum and maximum (saturation), which includes happiness.

For instance, if one considers that there exists a maximum level of happiness and unhappiness, then the general shape of this curve with convexity on the left and concavity on the right has to hold for happiness (replace “dose” with “wealth” and “response” with “happiness”). Kahneman-Tversky prospect theory models a similar shape for “utility” of changes in wealth, which they discovered empirically.



early as a function of the severity of the condition. This implies that when the patient is very ill, the distribution shifts to antifragile (thicker right tail), with large benefits from the treatment over possible iatrogenics, little to lose.

Note that if you increase the treatment you hit concavity from maximum benefits, a zone not covered in the graph—seen more broadly, it would look like the preceding graph.

FIGURE 32. Nonlinearities in biology. The shape convex-concave necessarily flows from anything increasing (monotone, i.e., never decreasing) and bounded, with maximum and minimum values, i.e., does not reach infinity from either side. At low levels, the dose response is convex (gradually more and more effective).

FIGURE 33. Recall the hypertension example. On the vertical axis, we have the benefits of a treatment, on the horizontal, the severity of the condition. The arrow points at the level where probabilistic gains match probabilistic harm. Iatrogenics disappears nonlinearly.

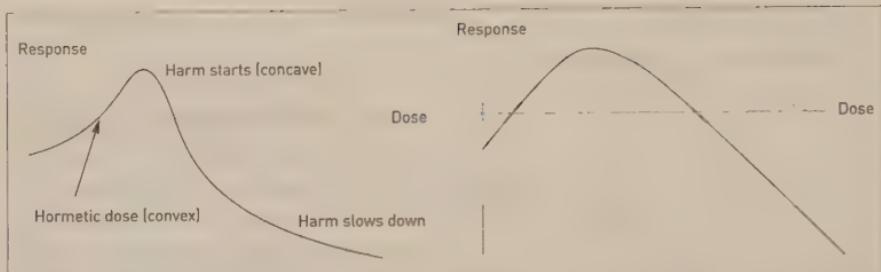


FIGURE 34. The left graph shows hormesis for an organism (similar to Figure 19): we can see a stage of benefits as the dose increases (initially convex) slowing down into a phase of harm as we increase the dose a bit further (initially concave); then we see things flattening out at the level of maximum harm (beyond a certain point, the organism is dead so there is such a thing as a bounded and known worst case scenario in biology). To the right, a wrong graph of hormesis in medical textbooks showing initial concavity, with a beginning that looks linear or slightly concave.

THE INVERSE TURKEY PROBLEM

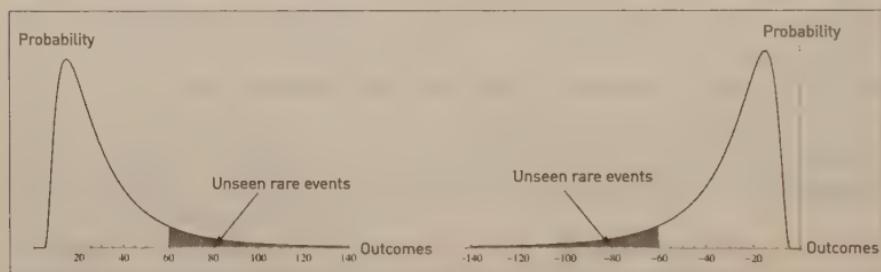


FIGURE 35. Antifragile, Inverse Turkey Problem: The unseen rare event is positive. When you look at a positively skewed (antifragile) time series and make inferences about the unseen, you miss the good stuff and underestimate the benefits (the Pisano, 2006a, 2006b, mistake). On the right, the other Harvard problem, that of Froot (2001). The filled area corresponds to what we do not tend to see in small samples, from insufficiency of points. Interestingly the shaded area increases with model error. The more technical sections call this zone ω_B (turkey) and ω_C (inverse turkey).

DIFFERENCE BETWEEN POINT ESTIMATES AND DISTRIBUTIONS

Let us apply this analysis to how planners make the mistakes they make, and why deficits tend to be worse than planned:

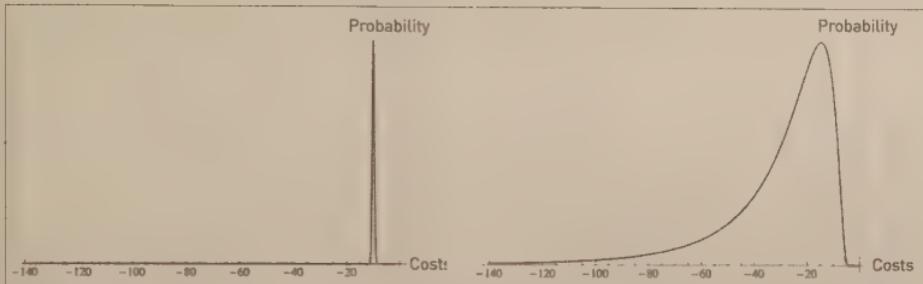


FIGURE 36. *The gap between predictions and reality: probability distribution of outcomes from costs of projects in the minds of planners (left) and in reality (right). In the first graph they assume that the costs will be both low and quite certain. The graph on the right shows outcomes to be both worse and more spread out, particularly with higher possibility of unfavorable outcomes. Note the fragility increase owing to the swelling left tail.*

This misunderstanding of the effect of uncertainty applies to government deficits, plans that have IT components, travel time (to a lesser degree), and many more. We will use the same graph to show model error from underestimating fragility by assuming that a parameter is constant when it is random. This is what plagues bureaucrat-driven economics (next discussion).

Appendix II (Very Technical): WHERE MOST ECONOMIC MODELS FRAGILIZE AND BLOW PEOPLE UP

When I said “technical” in the main text, I may have been fibbing. Here I am not.

The Markowitz incoherence: Assume that someone tells you that the probability of an event is exactly zero. You ask him where he got this from. “Baal told me” is the answer. In such case, the person is coherent, but would be deemed unrealistic by non-Baalists. But if on the other hand, the person tells you “I *estimated* it to be zero,” we have a problem. The person is both unrealistic and inconsistent. Something estimated needs to have an estimation error. So probability cannot be zero if it is estimated, its lower bound is linked to the estimation error; the higher the estimation error, the higher the probability, up to a point. As with Laplace’s argument of total ignorance, an infinite estimation error pushes the probability toward $\frac{1}{2}$.

We will return to the implication of the mistake; take for now that anything estimating a parameter and then putting it into an equation is different from estimating the equation across parameters (same story as the health of the grandmother, the average temperature, here “estimated” is irrelevant, what we need is average health across temperatures). And Markowitz showed his incoherence by starting his “seminal” paper with “Assume you know E and V ” (that is, the expectation and the variance). At the end of the paper he accepts that they need to be estimated, and what is worse, with a combination of statistical techniques and the “judgment of practical men.” Well, if these parameters need to be estimated, with an error, then the derivations need to be written differently and, of course, we would have no paper—and no Markowitz paper, no blowups, no modern finance, no fragilistas teaching junk to students. . . . Economic models are extremely fragile to assumptions, in the sense that a slight alteration in these assumptions can, as we will see, lead to extremely consequential differences in the results. And, to make matters worse, many of these models are “back-fit” to assumptions, in the sense that the hypotheses are selected to make the math work, which makes them ultrafragile and ultrafragilizing.

Simple example: Government deficits.

We use the following deficit example owing to the way calculations by governments and government agencies currently miss convexity terms (and have a hard time accepting it). Really, they don’t take them into account. The example illustrates:

- (a) missing the stochastic character of a variable known to affect the model but deemed deterministic (and fixed), and
- (b) F , the function of such variable, is convex or concave with respect to the variable.

Say a government estimates unemployment for the next three years as averaging 9 percent; it uses its econometric models to issue a forecast balance B of a two-hundred-billion deficit in the local currency. But it misses (like almost everything in economics) that unemployment is a stochastic variable. Employment over a three-year period has fluctuated by 1 percent on average. We can calculate the effect of the error with the following:

Unemployment at 8%, Balance $B(8\%) = -75 \text{ bn}$ (improvement of 125 bn)

Unemployment at 9%, Balance $B(9\%) = -200 \text{ bn}$

Unemployment at 10%, Balance $B(10\%) = -550 \text{ bn}$ (worsening of 350 bn)

The concavity bias, or negative convexity bias, from underestimation of the deficit is -112.5 bn , since $\frac{1}{2} \{B(8\%) + B(10\%)\} = -312 \text{ bn}$, not -200 bn . This is the exact case of the inverse philosopher's stone.

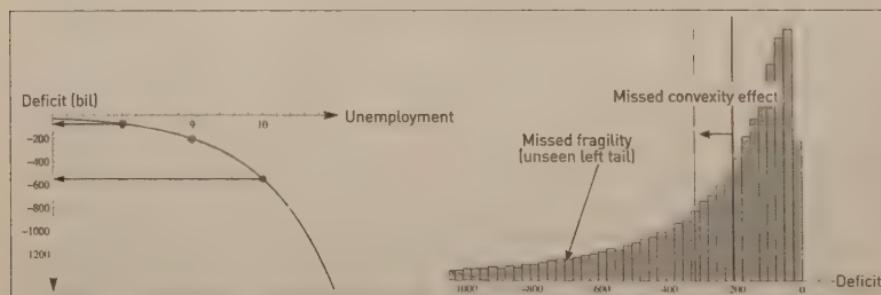


FIGURE 37. Nonlinear transformations allow the detection of both model convexity bias and fragility. Illustration of the example: histogram from Monte Carlo simulation of government deficit as a left-tailed random variable simply as a result of randomizing unemployment, of which it is a concave function. The method of point estimate would assume a Dirac stick at -200 , thus underestimating both the expected deficit (-312) and the tail fragility of it. (From Taleb and Douady, 2012).

Application: Ricardian Model and Left Tail—The Price of Wine Happens to Vary

For almost two hundred years, we've been talking about an idea by the economist David Ricardo called "comparative advantage." In short, it says that a country should have a certain policy based on its comparative advantage in wine or clothes. Say a country is good at both wine and clothes, better than its neighbors with whom it can trade freely. Then the visible *optimal* strategy would be to specialize in either wine or clothes, whichever fits the best and minimizes opportunity costs. Everyone would then be happy. The analogy by the economist Paul Samuelson is that if someone happens to be the best doctor in town and, at the same time, the best secretary,

then it would be preferable to be the higher-earning doctor—as it would minimize opportunity losses—and let someone else be the secretary and buy secretarial services from him.

I agree that there are benefits in *some* form of specialization, but not from the models used to prove it. The flaw with such reasoning is as follows. True, it would be inconceivable for a doctor to become a part-time secretary just because he is good at it. But, at the same time, we can safely assume that being a doctor insures some professional stability: People will not cease to get sick and there is a higher social status associated with the profession than that of secretary, making the profession more desirable. But assume now that in a two-country world, a country specialized in wine, hoping to sell its specialty in the market to the other country, and that *suddenly the price of wine drops precipitously*. Some change in taste caused the price to change. Ricardo's analysis assumes that both the market price of wine and the costs of production remain constant, and there is no "second order" part of the story.

TABLE 11 • RICARDO'S ORIGINAL EXAMPLE
(COSTS OF PRODUCTION PER UNIT)

	CLOTH	WINE
Britain	100	110
Portugal	90	80

The logic: The table above shows the cost of production, normalized to a selling price of one unit each, that is, assuming that these trade at equal price (1 unit of cloth for 1 unit of wine). What looks like the paradox is as follows: that Portugal produces cloth cheaper than Britain, but should buy cloth from there instead, using the gains from the sales of wine. In the absence of transaction and transportation costs, it is efficient for Britain to produce just cloth, and Portugal to only produce wine.

The idea has always attracted economists because of its paradoxical and counterintuitive aspect. For instance, in an article "Why Intellectuals Don't Understand Comparative Advantage" (Krugman, 1998), Paul Krugman, who fails to understand the concept himself, as this essay and his technical work show him to be completely innocent of tail events and risk management, makes fun of other intellectuals such as S. J. Gould who understand tail events albeit intuitively rather than analytically. (Clearly one cannot talk about returns and gains without discounting these benefits by the offsetting risks.) The article shows Krugman falling into the critical and dangerous mistake of confusing function of average and average of function. (Traditional Ricardian analysis assumes the variables are endogenous, but does not add a layer of stochasticity.)

Now consider the price of wine and clothes *variable*—which Ricardo did not assume—with the numbers above the unbiased average long-term value. Further assume that they follow a fat-tailed distribution. Or consider that their costs of production vary according to a fat-tailed distribution.

If the price of wine in the international markets rises by, say, 40 percent, then there are clear benefits. But should the price drop by an equal percentage, -40 percent, then massive harm would ensue, in magnitude larger than the benefits should there be an equal rise. There are concavities to the exposure—severe concavities.

And clearly, should the price drop by 90 percent, the effect would be disastrous. Just imagine what would happen to your household should you get an instant and unpredicted 40 percent pay cut. Indeed, we have had problems in history with countries specializing in some goods, commodities, and crops that happen to be not just volatile, but extremely volatile. And disaster does not necessarily come from variation in price, but problems in production: suddenly, you can't produce the crop because of a germ, bad weather, or some other hindrance.

A bad crop, such as the one that caused the Irish potato famine in the decade around 1850, caused the death of a million and the emigration of a million more (Ireland's entire population at the time of this writing is only about six million, if one includes the northern part). It is very hard to reconvert resources—unlike the case in the doctor-typist story, countries don't have the ability to change. Indeed, monoculture (focus on a single crop) has turned out to be lethal in history—one bad crop leads to devastating famines.

The other part missed in the doctor-secretary analogy is that countries don't have family and friends. A doctor has a support community, a circle of friends, a collective that takes care of him, a father-in-law to borrow from in the event that he needs to reconvert into some other profession, a state above him to help. Countries don't. Further, a doctor has savings; countries tend to be borrowers.

So here again we have fragility to second-order effects.

Probability Matching: The idea of comparative advantage has an analog in probability: if you sample from an urn (with replacement) and get a black ball 60 percent of the time, and a white one the remaining 40 percent, the optimal strategy, according to textbooks, is to bet 100 percent of the time on black. The strategy of betting 60 percent of the time on black and 40 percent on white is called "probability matching" and considered to be an error in the decision-science literature (which I remind the reader is what was used by Triffat in Chapter 10). People's instinct to engage in probability matching appears to be sound, not a mistake. In nature, probabilities are unstable (or unknown), and probability matching is similar to redundancy, as a buffer. So if the probabilities change, in other words if there is another layer of randomness, then the optimal strategy is probability matching.

How specialization works: The reader should not interpret what I am saying to mean that specialization is not a good thing—only that one should establish such specialization after addressing fragility and second-order effects. Now I do believe that Ricardo is ultimately right, but not from the models shown. Organically, systems without top-down controls would specialize progressively, slowly, and over a long time, through trial and error, get the right amount of specialization—not through some bureaucrat using a model. To repeat, systems make small errors, design makes large ones.

So the imposition of Ricardo's insight-turned-model by some social planner would lead to a blowup; letting tinkering work slowly would lead to efficiency—true efficiency. The role of policy makers should be to, *via negativa* style, allow the emergence of specialization by preventing what hinders the process.

A More General Methodology to Spot Model Error

Model second-order effects and fragility: Assume we have the right model (which is a very generous assumption) but are uncertain about the parameters. As a generalization of the deficit/employment example used in the previous section, say we are using f , a simple function: $f(x|\bar{\alpha})$, where $\bar{\alpha}$ is supposed to be the average expected

input variable, where we take φ as the distribution of α over its domain \mathcal{P}_α ,
 $\bar{\alpha} = \int_{\mathcal{P}_\alpha} \alpha \varphi(\alpha) d\alpha$.

The philosopher's stone: The mere fact that α is uncertain (since it is estimated) might lead to a bias if we perturbate from the *inside* (of the integral), i.e., stochasticize the parameter deemed fixed. Accordingly, the convexity bias is easily measured as the difference between (a) the function f integrated across values of potential α , and (b) f estimated for a single value of α deemed to be its average. The convexity bias (philosopher's stone) ω_A becomes:^{*}

$$\omega_A = \int_{\mathcal{P}_\alpha} \int_{\mathcal{P}_\alpha} f(x|\alpha) \varphi(\alpha) d\alpha dx - \int_{\mathcal{P}_\alpha} f(x \left(\int_{\mathcal{P}_\alpha} \alpha \varphi(\alpha) d\alpha \right)) dx$$

The central equation: Fragility is a partial philosopher's stone below K , hence ω_B the missed fragility is assessed by comparing the two integrals below K in order to capture the effect on the left tail:

$$\omega_B(K) \equiv \int_{-\infty}^K \int_{\mathcal{P}_\alpha} f(x|\alpha) \varphi(\alpha) d\alpha dx - \int_{-\infty}^K f(x \left(\int_{\mathcal{P}_\alpha} \alpha \varphi(\alpha) d\alpha \right)) dx$$

which can be approximated by an interpolated estimate obtained with two values of α separated from a midpoint by $\Delta\alpha$ its mean deviation of α and estimating

$$\omega_B(K) \equiv \int_{-\infty}^K \frac{1}{2} (f(x|\bar{\alpha} + \Delta\alpha) + f(x|\bar{\alpha} - \Delta\alpha)) dx - \int_{-\infty}^K f(x|\bar{\alpha}) dx$$

Note that antifragility ω_C is integrating from K to infinity. We can probe ω_B by point estimates of f at a level of $X \leq K$

$$\omega'_B(X) = \frac{1}{2} (f(X|\bar{\alpha} + \Delta\alpha) + f(X|\bar{\alpha} - \Delta\alpha)) - f(X|\bar{\alpha})$$

so that

$$\omega_B(K) = \int_{-\infty}^K \omega'_B(x) dx$$

which leads us to the fragility detection heuristic (Taleb, Canetti, et al., 2012). In particular, if we assume that $\omega'_B(X)$ has a constant sign for $X \leq K$, then $\omega_B(K)$ has the same sign. The detection heuristic is a perturbation in the tails to probe fragility, by checking the function $\omega'_B(X)$ at any level X .

* The difference between the two sides of Jensen's inequality corresponds to a notion in information theory, the Bregman divergence. Briys, Magdalou, and Nock, 2012.

TABLE 12

MODEL	SOURCE OF FRAGILITY	REMEDY
<i>Portfolio theory, mean-variance, etc.</i>	Assuming knowledge of the parameters, not integrating models across parameters, relying on (very unstable) correlations. Assumes ω_A (bias) and ω_B (fragility) = 0	1/n (spread as large a number of exposures as manageable), barbells, progressive and organic construction, etc.
<i>Ricardian comparative advantage</i>	Missing layer of randomness in the price of wine may imply total reversal of allocation. Assumes ω_A (bias) and ω_B (fragility) = 0	Natural systems find their own allocation through tinkering
<i>Samuelson optimization</i>	Concentration of sources of randomness under concavity of loss function. Assumes ω_A (bias) and ω_B (fragility) = 0	Distributed randomness
<i>Arrow-Debreu lattice state-space</i>	Ludic fallacy: assumes exhaustive knowledge of outcomes and knowledge of probabilities. Assumes ω_A (bias), ω_B (fragility), and ω_C (antifragility) = 0	Use of metaprobabilities changes entire model implications
<i>Dividend cash flow models</i>	Missing stochasticity causing convexity effects. Mostly considers ω_C (antifragility) = 0	Heuristics

Portfolio fallacies: Note one fallacy promoted by Markowitz users: *portfolio theory entices people to diversify, hence it is better than nothing*. Wrong, you finance fools: it pushes them to optimize, hence overallocate. It does not drive people to take less risk based on diversification, but causes them to take more open positions owing to perception of offsetting statistical properties—making them vulnerable to model error, and especially vulnerable to the underestimation of tail events. To see how, consider two investors facing a choice of allocation across three items: cash, and securities A and B. The investor who does not know the statistical properties of A and B and knows he doesn't know will allocate, say, the portion he does not want to lose to cash, the rest into A and B—according to whatever heuristic has been in traditional use. The investor who thinks he knows the statistical properties, with parameters σ_A , σ_B , $\rho_{A,B}$, will allocate ω_A , ω_B in a way to put the total risk at some target level (let us ignore the expected return for this). The lower his perception of the correlation $\rho_{A,B}$, the worse his exposure to model error. Assuming he thinks that the correlation $\rho_{A,B}$ is 0, he will be overallocated by $1/3$ for extreme events. But if the poor investor has the illusion that the correlation is -1 , he will be maximally overallocated to his A and B

investments. If the investor uses leverage, we end up with the story of Long-Term Capital Management, which turned out to be fooled by the parameters. (In real life, unlike in economic papers, things tend to change; for Baal's sake, they change!) We can repeat the idea for each parameter σ and see how lower perception of this σ leads to overallocation.

I noticed as a trader—and obsessed over the idea—that correlations were never the same in different measurements. Unstable would be a mild word for them: 0.8 over a long period becomes -0.2 over another long period. A pure sucker game. At times of stress, correlations experience even more abrupt changes—without any reliable regularity, in spite of attempts to model “stress correlations.” Taleb (1997) deals with the effects of stochastic correlations: One is only safe shorting a correlation at 1, and buying it at -1—which seems to correspond to what the $1/n$ heuristic does.

Kelly Criterion vs. Markowitz: In order to implement a full Markowitz-style optimization, one needs to know the entire joint probability distribution of all assets for the entire future, plus the exact utility function for wealth at all future times. And without errors! (We saw that estimation errors make the system explode.) Kelly's method, developed around the same period, requires no joint distribution or utility function. In practice one needs the ratio of expected profit to worst-case return—dynamically adjusted to avoid ruin. In the case of barbell transformations, the worst case is guaranteed. And model error is much, much milder under Kelly criterion. Thorp (1971, 1998), Haigh (2000).

The formidable Aaron Brown holds that Kelly's ideas were rejected by economists—in spite of the practical appeal—because of their love of general theories for all asset prices.

Note that bounded trial and error is compatible with the Kelly criterion when one has an idea of the potential return—even when one is ignorant of the returns, if losses are bounded, the payoff will be robust and the method should outperform that of Fragilista Markowitz.

Corporate Finance: In short, corporate finance seems to be based on point projections, not distributional projections; thus if one perturbs cash flow projections, say, in the Gordon valuation model, replacing the fixed—and known—growth (and other parameters) by continuously varying jumps (particularly under fat-tailed distributions), companies deemed “expensive,” or those with high growth, but low earnings, could markedly increase in expected value, something the market prices heuristically but without explicit reason.

Conclusion and summary: Something the economics establishment has been missing is that having the right model (which is a very generous assumption), but being uncertain about the parameters will invariably lead to an increase in fragility in the presence of convexity and nonlinearities.

FUHGETABOUT SMALL PROBABILITIES

Now the meat, beyond economics, the more general problem with probability and its mismeasurement.

How Fat Tails (Extremistan) Come from Nonlinear Responses to Model Parameters

Rare events have a certain property—missed so far at the time of this writing. We deal with them using a model, a mathematical contraption that takes input parameters and outputs the probability. The more parameter uncertainty there is in a model designed to compute probabilities, the more small probabilities tend to be underestimated. Simply, small probabilities are convex to errors of computation, as an airplane ride is concave to errors and disturbances (remember, it gets longer, not shorter). The more sources of disturbance one forgets to take into account, the longer the airplane ride compared to the naive estimation.

We all know that to compute probability using a standard Normal statistical distribution, one needs a parameter called *standard deviation*—or something similar that characterizes the scale or dispersion of outcomes. But uncertainty about such standard deviation has the effect of making the small probabilities rise. For instance, for a deviation that is called “three sigma,” events that should take place no more than one in 740 observations, the probability rises by 60% if one moves the standard deviation up by 5%, and drops by 40% if we move the standard deviation down by 5%. So if your error is on average a tiny 5%, the underestimation from a naive model is about 20%. Great asymmetry, but nothing yet. It gets worse as one looks for more deviations, the “six sigma” ones (alas, chronically frequent in economics): a rise of five times more. The rarer the event (i.e., the higher the “sigma”), the worse the effect from small uncertainty about what to put in the equation. With events such as ten sigma, the difference is more than a billion times. We can use the argument to show how smaller and smaller probabilities require more precision in computation. The smaller the probability, the more a small, very small rounding in the computation makes the asymmetry massively insignificant. For tiny, very small probabilities, you need near-infinite precision in the parameters; the slightest uncertainty there causes mayhem. They are very convex to perturbations. This in a way is the argument I’ve used to show that small probabilities are incomputable, even if one has the right model—which we of course don’t.

The same argument relates to deriving probabilities nonparametrically, from past frequencies. If the probability gets close to 1/ sample size, the error explodes.

This of course explains the error of Fukushima. Similar to Fannie Mae. To summarize, small probabilities increase in an accelerated manner as one changes the parameter that enters their computation.

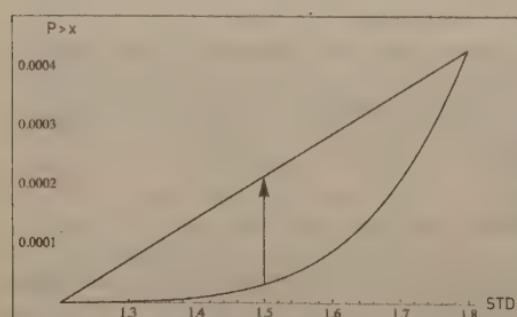


FIGURE 38. The probability is convex to standard deviation in a Gaussian model. The plot shows the STD effect on $P>x$, and compares $P>6$ with an STD of 1.5 compared to $P>6$ assuming a linear combination of 1.2 and 1.8 (here $a(1)=1/5$).

The worrisome fact is that a perturbation in σ extends well into the tail of the distribution in a convex way; the risks of a portfolio that is sensitive to the tails

would explode. That is, we are still here in the Gaussian world! Such explosive uncertainty isn't the result of natural fat tails in the distribution, merely small imprecision about a future parameter. It is just epistemic! So those who use these models while admitting parameters uncertainty are necessarily committing a severe inconsistency.*

Of course, uncertainty explodes even more when we replicate conditions of the non-Gaussian real world upon perturbating tail exponents. Even with a powerlaw distribution, the results are severe, particularly under variations of the tail exponent as these have massive consequences. Really, fat tails mean incomputability of tail events, little else.

Compounding Uncertainty (Fukushima)

Using the earlier statement that *estimation implies error*, let us extend the logic: errors have errors; these in turn have errors. Taking into account the effect makes all small probabilities rise regardless of model—even in the Gaussian—to the point of reaching fat tails and powerlaw effects (even the so-called infinite variance) when higher orders of uncertainty are large. Even taking a Gaussian with σ the standard deviation having a proportional error $a(1)$; $a(1)$ has an error rate $a(2)$, etc. Now it depends on the higher order error rate $a(n)$ related to $a(n-1)$; if these are in constant proportion, then we converge to a very thick-tailed distribution. If proportional errors decline, we still have fat tails. In all cases mere error is not a good thing for small probability.

The sad part is that getting people to accept that every measure has an error has been nearly impossible—the event in Fukushima held to happen once per million years would turn into one per 30 if one percolates the different layers of uncertainty in the adequate manner.

* This further shows the defects of the notion of “Knightian uncertainty,” since *all tails* are uncertain under the slightest perturbation and their effect is severe in fat-tailed domains, that is, economic life.

ADDITIONAL NOTES, AFTERTHOUGHTS, AND FURTHER READING

These are both additional readings and ideas that came to me after the composition of the book, like whether God is considered robust or antifragile by theologians or the history of measurement as a sucker problem in the probability domain. As to further reading, I am avoiding the duplication of those mentioned in earlier books, particularly those concerning the philosophical problem of induction, Black Swan problems, and the psychology of uncertainty. I managed to bury some mathematical material in the text without Alexis K., the math-phobic London editor, catching me (particularly my definition of fragility in the notes for Book V and my summary derivation of “small is beautiful”). Note that there are more involved technical discussions on the Web.

Seclusion: Since *The Black Swan*, I’ve spent 1,150 days in physical seclusion, a soothing state of more than three hundred days a year with minimal contact with the outside world—plus twenty years of thinking about the problem of nonlinearities and nonlinear exposures. So I’ve sort of lost patience with institutional and cosmetic knowledge. Science and knowledge are convincing and deepened rigorous argument taken to its conclusion, not naive (*via positiva*) empiricism or fluff, which is why I refuse the commoditized (and highly gamed) journalistic idea of “reference”—rather, “further reading.” My results should not depend, and do not depend on a single paper or result, except for *via negativa* debunking—these are illustrative.

Charlatans: In the “fourth quadrant” paper published in *International Journal of Forecasting* (one of the backup documents for *The Black Swan* that had been sitting on the Web) I showed *empirically* using all economic data available that fat tails are both severe and intractable—hence all methods with “squares” don’t work with socioeconomic variables: regression, standard deviation, correlation, etc. (technically 80% of the Kurtosis in 10,000 pieces of data can come from *one single* observation, meaning all measures of fat tails are just sampling errors). This is a very strong *via negativa* statement: it means we can’t use covariance matrices—they are unreliable and uninformative. Actually just accepting fat tails would have led us to such result—no need for empiricism; I processed the data nevertheless. Now any honest scientific profession would say: “what do we do

with such evidence?"—the economics and finance establishment just ignored it. A bunch of charlatans, by any scientific norm and ethical metric. Many "Nobels" (Engle, Merton, Scholes, Markowitz, Miller, Samuelson, Sharpe, and a few more) have their results grounded in such central assumptions, and all their works would evaporate otherwise. Charlatans (and fragilistas) do well in institutions. It is a matter of ethics; see notes on Book VII.

For our purpose here, I ignore any economic paper that uses regression in fat-tailed domains—as just hot air—except in some cases, such as Pritchett (2001), where the result is not impacted by fat tails.

PROLOGUE & BOOK I: The Antifragile: An Introduction

Wind energizes fire: Resembles La Rochefoucauld's comment on love.

Antifragility and complexity: Bar-Yam and Epstein (2004) define sensitivity, the possibility of large response to small stimuli, and robustness, the possibility of small response to large stimuli. In fact this sensitivity, when the response is positive, resembles antifragility.

Private Correspondence with Bar-Yam: Yaneer Bar-Yam, generously in his comments: "If we take a step back and more generally consider the issue of partitioned versus connected systems, partitioned systems are more stable, and connected systems are both more vulnerable and have more opportunities for collective action. Vulnerability (fragility) is connectivity without responsiveness. Responsiveness enables connectivity to lead to opportunity. If collective action can be employed to address threats, or to take advantage of opportunities, then the vulnerability can be mitigated and outweighed by the benefits. This is the basic relationship between the idea of sensitivity as we described it and your concept of antifragility." (With permission.)

Damocles and complexification: Tainter (1988) argues that sophistication leads to fragility—but following a very different line of reasoning.

Post-Traumatic Growth: Bonanno (2004), Tedeschi and Calhoun (1996), Calhoun and Tedeschi (2006), Alter et al. (2007), Shah et al. (2007), Pat-Horenczyk and Brom (2007).

Pilots abdicate responsibility to the system: FAA report: John Lowy, AP, Aug. 29, 2011.

Lucretius Effect: Fourth Quadrant discussion in the Postscript of *The Black Swan* and empirical evidence in associated papers.

High-water mark: Kahneman (2011), using as backup the works of the very insightful Howard Kunreuther, that "protective actions, whether by individuals or by governments, are usually designed to be adequate to the worst disaster actually experienced. . . . Images of even worse disaster do not come easily to mind."

Psychologists and "resilience": Seery 2011, courtesy Peter Bevelin. "However, some theory and empirical evidence suggest that the experience of facing difficulties can also promote benefits in the form of greater propensity for resilience when dealing with subsequent stressful situations." They use resilience! Once again *itsnotresilience*.

Danchin's paper: Danchin et al. (2011).

Engineering errors and sequential effect on safety: Petroski (2006).

Noise and effort: Mehta et al. (2012).

Effort and fluency: Shan and Oppenheimer (2007), Alter et al. (2007).

Barricades: Idea communicated by Saifedean Ammous.

Buzzati: Una felice sintesi di quell'ultimo capitolo della vita di Buzzati è contenuto

nel libro di Lucia Bellaspiga «Dio che non esisti, ti prego. Dino Buzzati, la fatica di credere»

Self-knowledge: Daniel Wegner's illusion of conscious will, in *Fooled by Randomness*.

Book sales and bad reviews: For Ayn Rand: Michael Shermer, "The Unlikeliest Cult in History," *Skeptic* vol. 2, no. 2, 1993, pp. 74–81. This is an example; please do not mistake this author for a fan of Ayn Rand.

Smear campaigns: Note that the German philosopher Brentano waged an anonymous attack on Marx. Initially it was the accusation of covering up some sub-minor fact completely irrelevant to the ideas of *Das Kapital*; Brentano got the discussion completely diverted away from the central theme, even posthumously, with Engels vigorously continuing the debate defending Marx in the preface of the third volume of the treatise.

How to run a smear campaign from Louis XIV to Napoleon: Darnton (2010).

Wolff's law and bones, exercise, bone mineral density in swimmers: Wolff (1892), Carbuhn (2010), Guadaluppe-Grau (2009), Hallström et al. (2010), Mudd (2007), Velez (2008).

Aesthetics of disorder: Arnheim (1971).

Nanocomposites: Carey et al. (2011).

Karsenty and Bones: I thank Jacques Merab for discussion and introduction to Karsenty; Karsenty (2003, 2012a), Fukumoto and Martin (2009); for male fertility and bones, Karsenty (2011, 2012b).

Mistaking the Economy for a Clock: A typical, infuriating error in Grant (2001): "Society is conceived as a huge and intricate clockwork that functions automatically and predictably once it has been set in motion. The whole system is governed by mechanical laws that organize the relations of each part. Just as Newton discovered the laws of gravity that govern motion in the natural world, Adam Smith discovered the laws of supply and demand that govern the motion of the economy. Smith used the metaphor of the watch and the machine in describing social systems."

Selfish gene: The "selfish gene" is (convincingly) an idea of Robert Trivers often attributed to Richard Dawkins—private communication with Robert Trivers. A sad story.

Danchin's systemic antifragility and redefinition of hormesis: Danchin and I wrote our papers in feedback mode. Danchin et al. (2011): "The idea behind is that in the fate of a collection of entities, exposed to serious challenges, it may be possible to obtain a positive overall outcome. Within the collection, one of the entities would fare extremely well, compensating for the collapse of all the others and even doing much better than the bulk if unchallenged. With this view, hormesis is just a holistic description of underlying scenarios acting at the level of a population of processes, structures or molecules, just noting the positive outcome for the whole. For living organisms this could act at the level of the population of organisms, the population of cells, or the population of intracellular molecules. We explore here how antifragility could operate at the latter level, noting that its implementation has features highly reminiscent of what we name natural selection. In particular, if antifragility is a built-in process that permits some individual entities to stand out from the bulk in a challenging situation, thereby improving the fate of the whole, it would illustrate the implementation of a process that gathers and utilises information."

Steve Jobs: "Death is the most wonderful invention of life. It purges the system of these old models that are obsolete." Beahm (2011).

Swiss cuckoo clock: Orson Welles, *The Third Man*.

Bruno Leoni: I thank Alberto Mingardi for making me aware of the idea of legal

robustness—and for the privilege of being invited to give the Leoni lecture in Milan in 2009. Leoni (1957, 1991).

Great Moderation: A turkey problem. Before the turmoil that started in 2008, a gentleman called Benjamin Bernanke, then a Princeton professor, later to be chairman of the Federal Reserve Bank of the United States and the most powerful person in the world of economics and finance, dubbed the period we witnessed the “great moderation”—putting me in a very difficult position to argue for increase of fragility. This is like pronouncing that someone who has just spent a decade in a sterilized room is in “great health”—when he is the most vulnerable.

Note that the turkey problem is an evolution of Russell’s chicken (*The Black Swan*).

Rousseau: In *Contrat Social*. See also Joseph de Maistre, *Oeuvres*, Éditions Robert Laffont.

BOOK II: Modernity and the Denial of Antifragility

City-states: Great arguments in support of the movement toward semiautonomous cities. Benjamin Barber, Long Now Foundation Lecture (2012), Khanna (2010), Glaeser (2011). Mayors are better than presidents at dealing with trash collection—and less likely to drag us into war. Also Mansel (2012) for the Levant.

Austro-Hungarian Empire: Fejtö (1989). Counterfactual history: Fejtö holds that the first war would have been avoided.

Random search and oil exploration: Menard and Sharman (1976), controversy White et al. (1976), Singer et al. (1981).

Randomizing politicians: Pluchino et al. (2011).

Switzerland: Exposition in Fossedal and Berkeley (2005).

Modern State: Scott (1998) provides a critique of the high modernistic state.

Levantine economies: Mansel (2012) on city-states. Economic history, Pamuk (2006), Issawi (1966, 1988), von Heyd (1886). Insights in Edmond About (About, 1855).

City-States in history: Stasavage (2012) is critical of the oligarchic city-state as an engine of long-term growth (though initially high growth rate). However, the paper is totally unconvincing econometrically owing to missing fat tails. The issue is fragility and risk management, not cosmetic growth. Aside from Weber and Pi- renne, advocates of the model, Delong and Schleifer (1993). See Ogilvie (2011).

Tonsillectomies: Bakwin (1945), cited by Bornstein and Emler (2001), discussion in Freidson (1970). Redone by Avanian and Berwick (1991).

Orlov: Orlov (2011).

Naive interventionism in development: Easterly (2006) reports a green lumber problem: “The fallacy is to assume that because I have studied and lived in a society that somehow wound up with prosperity and peace, I know enough to plan for other societies to have prosperity and peace. As my friend April once said, this is like thinking the racehorses can be put in charge of building the racetracks.”

Also luck in development, Easterly et al. (1993), Easterly and Levine (2003), Easterly (2001).

China famine: Meng et al. (2010).

Washington's death: Morens (1999); Wallenborn (1997).

Koran and Iatrogenics:

وَإِذَا قَبَلُوهُمْ لَا تَقْسِدُوا فِي الْأَرْضِ قَالُوا أَنَّمَا نَعْنَوْنَا مُصْلِحُونَ إِلَّا إِنَّهُمْ هُمُ الْفَسِدُونَ وَلَكُنْ لَا يَعْلَمُونَ
وَإِنَّا قَبَلْنَاهُمْ كَمَا أَنْتُمْ قَالُوا أَنْزَلْنَاكُمْ كَمَا أَنْتُمْ سُفَهَاءٌ إِلَّا إِنَّهُمْ هُمُ السُّفَهَاءُ وَلَكُنْ لَا يَعْلَمُونَ

Semmelweis: Of the most unlikely references, see Louis-Ferdinand Céline's doctoral thesis, reprinted in Gallimard (1999), courtesy Gloria Origgi.

Fake stabilization: Some of the arguments in Chapter 7 were co-developed with Mark Blyth in *Foreign Affairs*, Taleb and Blyth (2011).

Sweden: "Economic elites had more autonomy than in any successful democracy," Steinmo (2011).

Traffic and removal of signs: Vanderbilt (2008).

History of China: Eberhard (reprint, 2006).

Nudge: They call it the *status quo bias* and some people want to get the government to manipulate people into breaking out of it. Good idea, except when the "expert" nudging us is not an expert.

Procrastination and the priority heuristic: Brandstetter and Gigerenzer (2006).

France's variety: Robb (2007). French riots as a national sport, Nicolas (2008). Nation-state in France, between 1680 and 1800, Bell (2001).

Complexity: We are more interested here in the effect on fat tails than other attributes. See Kaufman (1995), Hilland (1995), Bar-Yam (2001), Miller and Page (2007), Sornette (2004).

Complexity and fat tails: There is no need to load the math here (left to the technical companion); simple rigorous arguments can prove with minimal words how fat tails emerge from some attributes of complex systems. The important mathematical effect comes from lack of independence of random variables which prevents convergence to the Gaussian basin.

Let us examine the effect from dynamic hedging and portfolio revisions.

A—Why fat tails emerge from leverage and feedback loops, single agent simplified case.

A1 [leverage]—If an agent with some leverage L buys securities in response to increase in his wealth (from the increase of the value of these securities held), and sells them in response to decrease in their value, in an attempt to maintain a certain level of leverage L (he is concave in exposure), and

A2 [feedback effects]—If securities rise nonlinearly in value in response to purchasers and decline in value in response to sales, then, by the violation of the independence between the variations of securities, CLT (the central limit theorem) no longer holds (no convergence to the Gaussian basin). So fat tails are an immediate result of feedback and leverage, exacerbated by the concavity from the level of leverage L .

A3—If feedback effects are concave to size (it costs more per unit to sell 10 than to sell 1), then negative skewness of the security and the wealth process will emerge. (Simply, like the "negative gamma" of portfolio insurance, the agent has an option in buying, but no option in selling, hence negative skewness. The forced selling is exactly like the hedging of a short option.)

Note on path dependence exacerbating skewness: More specifically, if wealth increases first, this causes more risk and skew. Squeezes and forced selling on the way down: the market drops more (but less frequently) than it rises on the way up.

B—Multiagents: if, furthermore, more than one agent is involved, then the effect is compounded by the dynamic adjustment (hedging) of one agent causing the adjustment of another, something commonly called "contagion."

C—One can generalize to anything, such as home prices rising in response to home purchases from excess liquidity, etc.

The same general idea of forced execution plus concavity of costs leads to the superiority of systems with distributed randomness.

Increase of risk upon being provided numbers: See the literature on anchoring (reviewed in *The Black Swan*). Also Mary Kate Stimmmer's doctoral thesis at Berkeley (2012), courtesy Phil Tetlock.

Stimmmer's experiment is as follows. In the simple condition, subjects were told:

For your reference, you have been provided with the following formula for calculating the total amount of money (T) the investment will make three months after the initial investment (I) given the rate of return (R):

$$T=I \cdot R$$

In the complex condition, subjects were told:

For your reference, you have been provided with the following formula for calculating the total amount of money A_n the investment will make three months after the initial investment A_{n-1} given the rate of return r .

$$A_n = A_{n-1} + (n+1) \sum_{j=1}^{n-1} [A_j T_j \frac{j}{n^2 - n + j} - j A_{j-1} T_{j-1} \frac{1}{j + (n-1)^2 + n - 2} + A_j T_{j-1} \frac{1}{j + (n-1)^2 + n - 2}]$$

Needless to mention that the simple condition and the complex one produced the same output. But those who had the complex condition took more risks.

The delusion of probabilistic measurement: Something that is obvious to cabdrivers and grandmothers disappears inside university hallways. In his book *The Measure of Reality* (Crosby, 1997), the historian Alfred Crosby presented the following thesis: what distinguished Western Europe from the rest of the world is obsession with measurement, the transformation of the qualitative into the quantitative. (This is not strictly true, the ancients were also obsessed with measurements, but they did not have the Arabic numerals to do proper calculations.) His idea was that we learned to be precise about things—and that was the precursor of the scientific revolution. He cites the first mechanical clock (which quantized time), marine charts and perspective painting (which quantized space), and double-entry bookkeeping (which quantized financial accounts). The obsession with measurement started with the right places, and progressively invaded the wrong ones.

Now our problem is that such measurement started to be applied to elements that have a high measurement error—in some case infinitely high. (Recall Fukushima in the previous section.) Errors from Mediocristan are inconsequential, those from Extremistan are acute. When measurement errors are prohibitively large, we should not be using the word “measure.” Clearly I can “measure” the table on which I am writing these lines. I can “measure” the temperature. But I cannot “measure” future risks. Nor can I “measure” probability—unlike this table it cannot lend itself to our investigation. This is at best a speculative estimation of something that *can* happen.

Note that Hacking (2006) does not for a single second consider fat tails! Same with Hald (1998, 2003), von Plato (1994), Salsburg (2001), and from one who should know better, Stigler (1990). A book that promoted bad risk models, Bernstein (1996). Daston (1988) links probabilistic measurement to the Enlightenment.

The idea of probability as a quantitative not a qualitative construct has indeed been plaguing us. And the notion that science *equals* measurement free of error—it is, largely but not in everything—can lead us to all manner of fictions, delusions, and dreams.

An excellent understanding of probability linked to skepticism: Franklin (2001). Few other philosophers go back to the real problem of probability.

Fourth Quadrant: See the discussion in *The Black Swan* or paper Taleb (1999).

Nuclear, new risk management: Private communication, Atlanta, INPO, Nov. 2011.

Anecdotal knowledge and power of evidence: A reader, Karl Schluze, wrote: “An old teacher and colleague told me (between his sips of bourbon) ‘If you cut off the head of a dog and it barks, you don’t have to repeat the experiment.’” Easy to get examples: no lawyer would invoke an “N=1” argument in defense of a person, saying “he only killed once”; nobody considers a plane crash as “anecdotal.”

I would go further and map disconfirmation as exactly where N=1 is sufficient.

Sometimes researchers call a result “anecdotal” as a knee-jerk reaction when the result is exactly the reverse. Steven Pinker called John Gray’s pointing out the two world wars as counterevidence to his story of great moderation “anecdotal.” My experience is that social science people rarely know what they are talking about when they talk about “evidence.”

BOOK III: A Nonpredictive View of the World

Decision theorists teaching practitioners: To add more insults to us, decision scientists use the notion of “practical,” an inverse designation. See Hammond, Keeney, and Raiffa (1999) trying to teach us how to make decisions. For a book describing exactly how practitioners don’t act, but how academics think practitioners act: Schon (1983).

The asymmetry between good and bad: *Segnius homines bona quam mala sentiunt* in Livy’s *Annals* (XXX, 21).

Stoics and emotions: Contradicts common beliefs that Stoicism is about being a vegetable, Graver (2007).

Economic growth was not so fast: Crafts (1985), Crafts and Harley (1992).

Cheating with the rock star: Arnavast and Kirkpatrick (2005), Griffith et al. (2002), Townsend et al. (2010).

Simenon: “Georges Simenon, profession: rentier,” Nicole de Jassy *Le Soir illustré* 9 janvier 1958, N° 1333, pp. 8–9, 12.

Dalio: Bridgewater-Associates-Ray-Dalio-Principles.

BOOK IV: Optionality, Technology, and the Intelligence of Antifragility

The Teleological

Aristotle and his influence: Rashed (2007), both an Arabist and a Hellenist.

The nobility of failure: Morris (1975).

Optionality

Bricolage: Jacob (1977a, 1977b), Esnault (2001).

Rich getting richer: On the total wealth for HNWI (High Net Worth Individuals) increasing, see Merrill Lynch data in “World’s wealthiest people now richer than

before the credit crunch," Jill Treanor, *The Guardian*, June 2012. The next graph shows why it has nothing to do with growth and total wealth formation.

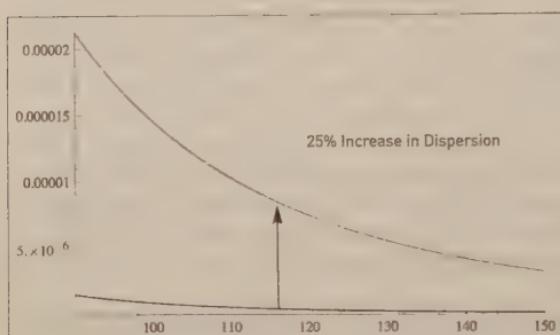


FIGURE 39. Luxury goods and optionality. On the vertical the probability, on the horizontal the integral of wealth. Antifragility city: the effect of change in inequality on the pool of very rich increases nonlinearly in the tails: the money of the superrich reacts to inequality rather than total wealth in the world. Their share of

wealth multiplies by close to 50 times in response to a change of 25% in dispersion of wealth. A small change of 0.01 in the GINI coefficient (0 when perfect inequality, 1.00 when one person has all) equivalent to 8% rise in real Gross Domestic Product—the effect is stark regardless of the probability distribution.

Camel in Arabia: Lindsay (2005).

Obliquity: Kay (2010).

Real options literature: Trigeorgis (1993), review in Dixit and Pindyck (1994), Trigeorgis (1996), Luehrman (1998), McGrath (1999)—the focus is on reversible and irreversible investments.

Translational gap: Wootton (2007); Arikha (2008b); modern Contopoulos-Ioannidis et al. (2003, 2008), commentary Bosco and Watts (2007).

Criticism of Wootton: Brosco and Watts (2007).

Epiphenomena and Granger-causality: See Granger (1999) for a review.

Lecturing birds how to fly: There are antecedents in Erasmus, "teaching fish how to swim." *Adages*, 2519, III, VI, 19. "*Piscem nature doces* Ιχθὺν νήχεσθαι διδάσκεις, *id est piscem nature doces*. *Perinde est ac si dicas* : *Doctum doces*. *Confine illi, quod alibi retulimus* : Δελφίνα νήχεσθαι διδάσκεις, *id est Delphinum nature doces*." The expression was first coined in Haug and Taleb (2010), posted in 2006, leading to a book, Triana (2009). We weren't aware of the Erasmus imagery, which we would have selected instead.

Education and its effect on growth and wealth: Pritchett (2001), Wolf (2002), Chang (2011).

Schumpeter's ideas on destruction for advancement: Schumpeter (1942). Criticism by Harvard economists about lack of technical approach in McCraw (2007).

Amateurs: Bryson (2010), Kealey (1996).

Scientific misattribution of the works of Bachelier, Thorpe, and others: Haug and Taleb (2010). Discussion in Triana (2009, 2011).

Ex cura theoria nascitur: In Coulter (2000), attributed to Paracelsus.

Jet engine: Scranton (2006, 2007, 2009), Gibbert and Scranton (2009).

Busting the episteme theory of cybernetics: Mindell, 2002. I thank David Edgerton for introducing me to his works.

Cathedrals and theoretical and axiomatic geometry: Beaujoan (1973, 1991), Portet (2002). Ball (2008) for the history of the construction of Chartres cathedral.

Epistemic base and conflation: The epistemic base is sort of the x , not $f(x)$. A great way to see the difference between x and $f(x)$ in technology, offered by Michael Polanyi: one can patent $f(x)$, a technique, but not x , scientific knowledge. In Mokyr (2005).

Epistemic Base: Mokyr (1999, 2002, 2005, 2009). The biggest problem with Mokyr: not getting ω_c . Further, this notion of the East missing trial and error (also see argument about China): see Tetlock in Tetlock et al. (2009). Mokyr and Meisenzahl have a different spin, with microinventions feeding macroinventions. Still intellectually weak.

Techne-Episteme in economics: Marglin (1996), but the tradition did not go very far.

Needham's works on China: Winchester (2008).

Tenure: Kealey (1996): "Adam Smith attributed the English professors' decay to their guaranteed salaries and tenured jobs. (As compared to Scottish Universities.)"

Fideism: Popkin (2003).

Linear Model: Edgerton (1996a, 1996b, 2004). Edgerton showed that it was a backward-fit idea, that is, fit to the past. Edgerton also writes: "This profoundly academic-research-oriented model of twentieth-century science is all the more surprising in view of the long tradition of *stressing the non-academic origins of modern science* [emphasis mine], particularly the craft traditions, and the insistence of much history of science, strengthened in the last 20 years, on the significance of industrial contexts for science, from dyeing to brewing to engine making."

Convexity bias: It was discovered early in commodity and financial futures; Burghardt and Hoskins (1994), Taleb (1997), Burghardt and Liu (2002), Burghardt and Panos (2001), Kirikos and Novak (1997), Pieterbarg and Renedo (2004). Many people blew up on misunderstanding the effect.

Example of detection and mapping of convexity bias (ω_A), from author's doctoral thesis: The method is to find what needs dynamic hedging and dynamic revisions. Among the members of the class of instruments considered that are not options *stricto-sensu* but require dynamic hedging can be rapidly mentioned a broad class of convex instruments: (1) Low coupon long dated bonds. Assume a discrete time framework. Take $B(r, T, C)$ the bond maturing period T , paying a coupon C where $r_t = \sum s_i ds$. We have the convexity $\partial^2 B / \partial r^2$ increasing with T and decreasing with C . (2) Contracts where the financing is extremely correlated with the price of the Future. (3) Baskets with a geometric feature in its computation. (4) A largely neglected class of assets is the "quanto-defined" contracts (in which the payoff is not in the native currency of the contract), such as the Japanese NIKEI Future where the payoff is in U.S. currency. In short, while a Japanese yen denominated NIKEI contract is linear, a U.S. dollars denominated one is nonlinear and requires dynamic hedging.

Take at initial time t_0 , the final condition $V(S, T) = S_T$ where T is the expiration date. More simply, the security just described is a plain forward, assumed to be linear. There appears to be no Ito term there yet. However should there be an intermediate payoff such that, having an accounting period i/T , the variation margin is paid in cash disbursement, some complexity would arise. Assume $\Delta(t_i)$ the changes in the value of the portfolio during period (t_i, t_{i+1}) , $\Delta(t_i) = (V(S, t_i) - V(S, t_{i+1}))$. If the variation is to be paid at period t_i , then the operator would have to borrow at the forward rate between periods t_i and T , here $r(t_i, T)$. This financing is necessary to make $V(S, T)$ and S_T comparable in present value. In expectation, we will have to discount the variation using forward cash flow method for the accounting period between t_{i+1} and t_i . Seen from period T , the value of the varia-

tion becomes $E_t [exp[-r(t_i, T)(T-t_i)] \Delta(t_i)]$, where E_t is the expectation operator at time t (under, say, the risk-neutral probability measure). Therefore we are delivering at period T , in expectation, as seen from period t_0 , the expected value of a stream of future variation $E_{t_0} [\sum exp[-r(t_i, T)(T-t_i)] \Delta(t_i)]$. However we need to discount to the present using the term rate $r(T)$. The previous equation becomes $V(S, T)|_{t=t_0} = V[S, t_0] + exp[r(T)] E_{t_0} [\sum exp[-r(t_i, T)(T-t_i)] \Delta(t_i)]$, which will be different from S_T when any of the interest rate forwards is stochastic. **Result** (a polite way to say “theorem”): *When the variances of the forward discount rate $r(t_i, T)$ and the underlying security S_i are strictly positive and the correlation between the two is lower than 1, $V(S, T)|_{t=t_0} \neq S_T$.* Proof: by examining the properties of the expectation operator. Therefore: $F(S, t_0) = F(S, t_0 + \Delta t)$, while a nonlinear instrument will merely satisfy: $E[V(S, t_0)] = E[V(S, t_0 + \Delta t)]$.

Critique of Kealey: Posner (1996).

General History of Technology: Missing convexity biases, Basalla (1988), Stokes (1997), Geison (1995).

Ideas of innovation: Berkun (2007), Latour and Woolfar (1996), Khosla (2009), Johnson (2010).

Medical discoveries and absence of causative knowledge: Morton (2007), Li (2006), Le Fanu (2002), Bohuon and Monneret (2009). Le Fanu (2002): “It is perhaps predictable that doctors and scientists should assume the credit for the ascendency of modern medicine without acknowledging, or indeed recognizing, the mysteries of nature that have played so important a part. Not surprisingly, they came to believe their intellectual contribution to be greater than it really was, and that they understood more than they really did. They failed to acknowledge the overwhelmingly empirical nature of technological and drug innovation, which made possible spectacular breakthroughs in the treatment of disease without the requirement of any profound understanding of its causation or natural history.”

Commerce as convex: Ridley (2010) has comments on Phoenicians; Aubet (2001).

Pharma's insider: La Matina (2009).

Multiplicative side effects: Underestimation of interactions in Tatonetti et al. (2012): they simply uncovered the side effects of people taking joint drugs together, which effectively swells the side effects (they show something as large as a multiplication of the effect by 4).

Strategic planning: Starbuck et al. (1992, 2008), Abrahamson and Freedman (2007). The latter is a beautiful ode to disorder and “mess.”

Entrepreneurship: Elkington and Hartigan (2008).

Harvard Business School professors' pathological misunderstanding of small probabilities: This is not an empirical statement, but just to have fun: for an illustrative example of a sucker who misses ω_B and ω_C , always start looking in Harvard. Froot (2001), Pisano (2006a, 2006b). Froot: “Because managers of insurance companies purchase reinsurance at far above the fair price, they must believe that risk management adds considerable value.” He thinks he knows the fair price.

Le Goff: Le Goff (1985): “*L'un est un professeur, saisi dans son enseignement, entouré d'élèves, assiégié par les bans, où se presse l'auditoire. L'autre est un savant solitaire, dans son cabinet tranquille, à l'aise au milieu de la pièce où se meuvent librement ses pensées. Ici c'est le tumulte des écoles, la poussière des salles, l'indifférence au décor du labeur collectif,*” “*Là tout n'est qu'ordre et beauté / Luxe, calme, et volupté.*”

Martignoni: Geschlechtsspezifische Unterschiede im Gehirn und mögliche Auswirkungen auf den Mathematikunterricht. Wissenschaftliche Hausarbeit zur Ersten Sta-

atsprüfung für das Lehramt an Realschulen nach der RPO I v. 16.12.1999. Vorgelegt von: Ulmer, Birgit. Erste Staatsprüfung im Anschluss an das Wintersemester 2004/05, Pädagogische Hochschule Ludwigsburg. Studienfach: Mathematik. Dozenten: Prof. Dr. Laura Martignon, Prof. Dr. Otto Ungerer.

Renan: Averroès et l'averroïsme, p. 323 (1852).

Socrates: Conversation with Mark Vernon (Vernon, 2009), who believes that Socrates was more like Fat Tony. Wakefield (2009) a great context. Calder et al. (2002) presents portraits more or less hagiographic.

Socratic Fallacy: Geach (1966).

Episteme-Techne: Alexander of Aphrodisias, *On Aristotle's Metaphysics*, *On Aristotle's Prior Analytics* 1.1–7, *On Aristotle's Topics* 1, *Quaestiones* 2.16–3.15.

Tacit-Explicit knowledge: Collins (2010), Polanyi (1958), Mitchell (2006).

TABLE 13 • KNOW HOW VS KNOW WHAT
AND THEIR SIBLINGS

TYPE 1	TYPE 2
Know what	Know how
Explicit	Implicit, Tacit
Demonstrative knowledge	Nondemonstrative knowledge
Episteme	Techne
Epistemic base	Experiential knowledge
Propositional knowledge	Heuristic
Literal	Figurative
Targeted activity	Bricolage
Rationalism	Empiricism
Scholarship	Practicé
Mathematics	Engineering
Inductive knowledge, using Aristotle's teleological principles	Epilogism (Menodotus of Nicomedia and the school of empirical medicine)
Causative historiography	<i>Historia a sensate cognitio</i>
Diagnostic	<i>Autopsia</i>
Letter of the law	Spirit of the law
Ideas	Customs
Ludic probability, statistics textbooks	Ecological uncertainty, not tractable in textbook
Logos	Mythos
Kerygma (the explainable and teachable part of religion)	Dogma (in the religious sense, the unexplainable)
Exoteric theology (Averroes and Spinoza)	Esoteric theology (Averroes and Spinoza)

All the terms on the left seem to be connected. We can easily explain how *rationalism*, *explicit*, and *literal* fit together. But the terms on the right do not appear to be logically connected. What connects *customs*, *bricolage*, *myths*, *knowhow*, and *figurative*? What is the connection between religious dogma and tinkering? There is *something*, but I can't explain it in a compressed form, but there is the Wittgenstein family resemblance.

Lévi-Strauss: Lévi-Strauss (1962) on different forms of intelligence. However, in Charbonnier (2010), in interviews in the 1980s, he seems to believe that some day in the future, science will allow us to predict with acceptable precision very soon, "once we get the theory of things." Wilken (2010) for bio. See also Bourdieu (1972) for a similar problem seen from a sociologist.

Evolutionary heuristics: This is central but I hide it here. To summarize the view—a merger of what it is in the literature and the ideas of this book: an evolutionary heuristic in a given activity has the following attributes: (a) you don't know you are using it, (b) it has been done for a long time in the very same, or rather similar environment, by generations of practitioners, and reflects some evolutionary collective wisdom, (c) it is free of the agency problem and those who use it survived (this excludes medical heuristics used by doctors since the patient might not have survived, and is in favor of collective heuristics used by society), (d) it replaces complex problems that require a mathematical solution, (e) you can only learn it by practicing and watching others, (f) you can always do "better" on a computer, as these do better on a computer than in real life. For some reason, these heuristics that are second best do better than those that seem to be best, (g) the field in which it was developed allows for rapid feedback, in the sense that those who make mistakes are penalized and don't stick around for too long. Finally, as the psychologists Kahneman and Tversky have shown, outside the domains in which they were formed, these can go awfully wrong.

Argumentation and the green lumber problem: In Mercier and Sperber (2011). The post-Socratic idea of reasoning as an instrument for seeking the truth has been recently devalued further—though it appears that the Socratic method of discussion might be beneficial, but only in a dialogue form. Mercier and Sperber have debunked the notion that we use reasoning in order to search for the truth. They showed in a remarkable study that the purpose of arguments is not to make decisions but to convince others—since decisions we arrive at by reasoning are fraught with massive distortions. They showed it experimentally, producing evidence that individuals are better at forging arguments in a social setting (when there are others to convince) than when they are alone.

Anti-Enlightenment: For a review, Sternhell (2010), McMahon (2001), Delon (1997). Horkheimer and Adorno provide a powerful critique of the cosmeticism and sucker-traps in the ideas of modernity. And of course the works of John Gray, particularly Gray (1998) and *Straw Dogs*, Gray (2002).

Wittgenstein and tacit knowledge: Pears (2006).

On Joseph de Maistre: Companion (2005).

Ecological, non-soccer-mom economics: Smith (2008), also Nobel lecture given along with Kahneman's. Gigerenzer further down.

Wisdom of the ages: Oakeshott (1962, 1975, 1991). Note that Oakeshott conservatism means accepting the necessity of a certain rate of change. It seems to me that what he wanted was organic, not rationalistic change.

BOOK V: The Nonlinear and the Nonlinear

More formally, to complement the graphical exposition, from Taleb and Douady (2012), the local fragility of a random variable X_λ depending on parameter λ , at stress level K and semi-deviation level $s^-(\lambda)$ with pdf f_λ is its K-left-tailed semi-vega sensitivity ("vega" being sensitivity to some measure of volatility), $V(X, f_\lambda, K, s^-)$ to s^- , the mean absolute semi-deviation below Ω , here $s^-(\lambda) = \int_{-\infty}^0 (\Omega - x) f_\lambda(x) dx$, $\xi(K, s^-) = \int_{-\infty}^K (\Omega - x) f_{\lambda+s^-}(x) dx$, $V(X, f_\lambda, K, s^-) = \frac{\partial \xi}{\partial s^-}(K, s^-)$. The inherited fragility of Y with respect to X at stress level $L = \varphi(K)$ and left-semi-deviation level $s^-(\lambda)$ of X is the partial derivative $V(Y, g(L, s^-(\lambda))) = \frac{\partial \xi}{\partial s^-}(L, u(\lambda))$. Note that the stress level and the pdf are defined for the variable Y , but the parameter used for differentiation is the left-semi-absolute deviation of X . For antifragility, the flip above Ω , in addition to robustness below the same stress level K . The transfer theorems relate the fragility of Y to the second derivative $\varphi''(K)$ and show the effect of convex (concave or mixed nonlinear) transformations on the tails via the transfer function H^K . For the antifragile, use s^+ , the integral above K .

Fragility is not psychological: We start from the definition of fragility as tail vega sensitivity and end up with nonlinearity as a necessary attribute of the source of such fragility in the inherited case—a cause of the disease rather than the disease itself. However, there is a long literature by economists and decision scientists embedding risk into psychological preferences—historically, risk has been described as derived from risk aversion as a result of the structure of choices under uncertainty with a concavity of the muddled concept of "utility" of payoff; see Pratt (1964), Arrow (1965), Rothschild and Stiglitz (1970, 1971). But this "utility" business never led anywhere except the circularity, expressed by Machina and Rothschild (2008), "risk is what risk-aversers hate." Indeed limiting risk to aversion to concavity of choices is a quite unhappy result.

The porcelain cup and its concavity: Clearly, a coffee cup, a house, or a bridge doesn't have psychological preferences, subjective utility, etc. Yet each is concave in its reaction to harm: simply, taking z as a stress level and $\Pi(z)$ the harm function, it suffices to see that, with $n > 1$, $\Pi(nz) < n\Pi(z)$ for all $0 < nz < Z^*$, where Z^* is the level (not necessarily specified) at which the item is broken. Such inequality leads to $\Pi(z)$ having a negative second derivative at the initial value z . So if a coffee cup is less harmed by n times a stressor of intensity Z than once a stressor of nZ , then harm (as a negative function) needs to be concave to stressors up to the point of breaking; such stricture is imposed by the structure of survival probabilities and the distribution of harmful events, nothing to do with subjective utility or some other figments.

Scaling in a positive way, convexity of cities: Bettencourt and West (2010, 2011), West (2011). Cities are 3-D items like animals, and these beneficial nonlinearities correspond to efficiencies. But consider traffic!

"More Is Different": Anderson (1972).

Comparative fragility of animals: Diamond (1988).

Flyvbjerg and colleagues on delays: Flyvbjerg (2009), Flyvbjerg and Buzier (2011).

Small Is Beautiful, the romantic views: Dahl and Tufte (1973), Schumacher (1973) for the soundbite. Kohr (1957) for the first manifesto against the size of the governing unit.

Size of government: I can't find people thinking in terms of convexity effects, not even libertarians—take Kahn (2011).

Small states do better: A long research tradition on governance of city-states. It looks like what we interpret as political systems might come from size. Evidence in Easterly and Kraay (2000).

The age of increasing fragility: Zajdenwebber, see the discussion in *The Black Swan*. Numbers redone recently in *The Economist*, “Counting the Cost of Calamities,” Jan. 14, 2012.

Convexity effect on mean: Jensen (1906), Van Zwet (1966). While Jensen deals with monotone functions, Van Zwet deals with concave-convex and other mixtures—but these remain simple nonlinearities. Taleb and Douady (2012) applies it to all forms of local nonlinearities.

Empirical record of bigger: Mergers and hubris hypothesis: in Roll (1986); since then Cartwright and Schoenberg (2006).

Debt in ancient history: Babylonian jubilees, Hudson et al. (2002). Athens, Harrison (1998), Finley (1953). History of debt, Barty-King (1997), Muldrew (1993), Glaeser (2001). The latter has an anarchist view. He actually believes that debt precedes barter exchange.

Food networks: Dunne et al. (2002), Perchey and Dunne (2012), Valdovinos and Ramos-Jiliberto (2010). Fragility and resources, Nasr (2008, 2009).

Fannie Mae: They were concave across all meaningful variables. Some probability-and-nonlinearity-challenged fellow in the Obama commission investigating the cause of the crisis spread the rumor that I only detected interest rate risk of Fannie Mae: not true.

Costs of execution: “Price impact,” that is, execution costs, increase with size; they tend to follow the square root—meaning the total price is convex and grows at exponent 3/2 (meaning costs are concave). But the problem is that for large deviations, such as the Société Générale case, it is a lot worse; transaction costs accelerate, in a less and less precise manner—all these papers on price impact by the new research tradition are meaningless when you need them. Remarkably, Bent Flyvbjerg found a similar effect, but slightly less concave in total, for bridges and tunnels with proportional costs growing at $10 \log|x|$ of size.

Small Is Beautiful, a technical approach: To explain how city-states, small firms, etc. are more robust to harmful events, take X , a random variable for the “unintended exposure,” the source of uncertainty (for Soc Gen it was the position that it did not see, for a corporation it might be an emergency need to some inventory, etc.). Assume the size of this unintended harm is proportional to the size of the unit—for smaller entities engage in smaller transactions than larger ones. We use for probability distribution the variable of all unintended exposures ΣX_i , where X_i are independent random variables, simply scaled as $X_i = X/N$. With k the tail amplitude and α the tail exponent, $\pi(k, \alpha, X) = \alpha k^\alpha x^{-1-\alpha}$. The N -convoluted Pareto distribution for the unintended total position $N \sum X_i$: $\pi(k/N, \alpha, X)_N$, where N is the number of convolutions for the distribution. The mean of the distribution, invariant with respect to N , is $\alpha k/\alpha-1$.

Losses from squeezes and overruns: for the loss function, take $C[X] = -b X^\beta$, where costs of harm is a concave function of X . Note that for small deviations, $\beta = 3/2$ in the microstructure and execution literature.

Resulting probability distribution of harm: As we are interested in the distribution of y , we make a transformation of stochastic variable. The harm $y = C[X]$ has for distribution: $\pi[C^1[x]]/C[C^1[x]]$. Consider that it follows a Pareto distribution with tail amplitude k^β and tail exponent α/β , $L_1(Y) = \frac{\alpha}{\beta} K^\alpha Y^{-1-\alpha/\beta}$ which has for mean $\frac{k^\beta \alpha}{\alpha - \beta}$. Now the sum: for the convoluted sum of N entities, the asymptotic distribution becomes: $L_N(Y) = N \frac{\alpha}{\beta} \binom{K}{N} Y^{-1-\alpha/\beta}$ with mean (owing to additivity) as a function of the variables which include N : $M(\alpha, \beta, k, N) = \frac{N \left(\frac{k}{N} \right)^\beta}{\alpha - \beta}$. If we check the ratio of expected

losses in the tails for $N=1$ to $N=10$ at different values of the ratio of β over α , the ratio of the expectation for 1 unit over 10 units $\frac{M(\alpha + \beta, \alpha, k, N=1)}{M(\alpha + \beta, \beta, k, N=10)}$ reveals the “small is beautiful” effect across different levels of concavity.

BOOK VI: Via Negativa

Subtractive Knowledge

Maps: A reader, Jean-Louis, a mapmaker, writes to me: “As a mapmaker, I learned a long time ago that the key to good mapmaking is precisely the info you choose to leave out. I have made numerous clients notice that if a map is too literal and precise, it confuses people.”

Imam Ali: Nahj-el-Balagha, Letter. 31.

The mosaic god is not antifragile: For God—the Abrahamic-Mosaic God (of Jews, Christians, and Moslems)—is the representation of total robustness and infallibility. Note that counter to initial impressions, the essence of perfection is robustness, not antifragility. I’ve received many messages suggesting that the (Levantine) God should be put in the antifragile category. This would be a severe mistake according to Eastern Mediterranean religions. Antifragility for a deity may apply to Babylonian, Greek, Syrian, and Egyptian mythologies. But Levantine monotheistic theology, from the ancient Semitic El (or Al) to the modern Allah or, to a lesser extent, what people call “the Lord” in the Bible Belt, from Genesis to the Koran, progressed into a definition of an increasingly abstract God—hence closest to the definition of pure robustness. The monotheistic God is certainly not fragile; but he is not antifragile. By definition, thanks to his maximally abstract quality, he is what cannot be improved, which is the very property of perfection—only imperfect mortals can improve, therefore need antifragility to try to improve. In the Koran, one of the properties of God is *Smd*, a word that has no synonym even in Arabic, hence cannot be translated; its meaning can only be conveyed through the iteration of partial descriptions. *Smd* is that which has reached such degree of completeness that it does not depend on external circumstances, anything or anyone; a bulwark against all manner of attacks; He transcends the notion of time. The idea is also present in other Levantine systems. Orthodox theology, through *theosis*, seeks merger with God, the aspiration to a level of completeness, hence independence from anything else.

Interdicts in religion: Fourest and Venner (2010) presents a list across all persuasions.

Steve Jobs: Beahm (2011).

Gladwell: “If you totted up all his hospital bills for the ten years that he had been on the streets—as well as substance-abuse-treatment costs, doctors’ fees, and other expenses—Murray Barr probably ran up a medical bill as large as anyone in the state of Nevada. ‘It cost us one million dollars not to do something about Murray,’ O’Bryan said.” Gladwell (2009).

Falsification and problems of induction: See references in *The Black Swan*.

Smoking and overall medical effect: Burch (2009).

Fractality: Mandelbrot (1983).

Edgerton’s shock of the old: Edgerton (2007).

Less Is More in Decision Theory

Simplicity and Steve Jobs: “That’s been one of my mantras—focus and simplicity. Simple can be harder than complex: You have to work hard to get your thinking

clean to make it simple. But it's worth it in the end because once you get there, you can move mountains." *Business Week*, May 25, 1998.

Heuristics as powerful—and necessary—shortcuts: Gigerenzer and Brighton (2009) bust the following myth, as presented in *The Selfish Gene* by Richard Dawkins, in which we find the following about how a baseball outfielder catches a ball: "[H]e behaves as if he had solved a set of differential equations in predicting the trajectory of the ball. . . . At some subconscious level, something functionally equivalent to the mathematical calculations is going on."

Not quite, Professor Dawkins. Gerd Gigerenzer et al. counter by saying that none of that is done. They write the following:

Instead, experiments have shown that players rely on several heuristics. The gaze heuristic is the simplest one and works if the ball is already high up in the air: Fix your gaze on the ball, start running, and adjust your running speed so that the angle of gaze remains constant. A player who relies on the gaze heuristic can ignore all causal variables necessary to compute the trajectory of the ball—the initial distance, velocity, angle, air resistance, speed and direction of wind, and spin, among others. By paying attention to only one variable, the player will end up where the ball comes down without computing the exact spot.

The same heuristic is also used by animal species for catching prey and for intercepting potential mates. In pursuit and predation, bats, birds, and dragonflies maintain a constant optical angle between themselves and their prey, as do dogs when catching a Frisbee.

Additional examples:

To choose a mate, a peahen uses a heuristic: Rather than investigating all peacocks posing and displaying in a lek eager to get her attention or weighting and adding all male features to calculate the one with the highest expected utility, she investigates only three or four, and chooses the one with the largest number of eyespots.

Just like humans. Another example:

To measure the area of a nest cavity, a narrow crack in a rock, an ant has no yardstick but a rule of thumb: Run around on an irregular path for a fixed period while laying down a pheromone trail, and then leave. Return, move around on a different irregular path, and estimate the size of the cavity by the frequency of encountering the old trail. This heuristic is remarkably precise.

Other: Czerlinski and Gigerenzer et al. (1999), Goldstein and Gigerenzer (1999), Gigerenzer (2008).

Makridakis, forecasting, and less is more: Makridakis et al. (1982, 1993), Makridakis and Hibon (2000), Makridakis and Taleb (2009).

Heuristic to measure risks: Taleb, Canetti et al. (2012)—with IMF staff.

Lindy Effects and Associated Topics

The Lindy effect was demonstrated in Mandelbrot (1997). Initially he used it for the artistic production, bounded by the life of the producer. In our conversations toward the end of his life, I suggested the boundary perishable/nonperishable and he agreed that the nonperishable would be powerlaw distributed while the perishable (the initial Lindy story) worked as a mere metaphor. Depending on

whether we condition for knowledge of the initial time, the remaining lifetime for the exponential remains constant regardless of future condition, for power-law increases with time since inception, by a factor of $(\alpha/1-\alpha)$, where α is the tail exponent; for Gaussian or semi-Gaussian it decreases.

Gott: Gott (1993, 1994) presented the Copernican idea but did not properly condition the probability; corrected in Caves (2000). See discussion in Rees (2003), a treatment of the paradox in Bostrom (2002).

Survival papers and distributional properties: Often powerlaws are mistaken for exponential distributions, owing to lack of data in the tails. So I assume a priori that an exponential is likely to be powerlaw, but not the reverse, as the error in the opposite direction is vastly less likely. Pigolotti et al. (2005). For empires, Arbesman (2011), Khmaladze et al. (2007, 2010), Taagepera (1978, 1979). For firms: Fujiwara. Also Turchin (2003, 2009).

Conditional expected time of survival across distributions: Sornette and Knopoff (1997). They show how, paradoxically, the longer one waits for an earthquake, the longer he would be expected to wait.

Other Neomania

Le Corbusier: Christopher Caldwell, “Revolting High Rises,” *New York Times*, November 27, 2005.

Cairns and ancient measures: Cairns (2007). His work was brought to my attention by Yoav Brand, who graciously offered me his book after a lecture.

Nonteleological design: How buildings mutate and change, Brand (1995).

The Dog: Moral, ii. 11; 1208 b 11. “And he says that when a dog was accustomed always to sleep on the same tile, Empedokles was asked why the dog always sleeps on the same tile, and he answered that the dog had some likeness to the tile, so that the likeness is the reason for its frequenting it.”

General and Philosophical Discussions of Medicine

Medicina soror philosophiae: For reflective histories of medicine, Mudry (2006), Pigeaud (2006); Camguillem (1995) discussion of iatrogenics. For the spirit, Pager (1996), Bates (1995).

Islamic medicine: Pormann and Savage-Smith (2007), Djebbar (2001).

De motu animali and attempts to mathematize medicine: In Wear (1995). Let me reiterate: math is good, the wrong math is not good.

Ancient medicine: Edelstein (1987), Lonrig (1998). Vivian Nutton’s *Ancient Medicine* (Nutton [2004]) is informative, but near-silent about the empiricists, and not too detailed about ancient practices outside of a few standard treatises. More on medicine (skeptics and methodists) in the monumental Zeller (1905) or even better the superb *Les Sceptiques Grecs* by Brochard.

Oranges: As they are named in Modern Greek, *portokali*, a corruption of “Portuguese”—further corrupted in Levantine Arabic into *burduqan*, and present under that name in the Sicilian dialect.

Medical heuristics: Palmieri (2003).

Medieval and Renaissance: French (2003).

General history: Conrad et al. (1995), Porter (2002, 2003), Meslin et al. (2006), Kennedy (2004).

Iatrogenics: Sharpe and Faden (1998), most complete; Illich (1995) the first movement; Hadler (2009) for the back, Duffin (1999), Welsh et al. (2011) on over-diagnosis (though no argument about noise/signal and filtering), Lebrun (1995).

Agency and iatrogenics: Just a random example: “Surgeons do more operations if they’re on the board of surgery centers,” June 22, 2012, “The Daily Stat,” *Harvard Business Review*.

More amusing historical perspective of iatrogenics: Gustave Jules A. Witkowski, 1889, *Le mal qu’on a dit des médecins*.

Rationalism/Galenism: Garicia-Ballester (1995).

Montaigne: “Mais ils ont cet heur, selon Nicocles, que le soleil esclaire leur succez, et la terre cache leur faute; et, outre-cela, ils ont une façon bien avantageuse de se servir de toutes sortes d’evenemens, car ce que la fortune, ce que la nature, ou quelque autre cause estrangere (desquelles le nombre est infini) produit en nous de bon et de salutaire, c’est le privilege de la medecine de se l’attribuer. Tous les heureux succez qui arrivent au patient qui est soubs son regime, c’est d’elle qu’il les tient. Les occasions qui m’ont guery, moy, et qui guerissent mille autres qui n’appellent point les medecins à leurs secours, ils les usurpent en leurs subjects; et, quant aux mauvais accidents, ou ils les desavouent tout à fait, en attribuant la coulpe au patient par des raisons si vaines qu’ils n’ont garde de faillir d’en trouver tousjors assez bon nombre de telles. . . .” [Note the detection of the attribution problem.]

On demandoit à un Lacedemonien qui l’avoit fait vivre sain si long temps: *L’ignorance de la medecine, respondit il.*

Et Adrian l’Empereur crooit sans cesse, en mourant, que la presse des medecins l’avoit tué.

Modern alternative medicine: Singh and Edzard (2008)—they had their skin in the game, as they were sued for it.

Homeopathy and empirical evidence: Goldacre (2007). See also the highly readable *Bad Science*, Goldacre (2009).

Modern evidence-based medicine: Manual in Sacket et al. (1998). Flaws of rationalistic methods, Silverman (1999), Gauch (2009), Sestini and Irving (2009).

Icing: Collins (2008): “There is insufficient evidence to suggest that cryotherapy improves clinical outcome in the management of soft tissue injuries.” I could not find papers saying the opposite. What benefits are proffered seem so marginal it is not even funny.

Convexity of blood pressure: Numbers from Welch et al. (2011).

Jensen’s inequality and pulmonary ventilators: Brewster et al. (2005), Graham et al. (2005), Mutch et al. (2007).

Paracelsus: Interesting character as a rebel; alas, seems to have been hijacked by homeopathy advocates such as Coulter (2000). Biographies in Ball (2006), Bechtel (1970), Alendy (1937).

Immortalization: Gray (2011).

Stendhal: Le Rouge et le noir: “La besogne de cette journée sera longue et rude, fortifions-nous par un premier déjeuner; le second viendra à dix heures pendant la grand’messe.” Chapitre XXVIII.

Specific Medical Topics

Note that the concern of this author is not evidence, but rather absence of it and how researchers manage such a problem. The focus is in detecting missed convexities.

Effectiveness of low-calorie sweeteners: One gets plenty of information by looking at studies by defenders with vested interests. De la Hunty et al. (2006) shows “advantages” to aspartame, with a meta-analysis, but focusing on the calorie-in calorie-out method, not overall weight gains. But reading it closely uncovers that the core is missing: “Some compensation for the substituted energy occurs but this is only about one-third of the energy replaced and is *probably* [emphasis

mine] less than when using soft drinks sweetened with aspartame. Nevertheless these compensation values are derived from short-term studies." Obviously, the paper was financed by a maker of aspartame. A better study, Anderson et al. (2012), though marred with conflict of interest (authors' support from food companies), concludes: "there is no evidence that LCS (low calorie sweeteners) can be claimed to be a cause of higher body weight in adults. Similarly evidence supporting a role in weight management is lacking." The last sentence is the only one that I can pay attention to as it is evidence "against interest." Had there been 'benefits, we would have known about them. In other words, we are incurring iatrogenics of these sweets-without-calories without evidence, as of 2012, that they even work!

Mithridatization and hormesis: In Pliny, Kaiser (2003), Rattan (2008), Calabrese and Baldwin (2002, 2003a, 2003b). Note that they miss the convexity argument or the insight about the departure from the norm—hormesis might just be reinstatement of normalcy.

Fasting and hormesis: Martin, Mattson et al. (2006). Cancer treatment and fasting, Longo et al. (2008), Safdie et al. (2009), Raffaghello et al. (2010)); on yeast and longevity under restriction, Fabrizio et al. (2001); SIRT1, Longo et al. (2006), Michan et al. (2010); review work in Blagosklonny et al. (2010).

Definition of hormesis: Mattson (2008) for local definition, Danchin et al. (2011) for more complex-systems approach.

Aging, longevity, and hormesis: An extremely rich research; Radak et al. (2005), Rattan (2008), Cypster and Johnson (2002) for the C-elegans; Gems and Partridge (2008), Haylick (2001), Masoro (1998), Parsons (2000); for inflammation and Alzheimer's, Finch et al. (2001).

Bone density and load: Dook (1997) for females, Andreoli et al. (2001) for more general athletes; Scott, Khan, et al. (2008) for general exercise. Aging for females: Solomon (1997), Rautava et al. (2007); Conroy et al. (1993) for young females.

Bone density and bicycle riding: Nichols et al. (2003), Barry et al. (2008).

Bone density and Olympic-style weightlifting: Some "weightlifting" studies mistake the resistance exercise on machines for real naturalistic weightlifting that stresses the skeleton. Conroy et al. (1993) is a more ecologically robust study because it focuses on weight.

Thyroid: Earle (1975).

Cholesterol: Non-naive look, Scrupe and Edelstein (2008).

Lewontin and life expectancy: Lewontin (1993). Got idea for the potential unreliability of the Lewontin estimation and was directed to the CDC data from some article on the Web I can't remember.

Outdoors not sports: Rose et al. (2008). Higher levels of total time spent outdoors, rather than at sports per se, were associated with less myopia and a more hyperopic mean refraction, after adjusting for near work, parental myopia, and ethnicity.

"Neurobabble," "brain porn" studies: Weisberg (2008), McCabe (2008), also "neuroscience and the law," report by the U.K. Royal Society. Note that the writer Jonah Lehrer used brain porn quite effectively, building a narrative using some loose brain story, playing the narrative fallacy to the hilt—until he was caught creating both narrative and data to back it up.

The pressure on dentists to generate revenues: "Dental Abuse Seen Driven by Private Equity Investments," Sydney P. Freedberg, Bloomberg News, May 17, 2012.

Significance: Simply, people in social science should not be using statistics any more than an accountant should be given a surgeon's knife. The problem of misunderstanding significance affects professionals. See McCloskey and Ziliak (1996),

Ziliak and McCloskey (2008), Soyer and Hogarth (2011), Kahneman and Tversky (1971), Taleb and Goldstein (2012).

Practitioners and theoreticians in mathematical finance failing to understand an elementary notion in statistics in spite of all the hype: Evidence in Taleb and Goldstein (2007).

Missing nonlinearities of dose response: The case of radiation is rather stark, Neumaier et al. (2012). “The standard model currently in use applies a linear scale, extrapolating cancer risk from high doses to low doses of ionizing radiation. However, our discovery of DSB clustering over such large distances casts considerable doubts on the general assumption that risk to ionizing radiation is proportional to dose, and instead provides a mechanism that could more accurately address risk dose dependency of ionizing radiation.” Radiation hormesis is the idea that low-level radiation causes hormetic overreaction with protective effects. Also see Aurengo (2005).

Statins and convexity: For instance, with statin drugs routinely prescribed to lower blood lipids, although the result is statistically significant for a certain class of people, the effect is minor. “High-risk men aged 30–69 years should be advised that about 50 patients need to be treated for 5 years to prevent one [cardiovascular] event” (Abramson and Wright, 2007).

Statins side effects and (more or less) hidden risks: Side effects in musculoskeletal harm or just pain, Women, Speed et al. (2012). General assessment, Hilton-Jones (2009), Hu Chung et al. (2012). Roberts (2012) shows another aspect of convexity of benefits, hence harm in marginal cases. Fernandez et al. (2011) shows where clinical trials do not reflect myopathy risks. Blaha et al. (2012) shows “increased risks for healthy patients.” Also, Reedberg and Katz (2012); Hamazaki et al.: “The absolute effect of statins on all-cause mortality is rather small, if any.”

Harlan Krumholz, *Forbes*, April 29, 2011:

Problem is that drugs that improve blood test results may not lower risk. For example, many drugs that reduce LDL or raise HDL or lower blood sugar or blood pressure, do not, against all expectations, lower risk—and in some cases they increase risk.

This is particularly true when considering treatment options to prevent a future event such as a heart attack. Unfortunately, for many drugs that affect risk factors, studies that investigate whether patients benefit are either not done or delayed. This is the case with ezetimibe, a Merck agent that reduces LDL. Because the study that will include information about patient outcomes will only be completed when ezetimibe comes off patent, we will not know how it actually affects risk for a few more years. This billion dollar drug’s approval and sales have been solely based on its effect on a blood test.

For the fibrates, though, we are more fortunate. There are studies of patient outcomes, and fenofibrate, the Abbott drug, has been tested twice in large studies. In both, the drug failed to reduce the risk of the patients taking it even as it very effectively lowered their triglyceride levels. Most recently, in a \$300 million trial by the National Institutes of Health, no benefit was shown for the Abbott drug when it was combined with a statin—compounded by a suggested harm for women. The former concern is sufficiently high to have prompted the FDA to convene an advisory committee to review the findings.

Back: McGill (2007); iatrogenics surgery or epidural, Hadler (2009), Sayre (2010).

Doctor’s strikes: There have been a few episodes of hospital strikes, leading to the cancellation of elective surgeries but not emergency-related services. The data

are not ample, but can give us insights if interpreted in *via negativa* mode. Extracting the effect of elective surgery, Argeseanu et al. (2008). See also Allebeck (1985), Gruber and Kleiner (2010), Siegel-Itzkovich (2000).

Diabetes and pharmacological treatments (ACCORD study): The ACCORD study (Action to Control Cardiovascular Risk in Diabetes) found no gain from lowering blood glucose, or other metrics—it may be more opaque than a simple glucose problem remedied by pharmacological means. Synthesis, Skyler et al. (2009), old methods, Westman and Vernon (2008).

Discussions of diabetes and diet: Taylor (2008), reversal in Lim et al. (2011), Boucher et al. (2004), Shimakura et al. (2010); diabetes management by diet alone, early insights in Wilson et al. (1980). Couzin, “Deaths in Diabetes Trial Challenge a Long-Held Theory,” *Science* 15 (February 2008): 884–885. Diabetes reversal and bariatric (or other) surgery: Pories (1995), Guidone et al. (2006), Rubino et al. 2006.

Autophagy for cancer: Kondo et al. (2005).

Autophagy (general): Danchin et al. (2011), Congcong et al. (2012).

Jensen’s inequality in medicine and workout: Many such as Schnohr and Marott (2011) got close to dealing with the fact that extreme sprinting and nothing (as a barbell) outperforms steady exercise, but missed the convexity bias part.

Art De Vany and Jensen’s inequality: Art De Vany, private correspondence: “Tissue gains are increasing but convex with nutrient intake (the curve is rising, but at a diminishing rate). This has to be the case for the point of origin to be a steady state solution. This implies that weight gain, including fat, is higher at the average intake than it is on a varying intake of the same calories and nutrients. Muscle and fat compete for substrate, so a fatter person will shift nutrient partitioning toward muscle because body fat induces insulin resistance in muscle. Insulin operates in a pulsate release and is far more effective with that pattern than with the chronic elevation induced by six meals a day. On the downside, where fat and muscle are lost, the curve is negatively sloped but declines at a diminishing rate (concave). This means you lose more fat feeding intermittently than continuously. The loss at the average intake (six per day keeps the variation of the average small) is less than the loss at the same intake but one that varies between a small intake and a large one. A more subtle point: you lose more weight when you eat at the average than intermittently, but that is because you lose more muscle in chronic deprivation than intermittent deprivation. Intermittent eating yields a superior body composition.”

Starvation, intermittent fasting, and aging: For the neuronal resistance and brain aging, Anson, Guo, et al. (2003), Mattson et al. (2005), Martin, Mattson et al. (2006), Halagappa, Guo, et al. (2007), Stranahan and Mattson (2012).

Caloric restriction: Harrison (1984), Wiendruch (1996), Pisched (2008).

Intense exercise: Synthesis of the literature on the effect of episodic energy imbalance, in De Vany (2011), who also, as a bonus, examines powerlaw effects.

Missing the point that pills are more speculative: Stip (2010) spends time on *via positiva* methods to extend life with complicated pharma stories.

Glucose and willpower: Note the effect of glucose making people sharper and helping willpower from experiments by Baumeister, see Kahneman (2011), might only apply to metabolically unfit persons. See Kurzban (2011) for a look at the statistical tools.

Cluster of ailments from lack of randomness, as presented in prologue: Yaffe and Blackwell (2004), Razay and Wilcock (1994); Alzheimer and hyperinsulolemia, Luchsinger, Tang, et al. (2004), Janson, Laedtke, et al. (2004).

Starvation and the brain: Stranahan and Mattson (2012). Long-held belief that the brain needed glucose, not ketones, and that the brain does not go through autophagy, progressively corrected.

Ramadan and effect of fasting: Ramadan is not interesting because people fast for only about 12 hours, depending on the season (someone who fasts from dinner to lunch can get 17 hours without food, which is practiced by this author). Further, they gorge themselves at dawn, and load on carbohydrates with, in my experience, the sweets of Tripoli (Lebanon). Nevertheless, some significance. Trabelsi et al. (2012), Akanji et al. (2012).

Benefits of stress: For the different effects of the two types of stressors, short and chronic, Dhabar (2009); for the benefits of stress on boosting immunity and cancer resistance, Dhabhar et al. (2010), Dhabhar et al. (2012).

Iatrogenics of hygiene and systematic elimination of germs: Rook (2011), Garner et al. (2006), Mégraud and Lamouliatte (1992) for Helyobacter.

The Paleo crowd, De Vany, Gary Taubes, and friends: Taubes (2008, 2011), De Vany (2011); evolutionary anthropology, Carrera-Bastos et al. (2011), Kaplan et al. (2000).

BOOK VII: The Ethics of Fragility and Antifragility

Modern philosophical discussions on capitalism: No interest in such a simple heuristic as skin in the game, even in insightful discourses such as Cuillerai (2009).

Courage in history: Berns et al. (2010).

Gladiators: Veyne (1999).

Treadmill: Lucretius, *Nimirum quia non bene norat quæ esset habendi / Finis, et omnino quoad crescat vera voluptas.*

Group and collective: Haidt (2012).

Adam Smith on capitalism: “A word he never uttered”: Simon Schama, private communication.

Stiglitz et al. dangerous report: Joseph E. Stiglitz, Jonathan M. Orszag, and Peter R. Orszag, “Implications of the New Fannie Mae and Freddie Mac Risk-based Capital Standard,” *Fannie Mae Papers*, Volume I, Issue 2, March 2002.

Meyer Lansky: Attributed to Ralph Salerno, retired NYPD mob investigator, in Ferrante (2011).

Unsavory activities by pharma finding patients rather than treatments: Stories of direct and indirect corruption, particularly in the psychiatric domain. A professor of psychiatry at Harvard Medical School received \$1.6 million from pharma. “Thanks to him, children as young as two years old are now being diagnosed with bipolar disorder . . .” Marcia Angell, *The New York Review of Books*. Angell used to be the editor of *The New England Journal of Medicine* and distrusts a large number of clinical studies. Further, how money is not spent on speculative research, but on “safe” bets with regular drugs, Light and Lexchin (2012).

Contradicting studies: Kahneman brought to my attention studies such as Malmendier and Tate (2008, 2009) showing managers investing more than needed in their companies, hence excess skin in the game as a result of overconfidence. Myron Scholes and Robert Merton had investments in LTCM. Indeed—but overall the free option dominates (just measure the aggregate payment of managers relative to gains by shareholders). There are “fools of randomness” and “crooks of randomness”; we often observe a combination. (Credit: Nicolas Tabardel.)

Asymmetries and extractive: Acemoglu and Robinson (2012) discusses an asymmetry with their notion of extractive economic institutions and environment, in which

someone gets rich at the expense of someone else, the opposite of the convex collaborative framework in which one's wealth leads to a compounding pie. *Role of institutions*, North (1990).

Caviar socialism and Burnyeat's problem: Riffard (2004), Burnyeat (1984), Wai-Hung (2002).

Collective blindness and diffusion of responsibility: In the animal domain (ants), Deneubourg, Goss et al. (1983), Deneubourg, Pasteels et al. (1983).

Life and socialization in Rome: Veyne (2001).

Elephant in the room: Things that everyone knows but remain undiscussed. Zerubavel (2006).

Mortality of large firms: Higher than expected, Greenwood and Suddaby (2006), comment Stubbart and Knight (2006). The best test is to take the S&P 100 or S&P 500 and look at its composition through time. The other one of course is in the literature on mergers.

Information cascades: The mechanism by which the crowd exacerbates fallacies, illusions, and rumors, Sunstein (2009) for a synthesis.

Alan Blinder problem: *Wall Street Journal* article with undisclosed conflict of interest: "Blanket Deposit Insurance Is a Bad Idea," Oct. 15, 2008, coauthored with R. Glenn Hubbard, dean of Columbia University Business School.

Comparative performance of family businesses: McConaughy and Fialco (2001), Le Breton-Miller and Miller (2006), Mackie (2001).

Skin in the game: Taleb and Martin (2012a).

Data Mining, Big Data, and the Researcher's Option, etc.

Misunderstanding in social science literature: Typical mistake, consider the ignorance of the problem by hyperactive promoters of the idea such as Ayres (2007): "Want to hedge a large purchase of Euros? Turns out you should sell a carefully balanced portfolio of twenty-six other stocks and commodities that might include Wal-Mart stock," p. 11.

Stan Young's crusade: Young and Carr (2011). Also Ioannides (2005, 2007).

Doxastic commitment: Levi (1980).

Salt: Very convincing Freedman and Petitti (2001), relies on visualization of data rather than metrics. Note "neither author consults for the salt industry," the kind of thing I read first.

Graph on Big Data: By Monte Carlo simulation; used >0.1 , or beyond what correlations are loved in social science (it is hard to analytically do the analysis because of the need for large matrices to remain positive-definite). The convexity is invariant to the correlation threshold.

Solution to the researcher's bias in clinical trials: Goldacre (2009) suggests the establishment of a database of trials, forcing researchers to record their failures. Anything is better than what we got.

The collective and fragility: The power of the collective rests on benefits from efficiency, hence fragility: people start substituting collective judgment for individual judgment. This works fine—it is faster and cheaper (hence more efficient) than having to reinvent the wheel individually. But like everything that is a shortcut, it ends blowing up in our faces. In the world in which we live the effect is compounded—the scale is larger and larger; the collective is planetary.

Jobs and artisan ethics: This makes me worry: "Playboy: 'Are you saying that the people who made PCjr don't have that kind of pride in the product?' Jobs: 'If they did, they wouldn't have made the PCjr.'" *Playboy [sic]*, Feb. 1, 1985.

Busting the hypothesis of hyperbolic discounting: Read and Airoldi (2012).

Other discussions of Big Data and researchers gaming the system: Baumeister et al. (2007) about self-reporting in psychology. Kerr (1998) about hypothesis following the results, and post hoc in Yauan and Maxwell; Yarkoni for the large M (dimension) low N (data) problem.