

Appendix

Technical Details

This appendix is not necessary to understand the text or notes. It should be skipped by readers not interested in technical details. Other readers will find it a convenient distillation of material scattered in existing literature, together with a few minor new contributions to the literature.

A1. Social and Biological Evolution

Evolution derives from a Latin word meaning “unfolding” or “unrolling.” Imagine an ornate hall rug just off the delivery truck. As you gradually roll it out, more of its patterns emerge and finally it is revealed in its full glory.

Popular use still reflects this original meaning. As most people use the word, evolution refers to any cumulative process of change or development, of unfolding over time. The word retains overtones of gradualism, of continuous improvement and increasing complexity over time, and of direction toward some final goal.

The technical meaning of evolution is quite different. In biology, the word has a much narrower and more specific meaning. Biological evolution certainly is a cumulative process, but it may or may not be gradual or increase complexity. It certainly does not have a preordained goal.

Since Darwin (1859), biological evolution refers to the process governing the changes over time in all life forms. The process, also called “natural selection,” involves variations among individuals and selective transmission of characteristics to offspring. The variants that more successfully reproduce themselves become more prevalent in later generations. In modern perspective, what evolves are the genes—sequences in DNA molecules that encode biological characteristics.

In this book, the word evolution is used somewhat more broadly than in biology, but not so broadly as in popular use. Human social behavior can change over time because of biological evolution, but over shorter time scales—years or decades—the major genetic factors are almost constant. More rapid social change comes from nongenetic mechanisms such as (a) turnover in the population via entry and exit or migration (or war); (b) resource redistribution; and (c) changes in individual behavior via imitation and learning (see Boyd and Richerson, 1985).

Societies can change dramatically from one decade to the next due to the evolution of transmissible cultural characteristics, sometimes called “memes.”

Social (or cultural) evolution and biological evolution follow the same abstract logic. It begins with a set of alternative characteristics or traits. New alternative traits are generated in some fashion, for example, by mutation or innovation. Evolutionary logic then analyzes how the population distribution changes over time. For example, in biology, one might look at a trait such as the number of eggs a bird lays. A simple set of alternatives would be one, two, three, or four eggs, and the biologist would keep track, over many seasons, of how many times each number was observed in the nest. A social scientist might be interested in a social custom like primogeniture (the eldest son inherits all the parents’ land) and would track its prevalence in some region over the generations. Or, on a more rapid time scale, one might track a particular style of tattoo versus alternative styles and other sorts of body decoration.

Fitness summarizes the result of competition among existing traits. It determines the growth rate for each alternative trait, and thereby alters their prevalence over time.

Fitness has two components: the survival rate of carriers of the trait, and the transmission rate from carriers to the population as a whole. Fitness depends on the general environment in which the traits operate: changes in the environment can alter fitness and thereby shift the outcomes. For example, four eggs might have highest fitness when food is locally plentiful, but one egg might have higher fitness when the parents have to fly far to find food.

A2. Coevolution and Dynamics

The current prevalence of each alternative trait can also affect fitness by altering survival or transmission rates. Biologists call this frequency dependence. Here is a cultural example. A particular style of tattoo may transmit rapidly when worn by only a few trendsetters, but may lose its cachet if it becomes too popular, and the transmission rate could collapse.

Traits do not evolve in isolation. Their fitness depends on other traits in relevant populations. For example, sharp talons enhance the fitness of an osprey with the eyesight, wingspan, and nesting location to capture large fish swimming near the water’s surface. But such talons won’t enhance fitness of birds living in many other habitats. Like the osprey’s physical and behavioral tool kit for fish hunting, the main traits in all creatures coevolve.

In particular, social traits coevolve with biological traits. A classic example is sickle cell anemia. The biological trait can be traced to a single point mutation in human DNA that substitutes one amino acid for another at one place in the hemoglobin protein. The altered protein precipitates more readily than the normal form when it releases the oxygen it carries, and this tends to collapse the red blood cell into a sickle shape. Such red blood cells tend to clump and to not take up as much oxygen. The body compensates by shortening the life cycle of red blood cells.

Individuals whose DNA carries two copies of the sickle cell trait have poor health. They usually don't survive long enough to have children, so their biological fitness is far below normal. In most environments, individuals with one copy for normal hemoglobin and one for sickle cell have fitness just a bit below normal. However, in environments where malaria is prevalent, their fitness is boosted by the shorter life cycle of red blood cells, because the malaria parasite infects red blood cells and has fewer opportunities to spread when the hosts are not around very long. On balance, the sickle cell gene boosts fitness in malarial environments when it is sufficiently rare, but always impairs fitness when it is so common that most babies inherit two copies.

The story is coevolutionary because the environmental prevalence of malaria depends, in part, on human activity. Traditional yam growing cultures require people to live near pools of standing water that help mosquitoes breed, and the mosquitoes spread the malaria parasite from one individual to another. The net effect is that the sickle cell gene boosts the yam growing meme and vice versa. The story is told in greater detail in Goldsmith and Zimmerman (2001) and Durham (1991).

Coevolution and frequency-dependent fitness make for nontrivial dynamics. Most evolutionary theorists look only at equilibrium, where all surviving traits have zero fitness and the alternative traits have negative fitness. There is a fascinating technical literature on the stability of equilibrium, launched in the 1980s by John Maynard Smith and George Price (see Smith, 1982).

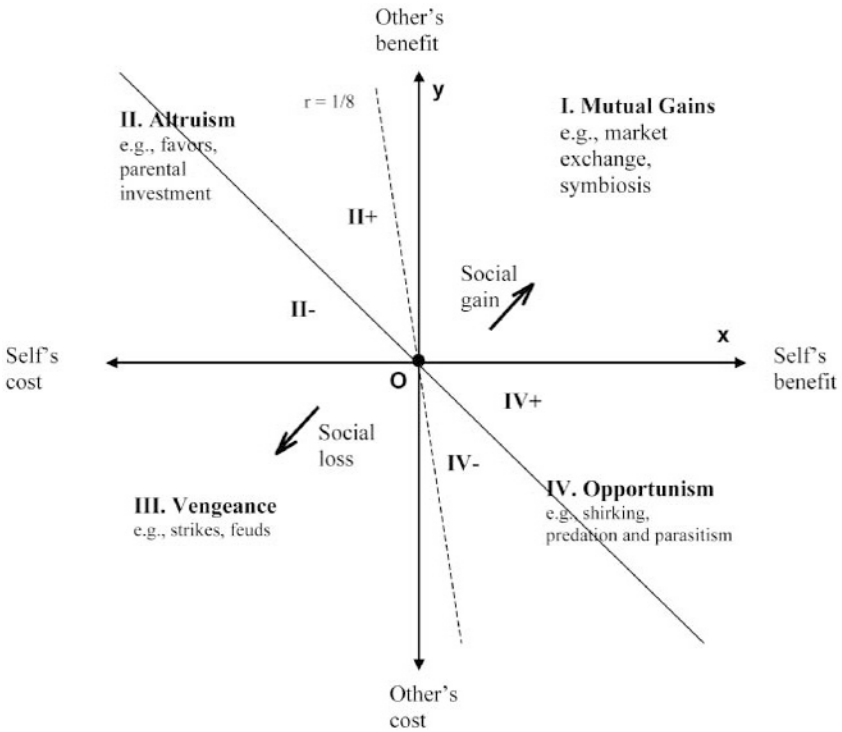
Of course, convergence to equilibrium is not guaranteed. Traits may indefinitely cycle among three or more alternatives. They also can fluctuate chaotically. The book presumes that, normally, the most important social traits are near equilibrium, but occasionally—in a major evolutionary transition—they are pushed out of a “basin of attraction” and a runaway dynamic carries the system rapidly toward a new equilibrium. Detailed theories about runaway (or positive feedback loop) dynamics are not yet very well developed, but the general perspective comes from the literature on nonlinear dynamics. See Friedman (1998) for a relatively accessible summary aimed at economics graduate students, and Gould and Eldridge (1993) for a nonmathematical collection of ideas.

A3. Social Dilemmas and Coordination Problems

Social creatures face a fundamental dilemma. Evolution selects for traits that increase the carrier's fitness, whether or not those traits help or harm other individuals. This individual imperative contrasts with the social imperative to help other members of the group and to avoid harming them, whether or not that is personally advantageous. A successful social group must somehow reconcile the individual imperative with the group imperative.

Figure A3 makes the point abstractly. The horizontal axis depicts the net fitness benefit ($x > 0$) or cost ($x < 0$) to a creature, denoted “Self,” associated with some activity. The vertical axis depicts the net fitness benefit ($y > 0$) or cost ($y < 0$) that Self's activity brings to all other creatures, denoted “Other.”

Figure A3: Payoffs to Self and Other



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Quadrant I is the region where both x and y are positive because the chosen activity simultaneously benefits both Self and Other. Biologists call this case mutualism or symbiosis, and cite examples like bees pollinating flowers while they gather nectar. Economists call this mutual benefit, and emphasize examples like voluntary trade. In quadrant I, there is sociality but no dilemma: we have a win-win situation.

The dilemma appears in quadrants II and IV; here, there is a conflict of interest between Self and Other. A quadrant II example is that Self gives food to Other. Such behavior is often called altruism. Quadrant IV is the region where x is positive but y is negative: the chosen strategy benefits Self at the expense of Other. For example, Self might steal food gathered by Other. The biological terms are parasitism and predation, and the economic terms are opportunism or exploitation.

It is important to realize that altruism doesn't always improve social efficiency, nor does exploitation always impair it. Social efficiency (i.e., the group imperative) is served to the extent that the sum $x + y$ increases, as indicated by the arrow labeled "social gain." The portions II+ and IV+ of quadrants II and IV above the

diagonal line represent efficient actions. For example, a well fed vampire bat loses only a little fitness (say $x = -1$) when it regurgitates blood into the mouth of a starving bat, but that other bat gains a lot (say $y = 3$) so the action is efficient ($x + y = 2 > 0$). The other quadrant portions II- and IV- are inefficient. Thus, it is not socially worthwhile for Self to incur a large personal cost that brings only a small benefit to Other, or to grab a small personal net benefit that creates large cost to Other.

Coordination problems are different. The idea is that mutual gains (a win-win outcome in quadrant I) are possible if Self and Other act in compatible ways. The standard example of a coordination problem is deciding on which side of the road to drive. If everyone drives on the right, as in the United States and continental Europe (or everyone on the left, as in Britain and some of its former colonies), there will be fewer accidents and everyone benefits. However, if some people drive on the left and some on the right, then accidents will be much more common.

There is no dilemma in a coordination problem: Self and everyone else is better off when she picks an action that coordinates with others in her group. But there can still be a problem, because group members might not choose compatible actions.

Why wouldn't they? Coordination failures can easily arise when the group hasn't worked together very long. For example, Team USA has more skilled basketball players than the other national teams, but, sometimes, the other team coordinates better and wins.

Another reason for coordination failures is that the benefits to coordinating may not split equally. The standard example (from 1950s textbooks) is a couple that wants an evening out together, but the man prefers a prizefight and the woman prefers opera. Each is least happy when they go separate ways, but that could happen in a struggle to choose the evening's event.

Many coordination problems are resolved by means of a hierarchy. The individual with highest status gets the first choice, then the second highest-ranking individual, and so on down the line. Wolves divide up the kill in exactly this way.

A4. Coping with Social Dilemmas: Kinship and Reciprocity

Abstractly speaking, the way to solve the social dilemma is to somehow rotate, counterclockwise, the vertical line in Figure A3 separating Self's gains from losses. Rotating the line forty-five degrees would completely solve the dilemma.

The main biological device is inclusive fitness, or kin selection (Haldane, 1955; Hamilton 1964; Williams, 1966). If Self and Other are kin, then the line rotates in the right direction. The amount of rotation depends on the degree r of relatedness. I haven't seen the diagram in textbooks, so the analytic geometry might be worth spelling out. If Self incurs a personal cost $x = -C$ to provide benefit B to Other, then the act increases inclusive fitness as long as $F = rB - C > 0$. The neutral line $x + ry = 0$ (like other iso-fitness lines) therefore has slope $-1/r$.

When Other is unrelated, then $r = 0$ and the line is vertical. The dashed line in the diagram has slope -8 , corresponding to $r = 1/8$, as with first cousins. If Self and

Other are clones or identical twins ($r = 1$) then the line rotates forty-five degrees and the dilemma completely disappears. Evolution pushes individuals toward socially efficient behavior because there is no distinction between self-interest and group interest when the group shares identical genes. An example: all cells in your body have a common interest because they share the same DNA and depend on specialized germ cells to reproduce. Slime mold amoeba also come close to $r = 1$.

The degree of relatedness r is as high as $3/4$ in hymenoptera, which includes social insects such as ants and bees. Primates like ourselves (along with most other creatures) have $r = 1/2$ between siblings and between parents and offspring. Relatedness drops off fairly quickly from there: for first cousins $r = 1/8$, as shown by the dotted line in Figure A3, and for second cousins r is only about 0.03.

Reciprocity is another device recognized by biologists since Trivers (1971). The idea is that when Other receives a favor $y = B > 0$ (or an injury $y < 0$), he will try to reciprocate with a return favor later. Such reciprocation brings fitness $F = dB - C$, where $x = -C$ is the cost to the donor. The discount factor d summarizes the probability that the favor will be returned, the delay in returning the favor, and the relative size of the return. Specifically, $d = q/(1+i)t$, where q is probability that the favor will be returned, i is the real interest rate, and t is the delay time.

The abstract representation of reciprocity is exactly the same as inclusive fitness, with the discount factor d replacing r . Reciprocity supports a larger fraction of all socially efficient behavior as d gets closer to 1. Large d means that the group is stable and faces repetitive symmetric opportunities for mutual aid, as with vampire bats. But d is small for typical members of a fission-fusion group facing once-off opportunities for mutual aid.

A5. Schematic Overview of the Moral System

Table A5 summarizes the main aspects of the human moral system. It contains prescriptions for proper behavior, possibly contingent on status; a means for monitoring actual behavior; and a means for transmitting observations, status updates, and prescriptions.

For example, a particular moral code might include the following prescriptive elements:

- share big game equally among all heads of households within the current group;
- mildly punish cheaters on this rule;
- threaten any outsiders entering our valley and try to kill them if they stay overnight;
- exile any insiders who fail to support this rule.

The code evolves as groups that embrace it are more or less successful than groups with differing codes. For example, a group that is more hospitable to outsiders may (or may not, depending on the social and physical environment) enjoy greater

Table A5 The Moral System

Shared Understanding of Proper Behavior

<i>Proper Behavior</i>	<i>Actual Behavior</i>
Coordinate mutual benefits	Enthusiastic support, “above and beyond”
Encourage efficient altruism	Adequate support
Discourage inefficient opportunism	Visible shortfall
Encourage costly punishment of particular sorts (e.g., in finding and sharing food, creating shelter, raising kids, finding mates.)	Hidden shortfall: cheating Hidden shortfall: lying
... depending on:	... shared via:
<i>Status</i>	<i>Transmission</i>
Age, sex, health, kinship, and marriage	Direct observation
Ingroup/outgroup	Stories, myths, and songs
Personal reputation	Gossip within group
Group reputation	Travelers’ tales

military success due to fewer losses and wider alliances. If so, the more hospitable code will spread.

The moral system relies on capacities for:

- Sharing understandings and information, via speech, memory, and cognition.
- Tracking individuals, using face recognition, memory, and cognition. That allows us to employ a code that depends delicately on status. (By contrast, ants can’t track individuals, just classes within the colony and outsiders.)
- Detecting intentions or “mind reading” using cues like body language, gestures, laughs and moans, and speech. This is key to adjusting reputation, hence, status, and to code enforcement. (Dogs and other social mammals are pretty good at this, too.)
- Emotions: guilt (internal reputation), anger (supports punishment codes), love (supports altruism, anti-opportunistic codes), joy of teamwork. The code must hook into these emotions to gain traction.

A6. The Unpleasant Arithmetic behind Hierarchy

As the group size increases, the probability of reaching consensus in a given amount of time drops rapidly. The difficulties of monitoring and keeping track of even bilateral relationships increase sharply as numbers increase.

Some arithmetic (or combinatorics, to use a fancier expression) shows the problem. In a group of size n there are $b(n) = n*(n-1)/2$ bilateral relationships. For a dozen people, this is $b(12) = 66$ relationships, quite manageable for humans. For a thousand people in a large village, it is $b(1000) = 499,500$, or about half a million relationships, far more than a normal person can track.

Multilateral relationships are important in many cases. For example, I might not be willing to work with a particular teenager unless his dad is along to keep him in line. These explode even faster. There are $n*(n-1)*(n-2)/6$ three way relationships, and using the factorial notation (!), there are $n!/(m-n)!$ relationships among m of the n people. Adding them up over all m between 0 and n , the total is 2^n relationships. Even for a dozen people this is $2^{12} = 4,096$ relationships. A socially adept person can quickly find the most important of them and keep track. But with a thousand people, the total number of relationships is 2^{1000} , more than the number of atoms in the universe. Keeping track of them, or even scanning a small subset, seems beyond human reach.

The solution is a layered hierarchy. For example, suppose the big boss has a dozen subordinates, each of whom has a dozen foremen in charge of a dozen ordinary workers. The three hierarchical steps allow the big boss to manage more than a thousand workers. (Taken literally, the number in the example is 1,728.)

A7. Markets' Inner Workings

Vernon Smith and many followers have conducted thousands of laboratory markets, using a variety of trading rules, different schedules of costs and values, different numbers of participants from all sorts of backgrounds, and so forth. The results are rather surprising. Given the right sort of trading rules, very high efficiencies can be consistently achieved, even with only a few buyers and a few sellers, say three or four of each. Standard economic theory predicts efficiency, but only with lots of buyers and lots of sellers. So the laboratory results, at first, deepen the mystery of how markets really work.

However, the best thing about laboratory markets is that you can rerun them, varying one thing at a time, and thus dissect their inner workings. Researchers have discovered four hidden forces that push toward competitive equilibrium (CE) prices and efficient exchange.

1. Market formats matter. The discussion in Chapter 2 suggested that posted prices (as in the farmers' market or in the supermarket) promote more efficient trade than haggling, and this is confirmed in the laboratory (e.g., Cason et al. 2003). Vernon Smith found that other market formats (or trading rules) are even more efficient. The continuous double auction (CDA, used in major financial markets) typically achieves 95–99 percent of the potential gains in the lab. At each moment in the CDA, traders can make public offers to buy ("bids") or to sell ("asks"), and a transaction is completed whenever anyone accepts an existing offer. Indeed, the CDA allows even random bidders to achieve very high efficiencies (Gode and Sunder, 1993).

2. Good trading rules discourage traders from acting too tough. Textbook monopoly theory says that sellers will hold back some low cost units when that will drive up price, even though this strategy creates a “deadweight” efficiency loss. Buyers who can affect price are similarly motivated to play tough by understating the quantity they wish to purchase. But CDA rules make it difficult for such strategies to work. Instead, the rules encourage traders to reveal the full amount they wish to trade, but to shade the prices they offer toward CE. This supports 100 percent efficiency while protecting against exploitation by traders on the other side of the market. Friedman and Ostroy (1995) show how this works in a simpler market format, the Call Market (CM).
3. Good trading rules can also use human learning biases to promote efficient trade. For example, suppose there are four buyers, each hoping to purchase a single unit, and four single unit sellers. Modern economic theory (available in advanced textbooks) predicts that each trader will offer a tough price that optimally trades off the probability of transacting against the transaction profitability. We have found in CM experiments that human traders, on average, start out offering prices about as tough as theory predicts, but that with experience, they make more generous prices and achieve very efficient trade. Careful data analysis indicates that traders react strongly when they miss a profitable transaction (by being too tough) and react much less when they could have obtained a better price (by being tougher). These reactions bias learning toward generous behavior and efficient trade (Cason and Friedman, 1999).
4. Good trading rules can drive out inefficient rules. Suppose that traders are used to a haggle market, and a new CDA market opens. Will traders move to the new market? At first, one might think so (efficiency is good), but there are two serious obstacles. First, buyers want to be where there are more sellers competing, and sellers want to be where the buyers are, so the existing market has a huge advantage. Also, even though the new market would be better, on average, if everyone used it, not everyone is average. Some buyers and some sellers are better off in the haggle market. Still, careful theory indicates that the better rules will prevail, and this has been confirmed in recent lab experiments. Here is the key insight. Buyers with the highest values and sellers with lowest cost have the most to gain by leaving the haggle market and going to an auction market, where they can keep a larger portion of their surplus. So these most valuable trading partners peel off first, leaving the haggle market less attractive. Now it's worthwhile for the most valuable remaining traders to peel off, and so on, until nobody is left in the haggle market that can trade in CE (Kugler et al. 2006; see also Friedman, 2007).

* * *

Friedrich Hayek shared the 1974 Nobel Prize for pushing the competitive equilibrium efficiency argument a bit further. His point is that nobody needs to know much for the markets to function well. All you need to know is your own personal circumstances plus the prices for the goods you buy and sell. When you buy carrots,

you don't need to know restaurant chefs' menus, matrons' dinner plans, or farmers' luck with weather and irrigation systems and seasonal labor. In gift exchange, by contrast, you do have to know quite a bit about the personal circumstances of the people with whom you exchange. Acquiring such information becomes increasingly problematic when a larger number of more diverse people engage in exchange, so markets have a huge informational advantage at larger scale.

The last paragraphs of the "Market Magic" section of Chapter 2 offered a short list of limitations to markets. Here is a more detailed list:

1. Gift exchange has a built-in tendency to split gains in some manner that participants regard as "fair." Markets have no such tendency. The CE price is determined only by supply and demand. It can turn out to be quite different than expected, and might produce a split that gives the lion's share of gains to some undeserving lout and might bankrupt some worthy citizen.
2. The arguments so far assume that trade has no effect on third parties. But if production or consumption helps or harms other people not involved in the market exchange, then we have an "externality" that may undermine efficiency. For example, people who live downwind of a large hog farm bear a cost, and a sculptor's neighbors may get an unpaid benefit. Markets that fail to recognize such external costs and benefits are generally not efficient, and sometimes, extremely inefficient. Chapter 11 mentions several examples like air pollution.
3. The arguments so far assume that people have secure ownership of the goods they buy and sell. But investment disappears and markets freeze up when people fear expropriation. Robert Mugabe's Zimbabwe and Afghanistan under the pre-Taliban warlords immediately come to mind.
4. The argument on price adjustment assumes that producers and consumers can respond to price in timely fashion. This is not always the case. For example, homeowners and most businesses have no idea what electricity costs until the bill comes at the end of the month. Chapter 12 notes how this lack of timely information helped create the 2000 California energy crisis.
5. Hayek's argument assumes that each person knows the personal benefits or costs of the goods he or she transacts. In financial markets, most investors have considerable uncertainty about the returns they will receive. Their perceptions may change suddenly, at tremendous personal and social cost. Chapter 7 examines some of the consequences.
6. Good market formats like the continuous double auction make it difficult for any one trader to push the price around, but in some situations a single trader is able to do so. (Or a group of traders might form a cartel to manipulate prices.) The lack of real competition can lead to inefficiency. Many observers believe that Microsoft's dominance in computer operating systems in the 1990s was a prime example. The text examines several other examples, beginning with Thales of Miletus.
7. Competition and efficiency are also hampered by informational obstacles. For example, if the seller of a used car knows more about its quality than the buyer, then a sensible buyer will bid on it very cautiously. This point comes up in Chapter 12.

8. The personal traits that help you do well in markets are quite different from the traits that help you do well in personal exchange. Success in auction markets comes from quickly recognizing opportunities to buy at a low price or to sell at a high price. Social emotions that are essential in personal exchange—empathy, gratitude, loyalty, and so on—are excess baggage in auction markets.

A8. The Duke and Serf Game

Player #1 (the Serf) first chooses an amount $k \in [0, 10]$ of corn to plant and consumes the rest of his initial endowment, so his current consumption is $c_0 = 10 - k$. Player #2 (the Duke, or Lord of the Manor) sees k and chooses the tax rate $t \in [0, 1]$. The crop size is $C(k) = (1+r)\sqrt{k} = 4\sqrt{k}$, reflecting diminishing marginal returns and productivity parameter $r = 3$. The Duke takes $T = tC$ and the Serf keeps $c_1 = (1-t)C$. The Duke seeks to maximize T and the Serf seeks to maximize $c_0 + c_1 - 10$, assuming that he needs to consume 10 over the year to stay alive.

To analyze this game, first note that the socially efficient outcome is to maximize the net surplus, $S = T + c_0 + c_1 - 10 = 4\sqrt{k} - k$. By standard calculus arguments, the solution satisfies $0 = dS/dk$, whose solution is $k^* = 4$. Plugging this into the appropriate expressions, we get the social optimum, $C^* = 8$ and $S^* = 4$. A minor technical qualification: if $r > 3.48$ in this example then the boundary condition $k \leq 10$ comes into play.

We solve the game via backward induction, that is, we find the subgame perfect Nash equilibrium. Whatever crop the Serf harvests, the Duke is personally better off by taking more of it. Rationally he will choose $t = 1$ or $T = C$. The rational choice of $k = K(t)$ by the Serf given anticipated take rate t will maximize his payoff $P = 10 - k + (1-t)4\sqrt{k}$. To find it, set $0 = dP/dk$, which yields $K(t) = 4(1-t)^2$. Given the (roving bandit) Duke's choice $t = 1$, the Serf will choose $K(1) = 0$, resulting in $C = 0$ and $S = 0$. This is a social dilemma: the equilibrium leaves both players far worse off than at the social optimum.

One way to cope with the social dilemma is to change the game so that the Duke chooses the tax rate before planting, and can't change his mind afterward. Giving the Serf access to an independent court would do the trick. Rationally, the Duke then would want to commit to a tax rate that maximizes $T(t) = tC(K(t)) = 8t(1-t)$. The first order condition $0 = dT/dt$ yields $t = 0.5$, which implies $k = K(0.5) = 1$ and $C = 4$, with net social surplus $S = 3$. This gets us 75 percent the social optimum. We can do even better if the courts enforce a take rate more favorable to the Serf.

Standard game theory texts (e.g., Watson, 2007) show how to set up the stationary bandit version as a repeated game in which Player 2 has discount factor $d \in [0, 1)$. A higher d means more patience, typically reflecting greater confidence in the future. Player 2 rationally restrains his greed up to the point that the discounted present value (see A9 below) of a steady take, $(1 + d + d^2 + \dots)tC = tC/(1-d)$, is as good as taking the entire harvest C now and getting nothing ever after, that is, up to the point that $t = 1-d$. Thus, a more patient Duke can tolerate a lower take rate t .

Another way to expand on the basic game is to allow the productivity r to depend on the Serf's prior investment in farm equipment, fertilizer, crop rotation, and so on. Since such investments take longer to pay off, the preceding arguments apply with greater force: the Serf will invest more when he has good reason to believe that the Duke is committed to a lower take rate.

A9. Asset Price and Fundamental Value

The Generalized St Ives Problem. Although every standard finance textbook explains the mathematics of expected present value, it might be helpful to begin here with a self-contained explanation, using a medieval theme.

Recall the ditty from Chaucer's era: "As I was going to St Ives/ I met a man with seven wives/ And every wife had seven sacks/ And every sack had seven cats/ And every cat had seven kits. / Kits, cats, sacks, wives[, man]/ How many were going to St Ives?"

It appears that we are asked to sum the geometric series $1 + 7 + 7^2 + 7^3 + 7^4$. Instead of grinding it out, let's find the general formula. Let $S(x, n) = \sum_{t=0}^n x^t$, whose value we seek for $x = 7$ and $n = 4$. The math trick is to notice that $xS(x, n) = \sum_{t=0}^n x^{t+1}$ is the same as $S(x, n)$ except that it is missing the first term, $x^0 = 1$, and has an extra term, x^{n+1} . Therefore $1 - x^{n+1} = S(x, n) - xS(x, n) = (1-x)S(x, n)$. As long as $x \neq 1$, we can divide both sides of the equation by $(1-x)$ to obtain the answer:

$$S(x, n) = (1 - x^{n+1})/(1 - x). \quad (1)$$

In particular, for the St Ives menagerie, we get $S(7, 4) = (1-7^5)/(1-7) = (1-16807)/(-6) = 16806/6 = 2801$. (When $x = 1$, of course, the sum is simply $S(1, n) = 1+1+ \dots +1 = n+1$.)

The ditty has a catch, however. Maybe the menagerie was returning from the fair, not going to it. But it seems likely that the narrator would travel faster, and so might have overtaken them. Using a bit of calculus and a lot of guesswork, we might say that the probability that the menagerie was going to St Ives was 25 percent. In that case, the expected number going to St Ives was $(.25) 2801 + (.75) 0 = 700.25$.

* * *

Fundamental Value. The fundamental value of an asset is the expected present value of the promised cash stream. "Present value" refers to the fact that a dollar in hand now is worth more than a dollar received later. If the interest rate at your bank is 5 percent, then you could put the present dollar on deposit and get back \$1.05 one year later, or get back $(1+.05)^2$ two years later, and so on. The present value of, say, \$10 received two years from now is the amount $\$10/(1+.05)^2$, about \$9.07, that you would have to deposit now to have the \$10 in two years.

The present value of a stream of regular cash payments (such as that promised by a conventional bond) is simply the sum of the present value of each payment. It is the sum of the geometric series $B + B/(1+r) + B/(1+r)^2 + \dots + B/(1+r)^n = B S(1/(1+r), n)$, where B is the amount received each period, r is the interest rate (e.g., .05 or 5 percent) and n is the number of periods over which the payment is promised. Plugging $x = 1/(1+r)$ into formula (1) above, multiplying numerator and denominator by $(1+r)$ and simplifying slightly, you find that the present value of the promised payments is $W = B(1+r - x^n)/r$. If you don't count the current payment, and so subtract B from the sum, you get the textbook formula

$$W = B(1 - (1/(1+r))^n)/r. \quad (2)$$

The value of a bond must take into account that the promise is not 100 percent certain to be honored. For example, if the probability were 90 percent of it being honored in full, and 10 percent of receiving nothing, then the "expected present value" would be

$$V = EW = 0.9W, \quad (3)$$

and that would be the fundamental value of the bond.

* * *

Great Expectations. With these technical points out of the way, we can ask the more interesting conceptual question: whose beliefs lie behind the expectation? A hypothetical outside observer who knows the future? The smartest investor? An average investor?

The first answer is wrong because financial markets in our world must rely on information that is actually available at the present time. We might enjoy "Monday morning quarterbacking" after the fact, or wish for divine revelation of the future, but in forming expectations, we must rely on what is known at the time. The second and third answers are also wrong, but for the opposite reason: they neglect useful information that is available. Smart as he (or she) might be, the smartest investor typically is unaware of important facts known by some other people. Friedrich Hayek received the 1974 Nobel Prize in Economics mainly for making this key point:

The knowledge of the circumstances of which we must make use never exists in concentrated or integrated form but solely as the dispersed bits of incomplete and frequently contradictory knowledge which all the separate individuals possess. The economic problem of society is thus not merely a problem of how to allocate "given" resources—if "given" is to mean given to a single mind. . . . It is rather a problem of how to secure the best use of resources known to any of the members of society, for ends whose relative importance only those individuals know. Or, to put it briefly, it is a problem of the utilization of knowledge which is not given to anyone in totality (1945, 77–78).

Thus, the expectation should incorporate all information presently available to anyone. Imagine investors not as gods who know what the future will bring, but rather as mind-reading angels who are willing to share everything they know with each other and to combine their information without bias or distortion. That is the nature of the beliefs behind the fundamental value V .

* * *

Information Aggregation. Of course, investors are not mind-reading angels. To the contrary, they are probably at least as greedy and selfish as the average human, and not generally inclined to share their private information with other investors. Hayek's claim is that the market gets the same result from human investors. If Hayek is right, the magic is not in the investors, but rather in the way that financial markets work. Somehow markets get selfish and greedy investors to reveal their knowledge and to summarize it all in asset prices. If this trick works, then price equals fundamental value and financial markets are efficient.

Getting investors to combine and summarize their knowledge into market prices would be a remarkable trick in its own right. As mentioned in the introduction, it would also be of crucial importance in economies like ours that rely on financial markets to allocate resources for the future. So how might the trick work?

Hayek never spelled it out, but the KidsRUs (KRU) example in the text makes the point. When you and your wealthy friends buy its stock, your purchases are often amplified by day traders and other investors who follow order flow and price changes. So the stock price goes up, and KRU can borrow more given the appreciated stock, or use its appreciated stock to buy up other firms, or use more valuable stock options to pay its managers and employees. These activities all increase the resources available to KRU.

A10. Notes on Networks

Networks are described mathematically as a set of nodes, together with a set of links (or edges or connections) between some pairs of nodes. The mathematical theory, called graph or network theory, has developed in fits and starts over two hundred years, and has gathered lots of applications, for example, in physics, computer science, and epidemiology. In most social science applications, each node refers to an individual person, and two people are linked if they have some specified relationship, for example, they work together or are they spend leisure time together.

Chapters 1 and 2 contrast societies with fission-fusion networks to societies with fixed hierarchies. The difference can be described in terms of the network architecture. For example, in 1203 CE, Genghis Khan reorganized his army as a strict hierarchy (or "tree" in graph theory jargon) as follows. Each ordinary warrior belonged to a ten-person squad called an *arban*. Each member of an *arban* was linked to every other member, and one of them was designated the leader and

belonged to a group of ten other leaders called a *zagun*. Members of the *zagun* were linked to each other and they selected a leader who, along with nine other *zagun* leaders, formed a *mingan*, sort of a battalion staff. It, in turn, had a leader who, with nine others, formed a *tumen*, whose leader controlled an army of 10,000 and, like nine or so others, reported to the great Khan, or to his top general. Genghis Khan believed in meritocracy and in delegating decisions to the lowest possible level, so this hierarchical organization—call it GK—was quite effective. Over the next several decades, it became the backbone of the most extensive empire the world had yet seen.

Fission-fusion networks have a different sort of architecture, recently called “small-world.” To sharpen the contrast, assume that there are again ten thousand people in the society, and that working groups consist of ten people all linked to each other, as in an *arban* of the great Khan. But in the present example—call it FF—the working groups are temporary and don’t have leaders. Instead, most people have links to a few others outside the current working group, and a few people (call them hubs) have hundreds of links, scattered fairly randomly throughout the society, including some to other hubs. Random collections of groups fuse when it is in their interest to do so, and form new links. Then they fission back to working groups, sometimes with the membership rearranged. The Shoshone and !Kung networks worked something like this FF example.

Mathematicians use various sorts of summary statistics to describe networks. For example, the *density* is the average number of links per node, a bit over ten in both examples. The *mean path length* is the average number of links needed to get from one randomly chosen node to another. It is almost eight in the GK example, because most pairs of random nodes are ordinary warriors in different *tumen*, so the connecting path has to pass all the way up through the ranks and back down again. The mean path length is only about four in the FF example because most people are linked to a hub, and any two hubs are likely to be linked directly or through a third hub; see Travers and Milgram (1969) and Watts and Strogatz (1998). The *clustering coefficient* is the probability that two nodes linked to a randomly chosen node are themselves linked. It is over 0.9 in the GK example, but less than that in the FF example.

To get everyone moving on the same battle plan in the GK example, the top general can reach each soldier via a set of four links. In the FF example, even if someone somewhere had a battle plan that everyone agreed to, it would probably reach more than half the people in four links, but it might take seven or more links to reach some people. On the other hand, by virtue of its fluctuating work groups, the FF architecture seems much better at generating novelty and, by virtue of its shorter path length, also better at spreading it. Those advantages would seem to be very important in the Pleistocene, and surely are crucial in the business world of the early twenty-first century.

Notes

The ideas presented in this book have many sources. It was my great fortune to learn from a series of generous mentors. Mathematicians Stephen Smale and Ralph Abraham taught me new ways to think about dynamic processes. Economists Robert Clower and Jack Hirshleifer (and watching the interbank FX market at Bank of America) helped shape my thinking about the inner workings of markets. My approach to evolutionary games, and especially to social dilemmas, owes much to Ken Binmore and Reinhard Selten. I gained philosophical and historical perspective from Axel Leijonhufvud.

Numerous colleagues helped at crucial junctures. A dinner conversation with Ernst Fehr convinced me to think more systematically about social preferences and their market impact. Repeated contacts with Santa Fe Institute researchers and MacArthur Preference Group members—Sam Bowles, Herb Gintis, Rob Boyd, Pete Richerson, and Stu Kauffman are the first who spring to mind—helped sharpen my thinking about the nature and evolution of morals. Intellectual debts to other individuals are acknowledged in the chapter endnotes below.

I accrued more debts while putting the book together. Dan McNeill and I talked about it for years, and during the process, he taught me much about how to write. It was my huge disappointment that, when the time came, Dan was not able to coauthor the book. Many of the chapter titles are his, and some of the more graceful turns of phrase, particularly in Chapters 5 and 6. His ideas on content as well as style shine through every chapter.

Several other people read chapter drafts and helped me correct errors and clarify my prose and my thinking: Art Argiewicz, Nick Despota, Bernie Elbaum, Benjamin Friedman, Sara Hendrix, Joel Leventhal, and an anonymous Palgrave reviewer. My deepest debt is to my dear wife, Penny Hargrove, who put up with me during countless preoccupied hours and, in the end, did a complete round of copyediting.

The people at Palgrave helped me turn a pile of drafts into a tidy volume. Jaime Marshall introduced me to the organization, Aaron Javicas signed me up, and Airie Stuart kept the project alive. I am especially grateful to acquisitions editor Laurie Harting for helping me finish what I started, and to the production crew, led by Rosemi Mederos. Marshall Somers compiled the bibliography and endnotes, and Kathryn Tobisch compiled the index. My heartfelt thanks to all.

This book is dedicated to the memory of my mom, Marion Thelma Siegel Friedman (1918–97). Humanist and skeptic, biology teacher and spiritual seeker, she first got me thinking about many of the questions asked in this book.

Prologue

Healy and Palepu (2003) summarizes the facts about Enron. The next two articles in the Spring 2003 issue of *Journal of Economic Perspectives* discuss accounting issues and conflicts of interest arising from the scandal wave. Several popular books on Enron have sold well, and one was made into a movie (see McLean and Elkind 2004).

Partnoy (2004) is a nontechnical discussion of the financial engineering behind the scandals. On the losses incurred by my pension fund, see “UC vies with Florida System to Take Helm in Enron Suit; 2 Pension Funds Top Losers in Collapse of Firm’s Stock,” by Lance Williams (*San Francisco Chronicle*, January 25, 2002).

Inappropriate mortgage loans are discussed in “Borrowers Face Dubious Charges in Foreclosures,” by Gretchen Morgenson (*New York Times*, November 6, 2007). Some of the conflicts of interest are discussed in “A Catastrophe Foretold,” by Paul Krugman (*New York Times*, op-ed page, October 26, 2007). I haven’t yet seen a good article on the financial engineering aspects; my own information comes mainly from colleagues and former students working in financial markets.

McAfee (2004) notes that loss of public trust was particularly disastrous for Enron’s pioneering product lines in market making.

“They lied about what they were doing”: Tyco is a partial exception. Ex-CEO Dennis Kozlowski is serving jail time for taking company money for personal purposes. The TV show *60 Minutes* ran a story called “Prisoner 05A4820” (March 25, 2007) in which Kozlowski convincingly claims that his board of directors approved everything he asked for, and he hid nothing. Of course, that reinforces the point that boards of directors were ineffective safeguards.

Data on the high-powered incentives: see “CEO Compensation Survey: Good-bye to Pay for No Performance,” by Joann Lublin (*Wall Street Journal*, April 11, 2005, R1). Chapters 8 and 12 discuss globalization and the other sources of threat and opportunity.

On lack of oversight by Boards of Directors, see “Deciding on Executive Pay: Lack of Independence Seen,” by Diana B. Henriques and Geraldine Fabrikant (*New York Times*, December 18, 2002). The consult-audit conflict of interest is discussed in the *Journal of Economic Perspectives* symposium cited above.

John Olson’s story is told in “Merrill Replaced Research Analyst Who Upset Enron,” by Richard A. Opper, Jr. (*New York Times*, July 30, 2002). Levitt (2002) tells his own story, and “S.E.C.’s Embattled Chief Resigns In Wake of Latest Political Storm,” by Stephen Labaton (*New York Times*, November 6, 2002) tells Harvey Pitt’s.

“Five Years Under the Thumb,” (*The Economist*, July 28, 2007, 73–74) summarizes the mixed reviews of Sarbanes-Oxley act five years after its passage. “Sarboxed In?” by James Surowiecki (*The New Yorker*, December 12, 2005, 46) is a more sympathetic analysis.

Chapter 1

“Morals are what made us human.” Of course, there is no shortage of competing opinions. Anthropologists in previous decades variously emphasized general intelligence, bipedalism, opposable thumbs, and tool-making. More recently, language seems to be the leading contender with morals gaining ground; see, for example, Klein (1999), and also McBrearty and Brooks (2000). Rhetoric aside, my point is no longer especially controversial: the moral system coevolved with language, tool-making, and do forth, and it is crucial to human cooperation.

On how amoeboids self-organize into a fruiting body, see Marée and Hogeweg (2001) and also Herbert et al. (2000). A theoretical investigation of what happens when spores from unrelated fruiting bodies are likely to mix is featured in Armstrong (1984). See <http://dictybase.org/> for general background.

On social dilemmas, see Appendix A3. It uses a four-quadrant diagram to show that, one way or another, cooperation depends on converting social dilemmas into games with mutual gains. Social creatures thrive to the extent they find devices that share the costs and benefits or, in economics jargon, internalize the externalities. (Appendix A1 and A2 offer background discussions on evolution, and on ultimate versus proximate causes.) A wealth of examples of animal cooperation and a classification similar to mine of devices solving the social dilemma can be found in Dugatkin (1997).

Hamilton (1964) formalized inclusive fitness and kin selection. As explained in Appendix A3, the key insight is algebraic: if cooperative behavior costs the individual some direct fitness c but brings fitness benefits b to others, then its inclusive fitness is $f = rb - c$, where r is the average relatedness of the others ($r=1$ for clones, $r=1/2$ for siblings, etc.) Behaviors with positive inclusive fitness tend become prevalent, and those with negative inclusive fitness tend to die out.

George Williams (1926–) is another great pioneer in the evolution of sociality; see especially Williams (1966). Dawkins (1976) is the most widely read book on the topic of the selfish gene, and rightfully so. E. O. Wilson (1975) provoked a very noisy controversy, partly because it suggested that kin selection arguments could explain human evolution. For a recent account, see Segerstrale (2001).

These books include descriptions of cooperation among bees and ants. The mechanism involves sophisticated trace chemicals called pheromones. Producing and detecting these chemicals allows ants, for example, to follow trails, and to identify fellow workers. The ultimate cause of cooperation, however, is inclusive fitness. An unusual genetic aspect of *hymenoptera*, called haplodiploidy, results in relatedness r as high as $3/4$ for sisters, who are unable to produce offspring themselves. Their best opportunity to pass on the genes they carry is to cooperate closely in feeding and defending the colony and helping to hatch eggs laid by their mother, the queen. With $r=3/4$, the fundamental social dilemma is not entirely eliminated, but it is greatly reduced; natural selection favors activities for which the social gains exceed 1.33 times the private cost. In most species, by contrast, r is only $1/2$ for full siblings (and parents and children), corresponding to a required benefit–cost ratio of 2.

Recent research has complicated the textbook story. In many insect societies, queens mate with several drones and in others, there are multiple queens, reducing r , but possibly improving the division of labor. Indeed, colony-level selection, rather than classic kin selection, may play the dominant role among bees and ants. See, for example, Wilson and Hölldobler (2005).

On cooperation among lions, see Packer and Pusey (1997); on mole rat societies, see Milius (2006).

Reciprocity, as explained in Trivers (1971), hinges on the discount factor. The sooner and more certain is the return favor, the closer the discount factor d is to 1.0, and the greater the range of prosocial behavior that can be supported by reciprocity. Trivers (1985) offers an accessible textbook treatment of reciprocity and other aspects of social behavior. The classic sociology article on reciprocity is Goulder (1960).

Cooperators must avoid non-kin when they bestow costly favors. The textbook example is the European common cuckoo, which survives on a “cheater” strategy. It lays an egg in the nest of other species whose eggs look similar. The cuckoo egg hatches sooner and the chick grows faster, and often kills off the host chicks. Host species must evolve ways to detect and evict these brood parasites as they become more prevalent, or else the host species dwindles. For a recent twist, see Soler et al. (1995).

Wilkinson (1984) reports reciprocal food sharing in vampire bats. Skepticism about Wilkinson’s findings appears in recent work such as Hammerstein (2003). The underlying problem seems to be Wilkinson’s small sample sizes, and the lack of other nonprimate examples. In an October 2007 personal communication, Wilkinson writes “I don’t think it is an accident that vampire bats have the largest brains for their body size of any other bat,” and that these bats clearly have the capacities for reciprocity. He acknowledges that the data have limitations, but remains confident that they demonstrate true reciprocity.

For a nice summary of research on primate grooming, see Maestipieri (2005, 199). Some evidence that reciprocity builds on kinship is noted in Ligon (1991, 51).

Hauser (2006) argues that evidence for reciprocity in food sharing is rather weak in bats and capuchin monkeys, though stronger in chimps, and lately he has found it in tamarinds.

On bonobos and chimps, and numerous references to the primary literature, see de Waal (2005). Once called “pygmy chimps,” bonobos are now recognized as a separate species that separated from common chimps about five million years ago, only about half a million years past the time of our last common ancestor. Genetically, bonobos and chimps are about equally related to us and to each other. Observations of bonobo social structure come mostly from zoos because these primates are hard to observe in the wild (see Parker 2007). The world’s most celebrated captive ape, Kanzi, at Georgia State’s Language Research Center, is a bonobo noted for his understanding of spoken English, his expressive language using a keyboard, and his kindness: see “Kanzi,” <http://en.wikipedia.org/wiki/Kanzi> and “Meet our Great Apes,” Great Ape Trust, Des Moines, Iowa, <http://www.iowagreatapes.org/bonobo/meet/kanzi.php>.

Sahelanthropus and Lake Chad (see Gibbons 2006, 237).

The human lineage first diverged from our closest cousins, the chimps and bonobos, about 6.5 million years ago, but DNA evidence points to a hybrid about 1.2 million years later that rebred back with chimps (or with our own ancestors)—see Patterson et al. (2006). On chimp lineages (see Wade 2006, 15).

Climate fluctuations (see Richerson et al. [forthcoming]). Its thesis is that extreme climate fluctuations, especially in the last several hundred thousand years, were a primary force behind the evolution of larger brains and human cultural evolution.

Patchy habitats . . . merge again . . . accelerating evolution. See Provine (1986), particularly the discussions of “shifting balance” equilibrium. Also see the discussion of plaid ecosystems versus the usual stripes in Richerson et al. (forthcoming).

Homo erectus: see Bobe and Behrensmeyer (2004). Some scholars give a separate name, *Homo ergaster*, to the early African lineages of *Erectus*. Naked skin: see, for example, Klein (1999, 292). Expensive brain: see Aiello and Wheeler (1995). They propose an evolutionary tradeoff between robust digestive systems and large brains. Specialists vs. generalists: see, for example, Potts (1996).

On sexual dimorphism and the emergence of male-female pair bonds: see, for example, “A Course in Evolution, Taught by Chimps,” by Nicholas Wade (*New York Times*, November 25, 2003). Among the wider families of apes, pair-bonding is observed in gibbons, but not in species more closely related to humans, such as gorillas, orangutans, and so on.

Group size and brain volume: see Dunbar (1996).

Contributions of young and old: see Kaplan and Guitierrez (2006).

Grandmothers: see Hawkes (2004). Some controversies remain, summarized in the article “Evolution’s Secret Weapon: Grandma,” (*New York Times*, October 5, 2007).

See Lee (1979) and Murphy and Murphy (1986) on group fusion among the !Kung and Shoshone, respectively.

Controversies abound regarding the relative importance of cultural and genetic evolution in shaping *Homo Sapiens*. The text emphasizes their coevolution without discussing specific mechanisms. For differing perspectives, see Choi and Bowles (2007) and Henrich and McElreath (2003).

Emotions in animals also remains a controversial topic. Our instinctive empathy often leads us to mistakenly read human motivation and human traits into animals, especially pets. For example, a bird song may seem cheery to us, even though its function is to warn other birds away from the singer’s territory. Scientists studying animal behavior are so wary of this mistake, known as the pathetic fallacy, that they often discount even very strong evidence on animal emotions. The balance is starting to return, as noted by de Waal and many other scientists: see for example de Waal (2005, 210) for evidence of envy in capuchins. The article “Scientist Finds the Beginnings of Morality in Primate Behavior,” by Nicholas Wade (*New York Times*, March 20, 2007) summarizes de Waal’s recent views.

I use the customary distinction between emotions contingent on others’ reaction to one’s behavior (pride and shame) and emotions that arise even when others are unaware of one’s behavior (guilt).

Whether the cognitive advances (theory of mind) or the emotions (empathy, etc.) are more important is also hotly debated by academics. That debate is pointless, in my opinion; both are essential and they reinforce each other in the human moral system.

Mirror neurons: for a popular account, see “Cells that Read Minds,” by Sandra Blakeslee (*New York Times*, January 10, 2006). On the connection to language, it cites an interview with Michael Arbib, a neuroscientist at the University of Southern California, who mentions an article he published in *Trends in Neuroscience* in March 1998. On the cup of coffee, it cites Iacoboni et al. (2005). Mirror neurons were first observed in macaques, where they play a very limited role; they are far more numerous and apparently more important in humans.

Spindle cells, the ventromedial nucleus and the two insulas are discussed in the popular article “Humanity? Maybe It’s in the Wiring,” by Sandra Blakeslee (*New York Times*, December 9, 2003).

The definition of morals is my own, though it seems consistent with views I recently encountered in Rawls (2001, 6): “Social cooperation is guided by publicly recognized rules and procedures which those cooperating recognize as appropriate to regulate their conduct,” and in Hauser (2006). Hauser proposes an analogy to the universal grammar that, according to Chomsky and followers, underlies all human languages. Hauser’s critics, such as philosopher Richard Rorty, emphasize the plasticity of moral codes and are skeptical about biological foundations. My argument doesn’t hinge on this debate about how tightly biology constrains cultural evolution, or on a parallel debate about the efficiency of cultural evolution. My point is, simply, that all established human groups have moral codes that are subject to cultural evolution.

The dictionary definition of morals is circular, and refers to moral constructs such as goodness and character. The *American Heritage Dictionary, 4th Ed.*, for example, says:

moral (adj.) 1. Of or concerned with the judgment of the goodness or badness of human action or character. 2. Teaching or exhibiting goodness or correctness of character and behavior. 3. Conforming to [moral] standards . . .

(noun) 1. The lesson or principle contained in or taught by a fable, a story or an event.

The air we breathe: only in the last two hundred years have scientists discovered that air is not elemental, but has several components (nitrogen, oxygen, carbon dioxide, water vapor); that a simple mathematical expression (the ideal gas law) governs air volume, pressure, and temperature; that a more complex equation (Navier-Stokes) governs air flow; and so forth. Common sense is adequate for normal activities in normal situations, but the deeper scientific understanding helps us refine unusual activities such as scuba diving and mountain climbing, and gives us broader insight into the weather, the unity of the plant kingdom, and many other facets of our world. Likewise, common sense about morals works well for everyday activities, but a deeper understanding of their origins and dynamics should provide wider insights into our world.

The Ultimatum Game was introduced by Güth et al. (1982). Rejections of unfair offers correlate with brain activity in the anterior insula region associated with disgust, according to Sanfey et al. (2003).

Experiments in small-scale societies: see Henrich et al. (2001). More details appear in the authors' forthcoming book, *Foundations of Human Sociality: Experiments in 15 small scale societies*. The interpretation given in the text also appears in Hauser (2006, 83).

Recipients of your affection: see the famous Rotten Kid Theorem in Becker (1974).

Vengeful emotions deter antisocial behavior: see Friedman and Singh (2004) and also the article "Payback Time: Why Revenge Tastes so Sweet," by Benedict Carey (*New York Times*, July 27, 2004).

The desire to achieve and maintain good standing can overpower even our most basic instincts, such as avoiding pain and preserving fertility. Gruesome examples include clitorrectomy in several contemporary African cultures, penile piercing in aboriginal Australia, and voluntary castration for male sopranos and harem attendants in medieval civilizations.

Leda Cosmides and John Tooby's classic 1992 collection, *The Adapted Mind*, argues that our minds are tuned to the tasks most important for our Paleolithic ancestors. In particular, it emphasizes the task of detecting cheaters.

Peter Richerson comments (in a November 2007 personal communication): "I think it is significant that the group that speaks the same language or dialect is also the group that delimits the boundaries of routine cooperation. The historian Benedict Anderson explains the rise of nationalism as a byproduct of our treating people who speak the same language as we do something like our ancestors treated fellow tribespeople."

Ngenika and Wolimbka: see Bernhard et al. (2006). The Swiss Army result appears in the immediately preceding article.

The cultural selection arguments advanced here and in the next section go back at least to Boyd and Richerson (1985). On the harsh codes of herdsmen, see, for example, Pettigrew (1975), Boehm (1999), and Kelly (1985).

Polyandry spread among the Nyinba: see Durham (1991, chap. 2). Primogeniture (only the first born male inherits) is an alternative moral solution to the same problem, quite prevalent historically in Europe, but it works better when agriculture is less labor intensive, or cheap agricultural labor is available.

Some anthropologists, such as Klein (1999), postulate that the Upper Paleolithic explosion was primed by some sort of genetic change, perhaps in speech processing circuits of the brain. Others argue for a gradual accumulation of the cultural prerequisites with no genetic break: see McBrearty and Brooks (2000). Either way, the explosion and its aftermath were cultural phenomena.

Kelly (1985) explains the Nuer and Dinka conflict.

Expansion out of Africa: see Wade (2006).

Anthropologists Diane Gifford-Gonzales and Peter Richerson gave me very helpful insights into the literature. Of course, they (like everyone else I acknowledge) should not be held responsible for remaining errors, misunderstandings, or idiosyncrasies.

Chapter 2

Uruk is called “Erech” in the Bible. The city’s deity, the goddess Inanna, is also known by her Akkadian name, “Ishtar.”

The little fantasy of early Uruk is consistent with current opinion of historians, as I understand it from De Mieroop (2006), Bottéro (2001), Nemet-Nejat (1998), and Kramer (1998).

On population and carrying capacity, see Hassan (1981).

Things change when there are no more frontiers: see MacArthur and Wilson (1967). The discussion is grounded in the distinction between *r*-strategies (expand quickly) and *k*-strategies (become more efficient at extracting resources).

Fagan (2003) has a wealth of general information on California lifestyles before 1500 CE. The population reached about 300 thousand by the end of that period.

The classic book on the transition to settled life is Sahlins (1972).

A sidelight on herding: although herding is the product of social evolution, it eventually affected human genetics. Children of herdsman enjoy greater health when they retain their ability to digest lactose later in life, so genetic mutations allowing greater lactose tolerance have spread over the centuries in every herding culture. For an overview, see Durham (1991).

On the diffusion of bow and arrow technology, see Klein (1999, 477) and also Diamond (1999).

Vayda (1967) discusses gift exchange among the Pomo, two (modern) counties north of Costanoan territory. They, and their Yurok and Karok neighbors to the north, enjoyed even larger salmon runs than the Costanoans.

Paul Samuelson, the first Nobel laureate in economics, is said to have named the idea of comparative advantage in Ricardo (1817) when challenged to identify a simple but nonobvious economic insight. Every microeconomics textbook now explains the idea in excruciating detail.

On Costanoans and fur seals: see Cooper and Etnier (2005).

Dow et al. (2006) contains a more elaborate and technical explanation of why sedentary hunter-gatherers took the first steps in the transition to agriculture. It also mentions the main alternative theories.

Chapter 4 of Diamond (2005) is an excellent brief description of Anasazi civilization, focusing on Chaco.

Hawkes (1992) discusses some aspects of the moral transformation. Boone (1992, 333ff) discusses the emergence of hierarchy in the Hawaiian Islands.

I can find only one partial exception to the rule that transferable wealth goes with hierarchy: two sedentary tribes of the Pacific Northwest, best known for their totem poles and potlatch feasts. Boehm (1999, 88) writes, “Neighbors of the Kwakiutl such as the Tolowa and Coastal Yurok also lived in year-round villages with food storage, but they kept their leaders weak and were politically egalitarian.” Why the exception? I conjecture that the villages were not such inviting targets for raiders, perhaps because they were small and hard to reach, or because the stored food was mostly acorns and other items with low value per pound.

In game-theory jargon, the participation constraint is much higher in hunter-gatherer life than in agricultural life, so utility levels will be higher. The same abstract argument applies to chimps: the alpha male and his supporters can bully other males, because they face mortal danger (from the males of neighboring groups) if they try to leave.

Joseph's story is Genesis 41.

Karl Polanyi and followers emphasized the role of redistribution; see, for example, Polanyi and Conrad (1957).

On Uruk in 4500 BCE, see Van De Mierop (2005).

On self-serving bias, see Babcock and Loewenstein (1997).

For the emergence of economic organization, see Howitt and Clower (2000).

On market formats more efficient than haggling, see Cason et al. (2003).

On the magic of CE, see any microeconomics textbook. The insight goes back to *The Wealth of Nations* by Adam Smith (1776), who famously wrote (Book IV, chap. 2) that each market participant is “led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for the society that it was not part of it. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it.”

Vernon Smith's experiments are nicely described in Smith (1982). The original paper is Smith (1962).

On Assyrian trader networks, see Larsen (1976).

On the Phoenicians, see Aubet (2001).

On Athens, see Millett (1991).

On Rome's open market economy, see Temin (2001) and Cameron and Neal (2003, 39–40). On Rome's stock market, see Malmendier (2006). On Rome's economic decline, see for example Cameron and Neal (2003, 41–42).

My thanks to Charlotte Cooper for pointers to the literature on California's first inhabitants, especially those of the central coast.

Chapter 3

Previous evolutionary transitions are discussed in, among other articles, Szathmari and Maynard Smith (1995). See, also, the last paragraph of Appendix section A2 on transition dynamics.

The quotes are from Polanyi (1944, 42, 57). The book argues that the market system was an aberration of the nineteenth century, which was breaking down in the twentieth century with the Great Depression and two world wars. Many economic historians now accept his view that ancient civilizations did not have a self-regulating market system, but evidence is spotty and controversies remain. Of course, his view of the market system's twentieth-century demise was, at best, premature.

Leijonhufvud (2007) is the source of the quotes in the forth paragraph.

For more on Basil's life and times, see Holmes (2005), and for Theophano's story, see Gibbons (2003). The millennium edition of the *Wall Street Journal* (January 11, 1999, R6) lists the sources of wealth for Basil and his contemporaries.

For more on contract enforceability, see Greif (1993).

Olson (1993) coins the terms roving bandit and stationary bandit. The *Duke-Serf* game is formalized and solved in Appendix section A8.

On the political pyramid of ancient civilizations, see, for example, Cameron and Neal (2003, chap. 2, 4). That textbook also contains population estimates used in this chapter.

While revising this chapter, I encountered North et al. (2006). Its perspective overlaps my own, but its focus is more on political changes than on market evolution.

“Monopoly profits . . . economically very inefficient.” Since Adam Smith, the point has been central to economic analysis. Actually, royal cartels are far less efficient even than a standard textbook monopoly, for three reasons. First, production (or trade) typically involves high cost producers. Second, over time, the barriers to entry raise costs. Third, the cartels often include double marginalization. For example, the Afghan silk traders would charge a monopoly markup and then the Byzantine traders would put a monopoly markup on top of that, raising the final price above that of a profit maximizing unified monopolist. Double marginalization is still discussed in some microeconomic texts: see, for example, Baye (2005, 420).

Europe’s early lead on cannon technology and the fall of Constantinople: see, for example, McNeill (1989).

Grantham (1999) argues that the economic collapse of Western Europe in the Dark Ages and its rise in medieval times are largely due to changes in access to markets and trade.

European contact with more advanced civilizations was spurred by the Mongols opening of the Silk Road in the 1200s, as well as by the Crusades: see Weatherford (2004) and Fernandez-Armesto (2006, chap. 3).

On the role of political fragmentation and competition, see Jones (1981).

The Champagne fairs are mentioned in most standard economic histories; see, for example, Cameron-Neal (2003, 65). A popular account of Troyes and its summer fair can be found in Gies and Gies (1981). The spirit of a smaller fair at Shrewsbury is nicely captured in Peters (1992).

For more on the community responsibility system and impartial justice, see Greif (2006). The influential article Greif et al. (1994)—or its overinterpretation—has been criticized in a number of later articles, including Dessi and Ogilvie (2003), and Sachs (2006). For more on private commercial law, see Bernstein (1998).

Arguably the last and best book in the “heroic tale” tradition is Boorstin (1983). I’ve drawn on it for the story of Prince Henry the Navigator. See Chapter 4 of Fernandez-Armesto (2006) for a less generous account of Dom Henrique’s career.

Weber is not as one-sided as some of his followers. Page 186 of Weber (1930) notes that the Protestant ethic “was in turn influenced in its development and character by the totality of social conditions, especially economic ones.” See also Tawney (1926), Clark (2007), and Landes (1998). Landes criticizes politically correct revisionist accounts such as Goody (1996).

My account also draws on Rosenberg and Birdsell (1986), and Maddison (2001, 63), which contains the ship count estimates.

I found the Spanish gold and silver estimates on UC Davis professor Richard Cowen's page <http://www-geology.ucdavis.edu/~cowen/~GEL115/>.

Acemoglu et al. (2005) shows how "Atlantic trade and colonial activity enriched and strengthened commercial interests, including new groups without ties to the monarchy." This led to legal and political reform, and strengthened property rights, a primary driver of growth and modernization. Shimer (2007) points up other Acemoglu themes relevant to the current discussion, for example, that spreading the franchise makes redistribution irreversible, whereas coups by old elite, and revolutions, raise fears of expropriation, and so deter investment and growth. Cervellati and Sunde (2005) present another related positive feedback story.

On China's Treasure Fleet, see Levathes (1996). Shiue and Keller (2007) summarize trade institutions in China (and continental Europe) in the 1700s and analyze location/price data, concluding that there was rough parity on efficiency of grain markets at that time. For contrasting perspectives, see Landes (2006) and chapter 4 of Fernandez-Armesto (2006).

Olson (1984) explains how unified control squelches innovation. Vested interests find it worthwhile to unite to protect their interests. The benefits of innovation greatly exceed the costs to the vested interests, but the benefits are too diffuse and too uncertain to sufficiently create powerful countervailing coalitions. Once the vested interests become sufficiently organized, the nation or empire loses its momentum and slowly declines.

The end of the Polynesian golden age is an exception. Their golden age was spurred by the discovery of truly virgin islands between Hawaii and New Zealand, and highlighted by accumulated skills in navigation and raft/outrigger construction and colonization. It ended not with unified control, but with exhaustion of resources, for example, on Easter Island, and collapse of trade (see Diamond 2005, chap. 2).

Chapter 4

Schumpeter sadly predicts capitalism's eventual demise in Schumpeter (1942). I can no longer find a quote indicating that Henry Kissinger also believed that communism would eventually triumph.

"Bathe . . ." is from *Milton: A Poem*, Book 2, Plate 41, by William Blake, 1810, and the "dark satanic mills" are from his 1804 poem *Jerusalem*. See Blake (1997).

The law of supply and demand destroys social responsibility: see Carlyle (1843).

"Seep across the boundaries": see Lasch (1996).

Population boomed: see, for example, Lee (2003). Of course, Russia in the 1990s is the biggest exception.

Most history books include a summary of the enclosure movement, for example, Palmer et al. (2002, 430). Dahlman (1980) offers a deeper analysis. He points

out that prior to enclosure, the open field system dominated northern Europe for a full millennium, and was quite efficient in providing local self-sufficiency. Enclosure became viable only with regional markets and specialization. The national wool trade provoked the first great wave of enclosure in England about 1550, but as late as 1750, about half of land under plow remained in the open field system. The next wave of enclosures virtually eliminated English open fields by 1850. Dahlman, like other observers, emphasizes the torn social fabric: whether or not small farmers received fair compensation for releasing their claims on the commons, they lost local ties and their children became rootless agricultural or factory workers.

Portsmouth block maker example: see Hicks (1969, 149).

The lines are from Blake (1997, Gnostic Verses viii).

For an excellent discussion of modernization and the labor market, see Leijonhufvud (2007).

Of course, the “market” for dissident politics is only metaphorical. The discussion draws on conversations with Jonathan Beecher, as well as his books.

On Luddites, see Pynchon (1984), who, in turn, cites the *Oxford English Dictionary* and *Encyclopedia Britannica*.

On Charles Fourier, see Beecher (1986) and Beecher and Bienvenu (1983).

“generous, conciliatory . . .” is from Beecher (2001, 5).

On the events of 1848, see Dureau (1984).

Marx (1844) contains the quoted lines on alienated labor.

Ricardo (1817) is still considered an intellectual landmark. Some of Marx’s contemporaries (e.g., the economists Gossens, Jevons, Menger, and Walras) discovered fatal flaws in Ricardo’s labor theory of value, but Marx seemed unaware of their work. Despite heroic efforts of modern economists in the 1970s and 1980s (e.g., Roemer, 1986) to find intellectual underpinnings, the labor theory of value is now dead. The consensus view is that, typically, market values are determined by the intersection of supply and demand, and that labor cost is just one factor affecting supply.

Goldman (1923), Remnick (1994), and Moynahan (1994) contain much of the material on the Soviet system. On Fascism, see Paxton (2004). *Animal Farm* by Orwell (1945) nicely captures the moral hypocrisy and hierarchy of the Soviet system.

Chapter 5

Aleksyan’s quote is from Remnick (1994, 318). The book also contains lots of very useful background information.

Sachs’ quotes are from Lipton and Sachs (1992). The authors, at that time, were official economic advisors to Yeltsin’s government. Their paper includes many caveats, especially about the political power of managers of loss-making state owned enterprises. Commentators Edmund Phelps and Mancur Olsen presciently

warned of the greater danger from insiders who might abuse the reform initiatives to accumulate power rather than to submit to market discipline.

Moynahan (1994) is a good general source. Khrushchev's corn fiasco is described on pages 199–201, gas filching on page 233, Gorbachev's mud cabin on page 223, his anti-alcohol campaign on pages 227–28 and 241, and the 1991 failed coup on pages 249–50. See also Richardson (1999).

The pervasive lack of trust, and predictions that the Soviet economy was headed down, come from Richard E. Ericson, personal communication, 1977.

An excellent summary of Russia's economic shocks and policies in the 1990s is Leijonhufvud and Craver (2001).

On the role of insiders—nomenklatura—in controlling productive assets since Gorbachev's reforms, see Grigoriev (1995). I thank Julia Urozhaeva for bringing this reference to my attention. Julia also rightly points out that Russian economic reformers did not intend to promote the oligarchs' crimes. In the 1990s, the oligarchs and their government allies managed to remove intended safeguards and to block serious reforms.

The rise of the oligarchs and looting of Russia, see Klebnikov (2000).

On pliant oligarchs, see the article "The Triumph of the Quiet Tycoon," by Peter Maass (*New York Times Magazine*, August 1, 2004). The articles note that Putin has arrested or chased out the top three oligarch—Berezovsky, Khodorkovsky and Gusinsky—and the remaining oligarchs have found that they can do as they want as long as they support Putin.

Shkolnikov et al. (2001) show an unprecedented drop in life expectancy from 1991 to 1994, especially for males, partially reversed by 1998.

Jack Hirshleifer and other academic economists such as Hershel Grossman and Stergios Skaperdas have written on competition in the absence of property rights; see, for example, Hirshleifer (1995).

Development economists are increasingly sympathetic to the propositions that (a) well functioning markets are the linchpin of economic development, and (b) good legal and moral infrastructure are the keys to well functioning markets. See, for example, Fafchamps (forthcoming).

See, also, the large related literature on rent dissipation. A popular account appears in a review of a 1998 book by Schleifer and Vishny that appeared in the February 13, 1999 issue of the *Economist* magazine. The book authors were major Western advisors in the 1990s Russian reform.

Putin-era stories: see the article "Business in Russia after Yukos," (*Economist* magazine, May 12, 2007, 67–68), which includes the quote about Khordorkovsky's trial; Specter (2007, 50–63) focuses on Anna Politkovskaya; "The Murder of Paul Klebnikov," (*Wall Street Journal*, July 14, 2004, A14), and also "Murdered US Editor Was Probing Russian Reporter's Death," (*Wall Street Journal*, July 16, 2004) by David Satter. The Kozlov murder was reported in the article "Austrians Cast Doubt on Russian Arrests in Murder Case," by Andrew E. Kramer (*New York Times*, June 15, 2007).

Bribery by, and extortion of, ordinary Russian businessmen are engagingly described in “Face Value: The Reluctant Briber” (*Economist* magazine, November 4, 2006, 79). “Russia under Putin” (*Economist* magazine, August 25, 2007, 25–28) documents the rise of KGB men to dominate government and big business in the Putin era.

Chapter 6

Vogel (1979) is an early book by a Harvard Business School Professor pushing Japan as a role model. Thurow (1985, 284) argues that the United States must subsidize key industries to compete with Japan. Page 298 asks the reader to compare U.S. policies like “propping up Harley-Davidson using high tariffs” to the self-evidently better “Japanese policy of subsidizing research on the fifth-generation computer.” Punditry is a tough business: the intervening twenty years have stood Thurow’s example on its head. Harley-Davidson, now a \$15 billion company, dominates its industry, with almost a 50 percent market share in the United States, and a rapidly growing share in Europe and even in Japan (now over 25 percent). Japan’s huge subsidy of fifth generation computing seems to have missed the technological boat and her computer industries are far less impressive now than twenty years ago.

The Tokugawa era and the Meiji restoration: see Landes (1998), and Jansen (2002). A more detailed look at the origins and impact of the zaibatsu can be found in Morck and Nakamura (2007).

Deming (2000) summarizes his ideas. His key speech to Japanese top management can be found at http://deming.eng.clemson.edu/pub/den/deming_1950.htm.

Toyota production system: see Ohno (1988).

The Japanese manufacturing system: see Aoki (1988), and articles such as Milgrom and Roberts (1990).

Hoshi and Kashyap (2001) include the Mazda and Maruzen examples in Chapter 5. I adapted the *jusen* material from pages 270–71. International bank ratings are shown on page 274, and bank mega-mergers are described on page 296.

Hoshi and Kashyap (2004, 3–26) is another source for material in this chapter. For example, page 12 cites other studies that conclude that net operating profits for Japanese banking industry have been negative since 1993.

Cargill, Hutchison, and Ito (1997) is a third source for much of the material. Pages 99–108 discuss liberalization in the 1980s and related topics, and pages 130–44 discuss *jusen*.

Peek and Rosengren (2005, 1144–66) documents “evergreen lending,” government pressure to misclassify bad loans as good, and so forth; see also Okada and Horioka (2007). This article points up banks’ central role in propping up zombies to the detriment of typical solvent firms. “Dead Firms Walking,” (*The Economist*, September 25, 2004, 81–83) discusses remaining zombie sectors. The Yoshikawa quote appears in: “Business Suicides: Japan’s Death Trap” (*Business Week*, June 3, 2002).

Wood (1992) is a journalist's account of the bubble years and the beginning of the zombie era.

The story of the three suicides comes from the article "Death of Three Salesmen—Partners in Suicide," by Mary Jordan and Kevin Sullivan (*Washington Post*, October 7, 1998), <http://www.washingtonpost.com/wp-srv/inatl/longterm/brokenlives/broken4a.htm>.

The Sogo saga is pieced together from *The Economist* articles "Unforgiven" (June 29, 2000), "Japan's Bankruptcy Department" (June 13, 2000), "The Slow Death of Japan, Inc." (October 12, 2000), "New Tricks," (October 26, 2000), and "Fiddling While Marunouchi Burns" (January 25, 2001), together with the *Asia Times* editorial "Japan: That Revealing Sogo Saga" (July 14, 2000), the *Mainichi Shimbun* story "Captain of Sinking Store Guilty of Hiding Assets" (March 29, 2005), and McIntyre (2000).

"The Sun Also Rises: A Survey of Japan," (*The Economist*, October 8, 2005), is an eighteen-page survey with a generally upbeat assessment of Koizumi's reforms and Japan's prospects for the future.

On Harold Stringer, see, for example, "Sony Chief Executive Says Company Is Back on Track" (*The AP*, December 12, 2007).

On Carlos Ghosn, see, for example, the article "Expenses Cited for End of Nissan's 6-Year Run of Record Profit," by Nick Bunckley and Micheline Maynard (*New York Times*, February 3, 2007).

"U.S. Private-Equity Kings Negotiate a Maze in Japan," by Aandrew Morse and Yukari Iwatani Kane (*Wall Street Journal*, November 23, 2007, A1) illustrates remaining obstacles to bankruptcy and restructuring in Japan.

"Japan still has the world's second largest economy": true, as of late 2007, by the standard comparison using market exchange rates to compare across countries. However, according to purchasing power parity measures, favored by some economists, China now has passed Japan. See "Clipping the Dragon's Wings" (*The Economist*, December 22, 2007, 68).

On "freeters," see "Still Work to be Done: Japan's Labour Market is Becoming More Flexible, but also More Unequal" (*The Economist*, November 29, 2007).

The quote in the last paragraph is from a July 2006 personal communication from Jeff Baer, an American who has worked and lived mostly in Japan since the late 1980s. His perspectives contribute to several other parts of the chapter.

Chapter 7

For more on Albanian Ponzi finance, see Jarvis (2000), Bezemer (1999), and Schmidt (2000). Ponzi schemes are named after Charles Ponzi, who swindled many Boston investors in 1920. They are also known as pyramid schemes. The idea is simply to lure investors by offering very high returns. Early investors are paid the promised returns using the funds raised from the next wave of investors. The pyramid grows as long as ever-increasing waves of new funds pour in from dazzled investors. In a finite world, this can't happen forever. The swindler tries to

abscond with the last wave of funds before investors realize that the most recent promises will be broken.

Temin and Voth (2004) and Kindleberger (2000) describe the South Sea Bubble. The absconder is mentioned in Mackay (1841, 55).

Millett (1991, 43) discusses Plato's attitudes, and the entire book discusses Athenian financial practices. In modern Greek, *eranos* refers to communal charity, for example, passing around a collection plate in church (Nikos Nikiforakis, personal communication, April 2007).

Fishing and farming villages; Thomas and Worrall (2002) refers to *eranos* loans as quasi-credit, notes its prevalence in villages in southern India, central Africa, and in the Philippines, and demonstrates its theoretical efficiency.

Roscas: see Besley (1995) and Besley et al. (1993). Roscas are not to be confused with microfinance as practiced by Grameen Bank and a host of similar institutions. Here, a bank or other lender (often subsidized by governments or NGOs) lends to a group of people who live or work together and who agree to joint responsibility for repaying the loan. This encourages the same sort of peer screening and monitoring and peer pressure as in *eranos*, although as in *daneizein* the lender is outside the group. See, for example, Yunus (1999).

“Neither a borrower nor a lender be; / for loan oft loses both itself and friend, / and borrowing dulls the edge of husbandry.” William Shakespeare, *Hamlet*, Act I, scene 3.

A recent *Wikipedia* definition of moral hazard is “the prospect that a party insulated from risk may behave differently than it would if it were fully exposed to the risk.” See moral hazard, http://en.wikipedia.org/wiki/Moral_hazard.

John Steinbeck's 1939 novel *Grapes of Wrath* captures the same moral intuitions in Dustbowl America: flinty-hearted bankers evict hard working families down on their luck from family farms.

Biblical rules on debt forgiveness are in Deuteronomy (15:15) and Leviticus (25).

Finance in Ur: see de Mieroop (2005).

Royal moral hazard: see Hicks (1969). He explicitly mentions prerevolutionary France and Czarist Russia as examples of the ill effects of tax exemptions and outsourcing tax collection.

The origins of paper money in China, see von Glahn (2005).

Palmer, Colton, and Kramer (2003) states that the French Revolution “was precipitated by the financial collapse of the government,” due mainly to “tax exemptions and tax evasions of privileged elements” and bad tax collection procedures (348). Czarist debts are mentioned on page 700.

The Florentine banking discussion draws mainly on the work of John F. Padgett, for example, McLean and Padgett (forthcoming).

One florin of bank capital could typically support five florins of bank loans: the mechanics are carefully explained in every intermediate macroeconomics text (and many beginning texts). Here is a quick summary tailored to medieval banks. The loans took the form of deposits in the borrowers' bank accounts. Not all depositors withdrew all their deposits (or repaid all the loans) at the same time.

Reserves (here the same as bank capital, in the form of gold coins called florins) just had to be sufficient to meet the net withdrawals most of the time; extra temporary reserves could be acquired from correspondent branches, if necessary. It turned out that keeping as reserves about 20 percent of the amount loaned was sufficient in the Florentine system. Thus, 80 percent of each florin of capital could be loaned out, and that amount would appear somewhere in the banking system as it was spent. In turn, 80 percent of that 80 percent could be loaned out in a second round. Taking into account third-round lending and beyond, the total loans supported by an additional florin of bank capital is the sum of a geometric series $0.8 + 0.64 + \dots = 5$. See Appendix section A9 for an explanation of such sums.

The nature of financial markets. This is an original spin on standard textbook material, for example, Fabozzi and Modigliani (2003).

Mugabe's impact on markets: see for example the article, "How to Stay Alive When it All Runs Out: Ordinary Zimbabweans Find Creative Ways to Survive" (*The Economist*, July 12, 2007).

Roman Republic: see Malmendier (2005). Amsterdam finance: see Penso de la Vega (1688/1996). See also Goetzmann and Rouwenhorst (2005, chap. 7). Efficient Financial Market Theory: the original insight is due to Hayek (1945). See also the very influential article Fama (1971)

Short sales restrictions: see the article "Get Shorty," by J. Surowiecki (*New Yorker*, December 1, 2003, 42).

See Keynes (1936), Minsky (1982), and Kindleberger (2000). Keynes' famous beauty contest metaphor ends as follows, "It is not a case of choosing those [faces] which, to the best of one's judgment, are really the prettiest, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practise the fourth, fifth and higher degrees." Applied to financial market bubbles, his point is that sophisticated pessimists should sometimes mimic optimists.

Malkiel (2003, 32) makes the point this way: "[Keynes'] theory might less charitably be called the 'greater fool' theory. It's perfectly all right to pay three times what something is worth as long as later on you can find some innocent to pay five times what it's worth."

Subprime lending. See, for example, "One Family's Journey Into a Subprime Trap," by James R. Hagerty and Ken Gepfert (*Wall Street Journal*, August 16, 2007, A1); "Burned by Real Estate, Some Just Walk Away," by Kemba J. Dunham and Rachel Emma Silverman (*Wall Street Journal*, October 18, 2007, D1), and Robert Kuttner's testimony to the House Committee on Financial Services (October 2, 2007).

As of October 2007, financial markets are suffering substantial losses on securitized home mortgages. The episode illustrates several themes of the present chapter. First, the spread of subprime mortgage contracts illustrates KMK Phase 2 demand-pull financial innovation. Second, promise guarantors such as Moody's and Standard and Poor's gave unrealistically high ratings to some of the securities (called collateralized debt obligations [CDOs]) engineered from pools of home mortgages. Possibly due to conflicts of interest, they didn't do their job properly.

Third, recent tightening of bankruptcy laws make it more difficult for homeowners to keep their homes when things go bad with a subprime loan, affecting the Phase 3 dynamics. Also, the homeowner is less likely to be dealing with the banks (or other entities) that originated the loan, with which he might personally negotiate a mutually beneficial workout. Instead, he is dealing with agents of a diffuse set of indirect lenders who are unaware of his personal circumstances. Foreclosure and cascading problems are then more likely, as in KMK Phase 3. Finally, the financial innovations (CDOs, private equity, hedge funds) make it difficult to see who will bear the losses. As in KMK Phase 4, this ambiguity slows financial recovery and hurts the real economy.

Unusually rapid movements in fundamental values: see, for example, Garber (1989). The academic tide began to turn: see, for example, Schiller (2002).

Sizeable bubbles in the lab: see Smith, Suchanek, and Williams (1988). Recent laboratory findings and open questions are summarized in Friedman (2008).

Chapter 8

See also Maslow (1943). The article and many other writings are collected in Stephenson (2000).

For the history of the Hudson's Bay Company, see Innis (1999) and Newman (2000).

Organization and management: see also Milgrom and Roberts (1992). This classic textbook mentions Hudson's Bay company, and analyzes organizations in terms of the coordination and motivation problems they must solve. While polishing this chapter, I encountered Roberts (2004), which also mentions Hudson's Bay and covers some of the same ideas as in the present chapter. See page 18 for a very compatible definition of corporate culture, and pages 174–75 for a discussion of “high commitment human resource management systems.”

Plato (1945, Books 5–7, 175ff) explains why everything should be run by philosopher-kings. Lenin (1902) contains a different version of the same idea.

Many business books implicitly assume that coordination and communication are the only problems, and ignore social dilemmas and motivation problems.

Malone (2004) is one of the higher quality examples. Its message is that lower communications costs, due to new computer networks, and so on, will bring about decentralization and democratization in the workplace.

The hold-up problem was analyzed first in Klein, Crawford, and Alchian (1978). Classic empirical work includes Masten (1984) and Monteverde and Teece (1982). Good textbook explanations can be found in Baye (2005) and in Milgrom and Roberts (1992).

The Caligula University example is based on a conversation in October 2007 with university employees who choose to remain anonymous. The computer engineer also prefers to remain anonymous. The quotes are from a conversation in May 2007.

The original paper on the how firms lower transaction costs is Coase (1937).

A classic book on boundaries of the firm is Williamson (1975).

The limits on internal rewards set by labor markets are called participation constraints by game theorists. Such constraints are a standard part of abstract theory and are discussed less formally in Milgrom and Roberts (1992).

On the transition to corporations one hundred years ago, see Chandler (1977). The historical account in this section draws on Lamoreaux, Raff, and Temin (2002). On the textile industry, see Scranton (1983).

The image of the late twentieth-century Merrimack River as a brick-lined canyon comes from personal correspondence with Art Argiewicz.

Economies of scale: see Smith (1776, chap. 1). Also, chapter 3 notes the role of mass markets.

Interchangeable parts are attributed to prerevolutionary France by the *Wikipedia* article http://en.wikipedia.org/wiki/Interchangeable_parts. It notes that the idea was brought to the United States by Thomas Jefferson, and that Eli Whitney (of cotton gin fame) obtained the first U.S. contract to manufacture guns this way in 1798. Eli Terry is credited with developing mass production of clocks in 1808.

Hicks (1969) notes contemporary data on the extent of economies of scale.

Leijonhufvud (2007) insightfully discusses how economies of scale and more extensive markets feed on each other.

“When the alternative was subsistence farming or worse.” In many ways, corporate blue collar jobs, although impersonal, were better than most nineteenth-century jobs in the old family firms. Think of Bob Cratchit’s work life under Ebenezer Scrooge in Dickens’ famous story, “A Christmas Carol.”

On Lowell and the Factory Girls Strike, see Chapter 1 in Sobel (1974) and also Zinn (2005).

The Swiss laboratory experiments are reported in Fehr, Kirchsteiger, and Riedl (1993). Their interpretation is based on Akerlof (1982). The delicate balance is documented in Charness, Kagel, and Frechette (2004) and in Falk and Kosfeld (2006), and other studies cited therein.

The Ford/Firestone debacle: see Krueger and Mas (2004). See also Mas (2007), which analyzes less famous but still large (\$400 million) losses in value due to labor problems at Caterpillar.

On the new environment, the particular list is the author’s. Each item on the list has its own extensive bibliography. On deregulation, see, for example, Kahn (2004).

On China and India’s entry into the market system, see, for example, the special (June 2006) issue of *CESifo Economic Studies*.

Tim Duncan is a basketball superstar, almost seven feet tall, noted for his agility. Shaquille O’Neill is another basketball giant. Tony Parker, listed at six foot two, is a basketball superstar noted for his quick moves.

Cannibalization costs are featured in Christensen (2003). The iPod story is part of the book *Sony vs Sony*, by Nihon Keizai Shimbun (a business daily).

Influence costs are prominently featured in Milgrom and Roberts (1992).

On medieval guilds, see Dessi and Olgilvie (2003).

On Prato, see <http://www.prato.turismo.toscana.it/comprare/eng/storia3.htm>.

History of Hollywood: see, for example, Thomson (2006).

The German university system was pioneered in Berlin by Friedrich Wilhelm von Humboldt (1767–1835); see http://en.wikipedia.org/wiki/Humboldt_University_of_Berlin

The Linux response to the virus: see Evans and Wolf (2005).

I'm not aware of publications that spell out how networks reduce cannibalization and influence costs and solve the holdup problem, but the point is self-evident. Networks also help solve the holdup problem for physical capital: once the network is wide enough, it can also support specialized equipment that can find several uses throughout the network.

I have no citations on networks mobilizing moral sentiments, but the point, again, is self-evident. A qualification on “incredible bursts of energy and creativity”: burnout eventually sets in. A dutiful corporate pyramid climber will give decades of steady effort, and that's what pays off in stable times.

Google's story is told in numerous books and magazine articles, for example, Vise and Malseed (2006).

Kntek is a pseudonym for a software company founded in 1996 that changed its name in 2005, and again in 2007, following mergers. Its story was recounted to me by MC, an engineer, on May 7, 2007.

The story of the American Buddhist software company was recounted to me by LM, an engineer, in June 2007.

EBay data can be found in its 2006 annual report. The figure of 700 thousand sellers comes from the article “EBay Moves to Recharge Its Auctions,” by Bob Tedeschi (*New York Times*, January 18, 2007).

U.S. Army combat networks: see for example the article “The Army's \$200 Billion Makeover March to Modernize Proves Ambitious and Controversial,” by Alec Klein (*Washington Post*, December 7, 2007, A01). Countering evolved insurgent networks: see Hammes (2006).

On the open source movement, see *The Economist's* special report March 18, 2006, 73–75.

U.S. construction industry: for example, see the 2006 annual report of Pulte Homes, the industry's largest corporation. But also see the article “Pulte Homes Cutting 1,900 Jobs: Builder Cites ‘Difficult’ Housing Market for Move,” (*AP*, May 30, 2007). The cut is about 20 percent of Pulte's workforce, and the CEO acknowledges that the company “is larger than the market presently allows.”

The life-and-death struggle was described to me by engineer RM in May 2007.

HP's VC Café is discussed in Malone (op cit., 2004, 93–95). The company had long been noted for its egalitarian moral code, called the HP Way, emphasizing trust and teamwork. Carly Fiorina (the CEO 1999–2005) tried to make the company more aggressive and star-oriented, touching off a culture war: Fiorina (2006) gives her side of the story.

Toyota's emulation of the Linux community is discussed in Evans and Wolfe (2005). Also see the survey “The New Organization: A Survey of the Company” (*The Economist*, January 21, 2006), which quotes the Toyota Way. Page 17 of that supplement notes that Boeing didn't design the 787 in-house; the development

team includes one hundred partner companies around the world. Team members constantly videoconference and work from a common real time database.

On outsourcing and the holdup problem: “The outsourcing provider and the client company may form alliances and take financial stakes in one other to make sure their interests are aligned,” Jon Watts of Booz Allen Hamilton is quoted on page 17 of *The Economist* survey just cited.

IBM: see the corporate Web site and annual reports. Although panned by Amazon critics as self-serving and shallow, Gerstner (2002) collects the basic facts.

Regarding business consulting services, see Hancock et al. (2005). A capsule summary from page 4: “dividing its business into components, focusing on those that really matter, responding rapidly to market changes, creating a variable [scalable] business model and operating in a resilient manner.”

Wal-Mart: see its 2007 annual report. The raft of recent books includes Fishman (2006). See also Lichtenstein (2006), the proceedings of an academic conference.

For a negative take on Wal-Mart employee relations, see Ehrenreich (2001). A reporter’s adventures in the minimum wage world of the working poor, the book discusses Wal-Mart’s “industrial engineering” (page 208) of “associates”; the “cult of Sam” on page 143; the Wal-Mart cheer, adapted from Japanese factories on page 178. Page 185ff argues that the company’s fictional family is worse than dysfunctional due to extreme inequality. In general, Ehrenreich notes that a single parent would have to have a \$14/hr job to minimally support two kids, but less than 40 percent of American workers earn that much. The book’s main theme is that the nation’s poor, the bottom 20 percent, are invisible to affluent Americans.

Sara Horowitz is profiled in the article “Freelancers of the World, Unite!” (*The Economist*, November 11, 2006, 76).

Chapter 9

Here is a quote from a Victorian philosopher: “Let us . . . consider in what particular ways this further evolution . . . may be expected to show itself. . . Will it be in strength? Probably not to any considerable degree. . . Will it be in swiftness or agility? Probably not. . . Will it be in intelligence? Largely, no doubt. . . Will it be in morality, that is, in greater degree of self-regulation? Largely also; perhaps most largely. Right conduct is usually come short of more from defect of will than defect of knowledge. . . A further endowment of those . . . sentiments responding to the requirements of the social state . . . must be acquired before the crimes, excesses, [etc.] that now so greatly diminish the duration of life, can cease. . . [Evolution will] work unceasingly towards a state of harmony” (Spencer 1896, chap. 13).

State of California expenditures are included in Aker (2006) and its citations. For U.S. annual crime rates by category 1960–2004, see <http://www.disastercenter.com/crime/uscrime.htm>.

Besides self-serving crimes, there are also crimes of passion, and crimes of honor or duty. The next chapter will examine some of them. The text distinguishes vice (behavior in Quadrant III in Figure A3 of the Appendix), where the actor is among those harmed, from self-serving crime (opportunistic behavior in Quadrant IV). In traditional usage, vice is habitual sin. Catholic doctrine defines mortal

sin as consisting of three elements (the sin is venial if some are absent): the matter is grave, the sinner has full knowledge, and he sins deliberately or gives full consent. The deadly sins are: pride, covetousness, lust, anger, gluttony, envy, and sloth. Those that “cry out to heaven for vengeance” are: murder, sodomizing, oppressing the poor, and defrauding laborers of wages. Thus, the focus is on character flaws, defective moral sentiments, and it includes opportunistic behavior. See for example <http://en.wikipedia.org/wiki/Sin>.

Bridgeman (2003) summarizes the evolutionary psychology approach to vice and other behavior. On chili, see Rozin and Vollmecke (1986). On adolescent male gamblers, see Rubin and Paul (1979). Paternity is much more concentrated than maternity in most premodern cultures. Technically, the point is that the left skewed wealth-paternity distribution creates a gap between expected wealth and expected biological fitness. Diamond (1992) notes an alternative explanation: risk-takers signal their otherwise unobservable talents, because risk-taking is more expensive for those less talented.

Fighting crime the old fashioned way: see Boehm (1999).

The harmless people: see Thomas (1958). On /Twi’s execution and the quotes: see Lee (1979, 394–95).

Napoleon changed the spelling of his last name to “Bonaparte,” more natural to the French eye.

Wilson (1988) is the main source of material on Corsica, and includes the following quotes: “Towns were relatively unimportant, and only 17 percent of the population lived in them in 1851, after a period of considerable urban growth” pp. 5. “Land of the vendetta,” attributed to Maupassant, pp. 14. Egalitarianism is discussed on pp. 13. The proverb is quoted on, pp. 182. The Arbellara story is distilled from pp.17–21. On honor, see chapter 4, especially. Male honor demanded ownership of guns pp. 91. Mediation by elders, chap. 9. Zonza, pp. 253. Corsica’s recorded homicide rate during most of the 1800s was 20–60 per 100,000 per year, and the actual rate probably was 2–3 times higher, pp. 15–16. The custom of her relatives killing a dishonored woman (especially if she would not divulge the name of her seducer) was fading in Corsica by 1800 pp. 108. Abduction was common, sometimes with the girl’s consent, e.g., to overcome her family’s objections pp. 102–10.

Bowman (2006), traces Western honor culture back to medieval times and discusses its decline in the twentieth century.

Any code of behavior inevitably has some gaps or inconsistencies by Gödel’s theorem; see Gödel (1931). For an absorbing popular account, see Hofstadter (1979).

The Code of Hammurabi is presented in Johns (1903) and in http://en.wikipedia.org/wiki/Code_of_Hammurabi.

On Justinian’s codex and the Talmud, see Rosen (2007, chap. 5).

“Courts interpret law and apply it”: A lawyer friend comments, “Actually, courts create most law and judges introduce new rules when a case demands it.”—Daniel McNeill (personal communication, September 2007).

Shasta county ranchers: see Ellickson (1991). Laws vs. norms: see Rosen (1997), Glazer et al. (1996), and Posner (2000).

“Feuding in Corsica was [probably] exacerbated by the process of incorporation into a modern state. The power of blood-vengeance sanctions to prevent or contain conflict was seriously weakened for a time and the internal balancing mechanisms of the traditional system were disrupted, all of which meant an increase, in the medium term, of feuding of a fairly unrestrained kind” (Wilson 1993, 53–54).

Some of the Bentham material was drawn from History of the University College of London http://en.wikipedia.org/wiki/History_of_University_College_London, and Jeremy Bentham http://en.wikipedia.org/wiki/Jeremy_Bentham, which cite sources such as Dinwiddy (1989). The Bentham Project Web site <http://www.ucl.ac.uk/Bentham-Project/info/aims.htm> notes that twenty-six volumes of Bentham’s collected works have appeared as of mid-2007, but the total might ultimately reach seventy volumes. Keneally (2006) reports Bentham’s panopticon proposal, and other schemes to profit from Britain’s prison system.

The text omits some other items of possible interest:

- Bentham’s panopticon proposal was resurrected and condemned by post-modernist writers, especially Foucault (1995, 195–228).
- Bentham’s early proposal to decriminalize sodomy has made him a hero to many in the gay rights movement.
- His second publication, *Defence of Usury*, sought to straighten out Adam Smith on financial markets, and advocated dropping interest rate ceilings.

The modern version of Bentham’s hedonistic calculus is the core of the academic field known as Law and Economics: see for example Posner (2006) and Wittman (2006).

“Murder occurrences vary wildly among different countries and societies. In the Western world, murder rates in most countries have declined significantly during 20th century and are now between 1–3 cases per 100,000 people per year. Murder rates of *Japan* and *Iceland* are among the lowest in the world, around 0.5; rate of *United States* is highest among all *developed countries*, at 5.5 (2004, [9]). On the other hand, developing countries often have rates of 10–100 murders per 100,000 people per year” (http://en.wikipedia.org/wiki/List_of_countries_by_homicide_rate).

Revenues and elasticities are a standard topic in economics textbooks, for example, Baye (2006, chap. 3).

On the history of gambling, see Ezell (1960). See Ernst and Young (1996) for the rake estimate. Other data comes from U.S. National Research Council (1999), National Opinion Research Center (1999), and Clotfielder et al. (1999).

“The \$50 Ticket: A Lottery Boon Raises Concern,” by Nelson D. Schwartz (*New York Times*, December 27, 2007, A1) reports detailed survey data from the Texas state lottery in 2006. Gamblers were more likely to make larger wagers when they had a high school education or less, or were younger, Black or Hispanic, male, or unemployed.

Grinols (2004) concludes that, after accounting for increased crime and reduced expenditures on other forms of entertainment, and so on, the social costs of the mega-casinos exceed the benefits in most communities. See also Grinols and Mustard (2006) and the article “As More States Look to Win The Economic Jackpot

with Casinos, Evidence Suggests They are Playing a Losing Hand,” by Mark Whitehouse (*The Wall Street Journal*, June 11, 2007).

Schwarzenegger’s deal with Indian casinos is reported in the article “More Slot Machines for Tribes; \$1 Billion for California,” by John M. Broder (*New York Times*, June 22, 2004). Also see “As Schwarzenegger Tries to Slow It, Gambling Grows,” also by John M. Broder (*New York Times*, October 10, 2004).

The event contracts mentioned were available on Tradesports.com (now Intrade.com) on July 6, 2007.

The article by Amy Schatz, “Another Gamble for Online Betting,” (*Wall Street Journal*, September 22, 2006, A7). The 2007 estimate is from page 34 of the *Economist* article on Poker cited below.

Prediction markets: see Wolfers and Zitzewitz (2004).

Much of the material on poker is collected from an unpublished 2004 term paper by Connor Egan. Hundreds of books are now available, for example, Gordon and Grotenstein (2004), not to mention innumerable Web sites. Also see “A Big Deal: Poker is Getting Younger, Cleverer, Duller and Much, Much Richer,” (*The Economist*, December 2007, 33–38).

An example (one of many) of horror stories of youngsters addicted to online poker is “The Gambler: The Hold-’Em Holdup,” by Mattathias Schwartz (*New York Times Magazine*, June 11, 2006).

Much of the information on U.S. alcohol consumption and regulation comes from 2005 ATF Annual Report—Publication 1000.4, 47–49. Most of the history comes from MacCoun and Reuter (2001, chap. 8).

The math: $3*(1-.25) = 2.25 > 2.0 > 1.50 = 3*(1-.50)$, so doubling is in the estimated range.

The Centers for Disease Control collect data on binge drinking: <http://www.cdc.gov/alcohol/datatable.htm>.

Tobacco statistics appear in MacCoun and Reuter (2001, chap. 8). The terms of the Master Settlement can be found on The National Conference of State Legislatures Web site, <http://www.ncsl.org/statefed/tmsasumm.htm>. According to Yahoo Finance, Altria’s share price was \$39.38 in June 1998, and rose to \$53.50 in December, with most of the increase taking place September through November. Collier et al. (2004) report the tobacco settlement damage award.

Reality is more complex than my quick summary of tobacco lawsuits. An expert witness for the prosecution reminds me that the tobacco industry settled many cases out of court prior to the Master Settlement in order to maintain the image of legal invincibility. He also notes that the industry’s “‘well funded research labs’ . . . never did any real science, as far as I can tell”; their real mission was to muddy the scientific waters (Glenn W. Harrison, personal communication, June 23, 2004).

The Web site <http://www.monitoringthefuture.org/> summarizes what works and what doesn’t for tobacco discouragement among teenagers.

“Decline in Daily Smoking by Younger Teens has Ended.” University of Michigan’s “Monitoring the Future” press release, December 21, 2006.

Worldwide industry calculated from http://en.wikipedia.org/wiki/Tobacco_industry#Production_by_Country. The 1999 figures are grossed up slightly for 2005.

The Web site <http://www.triallawyersinc.com/> savages the trial lawyer industry. See also “Class Inaction: Plaintiffs’ Lawsuits Against Companies Sharply Decline,” by Paul Davies (*Wall Street Journal*, August 26, 2006, A1).

Prison industry sources include Doyle, “Behind Bars in the U.S. and Europe,” (*Scientific American*, September 1999, 25); Marc Klaas, “A Bad Law, Set in Stone,” (*San Jose Mercury News*, November 14, 1999, P1), on the three-strikes law; “Joe Arpaio, Tyrant of the Desert,” (*Economist* magazine, March 20, 1999, 30); “Prisoners: More than Any Other Democracy,” (*Economist* magazine, February 25, 2005, 27–29); “Hotel California,” (*Economist* magazine, February 25, 2005, 27–29); and “California’s Prisons: Packing Them In,” (*Economist* magazine, August 12, 2006, 23).

Aker (2006) is a good overview of California’s criminal justice system. See Unger (2007) for a U.S. overview. Some useful background information appears in chapter 3 of Gilmore (2007). See also the articles “High Court Justice Supports Bar Plan to Ease Sentencing,” by Linda Greenhouse (*New York Times*, June 24, 2004) and “U.S. ‘Correctional Population’ Hits New High,” by Fox Butterfield (*New York Times*, July 26, 2004). The \$10.1 billion figure is Corrections and Rehabilitation, from State Government proposed 2007–8 budget; the corresponding figures for UC and CSU are \$5.45 and \$4.36 billion.

Johnson and Raphael (2006) is the source of the estimates on deterrence plus incarceration effects. (Unfortunately, the data don’t permit a reliable separation of the two different effects.)

Governor Schwarznegger backs down on prison costs: see “Guard Union in Showdown,” by Mark Gladstone (*San Jose Mercury News*, June 22, 2004, 1).

Leonard Scott’s three strikes are cited in LaDoris H. Cordell’s op-ed article (*San Jose Mercury News*, July 10, 2006, 16A). Of course, there are dangerous criminals out there, but three strikes only increases the danger. Consider a violent two-time loser who hates jail and is spotted by a burglary victim. Under three strikes, he has little to lose, and much to gain, by murdering his victim to avoid a third conviction. Likewise, if he sees police approach his car, he is much more likely to endanger bystanders in a high-speed chase.

Drugs and drug wars: see Spillane (2000). Drug use and human character: see Bennett (1989) and Wilson (1990). Bennett himself confessed to compulsive gambling in June 2003. <http://www.washingtonmonthly.com/features/2003/0306.green.html>. I found a lot of information and useful perspectives in MacCoun and Reuter (2001).

Chapter 10

Patty Hearst story: see http://www.crimelibrary.com/terrorists_spies/terrorists/hearst.

Marcus Foster: see “Murder in California” (*Time Magazine*, November 19, 1973).

Statistics on crime: see *New York Times Almanac 2004*, 308. The war against the American mafia: see Repetto (2006).

Joaquin Murieta is the inspiration for the recent film *Legend of Zorro*, and earlier Zorro films and pulp fiction. He also figures in higher brow works such as *The Splendor and Death of Joaquin Murieta*, a play by Pablo Neruda.

Much of the material on Chicano youth gangs comes from 1994 University of California, Santa Cruz term papers by Rafael Trevino, Antonio Gomez, Jose Renteria, and Francisco Marquez for Economics 106. They, in turn, cite Harris (1988), Virgil (1983), Mirande (1985), and Romotsky and Romotsky (1976). See also “Highlights of the 2004 National Youth Gang Survey,” Office of Juvenile Justice and Delinquency Prevention, U.S. Department of Justice, April, 2006.

Why would a young person join a gang? See LeBlanc (2003).

Levitt and Dubner (2005, chap. 3) offers some fresh evidence on how bad the gamble is: most ordinary gang members make less than the minimum wage and live at home with their moms.

On the importance of these part-time communities, see Putnam (2000).

Rance (2006) reflects a consensus view of outside observers. More recent analyses include the article “ Hamas May Find It Needs Its Enemy,” by Craig S. Smith and Greg Myre (*New York Times*, June 17, 2007).

The story of the Maccabees is told to Jewish children every Hanukkah.

Zealots: see Ben-Sasson (1976, 275) discusses a subcult called the daggersmen, or *sicarii* in Latin, who assassinated Jewish leaders who opposed them, as well as Roman soldiers and officials.

On early Christianity, see, for example, Cannon (2005) and Maccoby (1986).

Cairo headquarters: At that time, ruled by the great Fatimid Caliph al-Mustansir, the successor of Basil II’s contemporary, Al-Hakim. The entire Fatimid dynasty was Ismaili but the Assassins didn’t recognize al-Mustansir’s successors as legitimate. The remark about the Christian orders is on p. 307 of Joinville (1868).

Aga Khan: see *The Institute of Ismaili Studies* Web site, <http://www.iis.ac.uk/>.

The *American Heritage Dictionary*’s primary definition of a cult is, “A religion or religious sect generally considered to be extremist or false, with its followers often living in an unconventional manner under the guidance of an authoritarian, charismatic leader.”

The *American Heritage Dictionary*’s definition of terrorism is: “The unlawful use or threatened use of force or violence by a person or an organized group against people or property with the intention of intimidating or coercing societies or governments, often for ideological or political reasons.”

I emphasize threats against lives. The dictionary definition above would include groups that target property. For example, the Animal Liberation Front aims to damage laboratories that test dangerous products on mice, but does not target human enemies.

Hamas revenues: see United States Department of State (2006).

“Gaza Fighting Kills Palestinian Coalition,” CBS/AP dispatch, Gaza Strip, June 14, 2007

Goldberg (2004) reports on the Israeli settler’s movement.

“They Make a Wasteland and Call it Peace,” Tacitus, *Agricola*, chapter 30, quoting the British chieftan Calgacus.

T. Friedman (1998) has a chapter on the Hama massacre.

Thomas (2007) is a history of Mossad.

The argument in Iannocone (1992) is subtler than described in the text. It focuses on the social dilemma associated with contributing to public good provision, and shows that a cult can mitigate the problem by prohibiting mainstream activities and demanding personal sacrifices. Also see Berman and Laitin (2005). Again, the article contains far more theory and empirics than described in the text.

Rabin's murder: see Goldberg (2004).

For recent discussion of the PKK after Ocalan's capture, see the article "In the Rugged North of Iraq, Kurdish Rebels Flout Turkey," by Sabrina Tavernise (*New York Times*, October 29, 2007).

Brandon (2005) describes the Koranic duels. "Reforming Jihadists: Preachers to the Converted," and "A Jihadist Recants," (*The Economist*, December 15, 2007) report some success with similar strategies in Indonesia and Egypt.

For example, the scene "Dennis, the Constitutional Peasant," in *Monty Python and the Holy Grail*, 1975.

Danish newspaper cartoons controversy of September 2005: see the very detailed *Wikipedia* entry "Jyllands-Posten Muhammad cartoons controversy," http://en.wikipedia.org/wiki/Jyllands-Posten_Muhammad_cartoons_controversy.

Chapter 2 of Levitt and Dubner (2005) ostensibly concerns the role of asymmetric information, but the KKK episode far better illustrates the undermining of the cult's moral code. Likewise, the *Nuestra Familia* initiation oath has been trivialized in blogs and chatrooms; probably a new oath will be needed soon.

"The Battle of the Pump," by Thomas L. Friedman (*New York Times*, October 7, 2004, op-ed page) is a typical example.

Saudis fund mosques and madrassas: see, for example, "Al Qaeda and Saudi Arabia," by Khaled Abou El Fadl, on behalf of the U.S. Commission on International Religious Freedom, in *The Wall Street Journal*, November 10, 2003, op-ed page.

"Where Boys Grow up to be Jihadis," by Andrea Elliot (*New York Times Sunday Magazine*, November 25, 2007) mentions the role of Saudi-funded mosques and jihadi Web sites, but emphasizes the young Moroccan recruits' sense of moral outrage and personal ties to their buddies.

Dutch drug policy: see MacCoun and Reuter (2001, chap. 9).

Chapter 11

Kurlansky (1997) is the source for all assertions in the first paragraph and the first two sentences of the second paragraph, as well as material later in the chapter. The rest of the second paragraph alludes to Junger (1999).

"Commercial Fishing Industry Needs on Gloucester Harbor, Now and in the Future," a study by the Gloucester Community Panel, released June 6, 2005, contains some background information on the local economy and the role of the fishing industry.

Red tail deer, lions, and other territorial animals: see Hardin (1968) or a standard biology text such as Goldsmith and Zimmerman (2001). Hardin doesn't

mention the moral system of open fields, which, as noted in Chapter 4 and in Dahlman (1980), prevented the tragedy in medieval European commons.

Dungeness crab derby: see the article “Troubled Waters for Local Crabbers,” by Marke Krupnick (*San Jose Mercury News*, November 28, 2003, 3C).

Easter Island’s environmental catastrophe: see Diamond (2005, chap. 2). Mega-fauna extinction in America and Australia, see Diamond (1999).

A chart on territorial fish for the home aquarium can be found at http://www.liveaquaria.com/general/compatibility_chart.cfm.

Lansing (1991) is the source of the material on Balinese water temples. A more recent book, Lansing (2006) discusses its origins and stability as an “emergent . . . complex adaptive system.” The final Asian Development Bank report is “Reevaluation of the Bali Irrigation Sector Project Loan No. 522-INO in Indonesia,” Asian Development Bank RES: INO XXX, December 1997, <http://www.adb.org/Documents/PERs/RE-27.pdf>.

Sod buster sagas include Rolvaag (1927), and, of course, *Little House on the Prairie*, by Laura Ingalls Wilder, never out of print since its original publication in 1935.

Egan (2005) describes the Dust Bowl.

On the Ogallala Aquifer, see Kromm and White (1992), and the Web site <http://www.waterencyclopedia.com/Oc-Po/Ogallala-Aquifer.html>.

On twentieth-century cod fisheries and territorial limits, again, see Kurlansky (1997).

“Economic logic dictates”: see Demsetz (1984), for example.

“Mother’s milk of politics”: the quote is attributed to Jesse “Big Daddy” Unruh (1922–87), the leading power broker in California’s legislature for most of the 1960s. Another great Unruh-ism: “Sometimes we must rise above principles.”

Cawley (1996) reports on the sagebrush rebellion. See also the Colorado University Library’s *Sage Brush Rebellion* (Collection No. 32), <http://carbon.cudenver.edu/public/library/archives/sagebrsh/sagebrsh.html>.

Coda for Cod material: see Committee to Review Northeast Fishery Stock Assessments (1998) and Serchuk and Wigley (1992).

Kuznets curve: the original version relates income inequality to economic development, as countries progress from agriculture to manufacturing to services. The environmental Kuznets curve incorporates the idea that primitive agriculture and advanced services are less polluting. See, for example, Bradford et al. (2005), available at <http://www.bepress.com/bejeap/contributions/vol4/iss1/art5>. A special issue of the same journal, *Advances in Economic Analysis & Policy* 4, no. 2, is devoted to the pollution haven hypothesis and the race to the bottom. See also Copeland and Taylor (2004).

Missing markets: economists recognize that markets go missing mainly for two related reasons—property rights are not well defined and/or transactions costs are high. The original insight is due to 1991 Nobel laureate Ronald Coase; see, for example, Coase (1960).

ITQs in Alaska: see Pautzke and Oliver (1997) and the Web site http://www.fakr.noaa.gov/npfmc/sci_papers/ifqpaper.htm. My thanks to Jon Sutinen for pointing me to this article.

The Fuglvog quotes are from *Viewpoints* in the Alaskan Halibut episode of the PBS series “Empty Oceans, Empty Nets.” The Web site is <http://www.pbs.org/emptyoceans/eoen/halibut/viewpoints.html>.

My lab recently received a grant to find effective ways to organize the ITQ markets for fisheries in the Gulf of Mexico. Results will be posted on the Web site <http://leeps.ucsc.edu/projects>.

The Cap and Trade program for SO₂ emissions: see U.S. Environmental Protection Agency (2001). On compliance cost reductions, see table 3-2, page 25.

The consensus on global climate change is summarized and elaborated in “IPCC Fourth Assessment Report: Climate Change 2007,” a report in three parts by the Intergovernmental Panel on Climate Change. That panel shared the 2007 Nobel Peace Prize with former U.S. Vice President Al Gore. Their final synthesis report was released on November 17, 2007, and can be found at the Web site http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

Global warming measurement errors: see “Heat and Light,” (*The Economist*, August 11, 2005).

Exxon’s campaign: see Web sites such as <http://www.greenpeace.org/usa/campaigns/global-warming-and-energy/exxon-secrets> and <http://archive.greenpeace.org/comms/cbio/cancod.html>. In early 2007, following the retirement of its longtime CEO and the Republican Party’s defeat in congressional elections, Exxon announced that it was cutting off those funds: see “Exxon Cuts Ties to Global Warming Skeptics,” (MSNBC report, January 12, 2007).

Self-enforcing international environmental agreements: see Barrett (1994) and McGinty (2007).

The pitfalls of nonuniform carbon taxes: see Sinn (2007).

California’s climate policy: see Goulder (2007).

Porter hypothesis: see Popp (2005), available at <http://www.bepress.com/bejeap/contributions/vol4/iss1/art6>.

Ally of Bush is Defeated in Australia,” by Tim Johnston (*New York Times*, November 25, 2007), mentions the new prime minister’s promise to ratify the Kyoto protocol.

Special Report on Business and Climate Change,” (*The Economist*, June 2, 2007) contains recent information on GE and Silicon Valley VCs. See also “Google’s Next Frontier: Renewable Energy,” by Brad Stone (*New York Times*, November 28, 2007), and “Banks Urging U.S. to Adopt the Trading of Emissions,” by James Kanter (*New York Times*, September 26, 2007). The estimate of \$40 billion is attributed to Paul Bledsoe of the National Committee on Energy Policy, and is cited on page 6 of *The Economist’s* special report.

Paltsev (2007) contains cost estimates for several recent GHG market proposals.

See also “Kyoto’s Caps on Emissions Hit Snag in Marketplace: U.N. Mulls How to Fix Pollution-Credit System,” by Jeffrey Ball (*Wall Street Journal*, December 3, 2007, A1)

Sara Hendrix and Matt McGinty helped educate me about environmental economics and gave me helpful leads to the literature.

Chapter 12

“Ruling Jolts Even Saudis: 200 Lashes for Rape Victim,” by Rasheed Abou-Alsamh, (*New York Times*, November 16, 2007) notes that the rapists were sentenced to ten months to five years plus eighty to one thousand lashes—in several cases, lighter sentences than the victim’s. See also “Saudi Rape Victim Tells Her Story: Victim to Receive Whipping and Jail for Being in Nonrelative’s Car When Attacked,” by Lara Setrakian (ABC News, November 21, 2007). Recent reports of a royal pardon include “Saudi King Pardons Rape Victim Sentenced to Be Lashed, Saudi Paper Reports,” by Katherine Zoepf (*New York Times*, December 18, 2007). Tellingly, “the king fully supported the verdicts against the woman,” according to the Saudi Justice Minister, but issued the pardon perhaps to mollify international opinion.

On honor killings elsewhere, see “Pakistan Tries to Curb ‘Honor Killings,’” by Salman Massod (*New York Times*, October 27, 2004). The figure of 5,000 comes from a *Wikipedia* article, http://en.wikipedia.org/wiki/Honor_killings, which cites an estimate by the *United Nations Population Fund*.

The docudrama aired in the United States in May 1980, and has a page on the PBS Frontline Web site, <http://www.pbs.org/wgbh/pages/frontline/shows/princess/>. The diplomatic fallout is discussed in White and Ganley (1983). “The behavior of his granddaughter was an intolerable blot on his [Prince Mohammed’s] family honor and, say private Saudis, in similar circumstances they would have done the same thing themselves.”

The experiment on the Southern honor culture is reported in Cohen et al. (1996). Supporting evidence comes from capital punishment in the United States. In 2007, all but six of the nation’s forty-two executions took place in states south of the Mason-Dixon line, most of them in Texas. See the article, “At 60% of Total, Texas is Bucking Execution Trend,” by Adam Liptak (*New York Times*, December 26, 2007, A1).

The quote on honor culture among Arabs is from Pryce-Jones (2002, 41); see also his follow up piece in *National Review*, April 21, 2003, 36–38. Also, see Bowman (2006, chap. 9). Bowman includes material from Western great books and twentieth-century popular sources to document honor culture’s decline, especially following World War I. He hopes, with some caveats, for a revival in the twenty-first century.

“Enforce his will on others”: Nisbett and Cohen (1996, 4). The authors argue that extreme honor codes come from herdsman cultures, and they trace the distinctive cultures in the Southern United States to immigrants forced by the enclosure movement from ancestral pasture lands in Scotland and Ireland.

Upper Paleolithic culture: see, for example, Soffer et al. (2000).

In Tablet 6 of the *Gilgamesh* epic, Inanna offers herself to the protagonist, and he refuses, describing her ill treatment of several previous lovers. See Prichard (1958, 51–53) and Bottero (2001, 94).

Baldick (1965) is a history of dueling. Wilson (1988, 108) reports the decline of honor killings in Corsica. On the U.S. armed service honor codes, see <http://www.navy.com/about/during/personaldevelopment/honor/>.

City morals versus honor-bound pastoralists: the *Gilgamesh* epic contains this theme, as Gilgamesh, a city-dweller, fights but then becomes best friends with the barbarian Enkidu; see for example, Prichard (1958, 31–40). The Biblical story (I Samuel 17–31) of how David rose from shepherd to king also echoes some of these themes.

Moral codes evolve: examples include the very different Buddhist practices in Japan versus India, and the Protestant reformation, as discussed in Chapter 3. The Talmud documents a millennium of changes in Jewish religious law.

Morning-after pills: see, for instance, “Jesus and the FDA,” by Karen Tumulty (*Time Magazine*, October 14, 2002).

Premotor mirror neuron areas of the human brain, previously thought to involve action recognition, turn out to be sensitive to context, as well as action, implying that they automatically encode perceived intentions: see Iacoboni et al. (2005).

“Darwin’s God,” by Robin Marantz Henig (*New York Times Magazine*, March 4, 2007) is a very nice overview of recent controversies.

On kivas and ceremonies: see, for example, Waters (1963). On kosher laws, note that the Biblical commands are quite simple (e.g., in Leviticus 11), but became increasingly elaborate in later teachings such as the Talmud and Shulchan Aruch.

A tangential remark: Dawkins and Dennett argue that the insights of evolutionary psychology give much better explanations of the human condition than do traditional religious beliefs, and that standard logical arguments for the existence of God are bogus. It seems to me, however, that believers need not worry about the new scientific findings. Suppose that there indeed is a benevolent God who wants humans to seek His presence. If He prefers to work through natural processes rather than to constantly re-jigger natural laws, then we—beings who see intentions everywhere and who seek meaning—represent an elegant solution to the very tricky problem He gave himself.

The population, per capita income, and life expectancy estimates come from the U.S. Census Web site <http://www.census.gov/ipc/www/worldhis.html>, from table 1-1a of Maddison (1995) and from the *Encyclopaedia Britannica* (1961).

See for example, “How Free is the Free Market?” by Noam Chomsky (*LiP Magazine*, May 15, 1997), http://www.lipmagazine.org/articles/featchomsky_63.htm.

One of the more eloquent criticisms of globalization is “The Idea of a Local Economy,” in Berry (2001). For a classic treatment in a novel, see Callenbach (1982).

Wage Insurance: see Kletzer (2004).

Leamer (2007, 110) is the source of the quote.

Adam Smith’s observation is encapsulated in the title of chapter 3 of Smith (1776): “That the division of labor is limited by the extent of the market.” See also Anderson (2006) for a modern version of the point.

On inequality, see Levy and Temin (2007), Piketty and Saez (2003), and Goldberg and Pavcnik (2007). Alesina and Giavazzi (2006) argue that poorer people are among the major potential beneficiaries of freer international trade. See also “Larry Summers’s Evolution,” by David Leonhardt (*New York Times Magazine*, June 10, 2007).

On trade discouraging war, see John Stuart Mill (18xx, part 3, chap. 17); also, Bhagwati (2004, chap. 2) has a nice quote from section 14 of Mill.

On the Czech-Slovak breakup, see Innes (2001). On Belgium, see “Calls for a Breakup Grow Ever Louder in Belgium,” by Elaine Sciolino (*New York Times*, September 21, 2007) and “Belgium Sets Interim Government,” by Stephen Castle (*New York Times*, December 20, 2007). See also Arblaster (2005).

Defusing the crisis: see, for example, “India Success In Software Is Set Back By War Talk,” by Saritha Rai (*New York Times*, June 6, 2002).

Moral clarion calls: recent masters include all the leaders in World War II, as well as symbiotic regional bullies like Milosevic in Serbia and Tudjman in Croatia in the 1990s. Recall Konrad Lorenz’s view (*On Aggression* [1966], soon popularized in a host of books such as Morris [1967]) that aggression is a basic instinct. I argue that the willingness to wage war comes not from some primitive instinct, but rather from an essential part of the moral architecture. In the modern world, it can be amplified by media and exploited by opportunistic politicians.

German identity after World War II: this is an unscientific personal observation, gleaned mainly from chatting with young people on trains.

Roth (2006) persuasively argues that the boundary between categories 1 and 2 is neither fixed nor sharp. He is especially concerned with kidneys for transplant.

Some background on electric power deregulation: The industry was a natural monopoly when it came on line a century ago. One company could produce power and deliver it to a town or region at far lower cost per customer than two or more competing companies. To avoid monopoly’s ill effects (price far above competitive equilibrium and inefficiently low usage), the government closely regulated the industry, in particular by setting prices. Newer textbooks (e.g., Baye, 2006, chap. 14) point out the ill effects of regulation: overly costly production, sluggish innovation, and costly political struggles over the regulated price—a variant of influence costs discussed in Chapter 8. But by the mid-twentieth century, the power grid spanned thousands of generating facilities, so supplying power could be competitive.

Recent popular accounts of deregulated power markets include: “Flaws Seen in Markets for Utilities,” by David Cay Johnston (*New York Times*, November 21, 2006), and “Short-Circuited,” by Jerry Taylor and Peter Van Doren (*Wall Street Journal*, August 30, 2007, A11).

The “anti-gaming” quotes come from FERC (2003).

The 2007 Nobel Prize in Economics went to three pioneers of mechanism design theory: Leonid Hurwicz, Eric S. Maskin, and Roger B. Myerson.

On early electronic stock exchanges, see Domowitz (1993).

On health care, the 16 percent figure is for 2005, and the 20 percent projection is standard: see for example Borger et al. (2006). Grol (2006) discusses Dutch health care.

Education cites include Tyack and Cuban (1995), Goldin (1999), and Card and Payne (2002). The case for vouchers is made on <http://www.schoolchoices.org/index.html>.

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