
The Evolution of Private Property

Every Man has a property in his own Person. This no Body has any Right to but himself. The Labour of his Body, and the Work of his Hands, we may say, are properly his.

John Locke

This chapter illustrates the synergy among the rational actor model, game theory, the socio-psychological theory of norms and gene-culture coevolution (§7.10), highlighting the gains that are possible when ossified disciplinary boundaries are shattered. The true power of game-theoretic analysis becomes manifest only when we cast our theoretical net beyond the strictures of methodological individualism (§8.8). The underlying model is taken from Gintis (2007b). A general case for the methodological approach followed in this chapter is presented in chapter 12.

Authors tracing back to the origins of political liberalism have treated private property as a social norm the value of which lies in reducing conflict over rights of incumbency (Schlatter 1973). Our analysis of the bourgeois strategy as a social norm effecting an efficient correlated equilibrium embodies this classical notion (§7.3). However, we argued in chapter 7 that a social norm is likely to be fragile and unstable unless individuals generally have a *index-term* normative predisposition to conform. We here interpret the well-known phenomena of loss-aversion and the endowment effect (§1.9) as highly rational *forms of normative predisposition*. In this case, the norm is really pre-ethical, and is shared with many species of animals as well, in the form of territoriality.

11.1 The Endowment Effect

The *endowment effect* is the notion that people value a good that they possess more highly than the same good when they do not possess it (§1.9). Experimental studies (§11.2) have shown that subjects exhibit a systematic endowment effect. The endowment effect is widely considered to be an instance of human irrationality. We suggest here that the endowment effect is

not only rational, it is the basis for key forms of human sociality, including the respect for personal privacy and property.

Since the endowment effect is an aspect of prospect theory (§1.9), it can be modeled by amending the standard rational actor model to include an agent's current holdings as a parameter. The endowment effect gives rise to *loss aversion*, according to which agents are more sensitive to losses than to gains (§1.7). We here show that the endowment effect can be modeled as respect for private property in the absence of legal institutions ensuring third-party contract enforcement (Jones 2001, Stake 2004). In this sense, preinstitutional "natural" private property has been observed in many species, in the form of the recognition of territorial possession. We develop a model loosely based on the hawk-dove game (§2.9) and the War of Attrition (Maynard Smith and Price 1973) to explain the natural evolution of private property.

We show that if agents in a group exhibit the endowment effect for an indivisible resource, then property rights in that resource can be established on the basis of incumbency, assuming incumbents and those who contest for incumbency are of equal perceived fighting ability.¹ The enforcement of these rights will then be carried out by the agents themselves, so no third-party enforcement is needed. This is because the endowment effect leads the incumbent to be willing to expend more resources to protect his incumbency than an intruder will be willing to expend to expropriate the incumbent. For simplicity, we consider only the case where the marginal benefit of more than one unit of the resource is zero (e.g., a homestead, a spider's web, or a bird's nest).

The model assumes the agents know the present value π_g of incumbency, as well as the present value π_b of non-incumbency, measured in units of biological fitness. We assume utility and fitness coincide, except for one situation, described below: this situation explicitly involves *loss aversion*, where the disutility of loss exceeds the fitness cost of loss. When an incumbent faces an intruder, the intruder determines the expected value of attempting to seize the resource, and the incumbent determines the expected value of contesting versus ceding incumbency when challenged. These conditions will not be the same, and in plausible cases there is a range of val-

¹The assumption of indivisibility is not very restrictive. In some cases it is naturally satisfied, as in a nest, web, dam, or mate who provides for offspring. In others, such as a hunter's kill, a fruit tree, a stretch of beach for an avian scavenger, it is simply the minimum size worth fighting over rather than dividing and sharing.

ues of π_g/π_b for which the intruder decides not to fight, and the incumbent decides to fight if challenged. We call this a (natural) *private property equilibrium*. In a private property equilibrium, since the potential contestants are of equal power, it must be the case that individuals are *loss averse*, the incumbent being willing to expend more resources to hold the resource than the intruder is to seize it.

Of course, π_g and π_b will generally be endogenous in a fully specified model. Their values will depend on the supply of the resource relative to the number of agents, the intrinsic value of the resource, the ease in finding an unowned unit of the resource, and the like.

In our model of decentralized private property, agents contest for a unit of an indivisible resource, contests may be very costly, and in equilibrium, incumbency determines who holds the resource without costly contests. Our model, however, fills in critical gaps in the hawk-dove game. The central ambiguity of the hawk-dove game is that it treats the cost of contesting as exogenously given and taking on exactly two values, high for Hawk and low for Dove. Clearly, however, these costs are in large part under the control of the agents themselves and should not be considered exogenous. In our model, the level of resources devoted to a contest is endogenously determined, and the contest itself is modeled explicitly as a modified War of Attrition, the probability of winning being a function of the level of resources committed to combat. One critical feature of the War of Attrition is that the initial commitment of a level of resources to a contest must be *behaviorally ensured by the agent*, so that the agent will continue to contest even when the costs of doing so exceed the fitness benefits. Without this precommitment, the incumbent's threat of "fighting to the death" would not be credible (i.e., the agent would abandon the chosen best response when it came time to use it). From a behavioral point of view, this precommitment can be summarized as the incumbent have a degree of *loss aversion* leading his utility to differ from his fitness.

Our fuller specification of the behavioral underpinnings of the hawk-dove game allows us to determine the conditions under which a property equilibrium will exist while its corresponding anti-property equilibrium (in which a new arrival rather than the first entrant always assumes incumbency) does not exist. This aspect of our model is of some importance because the inability of the hawk-dove game to favor private property over anti-private property is a serious and rarely addressed weakness of the model (but see Mesterton-Gibbons 1992).

11.2 The Territoriality

The endowment effect, according to which a good is more highly prized by an agent who is in possession of the good than one who is not, was first documented by the psychologist Daniel Kahneman and his coworkers (Tversky and Kahneman 1991; Kahneman et al. 1991; Thaler 1992). Thaler describes a typical experimental verification of the phenomenon as follows. Seventy-seven students at Simon Fraser University were randomly assigned to one of three conditions, Seller, Buyer, or Chooser. Sellers were given a mug with the University logo (selling for \$6.00 at local stores) and asked whether they would be willing to sell at a series of prices ranging from \$0.25 to \$9.25. Buyers were asked whether they would be willing to purchase a mug at the same series of prices. Choosers were asked to choose for each price between receiving a mug or that amount of money. The students were informed that a fraction of their choices, randomly chosen by the experimenter, would be carried out, thus giving the students a material incentive to reveal their true preferences. The average Buyer price was \$2.87, while the average Seller price was \$7.12. Choosers behaved like Buyers, being on average indifferent between the mug and \$3.12. The conclusion is that owners of the mug valued the object more than twice as highly as nonowners.

The aspect of the endowment effect that promotes natural private property is known as *loss aversion*: the disutility of giving up something one owns is greater than the utility associated with acquiring it. Indeed, losses are commonly valued at about twice that of gains, so that to induce an individual to accept a lottery that costs \$10 when one loses (which occurs with probability 1/2), it must offer a \$20 payoff when one wins (Camerer 2003). Assuming that an agent's willingness to combat over possession of an object is increasing in the subjective value of the object, owners will be prepared to fight harder to *retain* possession than non-owners are to *gain* possession. Hence there will be a predisposition in favor of recognizing private property by virtue of incumbency, even where third-party enforcement institutions are absent.

We say an agent *owns* (is incumbent) something if the agent has exclusive access to it and the benefits that flow from this privileged access. We say ownership (incumbency) is *respected* if it is rarely contested and, when contested, generally results in ownership remaining with the incumbent. The dominant view in Western thought, from Hobbes, Locke, Rousseau, and Marx to the present, is that private property is a human social con-

struction that emerged with the rise of modern civilization (Schlatter 1973). However, evidence from studies of animal behavior, gathered mostly in the past quarter century, has shown this view to be incorrect. Various territorial claims are recognized in nonhuman species, including butterflies (Davies 1978), spiders (Riechert 1978), wild horses (Stevens 1988), finches (Senar et al. 1989), wasps (Eason et al. 1985), nonhuman primates (Ellis 1985), lizards (Rand 1967), and many others (Mesterton-Gibbons and Adams 2003). There are, of course, some obvious forms of incumbent advantage that partially explain this phenomenon: the incumbent's investment in the territory may be idiosyncratically more valuable to the incumbent than to a contestant or the incumbent's familiarity with the territory may enhance its ability to fight. However, in the above-cited cases, these forms of incumbent advantage are unlikely to be important. Thus, a more general explanation of territoriality is needed.

In nonhuman species, that an animal owns a territory is generally established by the fact that the animal has occupied and altered the territory (e.g., by constructing a nest, burrow, hive, dam, or web, or by marking its limits with urine or feces). In humans there are other criteria of ownership, but physical possession and first to occupy remain of great importance, as expressed by John Locke in the headquote to this chapter.

Since private property in human society is generally protected by law and enforced by complex institutions (judiciary and police), it is natural to view private property in animals as a categorically distinct phenomenon. In fact, however, decentralized, self-enforcing types of private property, based on behavioral propensities akin to those found in nonhuman species (e.g., the endowment effect), are important for humans and arguably lay the basis for more institutional forms of property rights. For instance, many developmental studies indicate that toddlers and small children use behavioral rules similar to those of animals in recognizing and defending property rights (Furby 1980).

How respect for ownership has evolved and how it is maintained in an evolutionary context is a challenging puzzle. Why do loss aversion and the endowment effect exist? Why do humans fail to conform to the smoothly differentiable utility function assumed in most versions of the rational actor model? The question is equally challenging for nonhumans, although we are so used to the phenomenon that we rarely give it a second thought.

Consider, for instance, the sparrows that built a nest in a vine in my garden. The location is choice, and the couple spent days preparing the struc-

ture. The nest is quite as valuable to another sparrow couple. Why does another couple not try to evict the first? If they are equally strong, and both value the territory equally, each has a 50% chance of winning the territorial battle. Why bother investing if one can simply steal (Hirshleifer 1988)? Of course, if stealing were profitable, then there would be no nest building, and hence no sparrows, but that heightens rather than resolves the puzzle.

One common argument, borrowed from Trivers (1972), is that the original couple has more to lose since it has put a good deal of effort already in the improvement of the property. This, however, is a logical error that has come to be known as the *Concorde* or the *sunk cost* fallacy (Dawkins and Brockmann 1980, Arkes and Ayton 1999): to maximize future returns, an agent ought consider only the future payoffs of an entity, not how much the agent has expended on the entity in the past.

The hawk-dove game was offered by Maynard Smith and Parker (1976) as a logically sound alternative to the sunk cost argument. In this game Hawks and Doves are phenotypically indistinguishable members of the same species, but they act differently in contesting over ownership rights to a territory. When two Doves contest, they posture for a bit, and then each assumes the territory with equal probability. When a Dove and a Hawk contest, however, the Hawk takes the whole territory. Finally, when two Hawks contest, a terrible battle ensues, and the value of the territory is less than the cost of fighting for the contestants. Maynard Smith showed that, assuming that there is an unambiguous way to determine who first found the territory, there is an evolutionarily stable strategy in which all agents behave like Hawks when they are *first* to find the territory, and like Doves otherwise.

The hawk-dove game is an elegant contribution to explaining the endowment effect, but the cost of contesting for Hawks and the cost of display for Doves cannot plausibly be taken as fixed and exogenously determined. Indeed, it is clear that Doves contest in the same manner as Hawks, except that they devote fewer resources to combat. Similarly, the value of the ownership is taken as exogenous, when in fact it depends on the frequency with which ownership is contested, as well as other factors. As Grafen (1987) stresses, the costs and benefits of possession depend on the state of the population, the density of high-quality territories, the cost of search, and other variables that might well depend on the distribution of strategies in the population.

First, however, it is instructive to consider the evidence for a close association, as Locke suggested in his theory of property rights, between ownership and incumbency (physical contiguity and control) in children and nonhuman animals.

11.3 Property Rights in Young Children

Long before they become acquainted with money, markets, bargaining and trade, children exhibit possessive behavior and recognize the property rights of others on the basis of incumbency.² In one study (Bakeman and Brownlee 1982), participant observers studied a group of 11 toddlers (12 to 24 months old) and a group of 13 preschoolers (40 to 48 months old) at a day care center. The observers found that each group was organized into a fairly consistent linear dominance hierarchy. They then cataloged *possession episodes*, defined as a situation in which a *holder* touched or held an object and a *taker* touched the object and attempted to remove it from the holder's possession. Possession episodes averaged 11.7 per hour in the toddler group, and 5.4 per hour in the preschool group.

For each possession episode, the observers noted (a) whether the taker had been playing with the object within the previous sixty seconds (prior possession), (b) whether the holder resisted the take attempt (resistance), and (c) whether the take was successful (success). They found that success was strongly and about equally associated with both dominance and prior possession. They also found that resistance was positively associated with dominance in the toddlers, and negatively associated with prior possession in the preschoolers. They suggest that toddlers recognize possession as a basis for asserting control rights, but do not respect the same rights in others. The preschoolers, more than twice the age of the toddlers, use physical proximity both to justify their own claims and to respect the claims of others. This study was replicated and extended by Weigel (1984).

11.4 Respect for Possession in Nonhuman Animals

In a famous paper, Maynard Smith and Parker noted that two animals are competing for some resource (e.g., a territory), and if there is some discernible asymmetry (e.g., between an "owner" and a later animal), then it is evolutionarily stable for the asymmetry to settle the contest conventionally,

²See Ellis (1985) for a review and an extensive bibliography of research in this area.

without fighting. Among the many animal behaviorists who put this theory to the test, perhaps none is more elegant and unambiguous than Davies (1978), who studied the speckled wood (*Pararge aegeria*), a butterfly found in the Wytham Woods, near Oxford, England. Territories for this butterfly are shafts of sunlight breaking through the tree canopy. Males occupying these spots enjoyed heightened mating success, and on average only 60% of males occupied the sunlit spots at any one time. A vacant spot was generally occupied within seconds, but an intruder on an already occupied spot was invariably driven away, even if the incumbent had occupied the spot only for a few seconds. When Davies “tricked” two butterflies into thinking each had occupied the sunny patch first, the contest between the two lasted, on average, ten times as long as the brief flurry that occurs when an incumbent chases off an intruder.

Stevens (1988) found a similar pattern of behavior for the feral horses occupying the sandy islands of the Rachel Carson Estuarine Sanctuary near Beaufort, North Carolina. In this case, it is fresh water that is scarce. After heavy rains, fresh water accumulates in many small pools in low-lying wooded areas, and bands of horses frequently stop to drink. Stevens found that there were frequent encounters between bands of horses competing for water at these temporary pools. If a band approached a water hole occupied by another band, a conflict ensued. During 76 hours of observation, Stevens observed 233 contests, of which the resident band won 178 (80%). In nearly all cases of usurpation, the intruding band was larger than the resident band. These examples, and many others like them, support the presence of an endowment effect and suggest that incumbents are willing to fight harder to maintain their position than intruders are to usurp the owner.

Examples from nonhuman primates exhibit behavioral patterns in the respect for property rights much closer to that of humans. In general, the taking of an object held by another individual is a rare event in primate societies (Torii 1974). A reasonable test of the respect for property in primates with a strong dominance hierarchy is the likelihood of a dominant individual refraining from taking an attractive object from a lower-ranking individual. In a study of hamadryas baboons (*Papio hamadryas*), for instance, Sigg and Falett (1985) hand a food-can to a subordinate who was allowed to manipulate and eat from it for five minutes before a dominant individual who had been watching from an adjacent cage was allowed to enter the subordinate’s cage. A “takeover” was defined as the rival taking possession of the can before thirty minutes had elapsed. They found that

(a) males never took the food-can from other males; (b) dominant males took the can from subordinate females 2/3 of the time; and (c) dominant females took the can from subordinate females 1/2 of the time. With females, closer inspection showed that when the difference in rank was one or two, females showed respect for the property of other females, but when the rank difference was three or greater, takeovers tended to occur.

Kummer and Cords (1991) studied the role of proximity in respect for property in long-tailed macaques (*Macaca fascicularis*). As in the Sigg and Falett study, they assigned ownership to a subordinate and recorded the behavior of a dominant individual. The valuable object in all cases was a plastic tube stuffed with raisins. In one experiment, the tube was fixed to an object in half the trials and completely mobile in the other half. They found that with the fixed object, the dominant rival took possession in all cases and very quickly (median one minute), whereas in the mobile condition, the dominant took possession in only 10% of cases, and then only after a median delay of 18 minutes. The experiment took place in an enclosed area, so the relative success of the incumbent was not likely due to the ability to flee or hide. In a second experiment, the object was either mobile or attached to a fixed object by a stout two meter or four meter rope. The results were similar. A third case, in which the non-mobile object was attached to a long dragline that permitted free movement by the owner, produced the following results. Pairs of subjects were studied under two conditions, one where the rope attached to the dragline was 2 meters in length, and a second where the rope was 4 meters in length. In 23 of 40 trials, the subordinate maintained ownership with both rope lengths, and in 6 trials the dominant rival took possession with both rope lengths. In the remaining 11 trials, the rival respected the subordinate's property in the short rope case, but took possession in the long rope case. The experimenters observed that when a dominant attempts to usurp a subordinate when other group members are around, the subordinate will scream, drawing the attention of third parties, who frequently force the dominant individual to desist.

In *Wild Minds* (2000), Marc Hauser relates an experiment run by Kummer and his colleagues concerning mate property, using four hamadryas baboons, Joe, Betty, Sam, and Sue. Sam was let into Betty's cage, while Joe looked on from an adjacent cage. Sam immediately began following Betty around and grooming her. When Joe was allowed entrance to the cage, Joe kept his distance, leaving Sam uncontested. The same experiment was repeated with Joe allowed into Sue's cage. Joe behaved as Sam

had in the previous experiment, and when Sam was let into the cage, he failed to challenge Joe's proprietary rights with respect to Sue.

No primate experiment, to my knowledge, has attempted to determine the probability that an incumbent will be contested for ownership by a rival who is, or could easily become, closely proximate to the desired object. This probability is likely very low in most natural settings, so the contests described in the papers cited in this section are probably rather rare in practice. At any rate, in the model of respect for property developed in the next section, we will make informational assumptions that render the probability of contestation equal to zero in equilibrium.

11.5 Conditions for Private Property Equilibrium

Suppose that two agents, prior to fighting over possession, simultaneously precommit to expending a certain level of resources to the contest. As in the War of Attrition (Bishop and Cannings 1978), a higher level of resource commitment entails a higher fitness cost, but increases the probability of winning the contest. We assume throughout this chapter that the two contestants, an incumbent and an intruder, are *ex ante* equally capable contestants in that the costs and benefits of battle are symmetric in the resource commitments s_o (owner) and s_u (usurper) of the incumbent and intruder, respectively and $s_o, s_u \in [0, 1]$. To satisfy this requirement, we let $p_u = s_u^n / (s_u^n + s_o^n)$ be the probability that the intruder wins, where $n > 1$. Note that larger n implies resource commitments are more decisive in determining victory. We assume that combat leads to injury $\beta \in (0, 1]$ to the losing party with probability $p_d = (s_o + s_u)/2$, so $s = \beta p_d$ is the expected cost of combat for both parties.

We use a territorial analogy throughout, some agents being incumbents and others being migrants in search of either empty territories or occupied territories that they may be able to occupy by displacing current incumbents. Let π_g be the present value of being a currently uncontested incumbent, and let π_b be the present value of being a migrant searching for a territory. We assume throughout that $\pi_g > \pi_b > 0$. Suppose a migrant comes upon an occupied territory. Should the migrant contest, the condition under which it pays an incumbent to fight back is then given by

$$\begin{aligned} \pi_c \equiv & p_d(1 - p_u)\pi_g + p_d p_u(1 - \beta)(1 - c)\pi_b + \\ & (1 - p_d)(1 - p_u)\pi_g + (1 - p_d)p_u\pi_b(1 - c) > \pi_b(1 - c). \end{aligned}$$

The first term in π_c is the product of the probabilities that the intruder loses $(1 - p_u)$ and sustains an injury (p_d) , times the value π_g of incumbency, which the incumbent then retains. The second term is the product of the probabilities that the incumbent loses (p_u) , sustains an injury (p_d) , survives the injury $(1 - \beta)$, and survives the passage to migrant status $(1 - c)$, times the present value π_b of being a migrant. The third and fourth terms are the parallel calculations when no injury is sustained. This inequality simplifies to

$$\frac{\pi_g}{\pi_b(1-c)} - 1 > \frac{s_u^n}{s_o^n} s. \quad (11.1)$$

The condition for a migrant refusing to contest for the territory, assuming the incumbent will contest if the migrant does, is

$$\pi_u \equiv p_d(p_u\pi_g + (1 - p_u)(1 - \beta)(1 - c)\pi_b) + \quad (11.2)$$

$$(1 - p_d)(p_u\pi_g + (1 - p_u)\pi_b(1 - c)) < \pi_b(1 - c). \quad (11.3)$$

This inequality reduces to

$$\frac{s_o^n}{s_u^n} s > \frac{\pi_g}{\pi_b(1-c)} - 1. \quad (11.4)$$

A private property equilibrium occurs when both inequalities obtain

$$\frac{s_o^n}{s_u^n} s > \frac{\pi_g}{\pi_b(1-c)} - 1 > \frac{s_u^n}{s_o^n} s. \quad (11.5)$$

An incumbent who is challenged will choose s_o to maximize π_c , and then contest if and only if the resulting $\pi_c^* > \pi_b(1 - c)$, since the latter is the value of simply leaving the territory. It is easy to check that $\partial\pi_c/\partial s_o$ has the same sign as

$$\frac{\pi_g}{\pi_b(1-c)} - \left(\frac{s_o\beta}{2n(1-p_u)} + 1 - s \right).$$

The derivative of this expression with respect to s_o has the same sign as $(n - 1)\beta\pi_b/(1 - p_u)$, which is positive. Moreover, when $s_o = 0$, $\partial\pi_c/\partial s_o$ has the same sign as

$$\frac{\pi_g}{\pi_b(1-c)} - 1 + \frac{s_u\beta(1-c)}{2},$$