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PROPERTY RIGHTS AND PROPERTY LAW

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DEAN LUECK AND THOMAS J. MICELI*

Abstract. This chapter examines the economics of property rights and property law. It shows how the economics of property rights can be used to understand fundamental features of property law and related extra-legal institutions. The chapter examines both the rationale for legal doctrine, and the effects of legal doctrine regarding the exercise, enforcement, and transfer of rights. It also examines various property rights regimes including open access, private ownership, common property, and state property. The guiding questions are: How are property rights established? What explains the variation in the types of property rights? What governs the use and transfer of rights? And, how are property rights enforced? In answering these questions we argue that property rights and property law can be best understood as a system of societal rules designed to maximize social wealth. They do this by creating incentives for people to maintain and invest in assets, which leads to specialization and trade.

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1. Introduction

This chapter examines the economics of property rights and property law. The purpose is to show how the economics of property rights can be used to understand fundamental features of property law and related extra-legal institutions. The chapter will examine both the rationale for, and the effects of, legal doctrine. The guiding questions are: How are property rights established? What explains the variation in the types of property rights? What governs the use and transfer of rights? And, how are property rights enforced? In answering these questions we argue that property rights and property law can be best understood as a system of societal rules designed to maximize social wealth. They do this by creating incentives for people to maintain and invest in assets, which leads to specialization and trade.

1.1. Property Rights and Property Law

Property rights have been a subject of discussion among philosophers as well as political and legal scholars long before economists began to examine their origins and consequences. Property rights were discussed and implicitly understood by ancient Greek and Roman writers, but it is perhaps Hobbes (1651) who first discusses property in a manner recognizable to modern economists. Indeed Hobbes' 'state of nature' can be viewed as open access dissipation. A wide range of Enlightenment thinkers such as Blackstone (1766), Hume (1739-1740), Locke (1690), and Smith (1776) also discussed property rights. Though they varied in their treatments all considered property rights as fundamental social institutions for creating wealth and preventing strife.

We define property rights as the ability (or expected ability) of an economic agent to use an asset (Allen 1999, Barzel 1997, Shavell 2004). As Demsetz (1967) notes in one of the classic early economic analyses, property rights represent a social institution that creates incentives to efficiently use assets, and to maintain and invest in assets. They may or may not be enforced by courts and because the actions of courts are costly, legal rights are but a subset of economic property rights. In addition to law (and statutorily-based regulations enforced by administrative agencies), property rights may be enforced by custom and norms (e.g., Ellickson 1991), and by markets through repeated transactions.¹

Property law is the body of court enforced rules governing the establishment, use, and transfer of rights to land and those assets attached to it such as air, minerals, water, and wildlife.² Intellectual property law similarly details the conditions under which the courts enforce rights to intellectual assets. In this framework, virtually all, if not all, branches of law are 'property rights law.' Labor law defines the court's role in enforcing rights to one's labor, contract law defines the rights of contracting parties, and so on. Because the economics of property rights originated with a focus on rights to land and associated natural resources (e.g. fisheries, pastures, water) the

¹ Enforcement may also be by violence as with the Mafia (Gambetta 1993).

² Merrill and Smith (2002) and Arruñada (2003), however, argue that the *in rem* nature of property ('real rights' versus *in personam* 'use rights' typical in contracts) is an important distinction that property rights economists have overlooked since Coase (1960). Merrill and Smith (2002, p. 375) argue that '[t]he simplifying assumptions [of economists] introduce blind spots that can limit the ability of law and economics scholars to explain the institution of property.' They cite doctrines like the *numerus clausus* principle, and Arruñada notes the importance of title systems as *in rem* enforcement institutions.

link between ‘property law’ and ‘property rights’ is firmly established. This chapter will develop this link by examining property rights generally and property law in particular. Yet, much of the analysis in this chapter is applicable to topics elsewhere in the handbook, though in many cases (e.g., contracts, torts) the literature has become so specialized that the connection to the economics of property rights might seem faint.

The economic analysis of property law is substantially less well developed than the economic analysis of contract law or tort law (for example, there is no generally applicable model), and this chapter reflects this state of the discipline. The economics of property rights, however, is well developed but mostly without a focus on property law.³ The disconnection between the economics of property rights and the economics of property law is longstanding. For example, Demsetz’s (1998) recent entry “Property Rights” in the *The New Palgrave Dictionary of Economics and the Law* makes absolutely no mention of property law, and much of the economics of property rights literature remains ignorant of property law.⁴ Similarly, property law scholarship often is ignorant of economics. This is not to say there has not been important work in property law with strong economic underpinnings (e.g., Ellickson 1993, Epstein 1985, Heller 1998, Merrill 1986, Rose 1990), but it is clear that economics has not yet penetrated property law as it has penetrated contract and tort law. While it is common for courses in contract law and tort law to be taught using economics as the guiding framework, an economics-based course in property law is almost unheard of.⁵ In part, this chapter seeks to break down this division by bringing the two literatures together.

1.2. Property Rights, Transaction Costs, and the Coase Theorem

The economics of property law begins with Coase (1960), who provides a property rights perspective on the problem of externalities, or ‘social cost.’⁶ Prior to Coase, economists viewed externalities as a source of market failure requiring government intervention to force the responsible party to curtail the harmful activity. Consider Coase’s famous example of the rancher and farmer with adjacent plots of land. The rancher’s cattle stray onto the farmer’s land causing crop damage. If the rancher’s profit, $\pi(h)$, and the amount of crop damage, $d(h)$, are functions of the rancher’s herd size, h , then the first-best optimal herd size, h^* , maximizes $\pi(h) - d(h)$. That is, h^* solves $\pi'(h) = d'(h)$.⁷ This is also the choice that would be made by a single party acting as both the farmer and rancher, Coase’s ‘sole owner’ solution. First-best then is synonymous with the zero transaction cost outcome. With separate parties, however, and the absence of a contract between the farmer and the rancher or some type of government intervention (a tax, fine, or regulation), the rancher would choose the herd size to maximize $\pi(h)$. This results in too many cattle because the rancher adds cattle until $\pi'(h) = 0$, which implies $h' > h^*$. Thus, the rancher must pay a tax (or face liability) for the damage from straying cattle, or he will expand his herd beyond the efficient (first-best) size.

³ The main exception to this is a deep theoretical literature on takings which is examined in section 8.

⁴ Merrill and Smith (2001) note this also.

⁵ An exception is Dwyer and Menell (1998).

⁶ Another important, though little known early property rights contribution is that of Alchian (1965).

⁷ We assume that $\pi'' < 0$ and $d'' > 0$, ensuring a unique optimum.

Note that this solution to the externality problem embodies a particular assignment of property rights--namely, that the farmer has the right to be free from crop damage. Another way to say this is that the farmer is labeled as the “cause” of the harm and therefore must face liability. And if the property right (or the legal liability rule) is structured properly, the rancher will purchase the right to impose crop damage up to the point where the marginal profit from the last steer just equals the marginal damage, yielding an efficient herd size.

Coase’s critique of this conventional, or “Pigovian,” perspective on externalities is not that it is wrong per se, but that it is incomplete.⁸ To illustrate, suppose that the rancher initially has the economic (and legal) right to impose crop damage without penalty. According to the Pigovian view, this would result in an excessive herd size because the rancher would expand the herd to h' . But note that the farmer would be willing to pay up to $d'(h)$, his marginal damage, for each steer that the farmer removes from the herd in order to avoid crop damage, while the rancher would accept any amount greater than his marginal profit, $\pi'(h)$. Thus, if transaction costs are zero, the parties will contract to reduce the herd to the efficient size. In other words, the farmer will purchase the rights to the straying cattle, the reverse of what happened under the Pigovian solution. The outcome in both cases is therefore first-best. This conclusion has become known as the Coase Theorem⁹, which can be stated in general terms as follows: *When transaction costs are zero, the allocation of resources will be efficient regardless of the initial assignment of property rights.*¹⁰

Coase challenged two assumptions implicit in the Pigovian view: first, that there is a unique cause of the harm, and second, that government intervention is necessary to internalize the externality. Coase noted that in general, and in the specific farmer-rancher example, the cause of harm is ‘reciprocal’ in the sense that if either party is removed, the harm disappears.¹¹ Second, by noting that well defined ownership can lead to transactions, the range of ‘solutions’ extends to private contracting as well as government regulation and taxation.¹²

1.3. The Impact of Transaction Costs: When Does Law Matter?

Although there has been debate among economists and legal scholars on the significance of the Coase Theorem and its implications, Coase (1960, 1988) has been clear on this issue. Economic and legal institutions are important and have impacts because transaction costs are *not zero* and

⁸ This tradition is attributed to A.C. Pigou’s *The Economics of Welfare* (1932).

⁹ Stigler (1987) takes credit for calling this proposition the “Coase Theorem.” Stigler also recounts a famous dinner at the home of Aaron Director where Coase convinced a formidable group of scholars (including Milton Friedman and Stigler) that his analysis was indeed correct.

¹⁰ Typically economists have argued that the Coase Theorem is conditioned on the size of wealth effects. Barzel (1997), however, argues that wealth effects are likely to be trivial and not a condition of the Coase Theorem. He notes that the standard example of rights shifting without compensation itself violates the assumption of zero transaction costs. This is because zero transaction costs means that a rights shift would have to be accompanied by a payment to the original rights holder.

¹¹ In technical terms Coase points out that most interesting actions (Y) depend on the inputs of both parties (a, b); that is, $Y = f(a, b)$. This ‘bilateral’ externality is discussed in section 7.1.

¹² This ‘contractual’ approach is discussed in section 4.4.

thus property rights are *not perfectly defined* (Allen 1999, Barzel 1997).¹³ The Coase Theorem thus stresses the role of transaction costs in shaping the institutions, including law, that determines the allocation of resources. Seen as the costs of defining and enforcing property rights, transaction costs include enforcement costs, measurement costs, and moral hazard costs (Allen 1998).

But Coase's insight goes further. Not only does the law matter for efficiency, as Demsetz (1972) explicitly points out, but the law itself is an economic choice, also expected to be driven by economic forces.¹⁴ Indeed, Coase's (1960) discussion of nuisance law suggests an economic logic to the law in its assignment of property rights among various parties to these disputes, but its relevance extends beyond the study of externalities. It is concerned with the larger question of how property rights are established, the types of property rights regimes that are allowed, and the rules that govern the use and transfer of property rights. In this sense, property law is a complement to markets. This is the real contribution of Coase, and it will emerge as a theme throughout this chapter in a wide range of property law settings.

1.4. Outline of Chapter

The remainder of the chapter is organized as follows. Section 2 develops the basic economic models of property rights that guide the analysis throughout the chapter. Section 3 examines the origin of rights. Section 4 follows with an analysis of the changes in property rights, or what has become known as the evolution of rights. Section 5 then examines various forms of voluntary exchange, including markets, leases, and inheritance. Section 6 examines involuntary transfers of title by adverse possession and theft. Section 7 examines various means of internalizing externalities. Section 8 considers issues related to state (collective) ownership, as opposed to private ownership, of property, including the optimal scale of ownership and takings. Section 9 considers restrictions on the alienability of property. Finally Section 10 concludes. Each section is a mix of formal and informal theory and application to law and related institutions.

Throughout we try to make clear that the goal of the chapter is to use economics to illuminate the rationale for and effects of property law doctrine. Where possible we summarize the empirical literature or explain empirical applications. The sections are not symmetric, simply because the literature is not symmetric.¹⁵

2. Basic Property Rights Models

Before examining property law doctrine it is appropriate to first examine the predominant types of property rights regimes and their economic structure. In this section we both describe the various types of property and examine the implications of these regimes for the use of and

¹³ Many scholars have called a case of zero transaction costs a 'Coasian world' but Coase (1988, p.174) claims 'The world of zero transaction costs has often been described as a Coasian world. Nothing could be further from the truth. It is the world of modern economic theory, one which I was hoping to persuade economists to leave.'

¹⁴ In another path breaking article, Coase (1937) uses a similar transaction cost argument to explain the boundary between markets and firms. Barzel and Kochin (1992) note the link between Coase's property rights and transaction costs theories.

¹⁵ Because of its focus on specific assets, we make little use of the 'property rights theory of the firm' (e.g., Hart and Moore 1990) which has become important in the economics of organization.

investment in assets. The models used in this section are fundamental to the later sections of the chapter that examine specific issues and legal doctrine.

As we noted above, the first systematic analysis of property rights began with the Enlightenment writers (e.g., Blackstone, Hume, Locke, Smith), but the formal modeling of the economics of property rights began with Frank Knight's (1924) analysis of public and private roads. Knight showed that a public road with no charge for access would be overused compared to the private road because users would not face the full cost of their actions. Gordon (1954) further developed Knight's preliminary model – establishing the now famous 'average product rule' for input use -- in the context of an open ocean fishery where no one could be excluded.¹⁶ Gordon's model was completed with Cheung's (1970) paper, which fully characterized the Nash equilibrium for an open access resource.

Our analysis of various property rights regimes will use a common set of notation in which a fixed asset (e.g., plot of land) is used in conjunction with a variable input (x) in order to produce a market output ($Y = f(x)$). If the input is available at a market wage of w , then the first-best use of the input ($x^*(w)$) must maximize $R = f(x) - wx$ and satisfy the first-order necessary condition $f'(x) = w$. The first-best value of the land is thus $V^* = \int_0^\infty R^*(x^*, t)e^{-rt} dt$, where r is the discount rate.¹⁷ We start with open access, or a complete lack of property rights, and then, in turn, examine private property rights, common property, and mixed property rights regimes.¹⁸

2.1. Open Access

Assume there are n individuals who have unrestricted access to a resource such as a piece of land, and that output from the land (e.g., beef from grazing animals) is given by $Y = f(\sum_{i=1}^n x_i)$ where x_i is the effort of the i^{th} individual, $f(\cdot) > 0$ and $f''(\cdot) < 0$, and the opportunity cost of effort is the market wage, w_i .¹⁹ Each person's objective is to maximize his own rent subject to the constraint of open access, which means that each user can only capture (and own) the output in proportion to his share of effort.²⁰ This means each person must solve the following constrained maximization problem:

$$\begin{aligned} \max_{x_i} R_i &= f^i(x_i) - w_i x_i \\ \text{subject to } f^i &= \left[x_i / \sum_{i=1}^n x_i \right] f(\sum_{i=1}^n x_i) \end{aligned} \tag{2.1}$$

¹⁶ Scott (1955) similarly shows the dissipation under open access and the private property solution.

¹⁷ Each period's rent can be viewed as a steady state outcome.

¹⁸ In law, since Roman times, open access resources have been called *res nullius*, or things unowned.

¹⁹ This production function captures the effect of competing users of the open access asset and is standard in the literature. Also, note that while ownership of the land is absent each person is assumed to have perfect ownership of themselves, their labor, and the product derived from the open access asset.

²⁰ This is a standard assumption but might be modified to explicitly distinguish use effort from violence effort.

Assuming that all users are homogeneous²¹ ($w_i = w_j$, for all $i \neq j$), the Nash open access equilibrium is $x = x^{oa}(n, w_1, \dots, w_n)$, which must satisfy the first-order necessary condition

$$\left(n - \frac{1}{n} \right) \left(\frac{f(\sum_{i=1}^n x_i)}{\sum_{i=1}^n x_i} \right) = \left(\frac{1}{n} \right) f'(\sum_{i=1}^n x_i) = w_i, \quad i = 1, \dots, n. \quad (2.2)$$

Equation (2.2), as Cheung shows, is indeed identical to Gordon's asserted average product equilibrium, but only in the limiting case of an infinite number of users with unrestricted access.²² Thus, in the limit as $n \rightarrow \infty$, (2.2) becomes

$$\left(\frac{f(\sum_{i=1}^n x_i)}{\sum_{i=1}^n x_i} \right) = w, \quad (2.3)$$

which states that the open access equilibrium level of effort occurs where the average product equals the wage. More importantly, this limiting case also implies that rents are completely dissipated; or that, $\sum_{i=1}^n R_i = \sum_{i=1}^n [f^i(x^{oa}) - wx^{oa}] = 0$. Similarly, the present value of the asset is also zero; that is, $V^{oa} = \int_0^{\infty} R(x^{oa}, t)e^{-rt} dt = 0$.

In this framework, the absence of property rights leads to overuse of the asset and complete dissipation of its value.²³ Complete dissipation is a limiting result, however, of the assumption of homogeneous users. If users are heterogeneous, dissipation under open access will be incomplete, and infra-marginal (low cost) users will earn rents (Libecap 1989). The presence of rent under open access may be an important factor in preventing the establishment of rights to the open access resource because those earning rents will have incentives to maintain the open access regime.

2.2 Private Property Rights

Private ownership, as Knight first noted is the straightforward solution to the open access problem.²⁴ Under the conditions of the Coase Theorem, the owner faces the full value and opportunity cost of asset use, he chooses the first-best level of use ($x^* < x^{oa}$), and generates $V^* > V^{oa} = 0$. The Coase Theorem also implies that, as long as property rights are well defined the organization of the asset's use will not matter: the owner may use the land himself, he may hire inputs owned by others, input owners may hire (or rent) the asset, or there may be a sharing arrangement between the asset owner and the input owners. In fact, under the conditions of zero transaction costs, any property regime (e.g., common property, state ownership) would generate the first-best use of the asset.

²¹ This has been the starting point with Knight, Gordon and Cheung,

²² Equation (2.2) is actually a weighted average of average and marginal products. Brooks et al. (1999) show that Cheung's (1970) equilibrium holds in a dynamic setting.

²³ Hardin's (1968) famously named "tragedy of the commons" is a popularized version of this literature.

²⁴ This was well understood by Hobbs, Bentham, Locke and Blackstone long ago.

Not only does private ownership create incentives for optimal resource use, it also creates incentives for optimal asset maintenance and investment. With open access, no user has any incentive to use inputs that have a future payoff.²⁵ To see the effect on investment, consider a slightly modified version of the model above.²⁶ Let future output be $Y_{t+1} = f(x_t)$, where x_t is current investment, available at a market wage of w , and the interest rate is r . The first-best use of the input (x_t^*) must maximize $R = f(x_t)/(1+r) - wx_t$ and satisfy the first-order necessary condition $f'(x_t)/(1+r) = w$. This outcome is generated under perfect private ownership. Now let π be the probability of expropriation (because of imperfect property rights) of the future output, so that $(1-\pi)$ is the probability the investor's output remains intact. The solution to the investment problem (x_t^π) is now to maximize $R = f(x_t) [(1-\pi)/(1+r)] - wx_t$ which must satisfy $f'(x_t) [(1-\pi)/(1+r)] = w$. This clearly implies less investment ($x_t^\pi < x_t^*$). Pure open access means that no investor could claim future output ($\pi = 1$), so $x_t^{oa} = 0$, and the rent from investment also equals zero.

In a recent article, Heller (1998) identifies a situation in which a large number of uncoordinated individuals have the right to exclude users, thus creating a regime in which assets are under-used because each rights holder can exercise a 'veto' over use. Because of the incentive to under use rather than over use the asset, Heller labeled this the 'anti-commons' and argues that many of the development problems in post-communist Europe are plagued with this problem of 'too many owners.' Buchanan and Yoon (2000) formalize Heller's idea and give it additional application in cases where competing bureaucracies can stifle development by exercising veto rights. De Soto's (2000) documentation of the difficulties of operating in an economy heavily laden with overlapping bureaucracies is a similar application (as discussed in Section 5.1.2). In a similar application, Anderson and Lueck (1992) study 'fractionated' ownership of land on American Indian reservations. They found that divided ownership of agricultural land (among large numbers of heirs to the original owner) led to dramatic reductions in the value of agricultural output.

It is not clear that the anti-commons phenomenon can usefully be regarded as a distinct property regime. The lack of investment incentives does not stem from 'too much ownership', but simply from severely divided interests in which unanimous agreement is required for decision.²⁷ In this sense, the anti-commons is like open access: too many people have access and thus no one can gain from optimal use. The difference seems to be that the decisions considered are investment decisions, so the anti-commons can be viewed as open access investment problem. The same land or apartments governed by 'too many' will be overused while investment will be suboptimal.

²⁵ Writing before Adam Smith, Wm. Blackstone (Book II, Chapter 1, 1765) recognized this and wrote: 'And the art of agriculture, by a regular connexion and consequence, introduced and established the idea of a more permanent property in the soil, than had hitherto been received and adopted. It was clear that the earth would not produce her fruits in sufficient quantities, without the assistance of tillage: but who would be at the pains of tilling it, if another might watch an opportunity to seize upon and enjoy the product of his industry, art, and labor?'

²⁶ This is based on the detailed analysis of Bohn and Deacon (2000).

²⁷ Heller and Eisenberg (1998) also call open access a problem of 'too many owners,' whereas the economic models examined above characterize this as a lack of ownership.

The empirical literature on private property rights is of two types.²⁸ First, there is a literature that attempts to measure the dissipation from open access and to compare resource use to that under private property. This rather small literature is dominated by studies on natural resources and especially of fisheries where open access regimes have been common (e.g., Agnello and Donnelly 1975, Bottomley 1963). These studies have estimated the deadweight losses from open access use and compared levels of asset use in open access regimes with those of private property and other limited access regimes. Second, there is a recent and growing literature on the effects of property rights security on resource use and investment. Much of this literature has focused on the investment effects of differences in legal title to land. In his survey article Besley (1998) notes that the econometric evidence for positive investment effects of more secure rights in developing countries is quite limited. These studies suffer, however, from data limitations (on both measures of investment and measures of property rights security) and from potential property rights endogeneity.²⁹ We expect more investment with better defined rights, but as we discuss in section 4, the choice of property rights regime can itself be influenced by investment levels or other correlated variables. Thus the econometric issue is how to find an instrument for property rights variables to isolate the effect of rights on investment. Still there is some compelling evidence for the importance of property rights in the cases of natural resource use (Bohn and Deacon 2000), American Indian reservation agriculture (Anderson and Lueck 1992), and urban residential land (Miceli et al. 2002).

2.3. Common Property Rights

In modern social science the term ‘commons’ or ‘common property’ originated in the analysis of what is now called open access. Yet, in law and custom common property has long meant, in stark contrast to open access, exclusive ownership by a group.³⁰ Common property regimes have been well documented, especially for natural resource stocks in less developed economies (Bailey 1992, McKay and Acheson 1987, Ostrom 1990), and their details have been studied in many settings (e.g., Acheson 1988, Dahlman 1980, Eggertson 1992, Stevenson 1991). Many writers on common property have noted the gains from group enforcement of rights to the resource (Ellickson 1993, McKay and Acheson 1987, Ostrom 1990, and Stevenson 1991), and we examine common ownership to take this empirical feature into account.³¹

Common property is best viewed as an intermediate case between open access and private ownership. Common property may arise out of explicit private contracting (e.g., unitized oil reservoirs, groundwater districts) or out of custom (e.g., common pastures and forests); it may have legal (e.g., riparian water rights) or regulatory (e.g., hunting and fishing regulations) bases that have implicit contractual origins. Contracting to form common property effectively creates a group that has exclusive rights to the resource (Eggertsson 1992, Lueck 1994). Acting together

²⁸ There is also a property rights literature that focuses on differences between private and regulated firms (e.g., public utilities) that we do not discuss here.

²⁹ We return to this issue in the context of the choice of title system in section 5.1.1.

³⁰ Indeed Hardin’s (1968) famous paper incorrectly characterizes the common pastures of English villages as open access resources when the historical record shows clearly that they were common property (e.g., Dahlman 1980, Smith 2000).

³¹ Further evidence that common property regimes are productive is seen from the disasters that have occurred when they have been dismantled by the state (effectively creating open access) as in the forests of Nepal and Thailand (Ostrom 1990).

individuals can realize economies of enforcing exclusive rights to the asset. Equation (2.2) implies that waste can be reduced simply by restricting access to the asset.

A contracting model can illustrate how common property can limit waste from the rule of capture.³² Contracting to form common property effectively creates a group that has exclusive rights to the resource. We assume that (contractual) agreement among group members pertains only to the group's size and the joint effort to exclude outsiders. In this setting, individuals acting together can realize economies of enforcing exclusive rights to the asset, so we also assume the costs of excluding (or policing) non-members can be represented as $p(n)$, where $p'(n) < 0$ and $p''(n) > 0$.

A simple and customary method of allocating use of common property is a rule that grants equal access to all members of the group (Ostrom 1990). Equal sharing of the asset avoids the explicit costs of measuring and enforcing individual effort (or use) but still creates an incentive for over use.³³ Effort is not explicitly part of the common property 'contract' so each member chooses his own effort (x_i) as he captures his share of the asset's output ($Y = f(\sum x_i)$ again) in competition with other group members. The size of the group is chosen to maximize the wealth of the group subject to the constraint of aggregate effort (X^c) by members operating in a common property regime, and in recognition of the costs of excluding outsiders. Optimal group size is a tradeoff between increased resource use with a larger group and increased enforcement costs associated with a smaller group. Formally the problem is

$$\max_n R = f\left(\sum_{i=1}^n x_i^c(n)\right) - \sum_{i=1}^n (w_i x_i^c(n)) - p(n), \quad (2.4)$$

where x_i^c is the individual's solution to the problem in equation (2.1). The optimal group size, n^c determines total effort³⁴ and must satisfy the first-order necessary condition

$$\frac{\partial R}{\partial n} = \sum_{i=1}^n \left[\left(f' \left(\sum_{i=1}^n x_i \right) - w_i \right) \right] \frac{dx_i^c}{dn} - p'(n) = 0. \quad (2.5)$$

Equation (2.5) states that the gain from an additional member in terms of a marginal reduction in policing costs must equal the marginal reduction in aggregate rent from overuse of the resource.

The net present value of the common property resource is thus $V^c = \int_0^\infty R(x^c, t) e^{-rt} dt > 0$, where $V^* > V^c > V^{oa} = 0$. While the value of an asset governed by common property is less than its first-best value, it could have greater value than private property depending on the magnitude of the policing cost and overuse effects.

³² The model is based on Lueck (1994). Also see Caputo and Lueck (1994) and Wagner (1995). Others use evolutionary game theory models (e.g. Sethi and Somanathan 1996).

³³ Common property might also be viewed as an output sharing contract with moral hazard. In this framework group members shirk as in a principal-agent model (see Lueck 1994). Evidence of both types of common property – asset sharing (e.g., share access to a pasture) and output sharing (e.g. share the cheese produced from cattle on the common pasture) – are found in the empirical literature.

³⁴ Total effort is given by $X^c = \sum_{i=1}^{n^c} x_i^c$.

Dissipation from internal capture can be limited by maintaining a homogeneous membership. With equal sharing rules, a homogeneous membership maximizes the present value of a common property resource (Lueck 1994, 1995). Once a group chooses an equal sharing rule there is an incentive to maintain homogeneity. With heterogeneous members and equal shares, highly productive individuals will supply too little effort and the less productive will supply too much compared to a homogeneous equilibrium, so dissipation will increase. In effect, equal-sharing rules increase group wealth with homogeneity among group members. This provides an economic rationale for preserving homogeneity by screening potential members, by indoctrination, or by restricting the transfer of memberships.

There are other potential limits on the capture behavior of individual common property owners that are not considered by the above model. For example, if group members expect to interact over long periods the incentive to overuse the resource may be limited by the desire to maintain a productive relationship. Accordingly, customary rules can evolve that restrict members, for instance, by limiting the size of private herds on a common pasture (Rose 1986, Smith 2000). For common resources that are attached to land such as oil, game, and water, ownership of the land can limit access to the resource. In effect, the group is the set of private landowners who have access to the common resource. In this case, private contracting to consolidate land holdings is a possible solution to the ownership problem for the attached resource (Libecap and Wiggins 1984, Lueck 1989).³⁵

Another benefit of group ownership, besides internalizing externalities, is risk sharing.³⁶ Group ownership of land spreads the risk of uncertain events like crop failure, thereby providing a form of insurance (Ellickson, 1993). Group ownership also promotes egalitarianism, or equal sharing of output, which historically has been the motivation for various communal societies (Cosgel, Miceli, and Murray, 1997). But, as discussed above, these benefits must be weighed against the cost of group ownership in the form of diluted incentives for effort.

It is difficult to know how important common property regimes are in modern economies. Certainly families and other ‘close knit’ groups routinely use common property rights to govern resources. The ‘lobster gangs’ of Maine are perhaps the most famous case. A growing sector of the housing market is comprised of so-called ‘common interest communities,’ like condominiums, cooperatives, and homeowner’s associations, in which residents use a quasi-governmental structure for maintaining common areas (e.g., fitness rooms, pools, trails, open space) and providing certain local public goods (Dwyer and Menell, 1998: 807-887). (See the further discussion in Section 7.5.) Common property seems to be less typical in business, perhaps because group ownership leads to costly transfers of rights that must ultimately be governed by political decision making. It may also be true that large-scale enforcement by the state (i.e., courts, police) has usurped the major advantage of common property. In water law,

³⁵ On the other hand, there are problems when resource rights are tied to land ownership. For example, further parcelization of land can exacerbate the rule of capture as it has done with oil discovered in urban areas. In addition, linking rights can create incentives for further parcelization. For instance, under riparian doctrine linking water to land sometimes yields long, narrow “bowling alley” parcels designed to extend water rights to many users (Dukeminier and Krier 2002).

³⁶ Smith (2000) finds little support for the risk sharing thesis in the context of the medieval open fields system.

however, riparian water rights and the public trust doctrine (as we show in Section 8.2.1 below) still contain important elements of a common property regime.

2.4. State Property Rights

A third, and increasingly important, category of property rights are those held by the state. Vast amounts of land, buildings, and capital equipment are owned by governments (local, state and federal). Local governments own schools, road ways, and fleets of police cars. States own universities, administrative buildings, and vast tracts of land, especially in the West, where statehood grants established state trust lands to be managed to finance schools. The federal government owns over one-third of the total land area in the United States, again with a much larger presence in the western states.³⁷ It owns the Outer Continental Shelf from the shore to the 200-mile international border and thus own billions of dollars worth of oil-gas and other resources.³⁸ The federal government also has vast holdings of urban real estate (e.g., The White House, federal buildings throughout the country) and billions of dollars of capital equipment ranging from fighter jets and aircraft carriers to personal computers and desks.

The specific set of property rights that govern these state assets varies widely and has not been systematically analyzed by economists.³⁹ All are under the control of some administrative agency, be it the US Army, the state highway department, or the Bureau of Land Management. The statutes and regulations and political forces that govern these agencies varies widely and thus lead to a range of outcomes. Many federal lands are managed passively and are thus open access for many uses, especially for outdoor recreation such as cycling, fishing, hiking, hunting, and rafting. This is true for the bulk of land administered by the Bureau of Land Management, the Forest Service, and the Fish and Wildlife Service.⁴⁰ Other lands and uses are governed by a combination of price and non-price (lottery, waiting lists) mechanisms, but open to virtually all citizens in principle. Commercially valuable natural resources, such as coal, oil-gas, and timber, are routinely leased to private firms, who essentially have private rights over certain attributes of the land (Nelson 1995). For example, ski resorts have long term leases to operate on federal lands, and commercial businesses such as hotels similarly tend to have long term agreements to operate in national parks. Moveable property like desks, planes and rifles are governed differently as well. In some cases state assets are assigned to individual users and thus become an almost exclusive usufruct right. It is well known that a soldier's rifle is 'his rifle' and no one else's. As a whole, the range of property rights regimes incorporate aspects of the three major types: private property, common property, and open access. Even so, what seems to be common to all of these regimes is a severe limit on transferability of rights, perhaps to limit the moral hazard incentives of agency bureaucrats.

³⁷ The total area of the 50 states is 2.27 billion acres and about 654 million acres (nearly 29%) is owned or administered by federal agencies. See Table 1-3, *Public Land Statistics 1999* (Bureau of Land Management 1999).

³⁸ States tend to own the subsurface estate between the coast and the federal lands which begin from 3-5 miles out.

³⁹ The main exception to this is the large literature on marine fisheries where a myriad of administrative regimes define the rights to fish stocks (Munro and Scott 1985).

⁴⁰ For these assets the typical rhetoric is that open access is good since 'they belong to all of us,' yet no one would make the same claim for an F-18 fighter jet.

Given the great variation in property rights, the analysis of state property not only requires a detailed knowledge of the asset and the relevant administrative agency but also a workable theory of bureaucracy. The limited applicable literature is found in the analysis on natural resource agencies, especially those governing federal lands and marine fisheries. For instance, an early study by Stroup and Baden (1973) examines the behavior of the Forest Service and its management of national forests. They point out the different incentives faced by Forest Service managers compared to those of private forest owners and how interest groups influence agency behavior. Since that time there has developed a literature that has examined the economic efficiency of public land management. A common conclusion is that federal lands are not particularly well managed, and that these inefficiencies often are coupled with lower environmental quality (e.g., Hyde 1981). More recently, Nelson (1995) notes the underlying and variable system of property rights in federal lands. Studies of the broadcast spectrum are also an example of economic analysis of property rights governed by administrative agencies (e.g., Hazlett 1990, 1998, 2004). Property rights to spectrum are, in fact, highly restrictive and generally non-transferable licenses to broadcast using certain technologies. These rights are similar to the rights to many public lands in their restrictions on use and transfer (e.g., federal grazing rights).

The relevant law for state property has origins in common law (e.g., mining on federal land in a first possession rule) but is primarily governed by statutes and regulations, all shaped by bureaucrats, interest groups, and politicians. These legal constraints shape the objective of agencies. For example, managers of state school trust lands in the West are typically mandated to maximize financial returns and are thus the land is managed intensively under a system of leases to private parties for uses ranging from farming to hunting to logging. National forests, however, are governed by federal ‘multiple use’ statutes which very often limit the ability of managers to generate revenue from forest use. These statutory constraints, in turn, shape the property rights that develop.

2.5. Mixed property rights and complex assets

Real property regimes are more complex than the open access, private property, common property, and state property discussions suggest. Real property rights regimes, in fact, are mixtures of these basic types. A rancher’s land may seem to be private but this is only a partial description. The right to the grass for grazing is private but the streams running through the property may be open access for fishing or recreation; or the grass may be a lease from a federal agency with mineral rights held by yet another private party. The underlying oil reservoir may be governed by a unitization contract (subject to oversight by a state oil conservation agency) among many neighboring ranchers, essentially mimicking common property. Predator control for coyotes that roam across many ranches may likewise be governed by a common property regime. Similar scenarios are found in residential and commercial real estate, and Bailey (1992) found a mixture of ownership regimes among aboriginal peoples. The evidence, though far from systematic, suggests a mixture of rights. Because assets are a complex collection of valuable attributes, ownership is also a complex collection of rights (Barzel 1982, 1997, Eggertsson 1990, Ellickson 1993, Kaplow and Shavell 2004, Merrill and Smith 2000, Rose 1998, Stake 1999), comprised of the four fundamental types.⁴¹ One of the more distinctive complexities of

⁴¹ Rose (1998, p.96) calls un-enforced attributes of land by the term ‘unpropertized common resources’

rights -- and one long recognized in law – is the distinction between use rights and transfer rights. The standard fee simple bundle included both the right to possess (use) and the right to transfer but many rights are only for exclusive use (e.g., riparian water rights, many servitudes).

Little work has been done to understand the forces that determine the optimal complexity of property rights.⁴² This area thus remains an important area for future work. Smith's (2000) study of the common field system of medieval Europe is one of the few to examine the economic logic of a mixed property regime. Smith notes that for crops the land in the typical village was private, but that for grazing the land was common property.⁴³ He notes how private property for crops provides incentives for investment and husbandry and how a larger scale of land ownership is optimal for grazing (of private herds). Lueck's (1989) study of wildlife law recognizes that wildlife is but one of many valuable attributes of the land for which the dominant property regime is most often governed by agricultural use. Ellickson (1993) similarly notes a wide range of mixed regimes, including legal and customary rights. These studies are important in furthering our understanding of the complexity of rights but are lacking a cohesive (and ultimately formalized) framework. The modern principal-agent literature on contracts, especially that on moral hazard, may be a starting point as our discussion of land leases in Section 5 suggests. The major question is to what extent each individual attribute of an asset can be treated as an independent asset whose ownership is independently determined.

The common law of property can be said to begin with the *ad coelum* doctrine's mandate that ownership of land includes all attributes in an infinite projection above and below the earth's surface.⁴⁴ In this system the only ownership question is the size of the surface boundaries. The *ad coelum* framework ultimately breaks down because various attributes (as the rancher example shows) have different surface projections. Thus the optimal tract size of land for a home may be one acre, but for an oil reservoir it may be ten thousand acres and for an airshed it may be much larger still. The law has long recognized the limits of the *ad coelum* doctrine and has developed to accommodate the demand of different attributes of land. The law of servitudes and the law of separate estates in water and minerals are clear examples. Modern public administration of environmental resources is a recent application (e.g. Rose 1998). The law of nuisance and trespass, the focus of Coase's analysis, has to do with conflicts that ultimately arise between the owners of adjacent parcels, which derive from complex assets with various dimensions of use. The doctrine of private necessity, for example, is an exception to the law of trespass, which actually allows one to use another's property in an emergency.⁴⁵ Thus emerges the traditional legal concept of property rights as a 'bundle of sticks,' an idea that accurately meshes with the

⁴² Karpoff's (1987) study of fisheries regulations, which we note later, implicitly recognizes complex assets.

⁴³ Smith labels this regime a 'semi-commons,' though like the term anti-commons it is not clear that this identifies a distinct and fundamental economic regime.

⁴⁴ The complete Latin phrase is *cujus est solum ejus est usque ad coelum*, which translates 'to whomsoever the soil belongs, he owns also to the sky and to the depths' (Dukeminier and Krier 2002, p.141).

⁴⁵ *Ploof v. Putnam* 81 Vt. 471, 71 A 188 (Supreme Court of Vermont, 1908). Here a person was allowed to tie-down a boat at a private dock during a severe storm without permission. The court ordered the user to pay for the use of the asset.

complexity and mixed ownership of real assets. As Ellickson (1993) notes, the common law allows a wide variety of subdivision of rights in time, use, and space.⁴⁶

3. The Origin of Property Rights

This section examines the origin of property rights. In both custom and law first possession has been the dominant method of establishing rights, and the rationale for and the effects of this mechanism will be examined closely. It will be clear that the manner by which possession is defined and enforced will be crucial in the type of rights that are created. Alternatives to first possession are also examined including auctions, lotteries, and administrative assignments.

3.1. First Possession

First possession rules can operate on different margins. For instance, the rule can grant ownership of a single bison to the first person that kills it under the so-called rule of capture, or it can grant ownership of the entire herd to the first person that claims ownership of the entire living herd. The behavior of the possessor and the use of the bison resource will obviously differ in the two cases. In the initial case, first possession applies to the *flow* of output from the *stock* of living bison, while in the second case the rule applies to the stock itself. In the bison example, the rule of capture is expected to emerge --and in fact did -- because the cost of enforcing possession to the live herd is prohibitive (Lueck 2002).

Figure 1 illustrates the effects of a first possession rule, beginning with an unowned asset. As the left branch of the figure shows, if applied to a stock, private property rights are established directly through possession. On the right branch, if only a flow (or a portion of the stock) can be possessed, the rule of capture ensues. Thus both paths have the potential for dissipation, either from a race to claim the stock or from open access exploitation. In a race, dissipation takes the form of excessive investment prior to ownership, but the resource is unaltered. In contrast, under the rule of capture, dissipation manifests as overuse of the resource (and possibly damage).

[Figure 1 here]

The stock-flow distinction also illuminates the temporal dimensions of ownership. For example, possession could grant ownership of a pasture in perpetuity or it could simply grant ownership of the grass currently being grazed by one's livestock. Perpetual ownership means ownership of the stock, while a shorter term of ownership means ownership of some flows. Granting rights to stocks also confers ownership to the future stream of flows, so the formal economic model is inter-temporal. Granting rights to flows, on the other hand, means ownership is a one-time event, so the formal economic model examines just one period. Of course, there can be ownership rights of intermediate term (e.g., patents, copyrights) but this simple dichotomy covers most of the important cases and serves to clarify the model.

⁴⁶ Some recent studies have noted that property law tends to allow only a certain number of standard bundles of rights (Ellickson 1993, Merrill and Smith 2000, Hansmann and Kraakman 2002). The explanations for this *numerus clauues* doctrine focus on measurement and information costs.

Consider an asset (e.g., a plot of land) that yields an instantaneous (net) flow of benefits $R(x(t))$, where $x(t)$ is the amount of a variable input supplied by private owners at time t .⁴⁷ Let r be the interest rate, and assume the flow value, $R(t)$, grows over time at the continuous rate $g < r$, so that the value of the asset grows over time. Also assume that each period's return is independent of past returns.⁴⁸ The term g can be thought to measure increases in the demand for the asset, perhaps because of population growth. This formulation also recognizes the usual case that during early periods assets are not sufficiently valuable to cover the costs of establishing ownership. The first-best, full-information outcome is

$$V^{FB} = \int_{t=0}^{\infty} R(x^*(t))e^{-(r-g)t} dt, \quad (3.1)$$

where $x^*(t)$ is the optimal input level in period t . In general, V^{FB} is not attainable because of the costs of both establishing and enforcing rights that efficiently allocate use of the resource.

3.2. Claiming the Asset

The left-hand side of Figure 1 shows the case when ownership of the asset is granted to the first person to obtain possession of the entire stock. To simplify, we assume that the method of possession does not damage other resources; this is equivalent to assuming that the asset is a simple, single attribute good. The first claimant thus obtains exclusive rights, into the indefinite future, to the flow of rents, $\int_0^{\infty} R^*(t)dt$, generated by the asset. Since establishing a bona fide claim will be costly and because $g < r$, rights may not be worth enforcing. Under these conditions, property rights to the asset will emerge, after an initial period without ownership, as the value of the asset increases (Demsetz 1967). Maximizing resource value is, in effect, a problem of optimally timing the establishment of rights under first possession.

Now assume there are one-time costs, C , of establishing enforceable rights, or demonstrating possession which grant the owner the exclusive right to the stream of production for all time. If there is a single potential claimant, the flow from the asset (and the rents) is available after rights to the stock are established. The decision to claim the stock is the result of private maximization which, in this case, means the net present value of the asset is

$$V^S = \int_{t^S}^{\infty} [R(x^*(t))e^{-(r-g)t}] - Ce^{-rt^S}, \quad (3.2)$$

where t^S is the time at which ownership of the stock (and the flow of output) is established under first possession. The optimal time to establish ownership is when the marginal return from waiting, given by the present value of the asset's flow at t^S , equals the marginal cost of waiting,

⁴⁷ The model here is derived from Lueck (1995, 1998).

⁴⁸ One can think of $R(t)$ as the steady-state flow of benefits. Note that if $g > r$, the present value of the asset would be infinite.

given by the present value of the opportunity cost of establishing rights at t^S , or

$R^* e^{-(r-g)t^S} = rCe^{-rt^S}$. Inspection of (3.1) and (3.2) shows that the value of the asset clearly falls short of first-best, or $V^* < V^{FB}$. This is because the net value of the asset must now account for the costs of establishing ownership, and the fact that these costs delay ownership and production to t^S from $t = 0$.

A first possession rule can dissipate value when there is unconstrained competition among potential claimants.⁴⁹ In the simplest case with homogeneous competitors, potential claimants gain ownership by establishing possession just before their competitors. A claim is worth staking as long as the net value of the asset is positive, so a competitive rush to claim rights causes ownership to be established at exactly the time, t^R , when the present value of the rental flow at t^R equals the present value of the entire costs of establishing ownership at t^R , or when $R^* e^{-(r-g)t^R} = Ce^{-rt^R}$. In such a race, rights are established prematurely at t^R , where $t^R < t^S$.⁵⁰ More important, the race equilibrium implies that the rental stream is fully dissipated; that is,

$$V^R = \int_{t^R}^{\infty} [R(x^*(t))e^{-(r-g)t} dt] - Ce^{-rt^R} = 0. \quad (3.2)$$

Heterogeneity among potential claimants can reduce, or even eliminate, the dissipation of wealth (Barzel 1994, Lueck 1995).⁵¹ Assume there are just two competitors (i and j) for ownership of the asset with possession costs $C_i < C_j$. Also assume that neither party knows each other's costs. In a race, person i gains ownership just before the closest competitor makes a claim, at time, $t^i = t^R - \varepsilon$, and earns rent equal to the present discounted value of his cost advantage, V^{R_i} . The key implication is that as the heterogeneity of claimants ($C_j - C_i$) increases, the level of dissipation will decrease. The analysis remains the same with rental value differentials such as $R_i \neq R_j$ or different expectations about the rate of growth of the flow value, $g_i \neq g_j$. In the extreme case, where just one person has costs less than the net present value of the asset's flows, the first-best outcome is achieved. Since only one person enters the race, there is no dissipation.

Altering the assumption about information can alter the racing equilibrium. Fudenberg et al. (1983) and Harris and Vickers (1985) show that if competitors have complete information about each other's talents a race will not ensue because only the low-cost individual will have a positive expected payoff of entering the race; that is, V^S is achieved if $C_i < C_j$, $i \neq j = 1, \dots, n$.

Even though claimant heterogeneity can limit or eliminate racing dissipation, there arises the possibility that a claimant can gain a cost advantage by expending resources, thereby altering the margins of dissipation (McFetridge and Smith 1980). For example, if competing claimants can acquire the technology to achieve the minimum costs (C_i), then homogeneity and the full dissipation equilibrium is re-established. This extreme result, however, relies on the assumption

⁴⁹ This phenomenon was first studied by Barzel (1968) in the context of research and technological development. Also see Mortensen (1982).

⁵⁰ The single claimant solution yields $t^S = (\ln r + \ln C - \ln R)/g$ while the race model gives $t^R = (\ln(r-g) + \ln C - \ln R)/g$. Inspection reveals $t^R < t^S$.

⁵¹ Suen (1989) also notes the importance of heterogeneity in reducing dissipation in the context of rationing by waiting.

that homogeneity can be attained easily by investing in the low cost claimant's technology. The more likely reality is that claiming costs depend not only on endogenous investment decisions but also on exogenous forces that generate and preserve heterogeneity. Consider two possibilities. First, if the distribution of talent across individuals is not equal, some people will have innate advantages that will be difficult or impossible to overcome with investment. Second, if there is random variability in opportunities, then some individuals will be in the position of being the low cost claimant; again, investment is unlikely to destroy the random advantage.

Because first possession is a rule that restricts competition to a time dimension, there is another reason why investment cannot routinely eliminate heterogeneity. Cost advantages, no matter how they were gained initially, are expected to diminish over time because potential investors ultimately will gain information that allows them to mimic the behavior of the low cost person (Kitch 1977, Suen 1989). As long as costs depend on exogenous factors, dissipation will be incomplete. In the worst-case race equilibrium, the first claimant will own just the value of his exogenous advantage; in the best-case, extreme heterogeneity or the full information game theory equilibrium, the first claimant will own the full potential value, V^S , of the asset.

3.3 *The Rule of Capture for Asset Flows*

When the costs of enforcing a claim to the asset are prohibitive, ownership can be established only by capturing or 'reducing to possession' a flow from the asset. (See the right side of Figure 1.) The rule of capture -- simply a derivation of the rule of first possession -- will occur when enforcing possession of the flow is cheaper than enforcing possession of the stock. Wildlife and crude oil are the classic examples: ownership is established only when a hunter bags a pheasant or when a barrel of oil is brought to the surface. The stock itself, be it the pheasant population or the entire underground reservoir of oil, remains unowned. As a result, the new 'race' is to claim the present flow $R(t)$ by capturing the product (e.g., the dead pheasant) first.

As a rule of capture, first possession can lead to classic open access dissipation (Epstein 1986, Lueck 1995). Under the rule of capture no one owns the asset's entire stream of flows,

$\int_0^{\infty} R(t)dt$. Now the formal economic analysis of dissipation is just one-period, rather than inter-temporal as in the race, and in fact is identical to the open access model developed in section 2.1, with an equilibrium level of effort determined by equation (2.2).

3.4 *First Possession in Law*

The law of first possession seems to be consistent with the model that includes two potential paths of dissipation (racing and over-exploitation). When first possession has the potential for a race, the law tends to mitigate dissipation by assigning possession when claimant heterogeneity is greatest. On the other hand, when first possession breeds a rule of capture, the law tends to limit access and restrict the transfer of access rights to limit open access exploitation. It should be noted that judicial opinions and statutes may use such terms as 'first in time, first in right,' 'priority in time,' or the 'rule of capture.' Regardless of the precise legal terminology, all of the subjects examined below are governed by rules in which legitimate ownership is created by

establishing possession before anyone else. Table 1 summarizes some important first possession rules.⁵²

[Table 1 here]

In those cases where first possession rules establish ownership in a resource stock, a number of common principles are evident. First, possession tends to be defined so that valid claims are made at low cost and before dissipating races begin, thus exploiting claimant heterogeneity.⁵³ Second, once rights are established, the transfer of rights to the resource is allowed routinely. Third, the use of auctions or other administrative allocation mechanisms are high cost alternatives.

In certain cases, establishing possession of an entire stock is especially costly and leads to the rule of capture, as in the case of so-called ‘fugitive’ resources (Rose 1986) such as oil and wildlife. In these cases a number of common principles can be found. First, the rule of capture may not produce severe dissipation when there are but a few users or when there are what Rose (1986) calls ‘plenteous’ goods. Thus open access may persist optimally as in the case of nineteenth-century whaling. Second, when dissipation becomes severe, access to the resource tends to be limited through legal, contractual, or regulatory methods. Third, transfer of rights to capturable flows tends to be restricted. Contemporary fishing regulations are perhaps the best example of such regimes, though the complexity of assets makes it difficult to eliminate the margins for dissipation (Karpoff 1987).

Even possession under the rule of capture can vary, as illustrated in the famous case of *Pierson v. Post* where the court was divided over whether possession of a wild fox was determined by “hot pursuit” or physical capture.⁵⁴ A similar distinction was present in nineteenth century Atlantic whaling (Holmes 1881, Ellickson (1989). Here, the rule of capture typically required that a harpoon be fixed to the mammal before a legitimate ownership interest was established, the ‘fast-fish, loose-fish’ rule. In the case of the aggressive sperm whale, however, the ‘iron holds the whale’ rule granted ownership to a whaler whose harpoon first was affixed to the whale so long as the whaler remained in fresh pursuit. The law seems to recognize how the precise way in which possession is defined will influence the outcome and tends to define possession so that waste (e.g., fruitless or dangerous whaling effort) will be minimized.

What must be done to maintain a legitimate claim? Ownership, says Blackstone, remains with the original taker, ‘till such time as he does some other act which shows an intention to abandon it.’⁵⁵ In general the law tends not to require a claimant to continually exert the effort required for

⁵² The analysis here suggests broad confirmation of the economics models, but the literature shows considerable disagreement among law and economics scholars on the merits of first possession rules (Merrill 1986). For instance, in studies of homesteading (Anderson and Hill 1990) and water (Williams 1983) first possession has been criticized as causing wasteful races. In contrast, studies of the broadcast spectrum (Hazlett 1990), homesteading (Allen 1991), and patents and mining (Kitch 1977) argue that racing dissipation is minimal.

⁵³ In a rare empirical study on this issue, Lerner (1997) finds evidence consistent with racing in the U.S. disk drive industry.

⁵⁴ *Pierson v. Post*, 1805, 3 Cal. R. 175, 2 Am. Dec. 264 (Sup. Ct. of N.Y. 1805). Dharmapala and Pitchford (2002) develop a formal model of the differential incentives under the two rules.

⁵⁵ Book II, Chapter 1. Of course, property rights can also be relinquished by gift or sale to another.

an initial claim, but he cannot remain an owner without incurring some continued possession costs (Holmes 1881).⁵⁶ An owner must actively and continuously enforce his ownership claim, regardless of whether he obtained ownership by first possession or by subsequent method such as purchase, inheritance, or bankruptcy. The law has two responses to a party lax in exerting effort at continued possession. If an owner intentionally ignores the property it can become abandoned and subject to being reclaimed under first possession. In certain cases, (e.g., minerals, trademarks, water) specific rules, often lumped together as ‘use-it-or-lose-it,’ have developed to determine precisely when the right has been abandoned. If an owner is simply inattentive enough to allow another party to establish continued use of the property, then adverse users can ultimately gain ownership under the doctrine of adverse possession (see section 6.1). Thus the law requires that an owner continue to exert effort to maintain possession but certainly not to the degree initially required to establish possession. In Holmes’s words (1881, p.236): ‘Everyone agrees that it is not necessary to have always present power over the thing, otherwise one could only possess what was under his hand.’ The general rule of not requiring the same effort for continuing possession as for establishing possession recognizes economies of enforcement by collective institutions and a protection of specific investments by the original claimant.⁵⁷

A first possession rule that leads to an optimal system of ownership for one attribute can leave rights unspecified to another attribute.⁵⁸ Establishing rights to land for farming, for instance, might create a system of rights inconsistent with the optimal use of wildlife or groundwater. The process of establishing possession might cause damage to adjacent environmental assets, as when the diversion of water under prior appropriation damages in-stream resources (Leschy 1987, Sprankling 1996). Indeed, the application of first possession to environmental goods (e.g., scenic view) is not well developed in the law. Private contracting to consolidate land holdings is a possible solution to the ownership problem for the attached resource, but this is an imperfect solution when contracting costs are positive (Libecap and Wiggins 1984, Libecap 1989). For example, detailed property rights to small, urban parcels of land can lead to severe open access dissipation for subsurface oil and gas production. Recent work by Hansen and Libecap (2004) shows that soil erosion during the ‘Dust Bowl’ can be similarly viewed as a failure of private contracting among many small farmers.

Possession rules can also swing dramatically from a rule of capture to a perpetual right to a stock. Water law illustrates the issue clearly. Under absolute ownership a landowner can claim groundwater under the rule of capture by pumping water to the surface; under prior appropriation, however, a successful first claimant earns a permanent withdrawal right to a measured quantity extracted each year. Indeed, such a switch in regimes begs the question of

⁵⁶ This principle is clearly articulated in the famous ‘dung case,’ *Haslem v. Lockwood*, 37 Conn. 500 (1871). In *Haslem* the plaintiff was a farmer who gathered manure from the ditch along a public highway into ‘heaps,’ leaving them overnight while he returned to his farm to get a cart for transport of the heaps. Before he returned the defendant had begun to load the heaps and take them away. The court, in deciding for the plaintiff, ruled that the manure was abandoned property in the public ditch, that the plaintiff established ownership via first possession by piling the dung into heaps, and finally, that the plaintiff having established ownership did not have to exert the same effort to maintain possession and was therefore justified in returning home to fetch his cart. Implicit in this case and elsewhere is the fact that collective institutions (e.g., courts, custom, police) actively enforce property rights once they are established, thus minimizing the resources devoted to continued possession.

⁵⁷ Continued possession or maintenance costs can be added to the first possession model, noting that net rents are $R(t)-c(t)$ where $c(t)$ is the current cost of maintaining possession. This addition will increase t^* in the claim model.

⁵⁸ Nuisance law, as discussed in section 7.4, addresses these problems.

what is the actual stock that is valuable to potential users. Is the bison herd the valuable stock, or is a single bison (which can yield meat and hides) a valuable stock in its own right? Ultimately the answer depends on the uses of the resource as well as on the relative costs (e.g., claiming possession, enforcing common property).

First possession rules are still relevant and likely to be important in the future. Berger (1985) notes many cases not examined here where first possession is the primary rule. For example, while the common law has tended to move away from the ‘coming to the nuisance’ doctrine (Wittman, 1980, Pitchford and Snyder 2003), nearly all states have enacted ‘right to farm’ statutes which effectively codify this first possession principle; namely, that no one can make a legitimate nuisance claim for activities in place prior to a location decision by the affected party (Berger 1985). The recent environmental policies that use transferable use or access permits require an initial allocation of property rights. For both fisheries regulations that use individual transferable quotas (ITQs) and pollution emission systems with transferable permits, rights tend to be established by being grandfathered in to the permit system. For fisheries, allocations have been based on historical catch; for pollution, allocation has been based on historical emissions (e.g., the sulfur dioxide trading program under the Clean Air Act amendments of 1990). Some economists have considered this a ‘free distribution’ (e.g., Stavins 1995) or ‘give away,’ but it is alternatively viewed as an allocation based on first possession. In these cases, first possession may protect the specific investments made by the original users of the assets and avoid the administrative and rent-seeking costs of auctions. Though it might seem reasonable to think that the era of discovering new resources has long passed, space (McDougal *et al.* 1963) and the deep sea may have surprises to offer. In space, geosynchronous satellite orbits have been claimed by first possessors, but the deep sea has been treated differently. For example, Epstein (1979) noted that the Law of the Sea conference rejected first possession rules for allocating claims to deep sea minerals, while recent legislation awards ownership of abandoned shipwrecks found in U.S. waters to the federal government rather than to the finder (Hallwood and Miceli, 2004).

3.5. Alternatives: Auctions, Bureaucracy, Politics, and Violence

Law and economics scholars studying first possession have often recommended auctions as the efficient method of establishing rights without closely examining the costs of auctions (e.g., Barzel 1968, Coase 1959, Haddock 1986, Posner 1992, Williams 1983). Assuming the same costs of establishing the rights (C), the winner of the ‘ideal’ auction pays V^S and begins production at t^S , thus maximizing the value of the asset. Yet, in practice, auctions will entail real and often large costs (Epstein 1979, McMillan 1994). Under first possession, private claimants must bear the cost, Ce^{-rt} , of enforcing a claim to the resource. Similarly, before the auction can take place, the state must establish rights to the asset at a cost, $C^S e^{-rt}$, and also incur costs, $C^A e^{-rt}$, of administering the auction. In addition, the state must survey and police the resource, determine what size parcels of the asset to sell, the method of auction to use, and so on (McMillan 1994). If the state cannot protect property rights adequately after the auction, potential buyers will bid less than V^* .⁵⁹

⁵⁹ Allen (1991) argues that this is the reason homesteading was often chosen over auctions for assigning rights to frontier land in many countries.

Epstein (1979) also notes that interest groups will attempt to alter the auction rules to suit their own advantage, leading to further dissipation of rent. Indeed, he notes that administrative alternatives simply were not available (*i.e.*, too costly) during much of the development of the common law. As a result, only if the state's costs $(C^S + C^A)e^{-rt}$ are less than Ce^{-rt} will V^* result from an auction.⁶⁰ The choice between auctions (or other administrative policies) and first possession is ultimately a trade-off between costly auctions and potential dissipation from races. In some cases -- future patentable innovations, sunken treasure, and the unused electromagnetic spectrum -- the resource cannot be auctioned simply because it has yet to be identified. First possession rules, as Epstein (1979) notes, generate incentives for private parties to discover new resources and new dimensions of known resources.

4. The Evolution of Property Rights

To this point several different property rights regimes have been studied in isolation, and the establishment of rights has been considered under the rule of first possession. This section examines the determinants of changes in property rights and how these changes take place. Though changes or differences in property rights can be examined with cross section or time series data, the earliest studies focused on temporal changes, and thus the term “evolution of property rights” has come to define the literature.⁶¹

4.1 The Demsetz Thesis

The evolution of property rights is one of the oldest topics in the economics of property rights, beginning with Demsetz's (1967) pioneering paper.⁶² Demsetz argues that property rights emerge to internalize the externalities present in open access.⁶³ Further, in what has become the classic argument on the topic, he posits that an increase in the value of an asset will increase the gains from ownership and thus lead to the creation of property rights. In support of this thesis, Demsetz recounts the anthropological evidence of alterations in property rights among the Montagne Indians of Quebec during the 18th century. Prior to the emergence of the beaver trade with Europeans, rights to beaver could be characterized as open access. However, once the trade increased their value, property rights to beaver populations emerged and were held by family units. The story of the emergence of rights to beaver among the Montagne has become the most famous story in the economics of property rights.⁶⁴

⁶⁰ Hazlett and Munoz (2004) argue that the time at which a resource is used can be substantially delayed under an auction system (the choice of t in the model) because of lobbying during the design period. They further estimate that these delay costs were around \$9 billion in the case of recent spectrum auctions in the United Kingdom.

⁶¹ Anderson and Hill (1975) appear to be the originators of this phrase. Recently the *Journal of Legal Studies* (Vol. 31, No.2 (part 2) (June 2002) published a special issue titled “The Evolution of Property Rights.”

⁶² Although Demsetz's paper might seem to fit in the “origins” topic in the previous section, it is more appropriately viewed as a study of the choice among various property regimes, so we place it here.

⁶³ Demsetz actually uses the term ‘common property’ to describe what is now called open access.

⁶⁴ But see McManus's (1975) account of property rights to beaver which indicates a more complex system of rights than the all-or-none choice Demsetz describes.

4.2. Empirical studies

The Demsetz thesis was not again explored until Anderson and Hill's (1975) study of the emergence of property rights to rangeland, livestock, and water in the American West. Anderson and Hill argue that the history of the West is largely consistent with Demsetz's thesis; as the frontier was settled assets became more valuable, and property rights emerged out of what we would now call open access. In a remarkably convincing historical analysis they show how the range was privatized after the introduction of barbed wire dramatically reduced the cost of enforcing rights to grasslands. This history shows how, holding resource values constant, changes in property rights enforcement costs can have dramatic effects on the choice of property rights regimes.⁶⁵

Umbeck (1977) and Libecap (1978) study the establishment of rights to gold and silver fields in California and Nevada, respectively, and find a history that again corresponds to Demsetz's beaver. In fact, the California gold rush is an even better application than the beaver because the discovery of gold signified a sharp increase in the asset's value and the property system that developed was much more detailed than that developed by the Montagne. Furthermore, for the gold case, there was no preexisting society as in the Montagne case; open access truly was the prior regime. In his sweeping study of economic history, North (1981) suggests that the general rise of agricultural societies, with private property rights in land, is consistent with this view of emerging rights. Indeed, one might argue that the settlement of North America is broadly consistent as well.⁶⁶ Over time rights to land, water, minerals, and even air in recent times, have been established as asset values have increased.

Econometric evidence confronting the Demsetz thesis has been scarce because of the severe data requirements. Such a test requires data on property rights regimes and the relevant economic parameters. Quantification of property regimes is particularly difficult and over a time series even harder. Libecap (1978), however, couples his historical account of changes in mining law with some econometric evidence, showing in a short time series that mining law became more precise as the value of mineral deposits increased. More recently Geddes and Lueck (2002) use panel data on state laws defining the rights of married women to hold property and contract, and find that states with a greater potential value of human capital (as approximated by levels of wealth, education, and the size of the market) tended to be the first states to expand rights for women. Geddes and Lueck's study is consistent with Demsetz and also with Schultz (1968) who noted that individual freedoms (or rights to one's own human capital) have tended to increase with increases in the value of human capital.

Despite numerous studies in support of the Demsetz thesis, there are many instances where property rights did not emerge even as asset values increased considerably. The case of oil and gas is perhaps the most dramatic, where rights to underground reservoirs remained subject to a rule of capture (see section 3.1) even as the value of these resources rose dramatically (Libecap 1989, Libecap and Smith 2002). Rights to the oil and gas stocks themselves took nearly a century to develop and never emerged in common law doctrine. In another example, property

⁶⁵ What is not discussed in Anderson and Hill is the destruction of Native American property regimes as these asset values increased.

⁶⁶ Eggertsson (1990) summarizes this literature; see also the *Journal of Legal Studies* (2002).

rights never emerged for the wild bison herds despite the rather dramatic increase in the market value of the bison with the advent of the bison hide market (Lueck 2002). In fact, it is precisely during the period of the most intense market activity that the bison's demise was swiftest. Property rights to marine fisheries often have also remained open access for extended periods, despite significant increases in the asset's value.⁶⁷

4.3. *The Theory of Rights Evolution and Variation*

Demsetz's original theory was informal and simple: increases in the net benefits of enforcing rights would increase the level of rights enforcement. His main theoretical contribution was simply and importantly to note that property rights themselves are economic goods amenable to the tools of economic theory and potentially subject to empirical analysis. While it seems trivial now, as do many breakthroughs, the insight has been critical to the economics of property rights and institutions. Yet, Demsetz did not develop a formal model, and his paper said little about the costs of a property regime, the mechanism of choosing rights, and the form of property rights.

Umbeck (1977) was the first to formalize Demsetz in his study of the California gold rush. Umbeck assumes that the net value of rights (V) was simply the benefits of rights (B) less the cost of enforcing rights (C). He assumes further that B was exactly the market value R of the asset (e.g., the price of a beaver pelt, or the rental value of a plot of land), and that enforcement costs positively depended on the asset value $C=c_0+c(R)$ where $c'(R) > 0$. The first-best, or zero transaction cost value of the asset is $V^* = R$, but the second-best value of the asset is $V = R - C(R)$. Property rights emerge only when $R > C(R)$, so that for low asset values the asset remains unowned. This is exactly the Demsetz thesis.⁶⁸

Implicit in the Demsetz model was the assumption that there will exist an asset value for which $R = C$, so that there are values for which property rights will be enforced and values for which they will not. Umbeck, however, notes that this outcome depends on the structure of the enforcement cost function C .⁶⁹ It is possible that as asset values increase there may be an even greater incentive to steal the asset thus raising enforcement costs. Simply, if enforcement costs rise faster than asset values, then the implication is that no property rights will be established at all, regardless of how high the asset value becomes. This means that if $c'(R) > 1$,⁷⁰ then no rights will be established because $C(R) > R$ for all values of R . This means the only clear prediction from the model is that parametric decreases in enforcement costs will increase the probability that property rights will emerge.⁷¹ Thus changes in asset values do not give unambiguous predictions. Allen (2002) notes the possibility that enforcement costs are increasing and convex in asset values (i.e., $c'(R) > 0$, $c''(R) > 0$). This extension implies that at lower asset values, an increase would lead to the establishment of property rights, but that at higher asset values, a further increase could actually lead to a reversal or abandonment of

⁶⁷ This should not be taken as evidence against Demsetz's general thesis, which is simply that property rights respond to economic costs and benefits.

⁶⁸ The first possession model from section 3.1.1 also implies that rights will emerge over time as asset values increase, given some costs of claiming and a first possession rule.

⁶⁹ Field (1986) also notes that enforcement costs depend on asset values. His model focuses on the number of owners of a tract of land, or what he calls the 'optimal number of commons.'

⁷⁰ Since $B = R$, $B' = 1$.

⁷¹ The case of the barbed wire fence fits this prediction (Anderson and Hill 1975).

property rights.⁷² A consideration of complex assets can also alter the model (Lueck 2002). If, for instance, land is valuable for the production of both bison and wheat, then an increase in the value of bison might not lead to an increase in rights to bison if this increase is correlated with an increase in the value of wheat, which requires land ownership on a smaller scale than is optimal for bison.

The choice of property rights can be put in a framework in which the maximization problem is $\max \{V_1, \dots, V_n\}$ where V_i is the net value of the asset generated under the i^{th} property rights regime (e.g., common property, state property, private property).⁷³ Each regime's value depends on market parameters and transaction cost parameters. With multiple viable choices an analytical solution may not be available, but in many empirical settings the choices may be rather limited. In the case of just two alternative property regimes, comparative statics predictions can be generated from $\partial(V^i/V^j)/\partial\chi$, where V^i and V^j are value functions for property regimes i and j and χ is a parameter. If this derivative can be signed, then there is a prediction for the choice of property regime.

4.4. *The Mechanism of Rights Changes*

The analysis of the mechanism by which property rights are established can be divided into several categories. First, there is what might be called an 'institutional invisible hand,' which can be attributed to Demsetz and even to Coase (1960). This is often linked to the common law (Posner, 2003). The evidence on whether the law has evolved in a manner consistent with efficient property rights is mixed.⁷⁴ The development of the prior appropriation water doctrine in the western states seems to be an affirmative case. In one of the defining cases, *Coffin et al., v. Left Hand Ditch Co.*,⁷⁵ a Colorado court noted that the riparian system used in eastern states was not useful for western water, which needed to be diverted for use. Yet, in recent years courts in western states have been reluctant to allow water rights to be defined for increasingly valuable 'instream uses' such as those for recreation and wildlife.⁷⁶

Second, game theory suggests that in the presence of repeated interaction, agents in open access can generate conventions or norms in which the parties agree to create a system of rights.⁷⁷ For instance, Sugden (1986) suggests an evolutionary explanation for such property conventions as 'first possession' and respect for property rights. Experimental work by Walker, Gardner and Ostrom (1990) shows how property regimes can emerge out of open access with repeated interaction, even with anonymous players.

⁷² Such reversals have been noted by Anderson and Hill (1975) and Smith (2002).

⁷³ Under the conditions of the Coase Theorem, of course, each regime would generate identical asset use and value.

⁷⁴ There is limited common law doctrine that compels adjoining landowners to share costs of common assets (e.g., walls as in *Day v. Caton*, 119 Mass. 513 (1876) and groundwater drainage as in *Ulmer v. Farnsworth*, 15 A. 65 Maine 1888). See Ellickson and Bean (2000).

⁷⁵ 6 Colo. 443 (1882).

⁷⁶ Only recent statutory changes have allowed the definition of these rights, suggesting that there is a tradeoff between common law and statutory rule-making. Similar outcomes can be found in the law of oil and gas, wildlife, and groundwater.

⁷⁷ Greif (forthcoming) makes a similar argument for other self-enforcing institutions (or social rules generally).

A third line of analysis, closely related to the second, is contracting for rights (Libecap 1989). That is, when the gains from another ownership regime exist, there is the potential for existing users or those who have access to form a deal to establish a new regime. Such an outcome is explicit in the formation of a unitization agreement to establish rights to an underground oil reservoir among parties who previously operated under a rule of capture. For such a contract to be an economic equilibrium there has to be rent from the new property regime, and each party to the contract must expect to increase their own rents. In the language of modern contract theory, a successful contract must satisfy the incentive compatibility and individual rationality constraints of all parties. Libecap (1989) finds that in many cases there is sufficient heterogeneity and information asymmetry among contracting parties that it is prohibitively costly to find a contract that meets the individual rationality constraints of all. Thus open access under a rule of capture can persist even when the potential rents are huge.

A fourth mechanism by which rights can be established is through politics and statutory rule-making.⁷⁸ Since rights are often initiated via political institutions, there must be rents for the political actors (e.g., politicians, interest groups, and bureaucrats) to implement the changes. Thus, there is yet another set of incentive compatibility and individual rationality constraints to add to the purely private contracting model. Rose (1998) recognizes these forces and, without developing a model, suggests that the modern evolution of rights to environmental goods has been more or less consistent with the Demsetz thesis. Riker and Sened (1991) explicitly show how transferable rights to airport landing slots – established in the 1980s -- did not emerge until the Secretary of Transportation and the Office of Management and Budget signed on. More generally, Levmore (2002) examines some interest group explanations for property rights changes and formation.

5. Voluntary Transfers of Property

This section examines voluntary transfers of property, including market transfers (sales) and leases (temporary transfers). It also examines laws governing inheritance, or the transfer of property from one generation to the next. For the most part, the focus is on transfers of land, though the principles are more general.

5.1. Protection of Ownership and Market Exchange

In addition to the use and investment incentives inherent in private ownership, there are the allocation incentives inherent in the market transfer of private property rights. As the Coase Theorem implies, because transaction costs are positive and property rights are imperfect actual market transfers must contend with various problems of enforcement. One particularly important problem in the transfer of property rights is the possibility of a claim by a previously defrauded owner. An important function of property law is to minimize this source of uncertainty over ownership, thereby facilitating market exchange (Baird and Jackson, 1984).

Information about potential prior claims on property is costly, however, so an efficient system for enforcing or maintaining ownership will balance the cost of greater certainty against the benefit. For example, consider a piece of property worth V if ownership is certain, but subject to

⁷⁸ Eggertsson (1990) calls the other models ‘naïve.’

a risk $p(x)$ that a past owner will assert a claim based on error or fraud, where x is the effort (in dollar terms) devoted to ensuring title. This might represent the cost of searching a public record of past transactions (if one exists) or of establishing verifiable proof of ownership. Assume that $p' < 0$ and $p'' > 0$. The owner's problem is to choose x to maximize $(1-p(x))V - x$, which must satisfy $-p'(x)V = 1$, or, the marginal cost of title assurance effort must equal the increase in the expected value of the property. It follows that it is not generally optimal to eliminate all risk of loss ($p(x^*) > 0$), though owners of more valuable property will invest more to secure ownership.⁷⁹

In terms of the law, there are two basic rules for establishing ownership of property that is sold by someone who turns out not to be the owner.⁸⁰ Under the *bona fide purchaser rule*, the buyer retains ownership of stolen property if he bought it believing the seller was the true owner, whereas under the *original owner rule*, the true owner can reclaim property by presenting adequate proof that it was wrongfully taken from him. The choice between these rules involves a trade-off. Whereas the bona fide purchaser rule inadequately deters theft, the original owner rule increases the buyers' cost of verifying that sellers have good title prior to purchase. For most property, however, the choice is not important because the likelihood that goods are stolen is small. But as property becomes more valuable, the problem of uncertain ownership becomes more important. This is especially true of land, for which an extensive public registry of ownership is maintained.⁸¹

5.1.1. Title Systems for Land

Land title in the U.S. is primarily protected by a public recording system that allows potential buyers to verify title by searching the record of past transfers, theoretically back to the root of ownership.⁸² Title search is a costly process, however, especially as one goes back in time and the quality of records deteriorates. Most states therefore have enacted statutes of limitation (so-called Marketable Title Acts), or less formal guidelines (established by local bars or title insurers), aimed at limiting title searches to a reasonable length. Baker, et al. (2002) develop a sequential search model (essentially a dynamic version of the model in the previous section) to characterize how far back in time buyers should search a title. They show that it is not generally optimal to search the entire record, implying that optimal search involves some residual uncertainty. A test of the model using cross-state data shows that title search guidelines vary according to the predictions of the theory. Specifically, prescribed search lengths are increasing in the cost of a title defect (as measured by title insurance premiums), the likelihood of errors in the record (proxied by the percent of developed land and the frequency of land transfer), and decreasing in title search costs.

Although the recording system is the predominant land title system in the U.S., other common law countries (and some states) have also used a system of land registration, called the Torrens

⁷⁹ This comes from the comparative statics derivative $\partial x^*/\partial V = -p''/p'V > 0$.

⁸⁰ This discussion is based on Shavell (2004, pp. 52-55). Also see Medina (2003).

⁸¹ Public registries of other valuable property, like boats, automobiles, and aircraft, are also maintained.

⁸² According to Black's Law Dictionary 'title is the means whereby the owner of land has the just possession of his property.' A 'deed' is a legal document which constitutes evidence of title.

system.⁸³ Under land registration, the government certifies ownership at the time of a transfer, thereby protecting the owner against nearly all claims; claimants can at most seek monetary compensation from a public fund (financed by registration fees). This is in contrast to the recording system, which awards successful claimants an interest in the land itself. Thus under recording landowners ordinarily purchase title insurance to provide them with financial compensation in the event of a loss.⁸⁴ More recently, Arruñada (2003) develops a model of *in rem* property rights to explain the predominance and structure of title institutions across many developed countries. Focusing on the costs and benefits of *in rem* property rights (versus contract rights), Arruñada finds that countries with recording systems tend to have a larger number of allowable property regimes compared to countries with registration systems.

Note that the two title systems provide opposing answers to the fundamental question of whom a title system should protect, the current possessor or the last rightful owner (Baird and Jackson, 1984). (In this sense, they reflect the difference between the bona fide purchaser and original owner rules.) The question is whether one is preferred on efficiency grounds. If transaction costs are zero, the Coase Theorem implies that land will be used efficiently under both systems (Miceli and Sirmans, 1995a). But since the actual transaction costs of land transfer are significant, the preferred system is the one that minimizes these costs, thereby facilitating exchange and investment (Miceli, Sirmans, and Turnbull, 1998).

Proponents of land registration claim that it lowers transaction costs relative to the recording system because it dispenses with the need to search anew the entire history of a parcel with each transfer (Bostick, 1987).⁸⁵ Actual attempts to compare the costs of registration and recording in those jurisdictions in the U.S. where they co-exist, however, have yielded mixed results, primarily owing to the high administrative costs of registration (Janczyk, 1977; Shick and Plotkin, 1978). Such comparisons, however, may miss the chief advantage of registration--namely, that it clears title to land in cases where land records are poor or have been destroyed. For example, land registration was instituted in Cook County, Illinois following the Great Chicago Fire, which destroyed nearly all land records. A recent study of land transactions in that county used the co-existence of both systems throughout most of the twentieth century as a natural experiment to compare land values under each system (Miceli et al., 2002). Because theory predicts that owners of higher risk properties should prefer the Torrens system, however, the empirical analysis had to control for sample selection bias in the data. Once this was done, the study found that land values in the sample were indeed higher under the registration system as compared to the recording system. Part of this increase in land value can be attributed to the protection of a current owner's subjective valuation, which can be linked to time and specific investments (Miceli 1997, pp.128-129). Holmes (1897, p.477) eloquently makes this point: '[M]an, like a tree in the cleft of a rock, gradually shapes roots to its surroundings, and when the roots have grown to a certain size, can't be displaced without cutting at his life.'

⁸³ This system was originally instituted in Australia in 1858; see, for example, Bostick (1987) and Shick and Plotkin (1978).

⁸⁴ Miceli et al. (2002) report that insurance claims are paid on roughly 0.05% of the total value of residential real estate transactions.

⁸⁵ Following Barzel (1982) the recording system can be said to reduce the costs of excess measurement.

5.1.2. Title Systems and Development

Economists have recently begun to examine the role of land title systems in promoting economic development. For example, De Soto (2000) argues that the absence of a well-functioning system for protecting land ownership (i.e., legal title) is the single largest impediment to economic growth in most developing countries. Lack of secure title inhibits land sales, discourages investment, and prevents owners from converting land assets (which are abundant) into financial capital. De Soto's evidence is largely anecdotal, but several empirical studies have established a link between formal land title and economic investment in various developing countries (Besley, 1995; Alston, et al., 1996; Miceli, Sirmans, and Kieyah, 2002). (Also see the discussion in section 2.2.) De Soto makes the argument that legally enforced property rights are superior to those enforced by extra-legal means, thus emphasizing the economic importance of law.

5.2. Leases

A lease is a voluntary transfer of possessory rights in property (the right of use) for a limited period of time. Such an arrangement can enhance efficiency by allowing gains from specialization. The division of ownership and use, however, creates potential incentive problems for both landlords and tenants regarding the optimal maintenance and use of the property. The problem is one of moral hazard, but it is also referred to as the 'rental externality' (Henderson and Ioannides, 1983).

To illustrate, presume that the value of a piece of property, $V(x,y)$, is an increasing function of inputs by both the tenant (x) and the landlord (y).⁸⁶ Further, suppose that V is the sum of the value of the property to the tenant during the term of the lease, $T(x,y)$, and the landlord's residual value (the value of the reversion), $R(x,y)$. The first-best choices of x and y maximize the joint value of the property, $V(x,y)-x-y$, but both the landlord and tenant will make their choices to maximize their individual returns. Specifically, the tenant will choose x to maximize $T(x,y)-x-r$, where r is the rent, while the landlord will choose y to maximize $R(x,y)-y+r$. Given a fixed rent, both parties will therefore under invest in maintenance. This is because the standard fixed rent contract does not specify and enforce the first-best investment levels.⁸⁷ We will see that several aspects of lease law can be interpreted as responses to this problem.

5.2.1. The Lease: A Contract or a Conveyance

Historically, all leases fell under the law of property, which viewed the lease as a conveyance of an interest in land to the tenant (Dukeminier and Krier 2002). This gave the tenant the right to exclude the landlord from entry during the term of the lease in return for a promise to pay rent. Yet even if the tenant defaulted on the rent, the landlord could not evict the tenant; he could only sue for recovery of the rent. At the same time, the landlord had no duty to maintain the premises

⁸⁶ Thus, both inputs can be interpreted as maintenance. The analysis would not change if the tenant input is interpreted as the rate of utilization, which would have a negative impact on V .

⁸⁷ Essentially, each party to the contract faces only a portion of the marginal product of investment (T_x/V_x for the tenant and R_y/V_y for the landlord). As noted in section 5.2.3, however, a zero transaction cost contract (Cheung 1968) would specify and enforce optimal investment levels for both parties.

during the lease period. The lease thus provided strong protection of the tenant’s possessory interest in the property.

In contrast, modern leases for housing are generally viewed by courts as contracts rather than conveyances.⁸⁸ This change has altered the obligations of the parties in important ways. First, landlords have a duty to maintain the property in a habitable state according to an ‘implied warranty of habitability,’⁸⁹ which tenants can enforce by withholding rent. Symmetrically, however, landlords who meet their duty of maintenance can evict tenants who fail to pay rent. The obligations of the landlord and tenant, like those of the parties to a contract, are therefore mutual.

This change in the law has an economic rationale (Miceli, Sirmans, and Turnbull, 2001). Historical leases were primarily for agricultural land, and landlord inputs were relatively less important. (In terms of the above model, y did not substantially affect T .) In this context, legal protection of a strong possessory interest promoted efficient tenant investment during the term of the lease. For example, the law prohibited landlords from re-taking possession of the land after the crops were planted but before harvest. Further, tenant use ordinarily did not have a detrimental effect on the value of the reversion (i.e., x did not have a large effect on R).

The situation is different in modern real estate leases, which are primarily for housing. Here, landlord maintenance during the term of the lease is crucial, so the law has provided tenants with an enforcement mechanism by transforming the lease into a contract with an implied warranty of habitability.⁹⁰ In addition, tenant inputs are much more likely to have an effect on the value of the landlord’s reversion (though in modern agriculture with sophisticated technology that can impact land this might be less true). For example, overutilization of rental housing will accelerate the rate of depreciation. The law addresses this problem with the doctrine of waste (Posner, 2003, p. 73), under which a tenant has a duty to invest in reasonable maintenance of the property. In terms of the above model, this forces the tenant to internalize the effect of his actions on the value of the reversion. The doctrine of waste and the warranty of habitability thus work in combination to create efficient bilateral incentives for maintenance in the presence of the rental externality.⁹¹

5.2.2. *The Duty to Mitigate Damages*

Another effect of the transformation of the lease from a conveyance to a contract concerns the duty to mitigate damages. Under the law of property, landlords had no duty to mitigate damages. If the tenant abandoned the property, the landlord had no obligation to attempt to re-let it; he could just sit tight and sue the tenant for the entire rent. The transformation of the lease to a

⁸⁸ That is, the contract and property doctrines are merging. As Dukeminier and Krier, (2002, p. 457) state: ‘Is a lease a conveyance or a contract? Actually, of course, it is both.’ That such a merger has occurred for commercial leases, however, is less clear.

⁸⁹ The key case is *Javins v. First National Realty Corp.*, 428 F.2d 1071 (1970). Also see Rabin (1984).

⁹⁰ See Hirsch (1999, Ch. 3) for an empirical analysis of the impact of habitability laws. Agricultural land leases also have implied covenants of ‘good husbandry’ which require the renter to maintain the quality of the land (Allen and Lueck 2003).

⁹¹ In this sense, the two doctrines resemble the tort rule of negligence with a contributory negligence defense, which establishes efficient bilateral incentives in accident settings. See Chapter xx.

form of contract, however, imposed on landlords the contractual duty to mitigate damages by taking all reasonable steps to re-let the property.⁹² The law enforces this duty by limiting the damages from tenant breach to the difference between the contract rent and the best rent the landlord could have obtained by reasonable efforts.

Mitigation of damages provides a clear economic benefit by preventing the property from being left idle. However, this raises the question of why the traditional law of leases did not impose such a duty. Economic theory suggests three possible reasons. First, agricultural tenants may have been in a better position than landlords to find substitute tenants, whereas the situation is reversed for modern residential leases. The change in the law thus simply reflects an application of the least-cost-avoider principle. Second, a duty to mitigate damages may result in inefficient re-letting of the property by landlords who mistakenly interpret tenant absence as a sign of breach. The no-mitigate rule therefore protects the tenant's possessory rights in settings where absentee use may be valuable--a situation that is more reflective of agricultural as compared to residential leases. A third possibility is that in agricultural settings the law is often less important than market enforcement via repeated interaction (Allen and Lueck 2003). For agriculture the law simply may not have developed to address this issue.⁹³

5.2.3. *Cropshare versus Cash Rent Leases in Agriculture*

The choice between a cash rent lease and a cropshare lease has been an important topic since the beginning of economics.⁹⁴ Adam Smith argued that the cropshare acted as an inefficient tax on effort. Writing roughly a century later than Smith, John Stuart Mill noted that cropshare leases had an ancient origin and that the level of cultivation was not suffering. Thus, he was reluctant to claim widespread inefficiency. Smith's tax analogy, however, influenced Alfred Marshall and other neoclassical economists who later analyzed the problem. Not until Cheung (1968) extended the Coase Theorem into share cropping did the modern analysis begin. Cheung demonstrates that if transaction costs are zero, then all land leases must be equivalent, and that, therefore, the (lease) contract choice must depend on transaction costs.⁹⁵

We present a model from Allen and Lueck (2003) that recognizes the complexity of assets and property rights to those assets as discussed in section 2.4. In both a cash rent and cropshare lease, property rights to the land are imperfect. Typically a lease agreement can only specify and enforce such basic parameters as acreage of the plot and type of crop. Such important features as soil moisture and soil nutrients cannot be economically enforced in the lease, so these attributes are essentially open access goods. In a cash rent lease the farmer pays a fixed annual amount per acre of land and owns the entire crop. As a result he supplies the optimal amount of his own inputs but overuses any inputs provided by the landowner, including the un-priced attributes of the land. In a cropshare lease, in contrast, the farmer does not pay any fee for use of the land but simply pays a predetermined share of the crop to the landowner at the time of harvest. In this arrangement the farmer and the landowner have shared ownership of the crop, so the farmer has

⁹² See generally Goetz and Scott (1983).

⁹³ Again, the duty to mitigate has not been universally applied to commercial leases. The reason may be that commercial leases are more like agricultural leases in terms of the factors noted in the text.

⁹⁴ Allen and Lueck (2003, chapter 4) give a detailed history of this literature.

⁹⁵ Cheung also postulated a risk-sharing effect that is discussed below.

an incentive, as Adam Smith noted, to under-provide these inputs. The farmer will also have less incentive to use inputs provided by the landowner, compared to a cash rent lease.

Consider a tract of farmland that can be used to produce crops according to $Q = h(e,l) + \theta$ where Q is the harvested crop, e is the farmer's composite input called effort, l is a composite input of land quality attributes, and $\theta \sim (0, \sigma^2)$ is a randomly distributed composite input that includes weather and pests. We assume that $h_e > 0$, $h_l > 0$, $h_{ee} < 0$, $h_{ll} < 0$, and $h_{el} = 0$, where the subscripts denote partial derivatives. The opportunity cost of the farmer's input is the competitive wage rate w per unit of farmer's effort, and the opportunity cost of the unpriced land input l is r per unit.

With risk-neutral landowners and farmers, the expected profit from the farming operation is maximized, resulting in the employment of e^* and l^* units of farmer and landowner inputs. These first-best input levels are identical for the cropshare and cash rent leases and satisfy the standard conditions that marginal products equal marginal costs for both inputs. When transaction costs are positive and lease enforcement is costly, however, the input choices will be second-best. In either lease, farmers have an incentive to exploit the land's un-priced attribute because they do not face the full costs. In addition, farmers have an incentive to under-report the output in the cropshare lease.

For the cash rent lease, the farmer owns the entire crop and chooses his inputs to maximize expected profit. Because the farmer does not have indefinite tenure of the land, he does not face the true opportunity cost of using the attributes of the land. If we denote the reduced costs he faces as $r' < r$, the farmer's objective is:

$$\max_{e,l} \Pi^r = h(e,l) - we - r'l. \quad (5.1)$$

The second-best solutions e^r and l^r satisfy $h_e(e) = w$ and $h_l(l) = r'$. Since $h_{el} = 0$, we note that the farmer's input level is identical to the first-best optimum; that is, $e^r = e^*$. However, since $r' < r$, the land is over-worked ($l^r > l^*$) because the farmer does not face the full cost of using the land's attributes (i.e., he ignores the value of the reversion).

In a cropshare lease, the farmer receive sQ and the landowner receives $(1-s)Q$, where $0 < s < 1$. The farmer's objective is:

$$\max_{e,l} \Pi^s = s[h(e,l)] - we - r'l. \quad (5.2)$$

Now the second-best solutions e^s and l^s satisfy $sh_e(e) = w$ and $sh_l(l) = r'$. These solutions indicate that the farmer supplies too few of his inputs because he must share the output with the landowner; that is $e^s < e^*$. As with cash rent, the farmer over uses the land attributes, or $l^s > l^*$; however, since $l^r > l^s > l^*$, the use of the land is less excessive than it is with cash rent. This means that although a share lease still provides the farmer with an incentive to over use the land, this incentive is not as powerful as it is with the cash rent lease.

Farmers and landowners choose the lease that maximizes the joint expected return to the tract of land. This requires comparing the expected net return to the land in both leases, where the net return is given by the appropriate indirect objective function. For the cash rent lease,

$$V^r(w, r, r') = h(e^r, l^r) - we^r - rl^r. \quad (5.3)$$

With the cropshare lease there are additional costs of measuring and dividing the harvested crop (Barzel 1982, Holmstrom and Milgrom 1992). These costs are given by μ so that the net value function is,

$$V^s(w, r, r', \mu) = h(e^s, l^s) - we^s - rl^s - \mu. \quad (5.4)$$

The joint maximization problem is $\max \{V^r, V^s\}$. The tradeoff between the two leases is straightforward.⁹⁶ The benefit of cash rent is the avoidance of the costs of dividing the harvested output. The benefit of cropshare is the reduction in the total distortion of input levels. Thus cropsharing should be observed when output measurement costs are low, and when soil attributes are easy to exploit. Cash rent leases should be observed under the opposite conditions. The effect of parameter changes on the net value of each contract can illuminate this tradeoff and lead to hypotheses about lease choice.

Consider first how changes in μ affect V^r and V^s . The net value of the cash rent lease V^r does not depend on output division costs. The net value of the crop share lease V^s however, declines as these costs increase. By the Envelope Theorem $\partial V^s / \partial \mu < 0$. This implies that as the costs of output division increase it is less likely that the cropshare contract will be chosen. The comparative statics for r are similar. By the Envelope Theorem $\partial V^s / \partial r = -l^s$ and $\partial V^r / \partial r = -l^r$. Because neither l^s nor l^r depend on r , the second derivatives of V^s and V^r with respect to r are zero. Therefore, V^s and V^r are linear functions of r . Thus, an increase in the cost of land attributes will lower the value of either lease (holding r' constant), but it will lower the value of the cash rent lease more because land inputs are used more intensively in a cash rent lease than in a cropshare lease ($l^r > l^s$). This implies that a cropshare lease is more likely to be chosen both as the unpriced attributes of the land become more easily damaged, and as land value increases.

Allen and Lueck (2003) find support for these predictions using data from North America and evidence from around the world. They show that cropshare leases are more likely when crop division costs are low and where the ability of farmers to adversely affect the soil is high. Further, cash rent leases often contain clauses that discourage exploitation of the soil. For example, hay crops are more susceptible to under-reporting since they are used on the premises, and thus are more often cash-rented. Land used for row crops is more susceptible to overuse than is land used for grains, and the data show that row crops are more likely to be cropshared.

The property rights - transaction cost approach to leases assumes that everyone is risk neutral, and relies on a trade-off between different incentive margins to explain lease terms. This approach contrasts with the more common approach – the traditional Principal-Agent (P-A)

⁹⁶ The formal comparative statics predictions are derived in Allen and Lueck (2003, chapter 4).

model – which assumes leases (or contracts in general) are designed to balance risk sharing against moral hazard. Despite the prominence of the risk-sharing paradigm (e.g., Newberry and Stiglitz 1979, Hayami and Otsuka 1993), the empirical evidence to support its implications is scarce, especially for agriculture. In one of the early studies to confront risk-sharing and contract choice, Rao (1971) found that crops with high yield and profit variability were less likely to be sharecropped than crops with low yield and profit variability – a refutation of the P-A model. Using data from several thousand farmland leases, Allen and Lueck (1999, 2003) present a series of empirical tests that find virtually no support for the risk-sharing approach. In a variety of empirical tests, Allen and Lueck find no support for the general hypothesis that share leases are more likely to be chosen over cash rent leases when crop riskiness increases. In fact, there is evidence that the relationship is the opposite; that is, as crop riskiness (in terms of yield variability) increases, cash rent leases are often more likely (Allen and Lueck 1995, 2003, and Prendergast 2000, 2002). This result holds across all crops and regions examined in Allen and Lueck (2003).⁹⁷

Compared to the basic P-A model, the transaction cost approach does not explicitly distinguish between principals and agents, nor does it make differential assumptions about the risk preferences of the contracting parties. In modern farming it is especially difficult to establish such a dichotomy because farmers and landowners have nearly identical demographic characteristics. Both farmers and landowners make decisions, so formal models more in line with double moral hazard are more appropriate (e.g., Eswaran and Kotwol, 1985; Prendergast 2002). More importantly, by diverting attention away from risk-sharing – which is hard to test and has thus far generated little empirical support – the approach opens the door to a wider array of pure incentive effects that shape organization.

5.3. *Inheritance of Land*

Inheritance rules govern the intergenerational transfer of land and other property. They thus represent an important means of voluntary transfer of property. As such, one function of these rules is to ensure that the wishes of testators (i.e., current owners) regarding the disposal of their property are fulfilled. An offsetting concern is to limit the extent to which the “dead hand” can constrain the uses of property into the uncertain future (Stake 1998a). In attempting to balance these goals, Anglo-American law gives testators considerable freedom in the disposal of their property, but imposes some constraints, including primogeniture and the Rule Against Perpetuities, which we discuss here.

The rule of primogeniture, under which all property passes to a decedent’s eldest son, was the predominant rule in early English common law and has also been used in cultures throughout the world.⁹⁸ The most common economic explanation for the rule is that it prevents inefficient fragmentation of land (Posner 2003, p. 517). There are, however, two objections to this rationale. First, a well-functioning land market should allow entrepreneurs to counteract the effects of

⁹⁷ Outside the area of agriculture a series of papers have found similar results (see the summary in Prendergast 2002). Akerberg and Botticini (2002), however, argue that risk sharing might still be important in contract choice if one takes into account the endogenous matching of farmer with different risk preferences and land suitable to crops of varying risk. Nearly all of this literature can be criticized though for data that does not reliably measure exogenous risk.

⁹⁸ Alston and Shapiro (1984) study the demise of primogeniture in the United States.

fragmentation. Thus, we would expect the rule to be most prevalent in societies where land markets are primitive or do not exist. (Baker and Miceli (forthcoming) provide evidence for this prediction.) Second, even if scale economies are important, why constrain a testator's choice of the most suitable inheritor? In particular, why not adopt a 'best-qualified' rule that maintains scale economies while expanding the testator's options? One possible explanation is that such a rule might promote wasteful rent seeking by competing heirs (Buchanan 1983).

Another constraint on a testator's discretion is the Rule Against Perpetuities, which limits restrictions that can be imposed in a will to a set period of time, equal to the lifetime of anyone alive when the will was created plus twenty-one years.⁹⁹ This time limit reflects offsetting economic factors (Shavell, 2004, pp. 67-72).¹⁰⁰ On one hand, testators (current owners who die with a will) should have broad control over the disposition of their property after their death, both to maximize their utility and to give them an incentive to acquire and create wealth during their lifetimes. Such control is especially beneficial if immediate heirs are known to be spendthrifts. On the other hand, testators may not be able to foresee the best uses of their property in the uncertain future, or may specify uses that future generations will deem harmful (e.g., imposing conditions for use based on race or religion), or create constraints that are extremely costly to undo.¹⁰¹ A final reason to limit testators' discretion is simply to preserve some amount of intergenerational equity in the distribution of wealth, given that the current generation, by definition, controls all wealth.

6. Involuntary Transfers of Property

This section examines involuntary transfers of property from one private party to another. (We examine involuntary transfers from private parties to the state (takings) in Section 8.) Initially, we discuss transfers that occur as a result of uncertainty about ownership or boundary location, and hence, for the most part, are unintentional. We conclude by discussing intentional involuntary transfers, or theft.

6.1. Adverse Possession

Adverse possession is a curious doctrine that appears to legitimize the theft of land by squatters. The doctrine establishes title in property to the current user or possessor without the consent of, or compensation to, the original legal owner. It therefore has little rationale in the absence of transaction costs and is viewed typically as a method of clarifying title that has become clouded over time (Dukeminier and Krier 2002). In order to gain title the adverse possessor must 'openly and notoriously' maintain exclusive possession for a statutorily specified term that ranges from one to thirty years in the United States. The precept of adverse possession is embedded in the common law and can be traced to an English statute enacted in 1275. Contemporary American law is a mixture of statutory and case law in which statutes define required time periods and

⁹⁹ Black's defines the rule as the '[p]rinciple that no interest in property is good unless it must vest, if at all, not later than 21 years, plus a period of gestation, after some life or lives in being at the time of the creation.'

¹⁰⁰ Also see Ellickson (1986), Epstein (1986), and Dukeminier and Krier (2002).

¹⁰¹ The doctrine of *cy pres* allows courts to substitute related, but less harmful, uses of bequeathed property in situations where prescribed uses are offensive to the current generation.

other specific conditions, while court decisions define ‘notorious’ possession and other less specific requirements.

As discussed above, adverse possession is recognizable as a first possession doctrine. The adverse possessor has ‘relative title,’ by virtue of prior possession, or has ‘rights against the rest of the world from the moment that he claims possession’ (Epstein 1986, p. 675.) Moreover, in a successful adverse possession action the original owner's title is deemed to be invalid. Consequently, first possession becomes an accurate description of the process by which ownership is established. The law essentially treats the property as abandoned by the original owner. Historical adverse possession cases have dealt with such issues as abandoned farmland, cabins in the woods, and old mining sites. Typical cases today deal with title to real estate in situations where property boundaries are either unknown or misunderstood. For example, a homeowner builds an addition that, it turns out, is actually on the neighbor's legal property. Under adverse possession the homeowner gains title to the property in question by virtue of his possession, through the addition, for the duration of the statutory period. In the historical cases, heterogeneity probably served to mitigate dissipation from first possession, and there is little evidence of racing among potential adverse possessors. In the modern real estate boundary cases, heterogeneity is at its extreme. There is only one potential claimant; hence, there is no dissipation.

Several theories have arisen to explain the details of adverse possession doctrine, treating it as a time-limited property right.¹⁰² The most common are that it lowers the transaction costs of clearing title to land, and that it prevents valuable land from being left idle. These arguments are not entirely convincing, however, given the quality of land records in most jurisdictions and the option value of leaving land undeveloped.

A more convincing argument is based on the presence of offsetting risks to ownership of land. The first risk arises from the possibility, discussed in Section 5, of past claims by previous owners who were deprived of their title through fraud or error. A time limit on such claims limits this risk to current owners. Specifically, let $p(t)$ be the risk of such a claim, where t is the duration of the prior owner's property right as specified by the adverse possession statute. We assume that $p'(t) > 0$, reflecting a higher risk to the current owner for longer-lasting property rights, and $p(0) = 0$.¹⁰³ The other risk is that the current owner may himself be displaced by a squatter. This possibility can be reduced, however, by periodic monitoring of the property to eject squatters or correct boundary errors (Ellickson, 1986). A longer time limit on the current owner's property right lowers this cost by reducing the required frequency of monitoring. Formally, let $m(t)$ be the cost of monitoring that the current owner must spend to retain title with certainty, where $m' < 0$ and $m(\infty) = 0$.

Now suppose the current owner contemplates investing in the land. Let $V(x)$ be the market value of an investment of x dollars, where $V' > 0$ and $V'' < 0$. Given uncertainty, the owner will choose x to maximize the expected value of the property, $(1-p(t))[V(x)-m(t)]-x$, taking t as given. This yields the first-order condition

¹⁰² See, for example, Ellickson (1986), Merrill (1985a), and Miceli and Sirmans (1995b).

¹⁰³ Note that land registration under the Torrens system effectively sets $t=0$ by extinguishing most past claims.

$$(1-p(t))V'(x) - 1 = 0. \quad (6.1)$$

Condition (6.1) defines the optimal investment, $x^*(t)$, as a function of the time limit, where $\partial x^*/\partial t = p'V'/(1-p)V'' < 0$. Thus, increasing the duration of property rights actually *reduces* investment incentives by increasing the risk of a past claim.

Given this characterization of the landowner's problem, we can derive the optimal duration of property rights as the value of t that maximizes the total value of the land net of monitoring costs.¹⁰⁴

$$V(x^*(t)) - x^*(t) - m(t). \quad (6.2)$$

Differentiating (6.2) and substituting from (6.1) yields

$$p(t)V'(x)(\partial x^*/\partial t) = m'(t). \quad (6.3)$$

Thus, the optimal time limit balances the detrimental effect of longer t on investment incentives (the left-hand side) against the savings in monitoring costs (the right-hand side).

Although all fifty states have adverse possession statutes, as noted, the length of the statutory period varies, ranging from one to thirty years with mean length of 13.63 years.¹⁰⁵ Two empirical studies of adverse possession statutes show that this cross-state variation is broadly explained by the economic model (Netter, et al., 1986; Baker, et al., 2001). In particular, states with slower urban growth rates and lower per acre farm values (reflecting a lower value of development) have longer statute lengths, while states with more efficient legal systems (suggesting lower monitoring costs) have shorter statute lengths.

6.2. The Mistaken Improver Problem

The analysis to this point has treated the probability of a competing ownership claim as a function only of the statutory period, but owners can actively lower the risk of a claim by surveying the property prior to development to detect boundary errors and eject squatters, or by searching the land records (as discussed in Section 5) to uncover title errors. Suppose that a survey reveals ownership with certainty. If the developer is the owner, he can proceed with development as if there is no risk of a loss,¹⁰⁶ whereas if the survey reveals someone else to be the owner, the developer can purchase the land if it is more valuable in a developed state. In this way, the value of the land is maximized. Determining ownership is costly, however, which may make it more profitable for the developer to proceed without a survey. This raises the possibility of mistaken improvement of another's property—the so-called mistaken improver problem.

To examine this problem formally, let V be the market value of a parcel of land if it were to be improved, and let p be the probability that the land is owned by someone else who values it in its

¹⁰⁴ We assume that whoever ends up as owner will spend $m(t)$.

¹⁰⁵ The data are from Leiter (1999). In some states, the length is conditional on whether the squatter has "color of title" (i.e., evidence that appears to, but does not legally, convey title).

¹⁰⁶ In that case, he will invest an amount $x^* > x^*(t)$ for any $t > 0$.

currently unimproved state at R . Further, suppose R is unobservable to the developer but is known to vary according to the distribution function $F(R)$. If the developer surveys at cost s prior to developing (in which case he learns R and only develops if $V > R$), the expected value of the land is $(1-p)V + pE\max[V, R] - s$, or

$$(1-p)V + p[F(V)V + \int_V^{\infty} R dF(R)] - s. \quad (6.4)$$

Expression (6.4) has three parts: the value if the developer is the true owner, the value if someone else is the owner, and survey costs. If, however, the developer proceeds without a survey, the value of the land is fixed at V , regardless of who turns out to be the owner (given the irreversibility of development). A survey is therefore optimal if (6.4) exceeds V , or if

$$p \int_V^{\infty} (R - V) dF(R) > s. \quad (6.5)$$

The left-hand side of this condition is the expected benefit of avoiding irreversible improvement of the land when it is owned by someone else who values it more highly in its unimproved state.

Developers will not necessarily make the first-best survey decision on their own, however, because they will ignore the opportunity cost of development when someone else is the owner. The law, however, provides victims of mistaken improvement remedies that potentially create the right incentives. The law of mistaken improvement dates back at least to Roman times, where the law of accession stated that materials affixed to land became the property of the owner. The mistaken improver could at most seek compensation for the value of the improvements. The modern law in most states is dictated by so-called betterment acts, which typically allow landowners the option of either paying for the improvements (according to the old rule), or forcing the improver to buy the land at its unimproved value (Dickinson, 1985).¹⁰⁷ It turns out that this ‘option’ remedy induces would-be improvers to internalize the opportunity cost of the improvements in the face of ownership uncertainty and hence gives them exactly the right incentives to conduct a survey (Miceli and Sirmans, 1999).

6.3. Partition of Real Estate

Another form of involuntary transfer, this time involving joint owners of property, is the right to partition real estate. Under the common law, each co-owner of a parcel of land has the right to force a physical partition of the property (partition in kind) into separately owned parcels. While this solution overcomes transaction costs among co-owners (due, for example, to the anti-commons problem discussed in section 2.2), it may result in excessive fragmentation if there are scale economies associated with the best use of the land. State partition statutes have sought to address this problem by providing courts with an alternative to in-kind partition--namely, forced sale of the undivided parcel with division of the proceeds to the co-owners in proportion to their ownership shares.

¹⁰⁷ Dukeminier and Krier (2002, pp. 152-53) also note that common law was originally ‘harsh’ in that the improver always lost the land and the improvement, but modern cases grant relief to the ‘innocent improver.’

The problem with forced sales, however, is that non-consenting owners only receive the market value of their shares, thus depriving them of any subjective value that they may attach to the land.¹⁰⁸ In terms of efficiency, forced sale will only be preferred to partition in kind if the preserved scale economies exceed the foregone subjective value of all non-consenting owners (Miceli and Sirmans, 2000). Courts seem sensitive to this trade-off. In particular, they tend to favor partition in kind, unless the resulting fragmentation would *materially* reduce the aggregate value of the land.¹⁰⁹ This standard offers courts a margin for protecting subjective value of non-consenting owners against expropriation.

6.4. Theft

The most obvious form of involuntary transfer of property is theft, which is classified as a crime. The economic theory of criminal enforcement is well developed and is discussed in Chapter xx. Here we comment on the intersection of criminal law and property law. In economic terms, the transfer of property by theft presents the following paradox--if a thief values the stolen property more than the owner does, then the transfer is efficient (though coercive). Thus, why not simply force the thief to pay a fine equal to the value of the stolen property, in effect, treating the theft as a tort in which the state is not involved in enforcement and policing? One objection is that the thief will sometimes avoid detection, thus lowering his expected cost and allowing some inefficient transfers, but this problem could be addressed by simply inflating the fine in proportion to the inverse of the probability of detection.¹¹⁰

A more fundamental objection to the ‘efficient theft’ argument is that it permits individuals to substitute coercive transfers for market transfers (Calabresi and Melamed, 1972; Klevorick, 1985; Coleman, 1988). Market transfers are generally more efficient than coercive transfers because courts may err in setting the right amount of compensation (the standard problem with liability rules), and because owners, fearing such a transfer, will devote excessive resources to the protection of their property (a form of rent seeking).

If the preceding argument makes sense for tangible property, it is all the more persuasive when the violation concerns one’s bodily integrity or civil rights. The law therefore seeks to deter such violations by setting the penalty above compensatory damages (and possibly including the risk of imprisonment) while labeling them as crimes (illegitimate transfers). (See the discussion of inalienability in Section 9.)

For real property, theft is a somewhat different phenomenon, because the asset (land) cannot be moved from its current location. This means that for real property, ‘theft’ is really damage to the asset—which is often handled by nuisance law (as discussed in section 7.4), or removal of some part of the asset (e.g. fence, game, timber)--which is a more typical criminal act.

¹⁰⁸ In effect, forced sales substitute liability rule protection of owners’ shares for property rule protection, thus creating the possibility of an inefficient sale (Calabresi and Melamed, 1972).

¹⁰⁹ See, e.g., *Trowbridge v. Donner*, 40 N.W.2d 655 (1950).

¹¹⁰ See Chapter xx on law enforcement, and also Chapter xx, which offers a similar economic rationale for punitive damages in torts.

7. Land Use Conflicts: Externalities and Property

Externalities arise when one party uses his property in a way that imposes a cost (or confers a benefit) on another party without first obtaining that party's consent. (In this sense, externalities are a form of involuntary transfer.) When assets are complex and transaction costs are positive, externalities are ubiquitous. As we noted above, externalities might be viewed as 'theft' for the case of an immovable asset. This is because property rights to at least some of the attributes of an asset will be imperfect and thus contain problems of open access or moral hazard. In the case of land, externalities are important since any parcel (except an island or continent) will have neighboring owners, but they also arise in the context of air quality, noise, and water, where property rights are especially hard to define and enforce.

In this section, we analyze various remedies for externalities (primarily harmful externalities), focusing specifically on a comparison of the standard tax-subsidy approach most commonly associated with Pigou, with the property rights, or Coasian, approach.¹¹¹ We also discuss the common law remedies of trespass and nuisance, public controls like zoning, and private responses like covenants.

7.1. A Model of Externalities in the Short and Long Run

In this section we develop a model of external costs that we will use to examine the various remedies just described. We examine the general case of 'bilateral care' externalities in which both parties can affect the amount of the damage. We also consider both short and long run notions of efficiency in anticipation of the fact that some remedies that are efficient in the short run are inefficient in the long run. To be concrete, consider, as did Coase (1960), a railroad whose trains emit sparks that occasionally set fire to crops on farmland adjacent to the tracks. Suppose that the number of trains being run is n_T and the number of farms (or total acreage) is n_F , resulting in crop damage equal to $n_T n_F D(x, y)$, where D is the damage (in terms of reduced crop value per acre) each train causes, x is dollar spending on precaution per train by the railroad (e.g., whether it installs a spark arrester), and y is dollar spending on precaution by each farmer (e.g., where he locates his crops).¹¹² We assume that $D_x < 0$, $D_y < 0$, $D_{xx} > 0$, and $D_{yy} > 0$, reflecting diminishing marginal benefits to precaution. The benefits of railroading and farming are captured by $b_T(n_T)$ and $b_F(n_F)$, which are the marginal benefit functions for the two activities, respectively, both of which are assumed to display diminishing marginal benefits (i.e., $b_j' < 0$, $j = T, F$). The total value of the two activities is given by

$$W = \int_0^{n_T} b_T(n_T) du + \int_0^{n_F} b_F(n_F) dz - [n_T n_F D(x, y) + n_T x + n_F y] \quad (7.1)$$

¹¹¹ The analysis is based on Polinsky (1979) and White and Wittman (1979).

¹¹² This formulation of expected damages assumes constant returns to scale in number of trains and farms. See Shavell (1980) for a similar model in the context of tort law.

In the short run, the numbers of trains and farms are fixed.¹¹³ Thus, the first-order conditions only concern the expenditures on precaution (x,y) that maximize (7.1) and are given by

$$n_F D_x(x,y) + 1 = 0 \quad (7.2)$$

$$n_T D_y(x,y) + 1 = 0. \quad (7.3)$$

These conditions state that the parties should invest in precaution up to the point where marginal benefits in terms of saved damages equal marginal costs. In the long run all assets become choice variables so the number of trains and farms (n_T, n_F) must also be chosen to maximize (7.1). The resulting first-order conditions for n_T and n_F are

$$b_T(n_T) - [n_F D(x,y) + x] = 0 \quad (7.4)$$

$$b_F(n_F) - [n_T D(x,y) + y] = 0, \quad (7.5)$$

which state that each activity should be increased to the point where the last unit (trains or farms) yields zero profit.

7.2. The Pigovian Tax-Subsidy Approach

The traditional (pre-Coase) approach to the control of externalities is the Pigovian, or tax-subsidy approach. The idea is that the government needs to impose a tax on, or pay a subsidy to, the source of the externality (the railroad in this case) in order to force it to internalize the damage that it causes. In a model in which damage depends on the actions of both parties it becomes immediately clear that ‘causation’ is ambiguous, as Coase (1960) first noted.

Consider first short run incentives regarding precaution, holding the number of trains and farms fixed. Under a tax, the railroad pays the government based on damages imposed. Both the railroad and farmer will choose efficient care under this remedy provided that, first, the marginal tax equals the marginal damages imposed on farmers (from (7.2), $t'(x) = n_F D_x$), and second, that farmers do not receive the revenue from the tax (except possibly as a lump sum payment). Symmetrically, a subsidy scheme under which the government pays the railroad to reduce crop damage achieves bilateral efficiency in the short run provided that the marginal reduction in the subsidy equals marginal damages (i.e., $-s'(x) = n_F D_x$).

Note that the structures of the tax-subsidy schedules are not fully determined by these conditions because the tax only impacts the marginal conditions for the choice of the inputs x and y . This is not the case, however, when we take into account long run efficiency. Consider first the railroad’s decision about the number of trains. According to condition (7.4), the railroad will only choose the efficient number if it internalizes the full cost of the crop damage per train. This requires that it pay a tax per train equal to $n_F D(x,y)$. (Note that this tax satisfies the marginal condition above.) Clearly, a subsidy that involves any payments to the railroad will therefore

¹¹³ The ‘short run’ is the same as economic models of torts which hold the ‘activity levels’ (e.g., automobile miles driven) fixed (see Shavell, this Handbook xxxxx). In tort models the ‘long run’ means that activity levels are endogenous.

result in too many trains. As for farming, condition (7.5) says that efficient entry of farmers requires that each farmer internalize the crop damage that his entry contributes to total damages. This condition is satisfied as long as farmers do not expect to receive any compensation for their losses (including lump sum compensation). In combination, these results show that only a tax scheme can achieve bilateral efficiency in both the short and long run.

7.3. *The Property Rule-Liability Rule Framework*

As discussed above, one of the contributions of Coase (1960) was to challenge the Pigovian assumption that externalities necessarily lead to market failure. This recognition suggests an expanded set of remedies for controlling externalities, which is best exemplified by the choice between property rules and liability rules (Calabresi and Melamed, 1972).¹¹⁴ Under property rules, right holders can refuse any unwanted infringements of their rights, enforceable by injunctions (or criminal sanctions in the case of theft). Property rules thus form the legal basis for voluntary (market) exchange of rights. In contrast, liability rules do not entitle right holders to refuse infringements of their rights; instead, they can only seek monetary compensation in the form of damages. Liability rules thus form the basis for court-ordered or non-consensual transactions.¹¹⁵ Together both types of rules define a property system seemingly designed to allocate resources to their highest valued uses in the presence of varying transaction costs.

As Kaplow and Shavell (1996) note, when transaction costs are zero, property rules and liability rules should be equally efficient because the Coase Theorem applies. The choice thus turns on transaction costs, particularly the costs of contracting, the costs of court adjudication, and legal administration. When contracting costs are relatively low, property rules are preferred because they ensure that all transactions are mutually beneficial. When contracting costs are high (e.g., public nuisance cases), however, the costs of reaching an agreement under property rules may prevent otherwise efficient transactions from occurring.¹¹⁶ Liability rules have an advantage in this case because they allow the court to force a transfer. In this way, a court-ordered transaction replaces a market transaction. This advantage of liability rules, however, needs to be weighed against the possibility of court error in setting damages, which may result in too many or too few transactions. Furthermore, because liability rules require courts to establish the initial terms of a transaction by setting damages (which the parties may later adjust), the administrative costs of using this rule will likely be higher than under a property rule (Kaplow and Shavell 1996).

In the context of the railroad-farmer conflict, a liability rule entitles farmers (victims) to seek monetary compensation for their damages but not to stop the damage from occurring.¹¹⁷ If liability is strict, the railroad (injurer) must pay full compensation regardless of its level of precaution. In terms of short run efficiency, strict liability induces efficient precaution by the railroad, but because farmers are fully compensated, they have no incentive to take precaution.

¹¹⁴ Also see Polinsky (1980a) and Kaplow and Shavell (1996) for more recent analyses of property rules versus liability rules.

¹¹⁵ Calabresi and Melamed (1972) also discuss a third rule, an inalienability rule, which prevents transfer of right under any circumstances (including consensual transfers). We discuss this rule in Section 9.

¹¹⁶ The issue here is identical to contracting problems association with such large scale resources such as air, groundwater, oil, and wildlife as discussed in section 4.4.

¹¹⁷ Though as noted, the Coasian tradition would not use the term victim given the ‘reciprocal nature’ of the externality problem.

(The outcome is identical to a tax scheme where the revenue is paid to victims as compensation.) In contrast, a negligence rule, which only holds the railroad liable for damages if it takes less than the efficient level of abatement as defined by (7.2) (for example, if it fails to install spark arresters), will induce both parties to take efficient care. The railroad will take care to avoid liability, and the farmers will take care to minimize their losses.¹¹⁸

Neither liability rule, however, will achieve long run efficiency. Under strict liability, too many farmers will enter because they do not consider the impact that their entry has on total damages. Although the railroad does face full liability for each train that it runs, equal to $n_F D(x,y)$, this amount is too large because of the excessive number of farms. Thus, too few trains will run (though the number of trains will be efficient, given the number of farms). The situation is reversed under a negligence rule. The railroad will invest in optimal abatement to avoid liability, but as a result, it will run too many trains (Polinsky, 1980b). In contrast, farmers will face the full amount of their damages, $n_T D(x,y)$, but too few farmers will enter because the number of trains is too large. In general, liability rules cannot create efficient long run incentives because of the constraint that what one party pays the other must receive.¹¹⁹

If the farmers' rights are protected by a property rule, they can block the railroad from running any trains by means of an injunction. The railroad, however, can seek to purchase rights to impose crop damage. For each train that it runs, the railroad will invest in abatement up to the point where the last dollar spent just equals aggregate marginal damages to all farmers, after which it will prefer to compensate farmers for the residual damages. Then, given efficient abatement per train, the railroad will run trains up to the point where the aggregate amount it has to compensate farmers equals the marginal benefit of one more train. This results in the efficient number of trains.¹²⁰

Efficient precaution by farmers can similarly be achieved by contracting. This requires that the railroad compensate farmers for their costs of precaution up to the point where the last dollar spent on precaution equals the marginal reduction in aggregate damages owed. Achieving the efficient *number* of farms (or acres) is much more problematic, however. According to condition (7.5), long run efficiency requires that farmers enter (or add acreage) up to the point where the marginal benefits of the last farm equal its marginal contribution to crop damage plus cost of precaution. But since farmers are compensated for these costs under the current assignment of rights, there exists an incentive for too many to enter. In theory, private contracting can prevent excessive entry, but only if the railroad can identify all *potential* entrants into farming and offer to pay them their marginal benefit of entry if they agree to stay out. Clearly this poses a significant informational demand on the railroad. (Of course, a similar problem faces farmers if the property right is initially assigned to the railroad.) This discussion illustrates the limits of private contracting in internalizing externalities, especially regarding long run efficiency (Frech, 1979; Wittman, 1984; Holderness, 1989), though these limits must be compared to the limits of public action in determining the optimal second best remedy.

¹¹⁸ See Chapter xx for a fuller discussion of the various negligence rules.

¹¹⁹ This is an example of the *paradox of compensation* (e.g., Cooter and Ulen 1999, p.169) which is also found in tort law and contract law remedies (Cooter 1985). It can be avoided by 'de-coupling' liability and compensation, or with a contract or compensation mechanism that defines and enforces the optimal choices for both parties.

¹²⁰ Another possibility is that the railroad could buy all the land and engage in farming, or farmers could collectively buy and manage the railroad.

7.4. The Law of Trespass and Nuisance

The primary common law responses to externalities are trespass and nuisance. Specific examples of trespass are squatters and boundary encroachment, while examples of nuisance are air, water, and noise pollution. More generally, Table 2 lists several thresholds that the common law has developed for distinguishing between the two doctrines (Merrill, 1985a; Miceli, 1997, p. 119).

[Table 2 here]

The primary remedy under trespass is an injunction against the unwanted intrusion.¹²¹ Thus, the landowner's right to exclude is protected by a property rule. The remedy under nuisance law is more complicated. First, the landowner can only obtain relief if the invasion is substantial, and even then, he may have to be satisfied with money damages (a liability rule). If the landowner wishes the harm to be enjoined, he must meet the further legal standard of showing that the harm outweighs the benefit of the nuisance-creating activity (Keeton, et al., 1984, p. 630).

Merrill (1985a, 1998) argues that this distinction between trespass and nuisance can be broadly understood in terms of the choice between property rules and liability rules. Cases of trespass ordinarily involve a small number of parties where the intruder is easily identifiable.¹²² Again, as we discussed above, contracting costs among the parties tend to be low, and property rules are the preferred remedy. In contrast, cases of nuisance often involve large numbers or sources of harm that are difficult to identify. Thus, transaction costs are high and contracting is unlikely to lead to the efficient outcome. In cases like this liability rules are preferred.

The well-known case of *Boomer v. Atlantic Cement Co.* provides an illustration of this choice.¹²³ The case involved a group of landowners who sought an injunction against a large cement factory because of the dirt, smoke, and noise that it produced. The court denied the injunction and instead awarded money damages on the grounds that the injunction would have forced the factory to shut down, causing a loss of jobs and the company's substantial capital investment. The court's decision seems correct in view of the high costs of contracting among the large number of affected homeowners that would have been necessary to keep the plant operating under an injunction.

The equally famous case of *Spur Industries v. Del Webb*¹²⁴ also illustrates the important issues but with a slightly different result. In this case a cattle feedlot (Spur) northwest of Phoenix had been in operation prior to the development of homes by Del Webb. As the home development expanded toward the feedlot homeowners became increasingly impacted by the smell of cattle manure. Del Webb filed suit on the basis of a public and private nuisance. The court agreed with the litigants that there was a nuisance and that the feedlot activity should be enjoined, but in

¹²¹ The doctrine of necessity noted in section 2.5 indicates that not all physical invasions are considered trespass.

¹²² The law also distinguishes 'private' from 'public' nuisances (Dukeminier and Krier, pp. 773-774). A 'public' nuisance represents a broader notion of harm borne by the general public rather than one or a few landowners. In the cases we examine below, *Spur* represents both a public and private nuisance case, while *Boomer* is a public nuisance case. As we note in section 7.5, zoning seems to emerge in cases of public nuisances.

¹²³ 26 N.Y.2d 219, 309 N.Y.S.2d 312, 257 N.E.2d 870 (Court of Appeals of New York, 1970).

¹²⁴ 108 Ariz. 178, 494 P.2d 700 (Supreme Court of Arizona, 1972).

addition it forced Del Webb to indemnify Spur for the cost of moving or closing the feedlot. In this manner the court used a combination of property and liability rules. It partly invoked the ‘coming to the nuisance’ defense (a property rule), which states that a party with a prior activity cannot be liable for a nuisance. (In so doing, it effectively labeled the feedlot as the ‘victim’.) The coming to the nuisance doctrine has a simple economic rationale in that a late-comer to an area impacted by nuisance activities will be faced with land prices that capitalize the reduction in value from the nuisance and thus later damages would be overcompensation.¹²⁵ However, in awarding damages (a liability rule) the court also recognized the costs of organizing a buyout by the many homeowners in the subdivided development, given that the feedlot had become an inefficient land use.

7.5. Zoning, Covenants, and Common Law Control

Probably the most common legal response to urban land market externalities in the United States is zoning, which is a form of public regulation.¹²⁶ The economic rationale for zoning is that ‘similar land uses have no (or only small) external effects on each other whereas dissimilar land uses may have large effects’ (White, 1975, p. 32), creating what the common law calls a ‘public nuisance.’ The widespread use of zoning, however, does not necessarily make it the most efficient response to externalities. High administrative and enforcement costs often exceed the saved “nuisance costs” (Ellickson, 1973). This would not be a problem, however, if the penalty for violations were payment of an appropriate fine, which would allow landowners to circumvent inefficient regulations. In this sense, zoning regulations are best enforced by a liability rule (White and Wittman, 1979). The fact that compliance with zoning ordinances is required, however, (that is, they are enforced by a property rule) forecloses this route to efficiency.

A private alternative to zoning is the use of land use servitudes (e.g., covenants, easements, or equitable servitudes) that impose limits on what landowners can do with their property.¹²⁷ Such restrictions are frequently observed in condominiums, coops, homeowner associations, and other common interest communities, which comprise a growing portion of the housing market (Dwyer and Menell, 1998: 808-887; Hansmann, 1991). The economic function of these restrictions is twofold: to overcome free rider problems in the provision of certain jointly consumed amenities (De Geest, 1992); and to internalize neighborhood and rental externalities (Cannaday, 1994; Hughes and Turnbull, 1996). Since these covenants overcome ‘market failures’ associated with ordinary housing markets, developers can charge a premium for them. Further, since the restrictions are attached to the deed rather than to the landowner (that is, they ‘run with the land’), they avoid the transaction costs that would be necessary if each new resident had to negotiate anew with all existing residents. In this sense, land use servitudes represent an effective private alternative to zoning for small-scale developments. They are less effective,

¹²⁵ See Wittman (1980) and Pitchford and Snyder (2003) for economic models of this doctrine. Pitchford and Snyder (2003) show how the ‘coming to the nuisance’ doctrine can lead to overinvestment by the first party in a sequential model of land use, and argue that the ruling in *Spur* fits their framework.

¹²⁶ Zoning was declared constitutional in *Village of Euclid v. Ambler Realty*, 272 U.S. 365 (1926). Economic analyses of zoning with a focus on property rights include Fischel (1985) and Nelson (1977). Siegan (1972) studies Houston, the only large American city without municipal zoning and finds that the lack of zoning has not adversely impacted land use.

¹²⁷ There is almost no economic analysis of servitudes or land use doctrines; but see Stake (1998b).

however, in controlling externalities in large-scale urban areas where development occurs in a piecemeal fashion over time.

Trespass and nuisance law also represent private alternatives to zoning. As noted above, trespass is effective in internalizing small-scale intrusions (for example, boundary disputes between neighbors), while nuisance law is best suited to harms that affect a few individuals (Ellickson, 1973). However, nuisance law is not well-suited to internalizing harms that are dispersed across a large number of landowners (public nuisances) because no one owner has an adequate incentive to incur the cost of bringing a nuisance suit, even though the aggregate harm may exceed the benefit (Landes and Posner, 1987, Chapter 2). Public regulation is the best remedy in these cases because the government can act as an agent for the group of affected landowners.

8. Public Property and Public Use of Private Property

In section 2 we noted that public or state ownership was one of the primary types of property rights. Here we examine the rationale for public ownership and public control (including regulation and takings) of private property.

8.1. The Optimal Scale of Ownership

When transaction costs are positive, the private ownership of land is not always the most efficient means of maximizing land value. The primary advantage of private ownership is that it creates the proper incentives for use and investment regarding actions taken within the boundaries of the property. However, since different uses of land have different optimal boundary requirements, it may be the case that the scale of an activity exceeds the existing boundaries of ownership (Ellickson, 1993). For example, Coase's example of straying cattle suggests that the rancher's parcel was too small. One solution to this problem is contracting between ranchers and neighboring owners who suffer harm (Ellickson, 1991), but if contracting costs are high, a better solution may be to consolidate ownership of the parcels (Libecap 1989). In this way, market transactions are replaced by internal governance methods (Ostrom, 1990).

The optimal solution depends on the cost of contracting among landowners (which increases with greater decentralization) compared to the cost of governance under consolidated ownership.¹²⁸ Both types of costs are likely to increase with the scale (or size) of the asset, because reaching an agreement will generally require dealing (either through contracts, monitoring, or political deals) with larger and more heterogeneous group of parties. For the largest scale activities, state ownership will likely dominate both private ownership (because no single owner will want to hold and manage such a large, undiversified portfolio of assets), and private contracting (because the state can use decision rules that do not require unanimity to lower the costs of agreement).¹²⁹ In an empirical application Lueck (1989, 1995) examines the ownership regimes that govern wildlife, a resource that often has an optimal scale of management that far exceeds the typical boundaries of private land holdings. Lueck finds a mix

¹²⁸ The problem is analogous to Coase's (1937) theory of the optimal boundary between the market and the firm.

¹²⁹ Libecap (1989), however, notes that virtually the same forces that make private contracting costly also make political solutions costly.

of private contracting and government ownership regimes that have developed in response to the potential externality problems.

8.2. *The Public Trust Doctrine*

The public trust doctrine is an ancient doctrine which grants ownership of navigable rivers, shorelines, and the open sea to the public.¹³⁰ The public trust doctrine can be viewed as the judicial creation of common property, which has roots in Roman law and the English common law. English and Roman public trust law both acknowledged inalienable public rights in navigable waterways and the foreshore. They allowed, for example, unrestricted access to large watercourses for travel and transportation. The public trust doctrine also has been a part of American law, providing public access to navigable waterways and authorizing state control over tidelands.¹³¹ In essence, the public trust doctrine ‘defines an easement that members of the public hold in common’ (Huffman, 1989, p. 527), thus creating a sort of common property resource among a disorganized public. In recent years some courts have extended the doctrine into new areas -- mostly environmental assets -- such as beaches, lakes, stream access, and wildlife (Sax 1970). For example, *National Audubon Society v. Superior Court*,¹³² perhaps the most important modern case, extended public trust status to wildlife habitat at California's Mono Lake, thereby effectively reallocating water rights. Similarly, recent law in Montana has extended the public trust claim to recreational uses (e.g., fishing, rafting) of waterways.¹³³

In its traditional application, navigable waters, the public trust asset was essentially a public good. When an asset is a public good, unrestricted access will not cause dissipation from overuse of the resource.¹³⁴ On the other hand, when the resource has private good characteristics, unrestricted access (especially by a large number of users) can trigger the rule of capture and creates a classic open access problem. Indeed, some critics (Cohen 1992, Huffman 1989) of new environmental applications of the public trust doctrine argue that expanding access to resources will lead to their degradation through overuse.¹³⁵ For instance, a public trust conversion of a private beach into a public beach may well lead to crowding and pollution of the beach.

8.3. *Eminent Domain and Regulatory Takings*

Large-scale economic developments like dams and irrigation projects, railroads, highways, and shopping centers often involve the assembly of a large contiguous parcel of land from relatively small and separately owned parcels. In all of these cases, the provider, whether public or private, faces a potential holdout problem (Cohen, 1991; Strange, 1995). The source of this problem is that, once assembly becomes public knowledge, each landowner realizes that he or she can impose a substantial cost on the provider by refusing to sell. This knowledge confers monopoly

¹³⁰ For an introduction see Dukeminier and Krier (2002, pp.816-823).

¹³¹ The seminal case is *Illinois Central Railroad v. Illinois*, 146 U.S. 387 (1892).

¹³² 658 P.2d 709 (Cal. 1983).

¹³³ *Montana Coalition for Stream Access v. Curran*, 682 P. 2d 161.

¹³⁴ There is still the problem of raising revenues to police and maintain the asset.

¹³⁵ Cohen (1992) and Rose (1986) note how an expansive public trust doctrine can be used by governments to avoid the Constitution's takings clause.

power on owners, who can each hold out for prices in excess of their true valuations, thereby endangering completion of the project.¹³⁶

One solution to the land assembly problem is to allow forced sales—that is, replace property rule protection of each owner’s land with liability rule protection.¹³⁷ This is the economic justification for the eminent domain power of the state (Posner, 2003, p. 55) which has common law origins. The ‘Takings’ clause of the Fifth Amendment of the U.S. Constitution explicitly grants the power, saying ‘nor shall private property be taken for public use without just compensation.’ The key components of this clause are the requirements of ‘public use’ and ‘just compensation,’ which we discuss in turn.

8.3.1. Public Use of Private Property

Merrill (1986) examines the scope of the takings power in the context of the public use requirement. He draws a distinction between the ‘means’ and ‘ends’ approach to public use. The means approach concerns the manner in which land is acquired for large-scale projects (is there a holdout problem?), while the ends approach refers to the use of the land (is it for a public or private good?). It is important to note that these are separable categories—that is, not all public goods require land assembly, and some private goods do. According to the ends approach, the takings power should be limited to provision of public goods by the government, whereas according to the means approach, it should be granted to any provider facing a holdout problem.¹³⁸

Merrill’s ‘ends approach’ appears more consistent with the plain meaning of public use, but it potentially results in two types of ‘errors.’ First, it may result in the use of eminent domain for the provision of public goods not requiring land assembly (Fischel, 1995a, p. 74). Merrill argues, however, that this overuse of the takings power (i.e., the substitution of coercive for consensual transactions) is self-limiting in the sense that the costs of market acquisition are generally less than the costs of eminent domain. Second, the ends approach apparently denies use of eminent domain to private providers facing a holdout problem. Historically, however, courts have tended to act in accordance with the means approach by granting takings power to private parties like railroad and canal builders who face serious holdout problems, though they nearly always attempt to justify their action in terms of the ends approach—that is, they identify some public benefit from the project (Merrill, 1986, p. 67). The need for such justification is somewhat surprising, however, given that courts routinely use liability rules (i.e., money damages) as a remedy in other disputes involving private parties. For example, awarding damages to the plaintiffs in the *Boomer* case rather than shutting the factory down amounted to a ‘private taking’ by the factory (Fischel, 1995a, p. 76). This was appropriate, we argued, because the factory faced a kind of holdout problem. The point is that the actual use of eminent domain appears to

¹³⁶ In this sense, the holdout problem resembles the anti-commons problem discussed in Section 2.2. It is important to distinguish this problem from the case of single owners of dispersed parcels who seek the best price for their property in one-on-one transactions. This is not a holdout problem because the owners are not seeking a price above the true valuation of their property, nor does any one owner’s refusal to sell affect the transfer of other parcels.

¹³⁷ One well known example of forced transfers is state law that compels the formation of reservoir-wide conservation ‘units’ for oil and gas production. Similar laws govern irrigation districts, soil conservation and predator control districts.

¹³⁸ Ulen (1992) argues that eminent domain should only be used when both conditions are met.

reflect economic logic (the means approach), and when necessary, courts bend the meaning of public use to conform to this standard (Fischel, 1995a, pp. 75-77). However, some critics have argued that in recent years, the public use doctrine has expanded to include private development projects seemingly beyond the original intention of the doctrine.¹³⁹

8.3.2. *Just Compensation for Takings*

In addition to public use, the eminent domain clause requires payment of just compensation following a taking. Courts have interpreted this to mean ‘fair market value.’ Several authors have argued, however, that fair market value generally undercompensates landowners because it ignores the owner’s subjective value (e.g., Knetsch and Borchering, 1979). Since subjective value is part of the opportunity cost of a taking, failure to compensate for it potentially results in over acquisition of land by the government. In an empirical study of land acquisition in Chicago, Munch (1979) found that compensation amounts differed systematically from market value. Generally, owners of high valued properties were overcompensated, while owners of low valued properties were under compensated. Epstein(1985; Ch. 15) however, contends that taxes used to finance compensation are themselves a form of taking, which act as a limit on the amount of land taxpayers will permit the government to acquire. In the same vein, Fischel (1995a, p. 211) argues that market value may be the ‘proper’ measure of just compensation because it balances the cost of undercompensation against the higher taxes that full compensation would require.

The economic literature on takings has focused on the link between compensation and investment decisions of landowners. One of the primary contributions of this literature, initiated by Blume, Rubinfeld, and Shapiro (BRS) (1984), has been to show that it may be inefficient to pay *any* compensation. This ‘no compensation result’ can be illustrated by a simplified version of the BRS model. Suppose there are multiple parcels of land, each worth $V(x)$ if the landowner makes an irreversible investment x , where $V' > 0$ and $V'' < 0$. The land may also be valuable for public use, yielding a benefit of $B(y)$, where y is the number of parcels taken and $B' > 0$, $B'' < 0$ (Fischel and Shapiro (1989). (Alternatively, y may be interpreted as the probability of a taking, or the fraction of a given parcel’s value that is extinguished by a regulation—see Section 8.3.3 below.) In the event of a taking, suppose that compensation of $C(x)$ will be paid for each parcel taken, where $C(x) \geq 0$, and $C' \geq 0$. Thus, total compensation will be $yC(x)$.

The time sequence is that landowners choose x given the anticipated behavior of the government and the compensation rule; then the government chooses y and pays $C(x)$. We will assume various objective functions for the government below. As a benchmark, note that the first-best choices (x^*, y^*) maximize $B(y) + (1-y)V(x) - x$, which is the sum of private and public benefits. The relevant first-order conditions are

$$(1-y)V'(x) - 1 = 0 \tag{8.1}$$

$$B'(y) - V(x) = 0. \tag{8.2}$$

¹³⁹ See, for example, the famous case of *Poletown Neighborhood Council v. City of Detroit*, 410 Mich. 616, 304 N.W.2d 455 (1981).

Now consider the decisions separately made by each party. In the first scenario, we view the government's taking decision as exogenous—that is, it is unaffected by the compensation rule. This is the assumption BRS (1984) make in their basic model, and represents what Fischel and Shapiro (1989) refer to as an 'inexorable' government. In this case, y is fixed (so condition (8.2) is irrelevant), while the landowner chooses x to maximize $(1-y)V(x) + yC(x) - x$, which must satisfy

$$(1-y)V'(x) + yC'(x) - 1 = 0. \quad (8.3)$$

Let x^j be the solution. Comparing (8.3) to (8.1) shows that $C'=0$ is necessary for the landowner to invest efficiently; that is compensation must be lump sum to ensure that $x^j=x^*$ (BRS, 1984). Intuitively, any positive relationship between x and the amount of compensation creates moral hazard that results in over-investment. It immediately follows that no compensation ($C(x)\equiv 0$ for all x) is efficient, although any lump sum rule is consistent with efficiency.¹⁴⁰

The efficiency of zero compensation does not hold up, however, under different assumptions about the government's behavior. Suppose, for example, that the government chooses y to maximize social welfare. Such a government has been characterized as 'benevolent' (Hermalin, 1995) or 'Pigovian' (Fischel and Shapiro, 1989). The optimal choice of y in this case is given by the first-order condition in (8.2). Note that, because the government chooses y after the landowner's investment of x is in place, (8.2) defines a function $y^g(x)$, where¹⁴¹

$$\frac{\partial y^g}{\partial x} = \frac{V'}{B''} < 0. \quad (8.4)$$

The amount of land taken is decreasing in x because the more the landowner has invested, the higher is the opportunity cost of a taking.

The landowner's objective function is the same as above, but he now maximizes it subject to the anticipated behavior of the government as described in (8.4). The first-order condition is

$$(1-y)V'(x) + yC'(x) - [V(x)-C(x)](\partial y^g/\partial x) - 1 = 0. \quad (8.5)$$

Note that compensation must again be lump sum, but zero compensation is no longer consistent with efficiency. This is reflected by the third term in (8.5), which implies that the landowner will over-invest if $C(x)<V(x)$ and under-invest if $C(x)>V(x)$. Intuitively, if the landowner expects to be under compensated in the event of a taking, he will increase his investment in order to lower the probability of a taking. Conversely, if he expects to be overcompensated, he will under-invest in order to raise the probability of a taking (Miceli, 1991; Hermalin, 1995).

This version of the model embodies two potential sources of moral hazard for the landowner. The first is the tendency to over-invest if compensation is an increasing function of x (the basis for the BRS no-compensation result), and the second is the effect of x on the government's

¹⁴⁰ This is another example of the *paradox of compensation* (see section 7.3).

¹⁴¹ By definition, $y^g(x^*)=y^*$.

taking decision through (8.4). One compensation rule that resolves both problems and induces a first-best level of investment is $C=V(x^*)$.¹⁴² That is, compensation is set at the full value of the land, evaluated at the efficient level of investment.

It is important to emphasize that the justification for compensation in this version of the model is *not* to prevent excessive acquisition of land by the government, as is often argued. Rather, it arises from the sequential decisions of the parties. Suppose, however, that the government is not benevolent, but instead acts on behalf of the majority, or some group with political influence (those who receive the benefits of the taking) while ignoring the costs to individual property owners, except to the extent that it must pay them compensation (Fischel and Shapiro, 1989; Hermalin, 1995; Nosal, 2001). Such a government is said to have ‘fiscal illusion’ in that only dollar costs enter its cost-benefit calculation (BRS, 1984).

In this case, the government chooses y to maximize $B(y) - yC(x)$, which yields the first-order condition

$$B'(y) - C(x) = 0. \quad (8.6)$$

As before, this defines a function $\hat{y}(x)$ whose characteristics depend on the nature of the compensation rule. The landowner now maximizes his objective function subject to $\hat{y}(x)$, which yields the first-order condition in (8.5) with $\partial y^g / \partial x$ replaced by $\partial \hat{y} / \partial x$. Clearly, $C=V(x^*)$ will again induce first-best investment by the landowner based on the same reasoning above. Moreover, setting $C=V(x^*)$ in (8.6) also yields the efficient taking decision by the government.¹⁴³

A final argument against the no-compensation result is due to Michelman (1967), who argues that compensation should depend on a comparison of the ‘settlement costs’ of paying compensation with the ‘demoralization costs’ of not paying compensation. In terms of the preceding analysis, settlement costs include administrative costs and the costs associated with moral hazard, while demoralization costs arise from the risk of an uncompensated taking (Fischel and Shapiro, 1988; Fischel, 1995, Chapter 4). Compensation should therefore be paid when the demoralization costs exceed the settlement costs. A related justification for compensation is that it provides risk averse landowners public insurance against the political risk (demoralization costs) associated with takings, given that private insurance for such risk is not readily available (Blume and Rubinfeld, 1984; Kaplow, 1986; Rose-Ackerman, 1992).¹⁴⁴

¹⁴² This rule is not the only one that achieves the efficient outcome. One alternative will be discussed in Section 8.3.3 below, and Hermalin (1995) proposes others.

¹⁴³ Alternatively, Fischel and Shapiro (1989) consider a compensation rule of the form $C=sV(x)$ where s is the fraction of the value of the land that the government will pay in the event of a taking. They argue that this is an easier rule to administer compared to $C=V(x^*)$ because it does not require the government to calculate x^* . The shortcoming is that the optimal value of s , which is strictly between zero and one, only achieves a second-best outcome.

¹⁴⁴ Though it has not been the subject of economic models, the public use constraint is empirically important and might be examined formally through the $B(y)$ function. For example, if $B(y) = B(\sum y_i)$, where $i = 1, \dots, n$ (and n is the entire population) then a public use requirement could limit state taking to those cases where some supermajority fraction -- say $(n-p)/n$, where $p < n$ -- was required (implicitly in the doctrine).

8.3.3. Regulatory Takings

To this point we have focused on compensation for takings of land under eminent domain, or physical acquisitions, but much more common are government regulations that restrict land uses without actually depriving the owner of title. Examples include zoning laws, and environmental and safety regulations. Historically, courts have granted the government broad powers to enact such regulations as an exercise of its police power, but when a regulation becomes especially burdensome, the affected landowner may claim that a ‘regulatory taking’ has occurred and seek compensation under the eminent domain clause.¹⁴⁵

The case law on this question is extensive, and though the Supreme Court has advanced several tests for compensation, there is no consensus on when a regulation crosses the threshold separating a non-compensable police power action from a compensable taking. Some noteworthy tests are the *noxious use doctrine*, which says that a regulation is not compensable if it protects the ‘health, morals, or safety of the community’;¹⁴⁶ the *diminution of value test*, which says that compensation is due if a regulation ‘goes too far’ in reducing the value of the regulated land;¹⁴⁷ and the *nuisance exception*, which says that compensation is not due for regulations that prevent activities that would be classified as nuisances under the governing state’s common law.¹⁴⁸

Like the takings analysis above, the trade-off for regulatory takings concerns the efficiency of the land use decision on the one hand, and the regulatory decision on the other. As a way of examining the threshold nature of this choice, consider the following compensation rule (Miceli and Segerson, 1994, 1996):

$$C = \begin{cases} 0, & \text{if } y \leq y^* \\ V(x), & \text{if } y > y^*. \end{cases} \quad (8.7)$$

Here, we can interpret y to be the extent of a landowner’s value that is lost as a result of a regulation. Note that this rule is conditional on the behavior of the government in that it requires full compensation if the government over-regulates ($y > y^*$), but requires no compensation otherwise ($y \leq y^*$). In this sense, it is like a negligence rule in tort law, and it yields an efficient equilibrium for the same reason.¹⁴⁹

¹⁴⁵ Such claims take the form of so-called inverse condemnation suits.

¹⁴⁶ *Mugler v. Kansas*, 123 U.S. 623, 1887.

¹⁴⁷ *Pennsylvania Coal v. Mahon*, 260 U.S. 393, 1922.

¹⁴⁸ *Lucas v. South Carolina Coastal Council*, 112 S.Ct 2886, 1992.

¹⁴⁹ The proof of efficiency is complicated, however, by the fact that the landowner and regulator act in sequence. Note first that if $x = x^*$, the government’s optimal response is y^* . To see why, observe that it will never choose $y < y^*$ given $B' > 0$, and it will prefer y^* to $y > y^*$ since $B(y^*) > B(y^*) - y^*V(x^*) \geq \max_{y > y^*} B(y) - yV(x^*)$. Next, suppose $x > x^*$. The government’s optimal response in this case is also y^* since $y^g(x) < y^g(x^*) \equiv y^*$ for $x > x^*$ by (8.4), which again implies that $B(y^*) > B(y^g(x)) - y^g(x)V(x) \geq \max_{y > y^*} B(y) - yV(x)$. Finally, if $x < x^*$, the government will choose y^* if x is near x^* , but it will prefer $y > y^*$ if x is sufficiently small. If the government is expected to choose y^* , $C = 0$ and the landowner maximizes $(1 - y^*)V(x) - x$, which yields x^* . This leaves $x < x^*$ and $y > y^*$ as the only possible outcome besides (x^*, y^*) , but for this to be an equilibrium, it must be true that $B(y) - yV(x) > B(y^*)$ for the government, and $V(x) - x >$

In addition to the efficiency of (8.7), the rule advances our understanding of actual takings law in several ways. First, it allows us to interpret ‘noxious uses’ as those activities that are efficiently regulated, and for which no compensation is due (the top line of (8.7)). Second, it provides an economic standard for when a regulation ‘goes too far’ under the diminution of value test. Specifically, a regulation goes too far—and compensation is due—when it is inefficiently enacted (the second line of (8.7)).¹⁵⁰ Finally, it establishes a standard that is economically equivalent to the common law definition of a nuisance (an activity that is efficiently prohibited),¹⁵¹ and hence is consistent with the threshold for compensation implied by the nuisance exception.

8.3.4. Compensation and the Timing of Development

It is clear from the above discussion that regulations often redefine property rights to the disadvantage of landowners. Faced with the threat of no compensation for alterations of their property rights, landowners can often reclaim these rights because they have private information and a first mover advantage over regulatory agencies and legislatures. In the process, they can preempt regulations and may do so in ways that counter the intended goals of the regulations. Land preservation and environmental regulations are perhaps the classic cases (Cohen 1999, Dana 1995). While regulators consider restrictions to preserve land, developers race to beat the regulations, often leading to more rapid development than would have otherwise occurred.

The incentive to preemptively develop can be seen in a two-period model of a landowner and a regulatory agency which can invoke a land use regulation that will lower the value of the land by preserving some environmental amenity (e.g., endangered species habitat, open space).¹⁵² The land’s value under the regulation depends on the landowner’s behavior. Specifically, the landowner can choose to maintain (m) or destroy (d) the amenity in period 1. The landowner has private information about the amenity and has a clear first mover advantage over the agency because of this information and because of his ownership incentives. Development and thus destroying the amenity has a one-time cost (K_D) and generates benefits (B_D) from development. K_D is the cost of developing early, for example, harvesting timber before it has reached the optimal harvest age. If the amenity is destroyed the probability that the land will be regulated is zero. However, if the amenity is maintained there is a probability, $\gamma \in (0, 1)$, that the regulation will be invoked because the agency will deem the amenity worth preserving.

$(1-y^*)V(x^*) - x^*$ for the landowner. Summing these conditions implies $B(y) + (1-y)V(x) - x > B(y^*) + (1-y^*)V(x^*) - x^*$, which contradicts the definition of x^* and y^* . This proves that $x < x^*$ and $y > y^*$ cannot be an equilibrium.

¹⁵⁰ In this sense, the noxious use doctrine and the diminution of value test are two sides of the same coin. This interpretation suggests that the disagreement between Holmes and Brandeis in *Pennsylvania Coal* was over facts rather than law (Miceli and Segerson, 1996, p. 70).

¹⁵¹ Keeton, et al. (1984, p. 630) defines a nuisance as an activity for which ‘the amount of the harm done outweighs the benefits.’

¹⁵² The model here follows Lueck and Michael’s (2003) application to the federal Endangered Species Act (ESA). Miceli and Segerson (1996) present a similar model of development with irreversible investment that generates premature development without compensation. Innes, Polasky, and Tschirhart (1998) also examine the incentives for landowners under the ESA.

If the regulation is invoked, the landowner loses all benefits from development in period 2, but he may earn a smaller amount of benefits from an alternative land use that does not harm the amenity ($B_A < B_D$). In the absence of the regulation, the optimal time to develop is in period 2. This is true both because it is privately optimal for the owner to wait to avoid K_D , and because the amenity may be preserved. The landowner takes as given market prices (which determine the magnitudes of the various benefits and costs) and the probability the agency will invoke the regulation.

The landowner will maximize the expected value of the land by choosing to destroy the amenity if the expected value of early development exceeds that of waiting, or if $(B_D - K_D) > (1 - \gamma)B_D + \gamma(B_A + C)$, where $C \geq 0$ is the expected compensation in the event of a regulation. This inequality leads to several straightforward comparative static predictions. First, if $C = 0$, increases in the probability that the land will be regulated (γ) will increase the probability of preemptive development. Second, as the net value of development ($B_D - B_A$) increases, amenity destruction is more likely. Third, as the opportunity cost of early development increases (K_D) it is less likely that habitat destruction will occur. Finally, preemptive development becomes less likely if $C > 0$, and full compensation ($C = B_D - B_A$) deters early development with certainty.

Dana (1995) offers anecdotal evidence of such preemptive development in the absence of compensation, and Lueck and Michael (2003) find that the federal Endangered Species Act (ESA) has led some forest landowners to preemptively harvest timber in order to avoid costly land-use restrictions. For example, they find that landowners in North Carolina who are closer to populations of endangered red-cockaded woodpeckers (and thus subject to potentially costly timber harvest restrictions) are more likely to prematurely harvest their forest and choose shorter forest rotations. In this setting the empirical evidence indicates some endangered species habitat has been reduced on private land because of the ESA's land use regulations. The extent of such counter-productive regulations is not widely known and is a potentially important area of empirical research.

9. Inalienability of Property Rights

As Posner (2003, p.75) notes: 'the law should, in principle, make property rights freely transferable' in order to allow resources to move to their most highly valued uses and to foster the optimal configuration of assets. He further notes that the long term trend has been to do just this: '[The] history of English land law is a history of efforts to make land more easily transferable and hence to make the market in land more efficient.' The same is true for most assets, including human capital. Yet, there remain many restrictions in both the common law and in statutes and regulations that limit the alienability of property. These 'inalienability' rules (Calabresi and Melamed, 1972) typically take the form of government restrictions on property and hence should be distinguished from state property in that they do not suspend or replace private ownership of the property in question, but merely limit its alienability (only one of the bundle of property rights). Inalienability rules apply to body parts, children, voting, military service, cultural artifacts, endangered animal species, the right to freedom (laws against slavery),

certain natural resources, state property (as noted in Section 2.4) and many other cases.¹⁵³ These restrictions may be complete (e.g., slavery) or and partial (e.g., water transfers). And, of course, they are enforced in varying degrees, both as part of law and as part of group-based rules such as those that arise to govern common property. There is little empirical literature that tests various theories of inalienability so the discussion here is mostly limited to claims of plausibility and consistency with previous analysis in this chapter.

The dominant economic reason for restrictions on alienability is that externalities can arise from transfers (Barzel 1997, Epstein 1985, Rose-Ackerman 1985, 1998, Posner 2003).¹⁵⁴ Transfers can have external effects on third parties if the rights to the assets are not well-defined.¹⁵⁵ As noted in the discussion of first possession rules, well-defined rights mean that exclusive rights are defined to the stock and, accordingly, its stream of flows over time. This implies that the law should allow rights transfers when there is clear ownership of resource stocks. When rights to the stock remain ill-defined, however, there may be a rationale for limiting, even prohibiting, transfers of the claimed flows in order to protect the asset itself. For example, the widespread prohibition on trade in wild game is likely to be such a case (Lueck 1989, 1998), though even here limits on markets can potentially deter the formation of property rights as discussed in section 4. Restrictions on the sale of children may find a rationale for the same reason: a market for children (or game) would lead to ‘poaching’ of animals and kids for which property rights enforcement is extremely costly.¹⁵⁶

The law on western water transfers offers a useful example of how less extreme imperfections in property rights can lead to restrictions on transfers that actually serve to clarify rights (Barzel 1997, Lueck 1995). The doctrine of prior appropriation, found in most western states, allows ownership of water separate from land ownership. Owners of such water rights (the name stems from the first possession rule used to originally assign them) are generally free to use and transfer these rights, but certain restrictions on transfers are common, most notably prohibitions on transfers to parties who are not located in the stream basin or who will have different uses for the water. On the surface these restrictions seem blatantly inefficient, akin to restricting the sale of milk to someone who lives in the same city or uses it only on their cereal like everyone else. Yet a consideration of the way rights to water are defined illuminates these restrictions. Assume the water is diverted for irrigation, and that a portion of the water is returned to the stream after irrigation (the ‘return flow’). Only the water actually used or ‘consumed’ is valued by the users, so ideally water rights would be defined in terms of actual water consumed. Under a perfect system of ownership, the transfer of water rights would maximize the value of the water in the

¹⁵³ Rose-Ackerman (1998) discusses political rights in detail but we do not examine these here. Andolfatto (2002), in work disconnected from the economics of law, shows how limits on transfers can be efficiency enhancing in the context of social programs such as social security entitlements.

¹⁵⁴ As usual the legal literature has discussed ‘distributive justice’ reasons for restrictions on transfers but we do not examine those here. Rose-Ackerman (1985) links these arguments to economic arguments.

¹⁵⁵ We explicitly ignore market effects from trade or ‘pecuniary externalities.’

¹⁵⁶ Although we have argued that liability rules can often internalize externalities when transaction costs are high, the examples suggest that some potential harms may best be dealt with by banning certain activities altogether.

stream by generating an equilibrium in which the marginal value of water is the same for all users (Johnson, Gisser, and Werner 1981).¹⁵⁷

In practice, however, it is too costly to measure and define water according to consumptive use, so typically only the amount diverted is actually measured and traded.¹⁵⁸ This implies that a consensual trade for diverted water rights might adversely impact a downstream water user if the trade alters the amount of water actually consumed. The return flow will vary depending on the nature and location of the water's diversion and use. If the water is diverted out of the basin then there is absolutely no return flow and a transfer out of basin will impose externalities on other rights holders not party to the transfer. If water is used more intensively by a new user, the return flow will be lower though not zero. Thus, if water is defined over diverted use, then unconstrained water rights transfer will not maximize the value of the water. But if transfers are restricted so that diverted rights mimic consumptive rights, then this restricted rights regimes will indeed maximize the value of the water. Restrictions on use and on out-of-basin transfers seemingly meet these conditions and can thus be explained as efficient restrictions on rights.¹⁵⁹ More generally, when an asset is complex – water rights can be defined over diversion, consumption, and even quality for that matter – then efficient property rights regimes may contain restrictions on alienation that might seem to be inefficient. Only by moving away from a strict neoclassical view of property rights can these restrictions be seen as having an economic rationale.

Another reason for restriction on transfers is asymmetric information, particularly that leading to adverse selection (Rose-Ackerman 1998). In the worst case, adverse selection can completely dry-up all markets associated with a commodity where product quality cannot be observed prior to purchase (Akerlof 1970). Some have used this argument to explain bans on the sale of human blood and body parts, while allowing donations (a modified form of inalienability). It is not clear, however, how donations rather than sales will eliminate the adverse selection problem. Friedman (2000, p. 242) argues that a better reason for only allowing organ donations is to discourage kidnapping and murder for purposes of harvesting and selling organs. Friedman's point is similar to that made above regarding poaching. Laws against involuntary slavery would similarly discourage forced capture and sale of people into slavery (Barzel, 1977). (It is harder to justify laws against 'voluntary slavery,' or indentured servitude, as a penalty for loan default when borrowers lack financial assets to serve as collateral.)

¹⁵⁷ Let n be the number of rights holders, C_i the consumptive use of for user i , W the stock of water in the basin, and f_i the marginal value of consumed water. The social problem is to maximize $V = \sum_{i=1}^n \int_0^{C_i} f_i'(w_i) dw_i$ subject to the water stock constraint $\sum_{i=1}^n C_i = W$. This solution requires $f_1' = f_2' = \dots = f_n' = \lambda$ where λ is the Lagrange multiplier and equal to the marginal value of consumed water.

¹⁵⁸ New Mexico, however, does defines rights in terms of consumption and has generally fewer transfer restrictions (Johnson, Gisser, Werner 1981).

¹⁵⁹ Now let diversion by user i be D_i where $C_i \equiv D_i(1-F_i)$ where F_i is user i 's fraction of the water returned to the stream. The stock constraint now becomes $\sum_{i=1}^n [(1-F_i)D_i] = W$ and the new solution requires

$f_1'/(1-F_1) = f_2'/(1-F_2) = \dots = f_n'/(1-F_n) = \lambda$. If transfers are restricted so that $F_i = F_j$ for all $i \neq j$ users, then this condition is identical to the first-best value derived above. Note that neither of these water models examines the costs of measurement and enforcement.

Similar restrictions on the types of property servitudes allowed (e.g., limits on ‘negative and in gross’ easements) might be explained based on asymmetric information (Dnes and Lueck 2004). In legal studies, the limitations on servitudes have been explained in relation to the Rule against Perpetuities as a method of preventing ‘clogging title’ (e.g., Gray and Gray 2000), although this argument has not been explored in economics. Consider the market for land of two types: fee simple unencumbered and land encumbered with a generic servitude. Assume that only the seller of the plot knows whether or not the land is encumbered. Buyers do not have this information but only know that one-half of the land is encumbered. The value of an unencumbered plot is V^f , while the value of the encumbered plots is $V^s < V^f$. Given the information asymmetry buyers will only pay the expected value of a plot, $EV = (V^s + V^f)/2 < V^f$. Following Akerlof (1970) and related literature, this means there will be no market equilibrium for the unencumbered plots; that is, only ‘low quality’ encumbered plots will be present in the market. Institutions that provide information (e.g., recording and registration systems) could eliminate asymmetry, as could some institutional ‘rules of the game’.¹⁶⁰ Posner (2003, p. 75) offers a similar reason for the use of terminable easements for railroads rather than fee simple ownership to a narrow strip of land passing by thousands of other owners.

Two other factors may be important in determining restrictions on transferability. First, interest group pressure may lead to restrictions on transfers that have purely redistributive effects. The literature on economic regulation provides evidence on this from many commercial areas. One area where such interest group pressure has been important has been the broadcast spectrum (Hazlett 1990, 1998). There the restriction on use and transfers seem to have little rationality in limiting externalities or mitigating information problems, but instead serves to protect incumbent users from competition. Second, for state property administered by bureaucratic agencies, limits on transfers may serve to limit the potential moral hazard of the bureaucrats who might gain from transfers without facing the opportunity cost of the transfer.

10. Conclusion

The economic analysis of property rights and the economic analysis of law are the twin offspring of Coase’s (1960) seminal work. Yet, today the economics of property law is a poor cousin to the economics of contracts, torts, and many other areas. In part this is because economic analysis of property law has not been as welcome among property law scholars as it has been among legal scholars of antitrust, contracts and torts. In part it is because property law is so broad, making comprehensive analysis a daunting task.

In this chapter we have surveyed the somewhat disjoint literature developed by economists and legal scholars, elaborated on some of the basic models, and highlighted areas where more work remains to be done. While many important issues remain it can be claimed that economic analysis reveals a fundamental logic to the main doctrines and features of property law. In short, the observed structure of property rights and property law can be best understood as a system of societal rules designed to maximize social wealth. Among the most important remaining issues for study is a systematic analysis of how the law addresses the use and transfer of complex

¹⁶⁰ This adds an additional rationale for title and recording systems discussed earlier.

assets. And, as always, more detailed empirical work is needed to fully test and understand the rationale for the law and its effects.

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TABLE 1: FIRST POSSESSION RULES

<i>Asset</i>	<i>Possession Rule</i>	<i>Stock-Flow & Duration of Rights</i>
Chattels (abandoned, lost, unclaimed)	recover or show intent to recover	stock – permanent
Intellectual property	invent, write	stock -- varies (17 - 100 years)
Land	occupation & cultivation of land	stock – permanent
Minerals (hard rock)	locate mineral deposit	stock – permanent
Ocean fisheries	land fish	flow -- current catch
Petroleum	bring oil to surface	flow -- current production
Water- appropriation doctrine	develop a diversion plan	stock – permanent
Water-- riparian doctrine	pump or divert water	flow -- current use
Wild game	kill or capture animal	flow -- current kill

TABLE 2: THRESHOLDS DISTINGUISHING TRESPASS AND NUISANCE

Trespass	Nuisance
Defendant’s act occurs on plaintiff’s land	Defendant’s act occurs on defendant’s land
Harm is ‘direct’	Harm is ‘indirect’
Invasion by ‘tangible’ matter	Invasion by ‘intangible’ matter
Interference with ‘exclusive possession of land	Interference with ‘use and enjoyment’ of land

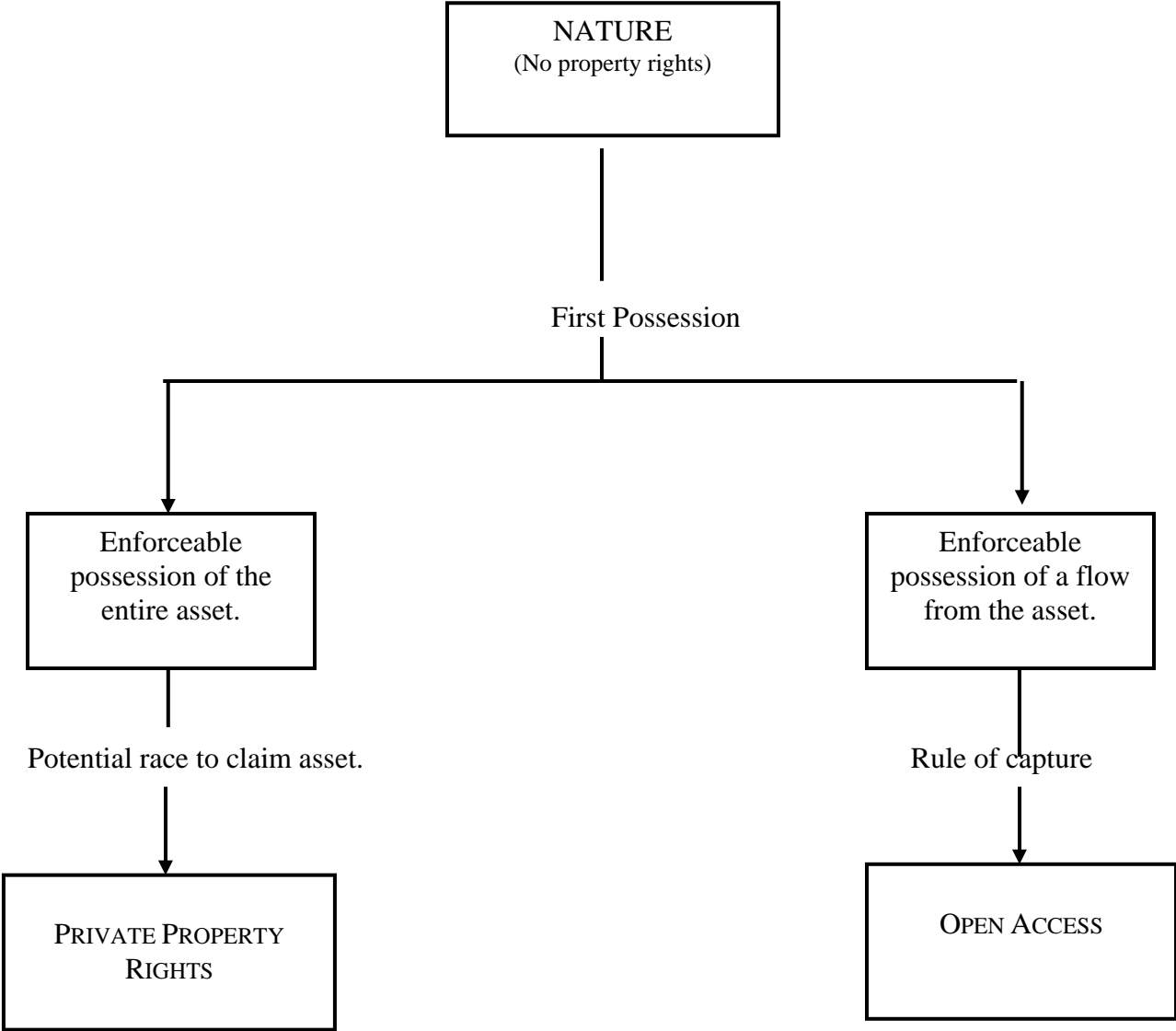


Figure 1: Property Rights under the Rule of First Possession