CONTRACTING FOR PROPERTY RIGHTS

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I. Introduction.

One of the major debts that economists, legal scholars, and other social scientists owe Ronald Coase is that his work drew attention to the institutional structure of production.[1] Through the late 1970s at least, the dominant neoclassical paradigm in economics focused on the behavior of firms in different market settings under the assumption that the underlying institutions were well-defined and operational. If they were not, market-like forces would generate pressures for institutional change; in other words, the market continually disciplined institutions so that they could not stray far from what would be considered optimal. Hence, institutions, as such, were neglected, deemed undeserving of serious scholarly concern. The wide exposure of Coase's work; his winning of the Nobel prize in economics in 1991; Douglass North's similar award in 1993; and the provocative questions raised by other scholars, such as Oliver Williamson, Harold Demsetz, and Yoram Barzel, provided more legitimacy for analyses of the roles played by institutional arrangements in economic decisions and performance. [2] Two new research streams followed: One was an evaluation of economic outcomes under different property rights regimes, and the other was investigation into transactions costs and why property rights came in so many varieties, often straying from what would appear to be optimal.

The first line of this research was attractive because it offered plausible explanations as to why societies with similar resource endowments could have wildly differing economic performance records, despite decades of economic advice and massive infusions of foreign financial aid in the post- war period. The central thesis was that the particular structure of property rights in an economy influenced the allocation and utilization of economic resources in specific and predictable ways. Weakly defined or poorly enforced property rights could explain

why some economies chronically underperformed. Accordingly, a property rights "solution" appeared as a policy recommendation for developing and transitional economies.[3] On a more micro level, attention to property rights also gave insights as to why some intractable resource problems, such as depletion of common-pool fisheries, seemed to defy managerial solution. In this area too, devising new regulations, such as individual transferable quotas, ITQs, seemed to be a more effective approach to the problem.[4] But after an initial flurry of optimism, frustration set in as things did not work out as smoothly as anticipated. Property rights regimes could not always be so easily transferred from one society to another as part of economic development policies and often were resisted or attenuated by local practices. Slow, incomplete, and controversial privatization efforts contributed to a stagnation of the economies of Russia, the Ukraine, and other transitional economies. In fisheries, ITQ policies were not embraced readily by the fishermen they were supposed to assist, and either met with resistance or could not be implemented until the fishery was so depleted that there were few other options.

These events shifted some attention to the second line of property rights research, investigation into how property rights develop, and why "efficient" regimes are not always observed (in fact, the ideal types are rarely observed). Analyses has required investigation into the details of the bargaining or "contracting" process among the parties establishing or modifying property rights and into the transactions costs they encounter. In these investigations the number and heterogeneity of the parties involved, the information that they hold, and the physical nature and value of the asset over which they were bargaining are identified as critical factors in agreement on and enforcement of property rights. Further, distributional issues are recognized as important–an area not normally considered by economists. How the proposed rights arrangement

blends with existing distributional norms affects its popular support and legitimacy. Additionally, individual net gains determine the position of the negotiating parties in property rights discussions. Even when there might be aggregate or collective economic benefits to a secure and well-defined property rights structure, if some parties perceive that they are better off under the status quo, they will resist the new arrangement. As a result, to secure a consensus, modifications in the proposed property rights regime often have to be devised, such as side payments (transfers) or restrictions on rights to be granted others. These modifications, however, change the nature of the proposed new regime and its ability to promote new investment and trade. Demands for compensation in bargaining reflects both legitimate concerns about the impact of a new property rights regime and rent-seeking or extortion (the hold up strategy). As a result of research into these bargaining conditions, property rights have come to be viewed as much more complex institutions than has been previously appreciated. Transactions costs and other bargaining problems can thwart negotiations and constrain possible arrangements and correspondingly, the potential economic options. Again, as Coase (1960, 39) warned: "But the reason that some activities are not the subject of contracts is exactly the same reason why some contracts are commonly unsatisfactory--it would cost too much to put the matter right."

II. Property Rights.

All societies and settings require some sort of property rights arrangement to control access and use of valuable resources if the losses of the common pool are to be avoided. Otherwise the value of the resource will be wasted away in competition for control, unproductive defensive and predation activities, emphasis on short-term uses when long-term may be more rewarding, associated neglect of long-term investment, limited market development for transfer

of assets to higher valued uses, third-party effects (externalities), and so forth. These losses underlie what Garrett Hardin termed the "tragedy of the commons" over thirty years ago.[5] Preventing these losses provides the motivation for individual agents to bargain privately (in small settings) or politically (in larger settings) to define a property rights structure and to modify it as conditions warrant.

Property rights refer to the sanctioned behavioral relations among economic agents in the use of valuable resources. They range from defining access and use of natural resources to defining the nature of market exchange and to work relationships within firms. They can assign ownership to private individuals, groups, or to the state. Regardless of the nature of the allocation, property rights must be clearly specified and enforced to be effective, and the degree of specificity depends upon the value of the asset covered.[6] For relatively low-valued assets and/or in cases where the number of parties is small and where there is a history of interaction, informal norms and local customs are sufficient for defining and enforcing property rights. For high-valued assets where the number of competitors is large and where new entry is common (so that the parties are heterogeneous and have little or no history of interaction), more formal governance structures, such as legally-defined private property rights, become necessary. In this latter case, the power of the state is usually necessary to supplement informal constraints on access and use.

Because of their impact on incentives for resource use, investment, and trade, property rights institutions underlie the performance and income distribution in all economies. In general, the ownership of an asset consists of three elements: (a) the right to use the asset (*usus*), (b) the right to appropriate the returns from the asset (*usus fructus*), and (c) the right to change its form,

substance and location (*abusus*). This last element, which amounts to the right to bear the consequences from changes in the value of an asset, is perhaps the fundamental component of the right of ownership. It implies that the owner has the legal freedom to transfer all or some rights in the asset to others at a mutually agreed-upon price. The flexible right of transfer induces an owner to operate with an infinite planning horizon and, thus, to show concern for the efficient allocation of resources over time.

In the limit, if property rights are so well defined that private and social net benefits are equalized in economic decisions, there will be no externalities. Resource use decisions made under these circumstances will maximize total wealth, given the existing income distribution and market demand composition. An alternative, although complete property rights assignment will have a correspondingly different income distribution, demand structure, and production mix. Nevertheless, the output chosen will maximize aggregate wealth under the new rights distribution. In a general efficiency sense, the issue is the completeness of the definition of property rights and not the specific allocation. When rights are not well defined or when they are attenuated by a group or the state, however, there are implications for economic performance. Restrictions on property rights may range from the significant to the trivial. The attenuation of property rights in an asset, affects the owner's expectations about asset uses, the value of the asset to the owner and to others, and, consequently, the terms of trade. Whatever specific form it takes, attenuation of property rights implies a shrinkage of economic options for the asset owner, and a corresponding reduction of the asset's value. If wide-spread in a society, attenuation of property rights can result in reduced economic performance, lower wealth, and fewer economic opportunities for its members.

Since property rights define the behavioral norms for the assignment and use of resources, it is possible to predict how differences in property rights affect economic activity. The comparative statics of assessing the impact of property rights institutions on economic performance, however, are complicated because causality also runs in the opposite direction. Competitive forces may erode institutions that no longer support economic growth. Population expansion and other changing market conditions exert pressure for dynamic adjustment in the existing rights structure through the refinement of rights and privileges or their transfer to others to facilitate responses to new economic opportunities. Predictions regarding the way in which property rights respond over time to changing economic opportunities, however, must consider transactions costs and equity factors. If transactions costs are low, then the initial assignment of rights may not matter because it can be modified routinely as necessary. This condition, however, does not describe most market conditions. Accordingly, rights often cannot be easily or quickly modified as economic factors change. The existing rights structure can have a durable and perhaps negative effect on the production and distribution. Transactions costs include the costs of bargaining, information, measurement, supervision, enforcement, and political action, and they help to determine how property institutions respond to changing economic conditions.

In general, there can be no assurance that institutional change (property rights) will always be structured so as to bring about rational resource use and rapid economic growth.[7] What actually happens depends upon bargaining or contracting in the process of creating or modifying property regimes. Changes in property rights arrangements affect distribution as well as production. Specifically, any redefinition of decision-making authority over resource use brings about shifts in the distribution of wealth and political power. What can be expected, then, is that

the attitudes toward institutional change taken by the various individuals involved in the rights-allocation process will be decided by the net gains they anticipate from a restructuring plan. Given this explanation, it is easy to understand why disagreements can occur, why bargaining can result in compromise and the establishment of rights structures that diverge from the pattern required for a fully efficient competitive system.

The problem of "producing" property rights reduces to one of creating effective agreement (in a group setting or in the political arena) on any proposed institutional reorganization:

> ....the heart of the contracting problem is devising politically acceptable allocation mechanisms to assign the gains from institutional change, while maintaining its production advantages. By compensating those potentially harmed in the proposed definition of rights and by increasing the shares of influential parties, a political consensus for institutional change can emerge. Those share concessions, however, necessarily alter the nature of the property rights under consideration and the size of the aggregate gains that are possible. If influential parties cannot be sufficiently compensated through share adjustments in the political process to obtain their support, otherwise beneficial institutional change may not occur, with potential economic advances foregone. Even though society is a whole is made worse off, the distributional implications lead influential parties to oppose institutional change.[8]

Accordingly, the process of private institutional change is complex, and can become derailed by high transactions costs. The bargaining underlying the creation or modification of institutions involves debate over the aggregate benefits of the new arrangement and the distribution of those benefits among the various interested parties. Negotiations can break down

if there are serious disagreements about either the net benefits of institutional change or their allocation. Conflicts, blocking cooperative solutions, can arise from, among other things, serious information asymmetries among the parties, bounded rationality, and an inability to devise side payments to compensate those who believe they will be harmed by institutional change. These problems increase with the size and heterogeneity of the bargaining group. As a result, institutional changes that would be anticipated in a transaction- cost-free environment may not take place or they emerge only in abbreviated form.

III. Contracting Issues.

The existence of aggregate gains from new institutions to reduce transactions costs is not sufficient to insure that such arrangements will emerge. The distribution of those gains is often of key interest to the negotiating parties, and the distributional conflicts may block or seriously modify the types of institutions that ultimately result. Problems of cooperation have been the focus of game theory where free riding and prisoners' dilemmas provide incentives for individuals not to cooperate regardless of the actions of the other parties. Ostrom (1990) on the other hand, provides empirical examples of how these contracting problems have been overcome in certain instances in the provision of public goods. Generally, the empirical cases of successful cooperation involve fairly stable, small communities where information is available on each individual's contribution, and where the parties have frequent contact with one another. In such communities, the existence of social norms facilitates cooperation. But the adequacy of those social norms and their durability in the face of relative price increases and new entry by non-members remain questionable. In examining conditions for cooperation, Harsanyi (1968, p. 321) argues that "*social norms* should not be used as the basic explanatory variable in analyzing social

behavior, but rather should themselves be explained in terms of people's individual objectives and interests."

In general, agreement on a new, socially-beneficial institutional structure depends upon (i) the size of the aggregate gains to be shared, (ii) the number and heterogeneity of the bargaining parties involved, (iii) extent of limited and asymmetric information, (iv) distribution issues and (v) the physical nature of the resource. Each of the bargaining parties is motivated to support beneficial institutional change by the size of the expected share of the gains that the new arrangement will bring. Haggling over any of these factors can block agreement and impede institutional change.[9]

The larger the expected aggregate gains, the more likely some agreement will take place. The total benefits of a new or modified property rights regime often will not be controversial–the wealth losses associated with common-pool competition can be apparent to all. If the alternative of no agreement is so dismal, then negotiations may proceed quickly. This condition explains why institutional change frequently occurs late in the history of the exploitation of a resource after common-pool losses have become so large that distributional concerns are relatively unimportant. Unfortunately, by that time, much wealth has been lost and the resource may not recover. Empirically, for example, acceptance of regulatory measures to restrict fishing effort come only when the fishery is so seriously depleted that there is little recourse. At that time draconian measures may be necessary, and the recovery may take a very long time.[10] In other cases, however, the benefits of agreement on a property structure are so obvious that the parties can devise an informal arrangement quickly. This condition characterizes much of the mining camps in American economic development where local miners' rules governed prospecting and

mining, allowing miners to focus on the search for and extraction of precious metals and avoid wasteful competition and uncertainty of control.[11] This condition also describes the ability of initial settlers on the Brazilian Amazon frontier to define informal rights during the very early stages of settlement.

The number and heterogeneity of the bargaining parties makes initial agreement and subsequent adherence to it more difficult. This is a standard outcome in cartels and other collective action settings.[12] The greater the number of competing interests with a stake in the new definition of property rights, the more claims that must be addressed in negotiations to build a consensus on institutional change. But the problem is compounded if the parties are also quite different in their expectations, costs, wealth, size, or other important attributes. Under these conditions, it will be much more difficult to reach agreement on a definition and distribution of property rights that satisfies all parties. For example, some parties may decide they are better off under the status quo than under a new definition of property rights, even though there is a consensus that the group as a whole would be better off under the proposed arrangement. Side payments are a way of compensating those who resist potential change, but deciding the amount to be paid, the nature and timing of the payment, and the identities of the parties to fund and to receive the transfer may be contentious.

Information problems can complicate an accord on any side payments that are under consideration to draw in recalcitrant parties. Agreement on a transfer requires agreement on the amount to be paid, which in turn, requires agreement on the value of current holdings and of any losses that some parties expect as a result of the new definition of property rights. The valuation of individual wealth under current and proposed property rights can be a serious problem when

there are information asymmetries among the parties regarding the value of individual holdings. These disputes will occur quite aside from any strategic bargaining efforts if private estimates of the value of current property rights and of potential losses from the new system cannot be conveyed easily or credibly to the other bargaining parties. In this case, an accord on share adjustments or other compensation either may not be reached or achieved only with great difficulty, delaying institutional changes to address common-pool losses. In addition to honest disagreements on the values of individual claims, the information problems encountered in devising side payments will be intensified if the parties engage in deception or opportunistic behavior. Deception can be used to increase the compensation given as part of an agreement on a new property rights arrangement. It occurs through willful distortions of the information released by various interests to inflate the value of current property rights and the losses institutional change might impose. Widespread deception by competing parties can make agreements more difficult by reducing any trust that might otherwise promote the more rapid consideration of individual claims in side payment negotiations.

Finally, agreement on a new rights structure will be affected by the distribution of wealth that it authorizes. All things equal, very skewed rights arrangements lead to pressure for redistribution through further negotiations, a lack of enforcement of existing ownership, theft, and other forms of violence.[13] If the wealth allocation under the existing property rights regime is so highly concentrated that few have a stake in it, then it will lack legitimacy and likely be unstable. Under these circumstances, the property rights system will not be an effective response to common-pool losses. Enforcement costs will be high, and those costs will drain wealth and resources from productive endeavors. Indeed, if the property system is perceived to be closed;

that is, if non-owners have few practical means of becoming owners (either through legal restrictions or through the size of the capital accumulation necessary to acquire assets), then owners and non-owners will have different incentives to maintain the property system. Some parties may prefer an incomplete specification of property rights because such an arrangement allows for greater redistribution. The tension between wealth creation through secure property rights and redistribution to redress a skewed distribution of wealth presents problems for effective institutional change. By contrast, if entry is relatively open, that is, if there are recognized opportunities for social and economic mobility, pressures for redistribution may be mitigated. With economic mobility, the wealth assignment over time will be seen as more flexible and more parties can anticipate improvements in well-being. If that is not the case, however, and the proposed system of property rights is seen as having very narrow beneficiaries, then a broad group consensus for change may not occur.

The physical nature of the resource affects private agreement on institutional change for defining or modifying property rights. The nature of the asset can make it difficult to calculate share values for negotiations. It may make the costs of marking and enforcing property rights more difficult. Relatively non observable, migrating resources are particularly difficult in the assignment of property rights, as experiences with fish, water (especially aquifers), and oil demonstrate. Stationary, observable resources with a history of stable prices are much more readily defined, valued, and traded in property rights negotiations.

IV. Contracting Issues Illustrated: The Development of Property Rights on the Amazon Frontier.

Economic frontiers provide a special opportunity to examine the emergence of rights structures–when they occur, the characteristics of the individuals involved, and when

modification of property rights becomes necessary. In that sense, they are laboratories for examining the contracting issues described in the previous two sections. Frontiers are defined with respect to distance from a market center, with land rents declining with remoteness. The economic frontier is the point where the net present value of claiming land just covers the opportunity costs of the claimant. Beyond the frontier, there are neither property rights nor markets. At the frontier, the conditions for market behavior begin to emerge, and the closer one moves toward the market center, the higher are land values and the more likely that formal property rights will exist. By analyzing settlement of a frontier it is possible to identify the factors underlying the demand and supply for property rights, both informal arrangements and formal title; ascertain the economic characteristics of the first settlers on the frontier; examine what the claimants do to obtain property rights; and determine what conditions facilitate agreement and which ones force further contracting.

The frontier examined here is in the Brazilian Amazon.[14] Some 5,000,000 km^2 of land is in the Brazilian Amazon, and as government land, most of it has been open to private settlement and claiming, in a manner similar to the North American frontier of the nineteenth century. Vast tracts of new territory have been opened through construction of road systems, such as the Belém-Brasília and TransAmazon highways. As the frontier has moved across the region, individuals have settled, claimed government land, negotiated informal property agreements with their neighbors, and later, sought title as formal recognition of their property rights. In some cases, conflict has resulted with land invasions by squatters on land that is already privately owned.

Frontiers have the potential to provide for the improved economic and social welfare of

settlers, but whether or how they will do so depends upon the property rights regime and how flexible that regime is to fluid, new economic conditions that emerge. If property rights are clearly assigned and enforced, individuals can exploit frontier resources in ways that maximize their wealth and that can reduce environmental problems. Frontiers also have the potential to be the site of conflicts over property rights and associated wasteful practices because, by definition, they are a place where formal legal and government institutions are largely absent. The provision of government infrastructure and services, such as land titles and enforcement mechanisms (judiciary and police force), is socially costly and is provided over time as land values rise. But just how smooth the process will be and how complete are the property rights that are assigned will depend upon local agreements, political conditions, and the nature of the land and other natural resources over which rights are to be defined.

With secure rights to land and the existence of land markets, price signals will direct land to those who will place it in its highest-valued use at any point in time.[15] This may involve consolidation of frontier plots and their subsequent transfer from initial settlers to those who arrive later with more farming experience and access to capital. The more broadly understood and accepted the property right, the more extensive will be the market for frontier land. This condition enhances the wealth of frontier settlers because it extends the number of potential buyers who are willing to pay more for the land than are other people on the frontier. Land often is the major (and only) asset held by early migrants, and their ability to claim and sell land and then move on to settle, claim, and sell, yet again and again, is a critical element in social and economic advancement. Through this process, eventually individuals acquire enough wealth to stay on site, develop it, and to become permanent farmers. This process suggests a life-cycle

dimension to frontier settlement, whereby relatively young individuals with little education, wealth, or options move to the frontier as entrepreneurial or risk-taking land speculators. The plots initially cleared by frontier settlers necessarily are small, often well under 50 hectares. These early farmers have very limited labor and often, minimal farming experience, and forest clearing and soil preparation are extremely difficult. Moreover, on remote frontiers, there are few markets for agricultural output, so that initial settlers engage in rudimentary, subsistence agriculture. But as transportation costs decline and population densities rise, local markets for farm products develop, and with sufficient improvements in roads and other forms of transportation, opportunities arise for specialization and the export of production to even more remote markets. Such production likely involves some minimal economies of scale as well as experience in farming and in commercial sales that initial settlers on the frontier probably lack. By transferring land from original settlers to more experienced arrivals market sales prove beneficial to both parties.

Another advantage of recognized and enforced property rights on the frontier is that they allow settlers to focus scarce labor and other inputs on clearing, farming, and other productive activities, rather than on defending their land claims. Subsistence farmers with limited resources can afford few distractions. Any circumstances that lead to the diversion of labor from agricultural pursuits to defensive ones, such as clearing swaths of land (that otherwise would be left in forest) to demarcate holdings and to allow for routine patrolling, reduces production and potential wealth. Indeed, defensive efforts could be so taxing that they would make frontier farming untenable. In the aggregate, violent conflict over land dissipates resource rents, and the associated uncertainty of control reduces land exchanges, investment, and land values.

Unfortunately, violent conflict occurs in parts of the Amazon. In addition to these advantages, secure property rights promote land-specific investment in at least two ways. One is that they allow for longer-term planning horizons because land owners have the assurance that their preferences will be implemented and that they will capture the returns from their investment activity. There will be little or no dissipation of the increased resource rents from investment due to competition for control. Absent a recognized property rights structure, however, short-time horizons instead dominate, and resource exploitation is more rapid and excessive than is socially optimal. Under such circumstances, the private and social net returns from production diverge, and the private incentives created by the commons are the source of many of the environmental and wasteful resource-use problems encountered on frontiers today, including the depletion of valuable rain forest stands, the overgrazing of natural pastures, and the rapid exhaustion of soil nutrients. Recognized title also promotes investment by providing collateral, allowing land owners to access capital markets. Frontier settlers typically are poor, and land is the most important asset that they have. Its use as collateral facilitates more substantial capital-intensive investments in irrigation, pasture improvements, planting of permanent crops (such as orchards), and timber management.[16]

The initial settlers to remote frontiers can rely on informal property arrangements, locally understood and respected. Where transportation costs are high, land values and expected returns from farming are low. As such, individuals with low opportunity costs are the first on the scene. Among early settlers, informal land allocation and use practices dominate. Land values are too low to justify formal documentation of individual land claims or to justify costly conflict among claimants. With abundant, cheap land, conflicting claims are avoided by the voluntary

movement of one of the contending claimants to another area. Rudimentary methods of denoting individual holdings are sufficient to divide land, and informal, temporary conflict resolution mechanisms are sufficient to address occasional disputes. Moreover, low resource values on the frontier typically mean that the resident population will be small and very homogeneous with respect to education, wealth, age, sex, and expectations for land allocation and use. Small numbers of homogeneous individuals provide conditions for successful collective action. Individuals will understand, appreciate, and support local, informal land institutions. Since land claims are uncontested, local land markets can develop among frontier residents, whereby exchanges occur without title. Through these exchanges, some consolidation of holdings occurs, and some settlers move on to new frontiers.

Alston, Libecap, and Schneider's (1995) analysis of 249 small-farm settlers in the northeastern Amazon state of Pará confirm these predictions. They found that those on the most remote sites were comparatively younger, less educated, with less urban experience, and with less wealth. In this regard, they were relatively homogeneous, differing from older, wealthier farmers with more education and larger farms closer to markets. In the areas furthest from market centers, property rights were informal–farmers did not have formal title to their lands. But there was little demand for title. Among the small claimants, there were few conflicts. Land exchanges were regional among local buyers who were familiar with local property arrangements. Land turnover among the first settlers was frequent, with the first farmers often settling and clearing property; selling it (even without formal title) to another settler; and then moving on. In this manner, young settlers appeared to acquire capital over time for more permanent settlement. On the frontier, property boundaries were observed by the settlers and

trespass uncommon. Small holders with fewer than 200 hectares occupied their lands and could detect intrusion. Farm boundaries were clearly marked by planting trees, often cashews. Their lands also were in production, which meant cleared of forest and placed in pasture and crops. Clearing made monitoring easier. Additionally, in Brazil property rights to farms in "beneficial use" are respected both by custom and by law. Much larger farms of 5,000 hectares or more with forested lands not in production were much more likely to have their property rights ignored with land invasions and redistribution to squatters.[17]

For farms closer to markets, with lower transportation costs, land values were higher, and the potential for disputes greater. Informal property rights institutions and conflict resolution mechanisms no longer were sufficient to allow claimants to appropriate potential land rents. With easier access, settlement density was greater, locational rents higher, and competition for the land more intense. With greater competition, private enforcement costs rose. Moreover, increased migration to the frontier brought more, heterogeneous individuals to the scene. These new claimants often did not understand or recognize local land property regimes. Efforts to negotiate new, local property arrangements among existing and new claimants under remote and fluid frontier conditions would have been plagued by high transactions costs of negotiation, especially when there was limited information about the value of the assets being claimed or traded (as would be the case for frontier land in the absence of much price data), free-riding, and monitoring problems (also a problem in the presence of dense forests which hide boundaries and conceal infringement or trespass).[18]

These issues suggest that early frontier property rights will be limited in scope and based on local, informal arrangements. But they will be difficult to maintain as additional migrants

appear, who have different experiences and expectations regarding the allocation and use of frontier lands. Violation of local rules, trespassing on previous land claims, and the absence of permanent conflict-resolution institutions, such as courts and police, ultimately will lead to dissatisfaction with existing, local arrangements. If they break down, resources will be diverted from production to defensive and predatory activities as competition for control ensues. As a result, settlers will begin to feel the uncertainty of tenure associated with conflict over land claims. This uncertainty will dampen any investment plans and encourage more rapid land use activities. Those wishing to make long-term investments to raise productivity or take advantage of new commercial opportunities, such as planting permanent crops, investing in untried field crops, and improving pastures, now that land is more scarce, will require more formal and secure tenure assurances.

Secure tenure, as represented by formal, enforceable title, will provide collateral for accessing capital markets for such investments and facilitate land sales to those with higher opportunity costs and greater education, wealth, and farming experience. These are the people most likely to be aware of new investment opportunities and to have experience in implementing them. By promoting investment and the transfer of land as necessary, titling will maximize land rents. If secure property rights are not provided, land transfers will not take place as readily, and individuals will focus on short-term, existing farm activities, foregoing investment, limiting sales opportunities, and channeling productive resources to defending their claims or seizing those of others.

As a result, as transportation costs fall through the construction of new roads and as the frontier shifts further into unsettled lands, having title offers greater returns, justifying the costs

of traveling to local land offices, requesting surveys, and completing the legal documents for title. According to those surveyed by Alston, Libecap, and Schneider, numerous trips to land offices were necessary to secure land agency responses. Title gives legal standing to the land owner with survey descriptions, recorded boundary markers, and date of recording to establish precedent for the claim. Previous owners are listed. This record can be valuable if there are disputes over land transfers. With title, the police power of the state is used to enforce private property rights to land. The courts issue eviction notices against trespassers or arbitrate boundary disputes, and law enforcement officials implement court orders. Further, formal title provides collateral for accessing capital markets for loans for investments in crops, fencing, land improvements.

To illustrate the value of having title, Alston, Libecap, and Schneider (1996) examine the interaction of the effects of title, land value, and investment for 206 small holders in the state of Pará. They find that title is a powerful determinant of investment among these settlers. With investment measured as the percent of farm land in pasture and permanent crops, having title significantly stimulates investment, increasing it by 21 to 48 percentage points, depending on the site. Investment, in turn, is the most important determinant of land value. Survey responses indicated title increases land value by 20 to 50 percent.

The Amazon frontier case illustrates the ability of individuals to negotiate effective informal property rights arrangements under conditions where there is a small number of relatively homogeneous bargainers. As those conditions change, there is demand for an institutional shift toward the more formal property rights provided by title. How smoothly this process takes place, however, involves political factors and the response of politicians and

bureaucrats to the demand for title. The situation in the Amazon frontier also illustrates the problems encountered in establishing and maintaining property rights when the parties are heterogeneous. The resource costs of insecure property rights are also demonstrated. In the region there are both small and large farms. As noted above, among small holders there is no record of important conflict over property. But between small land claimants (squatters) and large land owners there are serious disputes. Under Brazilian constitutional law, land must be kept in beneficial use, which in the Amazon means deforested and placed into pasture or crops. Some large farms of 3,000 hectares or more have significant amounts of forested land, and these properties are vulnerable to invasion and occupation by squatters. Once occupied and placed into cultivation, the squatters can call for the redistribution of the land from the current official owner under land reform. Land ownership in Brazil is highly skewed, and Brazilian governments are sensitive to the demands of the landless.[19] The government may intervene to seize the farm and redistribute it to the squatters. Brazilian courts, however, attempt to protect title, and usually rule in favor of the land owner. The associated uncertainty over control leads to violence, a reduction in land values, reduced investment, and paradoxically, greater deforestation. To show beneficial use, land owners harvest the rain forest more rapidly than they otherwise would and squatters, to prove their intention to stay on the land and to place it into cultivation, also cut the forest. In resolving the dispute, the government typically provides compensation to either the land owner or the squatters based in part on how much land the parties have placed in to cultivation (deforested).[20] There are international concerns about maintaining the stock of rainforest, and this objective is not helped by uncertain and confused property rights due to competition over land in the Amazon.

V. Contracting Issues Illustrated: Oil Field Unitization

A summary of some of the issues encountered in unitizing oil and gas reservoirs illustrates the transactions costs that can be involved more broadly in contracting for property rights. Transactions costs arise from information problems, equity concerns, and the physical nature of the hydrocarbon formation. The discussion shows the complexities that can bedevil efforts to define or modify property rights (in this case oil field shares) even in the presence of large aggregate gains from agreement.

The production of crude oil and natural gas potentially involves serious common-pool losses.[21] These losses arise as numerous firms compete for migratory oil and gas lodged in subsurface reservoirs. Under the common-law rule of capture practiced in the United States, private property rights to the hydrocarbons are assigned only upon extraction. Production rights are granted firms through leases from those who own the mineral rights, often surface land owners. Each of the producing firms has an incentive to maximize the economic value of its leases, rather than that of the reservoir as a whole. Firms competitively drill and drain, including the oil of their neighbors, to increase their private returns, even though these actions reduce the aggregate value of the reservoir. Oil reservoir value or rents are dissipated as capital costs are driven up with excessive investment in wells, pipelines, surface storage, and other equipment. Rents also are dissipated as production costs rise with too-rapid extraction. Rapid production of oil results in the early venting of natural gas and/or water, which otherwise help drive the oil to the surface. As natural gas and water are voided from the reservoir, costly pressure maintenance or secondary recovery actions must be implemented. These actions involve the use of additional pumps and injection wells. Total oil recovery falls as pressures decline because oil becomes

trapped in surrounding formations, retrievable only at very high extraction costs. Finally, rents are dissipated as production patterns diverge from those that would maximize the economic value of the reservoir over time.

The most complete solution to the common-pool problem in oil and gas reservoirs is unitization. With unitization, a single firm is designated as the unit operator to develop the reservoir as a whole. The unit operator often is the firm with the largest amount of leased area. Each of the firms that otherwise would be producing, as well as the unit operator, receives a portion of the net returns of production according to a negotiated, pre-set allocation formula. In effect, all firms become share holders in the ownership of the complete reservoir, rather than owners of individual leases. Indeed, under unitization, the lease loses its production significance. Wells and other equipment can be placed to maximize recovery and to minimize costs, and production can be controlled to maintain subsurface pressures and to increase overall recovery. With a single unit operator and the other lease holders acting as residual profit claimants, there are joint incentives to develop the reservoir in a manner that maximizes its economic value over time. With unitized development and operation of reservoirs, no difference exists between the amount of oil and gas privately supplied and the socially-optimal amount. When producers expect unitization to occur, exploration is encouraged because greater recovery rates and reduced costs are anticipated. Bonuses and royalties to landowners are higher because the present value of the oil and gas resource is greater with unitization.

The gains from unit agreement have been understood for a very long time, perhaps since first oil discovery in the U.S. in 1859. They can be huge, both from savings in capital costs and from increases in overall production that can be from two to five times unregulated output.[22]

With so much at stake, oil firms are motivated to reach agreement to form complete units. Yet, despite this motivation, complete unitization is much more limited than one would expect. Joe Bain commented in 1947 (p. 29): "It is difficult to understand why in the United States, even admitting all obstacles of law and tradition, not more than a dozen pools are 100 percent unitized (out of some 3,000) and only 185 have even partial unitization." Similarly, Libecap and Wiggins (1985) reported that as late as 1975, only 38 percent of Oklahoma production and 20 percent of Texas production came from reservoir-wide units.

Achieving consensus on a unit contract is difficult with agreements often completed only after years of negotiation, when many of the efficiency losses already have occurred. Even when unitization agreements are reached, not all are complete, leaving the potential for various forms of competition among owners that dissipate rents.[23] In an examination of seven units in Texas, Wiggins and Libecap (1985) and Libecap (1989b) showed that negotiations took from four to nine years before agreements could be reached. Moreover, in five of the seven cases, the area in the final unit was less than that involved in early negotiations. As some firms became frustrated, they dropped out to form subunits. But subunits led to a partitioning of the reservoir, the drilling of additional wells, and generally, did not minimize common-pool losses. For example, after unsuccessful efforts to completely unitize the 71,000-acre Slaughter field in West Texas, ultimately 28 subunits were established, ranging from 80 to 4,918 acres. To prevent migration of oil across subunit boundaries, some 427 offsetting water injection wells were sunk along each subunit boundary, adding capital costs of $156 million.

Other costs of not completely unitizing are shown on Prudhoe Bay, North America's largest oil and gas field, first unitized in 1977. Two unit operators, separate net revenue sharing

formulas for oil and gas, and associated competition among the oil and gas owners resulted in protracted and costly conflicts among the parties on the field.[24] This arrangement did not effectively address the common-pool problem. In 1996, concerns about wasteful production practices led the Alaska Oil and Gas Conservation Commission to initiate hearings on a mandatory restructuring of the Prudhoe Bay Unit.[25]

Even though unitization increases the aggregate returns to be divided among the firms on a reservoir, this fact alone is not enough to bring rapid agreement on unitization plans. There are a variety of issues to be settled in negotiations. The parties must negotiate a sharing rule or participation formula for the allocation of costs and revenues from production, and because remaining production often lasts 20 years or more, the rules must be durable and responsive to considerable uncertainty over future market and geological conditions. Units require pre-set agreements and no renegotiation. All entry or exit of parties must follow specified parameters if property rights are to be stable. There may be different sharing rules for different phases of unit production, such as primary and secondary production, and the rules should apply to all firms on the reservoir. This is termed a single participating area, and there should not be separate participating areas for oil and gas. Otherwise, different incentives for oil and gas production will emerge, as happened on Prudhoe Bay. To align all of the interests in maximizing the economic value of the reservoir, development, capital, and operating cost shares must be equal to revenue shares. In that case, each party will be a residual claimant to the profits from effective operation of the entire unit. Under these circumstances, the parties would not want to hold up needed investment or delay new production practices (such as drilling injection wells) in order to opportunistically force a re-negotiation of the contract. Such actions would not only reduce unit

profits, but would invite similar strategic behavior by other parties, eroding the basis for any long-term cooperation to maximize the value of the unit. As such, the profit-sharing formula provides for self-enforcing cooperative behavior among the working interests and expands the "self-enforcing range" of the contract.[26] Accordingly, although reaching agreement on the sharing formula involves long and costly negotiations, once established the formula reduces *ex post* enforcement costs.

Alternatively, if there is a wedge between the cost and production shares assigned to any party, then the consensus will fail and conflicts emerge. For example, if the sharing formula does not uniformly allocate each type of cost in the same proportion as production, certain owners will advocate actions that would skew development in the direction of those expenditures (such as injection wells) in which they carry a relatively light load—even if that is inconsistent with maximizing the overall value of the unit. Dissension, violation of the unit agreement, and rent dissipation are likely results. To resolve such disputes, some parties (typically those with the largest leases and the most to lose) may devise side payments that restore consensus and allow development to proceed. Although side payments may balance interests at one particular point in time and persuade all parties to support a common course of development, they do not assure incentive compatibility over the remaining life of the unit. New disputes and conflicts will emerge (and the need for additional side payments will ultimately arise) if cost and production shares are not made equal. Interests can easily fall out of balance as soon as circumstances (expected prices, costs, or production possibilities) change, which they inevitably do. Further, efficiency losses inflicted on the unit from disagreement and non-optimal production practices may be irreversible due to resulting changes in reservoir dynamics. Accordingly, *ex post* efforts

to align interests via side payments are not apt to be as effective as the *ex ante* proportionate assignment of costs and production to each party. Importantly, aligning incentives through a profit-sharing formula reduces the information necessary for implementing a unit agreement. The contract can be left relatively simple because new information will be incorporated and plans adapted by consensus over the life of the unit in a manner that maximizes its value and the returns to the parties. For example, new information about the configuration, extent, and communication of reservoirs is revealed through production. This knowledge may require extension or contraction of the unit with the corresponding addition or dropping of interests from the unit. When parties are added or deleted, the relative position of the incumbent interests is maintained as outlined in the initial profit-sharing formula. Re-negotiation of the formula is not required. Similarly, the allocation formula is robust against unexpected changes in oil prices, costs, or recovery methods. The incentives of the working interest owners remain aligned (without side payments or re-contracting) even as these features of the project are unpredictably altered.

Further, a *single* unit operator must be selected to develop the field. Multiple unit operators lead to conflicting objectives and hinder the coordinated production practices necessary to maximize the value of the reservoir. Supervision of the unit operator by the other interests must be determined, with voting based on share ownership. If an incentive-compatible sharing rule is adopted, each party will favor a production plan that maximizes the economic value of the unit, and execution can safely be left in the charge of a single unit operator without detailed performance provisions or enforcement guidelines defined at the initiation of the contract. Any firm with a lease interest in the reservoir and the technical competence to develop it would

provide incentive-compatible management. Beyond this, reliance on a single unit operator reduces the transaction and coordination costs that would arise if there were multiple unit operators and as such, further enhances the overall net value of the reservoir.

Determining which firms should be included in the unit and selecting the unit operator can be contentious, but reaching agreement on the basic sharing or participation formula is the most difficult. Shares are based on estimates of each firm's contribution to the unit. Those firms with leases that have a natural structural advantage will want to retain the value of this advantage in the unitization formula. Such firms are unlikely to agree to a unitization agreement that does not give them at least as much oil or gas as they would have received by not unitizing. Even if the increase in ultimate recovery from unitization is so great that these parties will receive more from unit operations than from individual development, they have a much stronger bargaining position in negotiations than less-favored tract owners. They can hold out for the most favorable allocation formula, secure in the knowledge that the regional migration of oil will continue toward their tracts during any delay in negotiations. Indeed, holding out may increase the value of a structurally-advantageous location. If the firms form a subunit without the participation of the owners of better located tracts, the pressure maintenance operations of the unit may increase the amount of oil migration toward the unsigned tracts. The holdouts then benefit from the unit without incurring any costs of the pressure maintenance activity.

Other significant problems involve incomplete and asymmetric information about current lease values and the effects of unit-wide production, such as secondary and enhanced recovery, which are risky technologically and economically. These actions change the time pattern of oil and gas production, perhaps lowering short-term payments to some royalty and working interests,

while increasing payments over the long-term. Production patterns, however, are estimated only imperfectly so that there may be disagreement as to the present value of leases and proposed unit shares. Some parties may refuse to join the unit because they have different information and assess the risks and rewards differently than do the proponents of the unit.

Estimates of pre-unitization lease values determine unit shares, and each firm wants the most favorable valuation possible. The level of information available to the contracting parties for determining lease values depends upon the stage of production in which contracting occurs. In exploration, little is known regarding the location of hydrocarbons and commercial extraction possibilities. At that time, all leases are relatively homogeneous, and unitization agreements can be comparatively easy to reach, using simple allocation formulas, often based on surface acreage. Since no party knows whether the formula is to its particular advantage or disadvantage, negotiators can focus on the aggregate gains from unitization. Information problems and distributional concerns, however, arise with development, as oil and gas reserves are proved and expanded. With the initial discovery well and the drilling of subsequent wells, lease heterogeneities emerge. Because reservoirs are not uniform, the information released from a well is descriptive of only the immediate vicinity. Hence, through drilling their individual leases, firms gain knowledge of their portion of the reservoir. The full extent of the deposit and the productive potential of other areas of the reservoir will be revealed only through the drilling activities of other firms.

There are disagreements among the unitizing parties over the nature of lease information produced and how to evaluate it in setting lease values. Some of the information is public, objectively-measured, and noncontroversial, such as the number of wells on the lease, its surface

acreage, and the record of current and past production. Other data are more private, more subjective, and hence, more likely to be disputed, such as the amount of oil below lease lines, remaining reserves, net oil migration, and bottom hole pressure. As a result of disagreements over subsurface parameters, unit negotiations often must focus on a small set of objectively measurable variables, such as cumulative output or wells per acre. These objective measures, however, may be poor indicators of lease value. Differences in the data available for estimating lease values and unit shares in negotiations inhibit agreement between the lease owner and other firms on the formation of a unit, even when there are large aggregate gains from such action. These conflicts over lease values and unit shares will continue until late in the life of a reservoir. With the accumulation of information released through development and production, public and private lease value estimates converge as primary production (production based on natural subsurface pressure) approaches zero. At that point, a consensus on shares and the formation of the unit is possible. This suggests that unit agreements are more likely to be reached late in the life of the reservoir after most of the common pool losses have been inflicted.

In unit negotiations, each of the bargaining parties compares the expected value of its returns under the status quo or nonunitized production with the expected value of returns with unitization, based on its offered share in the unit. The status quo returns are net of the firm's share of common-pool losses, if the unit is not formed at that time. If the firm's private information indicates that the organizing committee's estimates of its lease values, based on public information, are too low, the firm may delay joining the unit. The decision will be based, in part, on whether the firm expects future production data to confirm its private value estimates and justify an upward revision in its unit share. The firm will also be concerned as to whether

this gain in unit share offsets its portion of reservoir damage from delaying the unit. In addition to delaying because of conflicts based on information asymmetries, the firm also may decide to delay joining if it can obtain concessions from other parties by holding out. In the meantime, non-unitized production shares are determined by relative lease production capabilities, subject to any constraints imposed by regulatory authorities. Most states, as well as the federal government, have some type of compulsory unitization rule to limit the ability of a minority of holdouts to block a unit. Due to political opposition by small firms that receive regulatory-related benefits, Texas, the second largest oil producing state, does not have a compulsory unitization law.[27]

Even when unit agreements can be reached the contracts may not fully align incentives to maximize the value of the reservoir over time. Libecap and Smith's (1999a) empirical investigation makes use of the largest data set of unitization contracts compiled to date—60 unit contracts in the United States and Canada.[28] In their survey, they find that units with relatively simple and homogeneous geologic structures (no clustering of oil and gas in separate parts of the reservoir) and only one production phase (no secondary recovery), have effective unit contracts and no history of wasteful contention among the parties. These units have sharing or property rules that assign costs and revenues equally to each party and hence, align incentives for optimal unit-wide production. These conditions describe 78 percent (47 of 60) of the units, underscoring the importance all parties place on reaching effective agreement to maximize the value of the reservoir over the life of the contract. 22 percent of the units, however, do not have the requisite sharing rules. These are more complex units with multiple production phases and/or separate concentrations of oil and gas (gas cap). Because of complicated geological conditions and

associated uncertainty over lease values, negotiating conditions are more complicated for these units, and such conditions affect the ability of the parties to reach agreement on an incentive-compatible property sharing formula. Especially in formations where oil and gas are in separate pockets (gas caps), incomplete agreements exist, and conflicts and rent dissipation follow, as illustrated by the case of the Prudhoe Bay Unit. In these cases, negotiating over unit shares amounts fundamentally to the trading of disparate assets among the parties. Because the reservoir has distinct physical properties that are not uniformly distributed, the respective leases generally reflect assets that differ very much in kind, as well as quantity. Some lease owners may have mostly gas beneath their leases while others have mostly oil. In order to completely unitize the reservoir, the two sides have to adopt (at least implicitly) agreed terms of trade by which an interest in gas is exchanged for a compensating interest oil. Similarly, certain parties may hold leases that provide natural sites for production wells (for example, high on the formation) during primary production, while others may hold leases that are better candidates for water or gas injection (for example, low on the formation) during secondary production. Again, it will be necessary for the parties to adopt terms of trade based on the lease locations and the potential for enhanced recovery efforts to supplement the natural reservoir drive

Through repeated negotiations, the parties typically are capable of translating differences in quantity of resources into ownership shares in the unit. However, differences in kind are more problematic. The basis for placing relative values on the oil and gas assets often is not obvious to the bargaining parties. Gas ownership presents a particular problem. The valuation of gas in the reservoir depends on whether it is assumed to be marketed, as opposed to being re-injected in

support of enhanced oil recovery efforts. Due to limited transportability in some cases, the existence of any external market for the gas may be doubtful, especially in remote locations. To the extent that the imputed value of gas is speculative, the parties find it difficult to adopt any definite terms of trade of oil for gas and are unable to agree on any particular distribution of equity in the unit as a whole. Gas values are more volatile than are those for oil and they do not always track one another, making valuation and exchange of gas and oil properties difficult. In response to these conditions, the parties may elect to partition the unit in a way that isolates differences among tracts and permits them to be negotiated separately. The simplest example of this occurs when a reservoir is spatially partitioned into separate gas cap and oil rim participating areas (PAs), based on the preponderance of oil or gas in various parts of the reservoir. Individual sharing formulas are then negotiated for each PA. Under these arrangements, each party is assigned a distinct share in the operations of the participating area, but *not* the unit as a whole. The party whose lease overlies a relatively large share of the oil, for example, is assigned a relatively large share of equity in the oil rim PA, and perhaps little or none of the equity in the gas cap PA. Alternatively, a reservoir may be partitioned across time, as when production efforts are divided into primary and secondary recovery phases, with each working interest owner accepting distinct interests in reservoir operations during each of the two phases. Both types of partition (dual PA and multi-phase recovery) are quite common in the industry because they reduce the costs of reaching initial agreement on the unit. But they may weaken the ability of the unit to align incentives and hence, maximize the economic value of the reservoir. When the reservoir is partitioned along any dimension, a boundary is created that may incite competition for resources and for value. The existence of such partitions may render the unit incomplete and

hence, create conflicts of interest that must be managed by the lease owners in order to avoid inefficient, competitive development.

VI. Concluding Remarks.

Property rights are essential social institutions for combating the potential wealth losses associated with the common pool. That is, when there is no clear definition of ownership over valuable assets, then parties will wastefully compete for them and under invest in them. Third-party effects or externalities will result. In the most extreme case, the value of the asset will be fully dissipated through competition for control and lost opportunities for investment and exchange. More commonly, however, such extreme cases will be avoided, but the potential wealth from effectively exploiting the resource will not be reached, and some unsatisfactory, underperforming state will prevail. To remedy this situation, individuals have incentives to negotiate privately or larger settings, publicly, to develop more complete property rules. But the desire to mitigate the losses of the common pool and to secure the associated gains is not always sufficient to bring beneficial institutional change. Even when some agreement on property rules is possible, its form may deviate sharply from what would seem to be the most desirable arrangement.

Attention to the details of the bargaining or contracting process explains why. The parties are motivated by rational self interest in distribution--their share of the aggregate social returns from agreement. If the anticipated shares makes the parties better off relative to their status quo position, then agreement is likely. If not, the parties are motivated to continue under the current regime, even if there are aggregate social losses from so doing. The larger the total benefits of devising new or modifying old property rights, the more probable is agreement. Further, the

more homogeneous are the parties, the more likely that they will be able to construct and agree upon an assignment of property rights (shares). Where the parties differ in important dimensions, such as production cost or access to information about the value of the asset, then agreement on property sharing rules is going to be more difficult. And if the numbers are large, the transactions costs of reaching agreement will be increased. These points help explain the persistence of seemingly ineffective property rights arrangements across societies and across time. The parties may agree that something must be done, but they cannot agree on how to proceed most effectively.

The Amazon frontier illustrates a number of the issues raised here. The first settlers on the frontier are reasonably homogeneous and they realize that a failure to adopt local rules about property could lead to devastating competition and conflict. Without social rules to constrain competitive behavior, the settlers could fail on the frontier. Their numbers are small in any location, the claimants are similar, and the value of the land is comparatively low. Serious disputes are too costly to undertake. Collective action is possible. But as land values rise with the passage of the frontier following the construction of new roads, more claimants appear. These have different characteristics and have higher opportunity costs. Informal arrangements no longer provide the security of ownership necessary to promote investment and exchange. Title becomes necessary. Some property owners may have large undeveloped holdings of land that invite trespass from those that do not have land. And if the land is valuable enough, it may pay the owner to seek to evict the trespassers. Conflict may result. Government intervention and redistribution are possible, but although they address distributional concerns, these actions weaken property rights and their associated economic benefits.

The second empirical case examined in this chapter, oil field unitization, is particularly valuable for understanding the contracting underlying property rights arrangements because the details of negotiation are so rich and because the variety of outcomes is so large, with predicable results. In most cases the parties on an oil reservoir see the benefits of eliminating competitive extraction through the adoption of a unit agreement, but the devil is in the details–the assignment of individual shares in the unit. Cost and revenue shares must be the same for each party in order to make them claimants for the net revenues of unit production. But agreement on these shares can take a very long time–10 years or more, all the while wasteful competitive production may be occurring. If the parties are quite homogenous with respect to their holdings and the formation is comparatively simple, a unit agreement can be reached quickly. And the agreement can be incentive-compatible so that simple rules and minimal governance are all that are necessary to insure a production path that maximizes the economic value of the unit as a whole. But if the parties are heterogeneous with respect to their holdings of oil and gas, and if their leases differ sharply in productive potential and strategic location on the formation, then agreement on ownership shares in the unit is more difficult. And when agreement is reached, it may not fit the ideal type, with differing cost and revenue shares and multiple unit operators. These conditions encourage dissension and wasteful production practices within the unit.

Given the importance of property rights institutions for efficient resource use, more attention must be paid to them, and where they are effective, they must be protected. There is always tension between the productive benefits of secure property rights and the distributional results of a property allocation. Distributional concerns drive the negotiations for developing and modifying property rights. Understanding these concerns and how they impact contracting for

property rights is necessary for explaining why a society has the kinds of property rights that are observed and the obstacles that will be faced in attempts to modify them. Even so, high levels of economic welfare cannot be taken for granted. As property rights are abridged in response to distributional concerns, the range of economic opportunities available to the owner is narrowed. The resulting shift in expected returns can lead to different (and less valuable) resource uses with profound economic welfare consequences for the entire society.

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12. Schmalensee (1987).

13. Alston, Libecap and Mueller (1999a, 1999b, 2000).

14. This discussion is based on Alston, Libecap and Schneider (1995, 1996); and Alston, Libecap and Mueller (1999a, 1999b, 2000).

15. Demsetz (1967).

16. The important roles of title and collateral in economic development is shown by Feder and Onchan (1987) and Feder and Feeny (1991) for small farmers in Thailand.

17. See Alston, Libecap, and Mueller (2000).

18. See Olson (1965) for description of the problems of negotiation among heterogeneous parties.

19. Alston, Libecap, and Mueller (1999a, 37).

20. See Alston, Libecap, and Mueller (2000).

21. For general discussion of the common-pool problem using fisheries to illustrate the issues, see Gordon (1954) and Cheung (1970). For application to oil see, Libecap (1998a, 1998b) and Libecap and Smith (1999a).

22. Oil Weekly (April 13, 1942; May 3, 1943). The Oil and Gas Journal (December 7, 1964) predicted that unitization would raise oil recovery by 130 million barrels on the Fairway field. For additional discussion, see Libecap and Wiggins (1994).

23. Wiggins and Libecap (1985) and Smith (1987) examine some of the bargaining issues faced by unit negotiators.

24. The problem may be resolved with the recent purchase of ARCO, one of the unit operators, by British Petroleum, the other unit operator.

25. Oil Daily, May 7, 1996, 2.

26. As described by Klein and Murphy (1997: 417), "the self-enforcing range measures the extent to which market conditions can change, thereby altering the gains to one or the other party from nonperformance, without precipitating nonperformance."

27. For discussion of state regulations, see Libecap and Wiggins (1985) and Libecap (1989b). Libecap and Smith (1999b) also outline why firms might legitimately oppose compulsory unitization regulations.

28. The empirical investigation uses 60 unit operating agreements from oil and gas reservoirs in Alaska, Alberta, Illinois, Louisiana, Oklahoma, New Mexico, Texas, and Wyoming.