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Fence-in laws in most states require ranchers to pay for fences to keep their livestock from trespassing onto others' property. Some states, or jurisdictions within states, have a fence-out rule that requires ranchers' neighbors to pay for fences to keep livestock out. Both rules are Pareto optimal. Using a potential Pareto criterion, we show that a preference for fence-out in some areas may end as conditions change, such as increased nonranching land uses. Changed conditions may have legal consequences. Specific fence-out and fence cost-sharing provisions may be potentially Pareto inefficient and may be challenged for being unconstitutional under the due process clause.

Key words: due process, fence law, open range, potential Pareto criteria

Introduction

Although English common law which required the enclosure of livestock was brought to the United States, many states found that the vast areas of open grazing space favored adopting a fence-out rule (Hart). Under fence-out, livestock owners (hereafter called ranchers) may let their livestock roam and are not responsible for damages caused by meandering livestock. Rather, persons—often crop farmers who want to keep out stray livestock—have the burden of erecting a fence. Most states used a fence-out rule for a period of time. A fence-in rule has been reestablished in a majority of jurisdictions. Under fence-in, property owners have the right to be free of the livestock of others, and ranchers are liable for damages their animals cause to neighboring property.

Assorted state fence laws regarding the enclosure of livestock assign and protect property rights (Kantor; Runge; Taylor and Geyer). Economists have analyzed competing interests associated with livestock to develop a theorem on social cost (Coase) and to distinguish property and liability rules (Bromley; Buchanan; Ellickson 1991; Vogel). Recent research argues that liability rules, as opposed to property rules, are a preferred enforcement response for harmful externalities (Kaplow and Shavell), suggesting that fence laws incorporating property rule protection may not be optimal. The historic reasons for fencing laws (Kantor) and the distinct economic consequences of fence-in and fence-out rules have received attention (Ellickson 1991; Taylor and Geyer).[1] However, the welfare attributes and assignments of fence costs by current laws deserve further consideration.

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[1] Historic reasons include the increased use of land for crops, the expansion of the railroad network, increased benefits from closing the open range, and a shift of the benefit-cost ratio in favor of having livestock owners enclose their animals.

An economic model can help prescribe when an area might find it advantageous to shift from fence-out to fence-in. To begin, we argue that trespassing livestock constitute a harmful externality rather than the taking of a thing. A model is developed to demonstrate the economic differences between fence-out and fence-in rules. We also evaluate cost-sharing provisions whereby neighboring property owners must pay a portion of fence costs. We find that extended Pareto criteria, such as potential Pareto criteria, can suggest a social choice based on aggregate welfare, whereas the strict Pareto rule voices indifference.

Fence-rule preferences remain a significant issue in the U.S. and many other parts of the world. Our economic analysis offers insights on the selection of a fence-in or fence-out rule. Whereas ranchers and their neighbors have opposing views which are impossible to weigh using the Pareto criterion, we argue that economic growth, combined with potential Pareto decision making, eventually comes to favor fence-in. This finding may be compounded in areas of the western U.S. where deleterious effects from overgrazing and new recreational land uses may favor fence-in rules. Increases in population and more intensive use of land for crops in parts of Asia, Africa, Latin America, and Australia also may support revising existing fence-out rules. Undercompensation for livestock trespass and the implementation of grazing management strategies, such as fencing to preclude overgrazing, may lessen the strengths of fence-out still further.

Changes in conditions that provide an economic justification for shifting to a fence-in rule also may have legal consequences. Fence laws interfere with private property rights by requiring one or more persons to build a fence to prevent trespasses by livestock. The demise of ranching may mean that a fence law interferes with property rights so that, in actuality, the law offends substantive due process requirements prescribed by state constitutions or the Fifth and Fourteenth Amendments of our federal Constitution.[2] Both fence-out rules and cost-sharing provisions may affront due process and be unconstitutional.

A Model of Fence Rules

State fence statutes establish rules that assign rights in competing interests between ranchers and neighboring property owners. While there are intermediate ways that these rights can be shared, the most fundamental choice is between fence-out and fence-in rules. Under common law in the United States, a covenant of quiet enjoyment accompanying most real estate transfers includes the right to be free of others' livestock.[3] This right developed under the presumption that persons who sow crops should be able to reap the returns from their labors (Blackstone). To facilitate such returns, livestock owners are liable for damages caused by trespassing livestock. The covenant of quiet enjoyment with a right to be free of others' livestock is embodied in fence-in rules, which we denote as F^i. A fence-out rule, F^o, allows others' livestock to interfere with neighbors' property uses. This section of our article examines opposing F^o and F^i alternatives using welfare economics tools which explicitly incorporate transactions costs. Transactions

[2] *Choquette v. Perrault*, 569 A2d 455-60 (Vt. 1989).

[3] Persons selling property generally make a covenant that new owners shall enjoy possession of the premises in peace and without disturbance.

costs include all discovery, bargaining, decision, policing, and enforcement costs attributable to the livestock externality (Dahlman).

Under F^i, a rancher is expected to maintain a barrier to prevent livestock from entering neighbors' property and may be liable when livestock trespass onto a neighbor's property. Neighbors, including crop farmers, have a right to be unencumbered by damage from a rancher's livestock. Neighbors may use the courts to enjoin trespassing livestock. Under F^o, ranchers do not have to construct a fence to enclose their livestock. Rather, ranchers receive an entitlement by which their livestock can roam on neighbors' property and receive free forage. The entitlement to injure granted by an F^o rule is a property rule protecting ranchers from liability for animal trespass. Under F^o, ranchers do not have to pay compensation for livestock-caused losses unless the neighbor has constructed a fence.

Kaplow and Shavell argue that liability rules are economically preferred to property rules in externality settings, and that this preference is reversed for the protection of things. In their theory, which is guided by the potential Pareto criterion, only perfect governmental information or perfect bargaining by individuals can remove the efficiency advantage of liability rules for externalities. Trespassing livestock destroy vegetation of neighboring property owners. The destruction of vegetation suggests that animal trespass should be considered an externality rather than a taking of a thing. A livestock owner and neighbor have little common value in the ruined object, and no object exists to be returned to the neighbor. The independence of a livestock owner's benefit and the harm to the neighbor shows the existence of an externality (Kaplow and Shavell).

An Economic Interpretation of Fence-Out

We initially assume that there is but one rancher, R, and one neighbor, N, who is often a crop farmer. The profitability of the entrepreneurial activities of R and N is shaped by the social choices between the polar rules, F^i and F^o. Moreover, management decisions made by R and N will be affected by the choice. When R selects an animal stocking rate for the ranch under F^o, R expects that this rate may influence two important components of profit. The first component is incurred on-ranch (independent of interactions with N). It is solely controlled by R and is a function of the stocking rate. Denote this profit component as $\pi_R(s)$, where s is the stocking rate. The second profit component is the net result of the livestock-caused interdependence with N. The second component combines three elements: (*a*) the livestock weight gain attributable to off-ranch forage, (*b*) the cost of damages assessed against the rancher for transgressions of livestock through sturdy fences erected by N, and (*c*) any transactions costs incurred by R as a consequence of R's interdependence with N. Define the net returns from cattle trespassing on neighbors' property as $r^o(s; f, m)$. This expresses externality net returns as a function of stocking rate (s), the proportion of the property's perimeter that is fenced (f), and the intensity of farming (m).

Assuming that the rancher is profit driven, R will choose an optimal level of stocking to solve the following problem:

$$\max_s \ \pi_R(s) + r^o(s; f, m). \tag{1}$$

The variables f and m are exogenous in the sense that they are controlled by N. If N chooses levels f^o and m^o, and R solves (1) by selecting the level s^o, the resultant profit for the rancher is given by $\pi_R^o = \pi_R(s^o) + r^o(s^o; f^o, m^o)$. By construction, all economically relevant impacts, including transactions costs, are contained in this result.

Given some expectations regarding stocking rate, the neighbor can decide whether to farm, what to farm, whether to fence, and so on. For simplicity, assume that N has to make two important decisions: the intensity of farming (m), and the proportion of the property's perimeter that is fenced (f). The decision variables m and f are both assumed to lie in the unit interval, such that $f, m \in [0, 1]$. The boundary value of $f = 0$ means no fencing, and a value of one corresponds to total fencing. Similarly, a no-farming decision is represented by $m = 0$, while the most intensive farming practical is indicated by $m = 1$.

In this framework, on-farm profit from an uninvaded and unfenced crop will be a function of farming intensity only. Let this component of profit be denoted by $\pi_N(m)$. Because m is a costly input to the production process, $\pi_N(m)$ need not be maximized at $m = 1$. Two additional components of profit are the cost of fencing and the net cost of N's interdependence with the rancher. If p is the per unit cost of fencing, then total fencing costs are $p \cdot f$. The net cost of the livestock interdependence must incorporate three elements: (a) the value of crops lost to livestock, (b) damage assessments received from the rancher for livestock trespass through worthy fences, and (c) N's transactions costs associated with this interdependence. These three elements will be jointly determined by the crop farmer's management and fencing decisions together with the stocking rate selected by R.

If the sum of the three elements is given by $n^o(f, m; s)$, then the neighbor's profit-optimization problem is:

$$\max_{f,m} \pi_N(m) - p \cdot f - n^o(f; m, s). \tag{2}$$

The neighbor's optimal level of fencing and farming intensity given by f^o and m^o depend on the rancher's chosen stocking level, s^o. The decisions of R and N are not sequential in this model; they are co-dependent with each agent's decision predicated on variables under the other's control. The result under the F^o rule, from N's point of view, is that profit is $\pi_N^o = \pi_N(m^o) - p \cdot f^o - n^o(f^o, m^o; s^o)$. It is possible, because of the two negative elements of (2), that farming may be unprofitable even when the first term is positive. Due to the costly presence of livestock, in terms of fence costs and/or net crop losses, marginal farming enterprises may need to select $f^o = 0$, and $m^o = 0$.

An Economic Interpretation of Fence-In

To model the fence-in rule, we begin by modifying the rancher's profit-maximization problem (1). Not only do fencing decisions and costs now fall to R, but the composition of interdependence and transactions costs will change as well. R may receive forage benefits from off-ranch property, but the amount of any damage awards against R must be debited from such benefits. Transactions costs will be altered as well, although the multifaceted nature of these costs makes it difficult to argue that they are always increased or decreased. R's general profit-maximization problem under F^i is given by:

$$\max_{f,s} \pi_R(s) - p \cdot f - r^i(f; s, m), \tag{3}$$

where the r^i functional is the net cost of the livestock externality to the rancher.

In contrast to F^o, the neighbor's optimization problem under F^i omits fencing costs. Secondly, the nature of the profit component attributable to the externality is modified as well. The properly revised problem is given by (4), where the n^i function captures liability awards received from R, net of crop losses and transactions costs:

$$\max_{m} \pi_N(m) + n^i(m; f, s). \tag{4}$$

If, in response to problems (3) and (4), R and N select decision levels at f^i, s^i, and m^i, then the profit under F^i will be $\pi_R^i = \pi_R(s^i) - p \cdot f^i - r^i(f^i, s^i; m^i)$, and $\pi_N^i = \pi_N(m^i) + n^i(m^i, f^i; s^i)$. Due to their influence on the behavior of the two agents, the two alternative rules produce different profits.

Contrasting F^o and F^i

In figure 1, rules F^o and F^i are compared in terms of the consequential welfare of the two agents. This graph depicts the relative profit outcomes of the two alternative rules. In comparison to F^o, F^i generally will increase the welfare of the neighbor while reducing the welfare of the rancher. In general, both points (and both rules) will be economically efficient in the Paretian sense that one party loses in changing from one rule to the other. Consequently, for this situation and for externalities in general, unanimity is not a workable way to select a rule. The two agents disagree regarding the preferred rule.

In this representation, the social choice question reduces to which person and which set of land use activities is to be favored. A fence-out rule favors ranching, and F^i is more supportive of crop farming. Suppose that F^o is the rule of choice, and the two agents have established their profit-maximizing management practices at f^o, m^o, and s^o. If society were to now adopt the F^i rule, R's net marginal benefit for the last animal unit (the s^oth one) would fall unless the neighbor is fully fenced ($f^o = 1$). Net marginal benefit falls because of the loss in free, off-ranch forage and the need to pay for all crop damage. Therefore, if profit is to be maximized, the rancher must decrease the stocking rate. In addition, the financial burden of fencing costs under F^i may cause a marginal ranching operation to become unprofitable, in which case the rancher reduces stocking to $s^i = 0$. Both the loss of off-ranch forage and the shifted cost of fencing tend to reduce livestock production. Thus, it is to be expected that $\pi_R^i < \pi_R^o$, and $s^o \geq s^i$.

Similarly, it is true that farm production tends to be increased by the shift from F^o to F^i; $m^i \geq m^o$, because livestock may no longer take crops of the farmer without compensation (thus raising the marginal net benefits of m to the neighbor), and because the shifted costs of fencing may cause an unprofitable farm ($m^o = 0$) to become profitable ($m^i > 0$).

Having established the impact of fence rule alternatives on a single rancher and a single neighbor, the model may be expanded to a region composed of many potential ranchers and their potential neighbors.[4] Suppose that there are R^o ranchers and N^o

[4] The adjective "potential" is advisable, because the rule choice has been demonstrated to affect profitability, and therefore whether livestock or crop production takes place on particular properties.

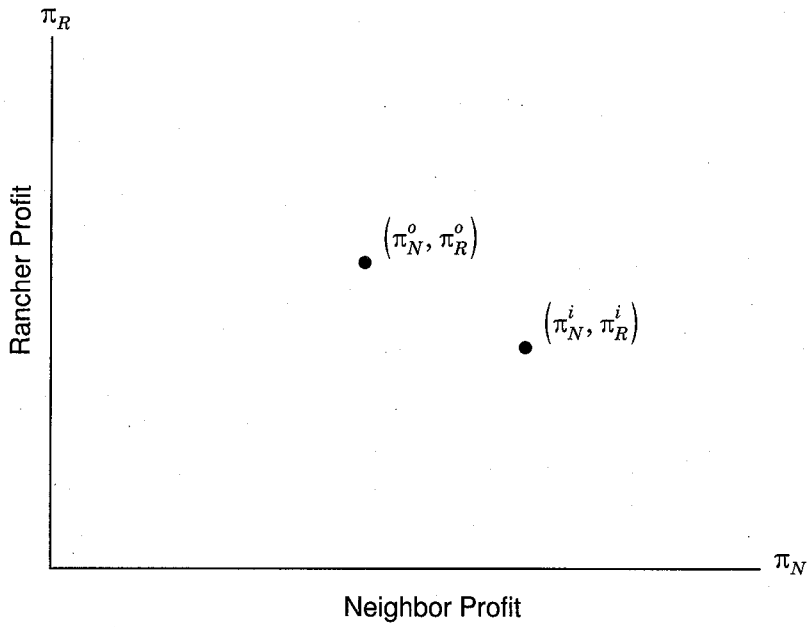

Figure 1. Profit possibilities for the fence rules

neighbors when the F^o rule is in force. Aggregate profit for each group is then defined as the sums of profit obtained within each group. Expressed as a two-element vector, we have:

$$\Pi^o = \left(\Pi_N^o, \Pi_R^o\right) = \left(\sum_{n=1}^{N^o} \pi_n^o, \sum_{r=1}^{R^o} \pi_r^o\right).$$

Likewise, a similarly defined vector can be established for the F^i rule for which there are R^i ranchers and N^i neighbors:

$$\Pi^i = \left(\Pi_N^i, \Pi_R^i\right) = \left(\sum_{n=1}^{N^i} \pi_n^i, \sum_{r=1}^{R^i} \pi_r^i\right).$$

If the amount of land dedicated to ranching and farming is correlated with the number of agents who are ranchers or neighbors, then it is to be expected that $R^o \geq R^i$, and $N^o \leq N^i$. As before, aggregate welfare for ranching interests is higher under F^o than it is under F^i, and vice versa for aggregate welfare received by neighbors.

Hence, Paretian decision making is mute in that there are many losers in any shift from F^o to F^i, or from F^i to F^o. On the other hand, extended Pareto criteria—such as those denoted potential Pareto criteria or compensation tests—can recommend a preferred policy (Griffin 1995). Such criteria base the selection on whether gainers hypothetically can compensate the losers. In the present case, this is equivalent to comparing $\Pi_R^o + \Pi_N^o$ with $\Pi_R^i + \Pi_N^i$, and then selecting the rule yielding the higher total

profit. While such extended criteria can be objectionable on distributional grounds, status quo biases, technical shortcomings (e.g., Scitovsky and Boadway paradoxes), or other normative concerns, they still can be helpful.

Fencing Costs

The two polar rules, F^i and F^o, should often result in different levels of fencing, $f^o \neq f^i$. However, if the cost of fencing is relatively inconsequential to the person responsible for fencing, then fencing will be nearly complete with either rule ($f^o \approx 1$, or $f^i \approx 1$).

Assuming that the per unit cost of fencing, p, is sufficiently large to influence profitability for both ranchers and neighbors, the rule can determine whether a particular land use is profitable. If p is relatively large and economic conditions (e.g., prices for meat and crops) are such that ranching is dominant, then it may be expected that $f^o \leq f^i$. When ranching predominates, adding a farm may be expected to increase boundary length between ranches and farms because the new farm is less likely to border other farms. Similar reasoning suggests that $f^o \geq f^i$ when general economic conditions cause farming, or at least nonranching, to be the dominant land use activity. The impact of rule selection shows an F^o rule resulting in lower total fence costs when ranching is dominant. If farming is dominant, then fencing costs are minimized by F^i.

Under the statutory fence provisions, the fencer does not always bear fence costs. Intermediate options exist for assigning costs under fence law. One option requires neighboring ranchers to share fence costs, often with cost shares based on need (e.g., Michigan). Another option requires neighbors to contribute to the cost of fences, generally one-half of the cost of a fence, regardless of need. This choice has been adopted in several jurisdictions, including Colorado, Idaho, Illinois, Indiana, Missouri, Nebraska, Ohio, Virginia, and Wyoming.

For jurisdictions with a fence-in rule (e.g., Missouri), equations (3) and (4) may be altered to reflect cost-sharing provisions. The required modifications are straightforward. Fence costs for a rancher's profit maximization [equation (3)] are reduced to $b \cdot p \cdot f^i$, where b is the proportion ($0 \leq b \leq 1$) of the costs to be borne by the rancher. In addition, fencing costs in the amount of $(1 - b) \cdot p \cdot f^i$ must be subtracted for the neighbor [equation (4)]. The differing nature of transactions costs also may mean that the profit amendment functions r^i and n^i should be modified as well. For example, before constructing a fence, the rancher must incur transactions costs in seeking the neighbor's share of fence costs.

These modifications will induce predictable changes in the welfare results presented previously. The rancher's and neighbor's profits will now depend on the cost-sharing parameter b, with $b = 1$ equivalent to the pure F^i rule analyzed earlier. As b declines from 1 to 0, ranching profit will be enhanced and farming profit will decline. Using variable institutional welfare frontiers (Griffin 1991), the consequences of alternative cost shares are depicted in figure 2 by the solid frontier. The endpoint of this frontier corresponding to $b = 1$, (π_N^i, π_R^i), is identical to the welfare result obtained previously for the pure F^i law. The other endpoint of this frontier corresponds to $b = 0$. The frontier may be expected to pass below (π_N^o, π_R^o) due to the heightened transactions costs of sharing costs and the propensity of the rancher to "overfence" given the fencing subsidy provided by the neighbor.

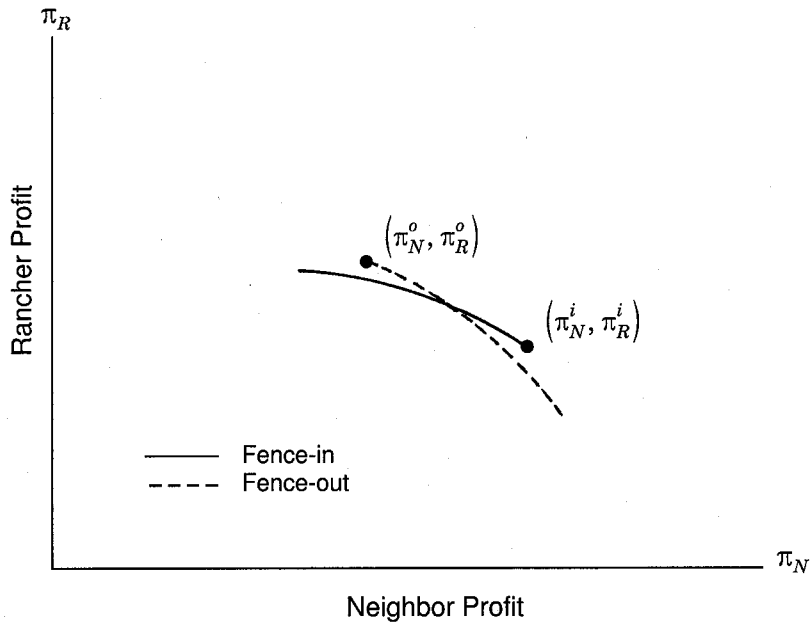

Figure 2. Profit possibilities for fence cost sharing

To investigate fence-out in the presence of cost sharing as established in some fence-out laws (e.g., Colorado), the property rights underlying optimization equations (1) and (2) also must be modified. An analogous procedure to that above obtains the dashed frontier of figure 2 applicable for an F^o rule with variable cost sharing. Again, the endpoint of this frontier, (π_N^o, π_R^o), is the same as that obtained for the pure F^o rule.

Inspection of both welfare frontiers reveals some interesting results. First, unlike the pure F^o and F^i rules that are Pareto noncomparable, some cost-sharing arrangements are Pareto inferior to other arrangements. The inferior arrangements are those where there is a high level of cost sharing by the agent not making the fencing decision. Second, eliminating the Pareto inferior positions and joining the Pareto superior portions of the solid and dashed curves produces a welfare frontier with a positive concavity between points $\underline{\pi}^o$ and $\underline{\pi}^i$. A potential Pareto criterion will select one of the endpoints, either F^i or F^o, with the fencing decision maker bearing all fencing costs.

Additional Considerations for a Fence Rule Preference

The derogation of the traditional property right of quiet enjoyment by fence-out laws adopted many years ago raises the question of whether the justifications for fence-out continue to support such a rule. This section extends the inquiry in three directions. In the first, undercompensation of neighbors for livestock trespass may occur leading to underperformance of an F^o rule. The second identifies grazing management strategies that offer benefits from more exacting management of a range resource. Third, changed

economic development conditions may suggest a shift from an F^o rule to an F^i rule for some areas.

Undercompensation for a Harmful Externality

As discussed earlier, a trespass by an animal resembles a harmful externality more than the taking of a thing. Harmful externalities generally are best controlled by a conventional liability rule rather than a property rule (Kaplow and Shavell). Given that an F^o rule is a property rule protecting injurers, F^o may not constitute an optimal solution from a potential Pareto perspective, because neighbors may be undercompensated when livestock unlawfully enter upon their property.

Although trespassing livestock may qualify the neighbor (the property-right holder) for relief under state tort law, the damages may be too low. Haddock and McChesney argue that an appropriation of a property right under a liability rule may result in the defendant paying ordinary damages. While the standard tort model with ordinary damages can manage an externality, it also can leave a plaintiff undercompensated. Ordinary damages exclude a neighbor's feelings of the property's value, so that undercompensation occurs when a neighbor's property has an idiosyncratic or situational value greater than the property's ordinary value.

Kaplow and Shavell argue that the property possessor will normally value property more than potential takers. Ellickson (1986) suggests that neighbors may be undercompensated in livestock disputes due to social reasons and the inconvenience of collecting damages. Moreover, legal costs also inhibit efforts to collect trespass damages. The inability to recover costs for time and efforts and the potential of a settlement awarding less than full recovery may mean that possessors of property are not fully compensated for trespass damages. The ability of ranchers to allow their animals to trespass on the property of neighbors under an F^o rule may deprive neighbors of the full value of their property.

Grazing Management Strategies

Fence-out reform pressure also may arise from new agricultural research information on range management and new scientific management techniques (Hams; Pearson and Ison). In the alternative, the application of scientific findings or management techniques to achieve the ecological or sustainable use of range resources may favor the demise of fence-out in some areas. And, as recently reported by Hu, Ready, and Pagoulatos, economically optimal grazing does not necessarily equate to ecological sustainability.

Livestock production may benefit from management to preclude overgrazing. Fence-in accompanied by appropriate management techniques may help preserve native vegetation and habitats. Or, more active management under an F^i rule may prevent the destruction of vegetation by meandering livestock near water sources and adverse effects of livestock on fish habitats, water quality, and sport activities. Knowledge of plant types, herbicide applications, and mechanical plant controls may increase the productivity of rangelands only if accompanied by a period of no grazing (Vallentine). Exclusion of livestock is possible not only with a fence, but also without a fence through individual control of the location of livestock. Under fence-out, control of the location of

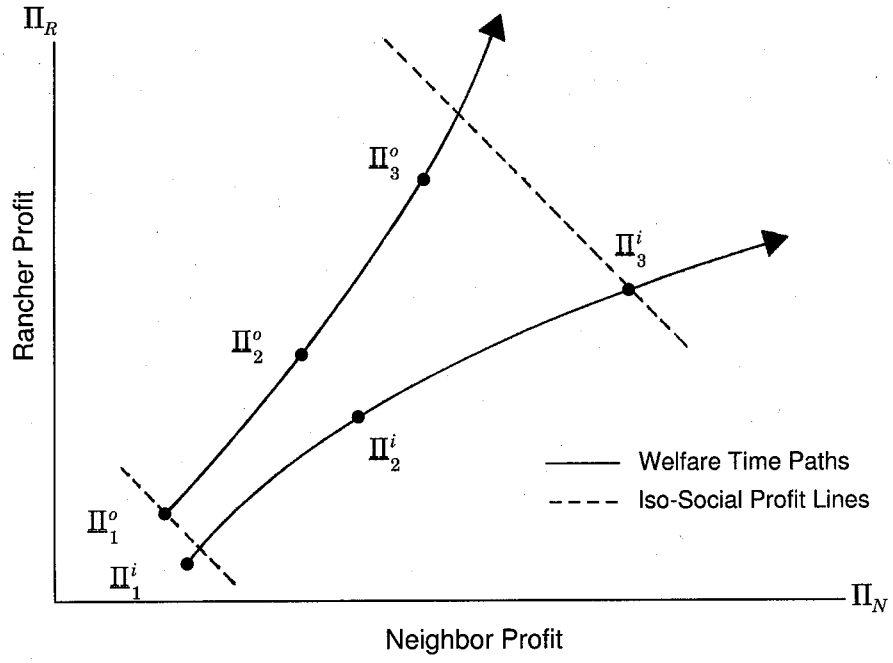

Figure 3. Profit possibilities evolving over time

another's livestock is difficult to impossible. This suggests that implementation of some management practices is best achieved under a fence-in rule.

Along with increased productivity, secondary benefits of range management practices may include increased quality of forage, control of poisonous plants, and increased water availability for herbaceous plants (Vallentine). Or, in areas where overgrazing denigrates productivity, as reported in numerous third-world countries (Hubbard; Jahnke; Simpson, Cheng, and Miyazaki; Whyte), F^i may allow for the better use of grazing resources. Again, the significance of the use of grazing management strategies is that the adopters might best appropriate the returns of these technologies under a fence-in rule.

Changing Economic Conditions

A more interesting question than asking which rule to select may be to ask *when* is the optimal time to switch from F^o to F^i. Unique economic conditions in arid areas with low forage production per unit of land, limited watering locations, and high fencing costs often favor a land-extensive means of livestock production. These conditions would arguably lead to welfare points such as Π_1^o and Π_1^i in figure 3, where the subscripts indicate time period 1. Under these circumstances, a fence-out rule may be socially justified. Total social profit is definitely higher with F^o. The added total profit of F^o may outweigh arguments favorable to F^i, such as the customary right to quiet enjoyment of one's property, in an area where livestock production is the dominant activity.

The preferred rule may change over time. An increase in nonranching land uses and the elevated worth and intensity of agricultural cultivation may render an existing

fence-out rule no longer preferable (Epstein). Emerging land use demands, including recreation and ecological concerns, also may favor fence-in. As recreational activities and ecological concerns become more prevalent, sometimes even providing income opportunities for property owners, the new interdependencies among actors may support an alternative rule. Changed conditions may require changing from an F^o rule to an F^i rule to enhance the productivity of rangelands.

If changing economic conditions infer the value or amount of open grazing under a fence-out jurisdiction has declined relative to other land use values, time paths for F^o and F^i rules given by the two solid curves of figure 3 may be reasoned.[5] At any time, particular points on these loci identify the welfare situation that would prevail for a specific fencing rule. Pairs of profit possibilities applicable for the same time period, such as Π_2^o and Π_2^i, will be Pareto noncomparable. However, the declining economic attractiveness of grazing relative to other land-dependent activities will, over time, alter the two rules' rankings in terms of total welfare. Thus, at some time the F^i rule will become preferred from the vantage of a potential Pareto criteria, as shown by Π_3^i in figure 3. While the optimal timing for switching from F^o to F^i should not be based exclusively on total welfare, given distributional considerations such as hardships in adjusting to the new rule and other factors, total economic attractiveness undoubtedly is an important datum.

An Unconstitutional Deprivation

While various factors may mean it is economically beneficial to shift from an F^o rule to an F^i rule, changes in conditions may create a legal problem that forces altering an existing fence rule. Under federal and state due process requirements, a governmental property rule regulation must have a substantial relation to a legitimate public purpose (Centner). Legislation that deprives a person of property rights but does not require compensation may be an unconstitutional property rule regulation known as a substantive due process deprivation (Davis and Glicksman; Wiseman).

A substantive due process violation may be based on changed economic conditions. Cost-sharing provisions in fence laws seek to have neighbors share costs according to the benefits they receive from a fence (*Choquette v. Perrault*). Fence-out and cost-sharing provisions may no longer serve a public purpose because of changed conditions. Law cases show three arguments that may be used to show that a cost-sharing or fence-out provision effects an unconstitutional deprivation of property: (*a*) absence of a legitimate public purpose, (*b*) changes in conditions nullifying a former public purpose, and (*c*) the lack of a substantial relation to a legitimate purpose. Decided law cases would support a court in ordering a shift from F^o to F^i. In the same manner, decided cases could be used to nullify a cost-sharing requirement.

To show a substantive due process deprivation, a plaintiff generally needs to establish that the governmental action is not substantially related to a legitimate public purpose. The economic analysis of an F^o rule showed that neighbors bear the entire cost of a fence required to keep out ranchers' livestock. Similarly, a cost-sharing provision foists

[5] The envisioned time paths abstract from the presence of fixed factors and other rigidities that make it impossible to immediately shift from $\underline{\Pi}^o$ to $\underline{\Pi}^i$.

costs on neighbors who would not need a fence except to prevent entry of ranchers' livestock. Such obligations may be judged burdensome or oppressive,[6] or to infringe on a property owner's constitutional rights (Steward). Or, due to demise of a public purpose, a court may conclude that a cost-sharing provision is unconstitutional as applied to landowners without livestock (*Choquette v. Perrault*).

The *Sweeney* and *Choquette* cases show that changes in conditions nullifying the public purpose can trigger a constitutional due process deprivation. Emerging recreational activities or the application of grazing management techniques may emasculate the former public purpose of a fence-out or cost-sharing provision for an area or a state. As some state fence-out statutes specifically recognize a fence-in rule for herd districts and other areas, a locale with a fence-out rule may face this constitutional issue when a change in property use results in the demise of the former public purpose.[7]

Implications and Concluding Comments

Fence laws have been enacted to respond to competing interests in property. Fundamentally, a fence-out rule favors ranching activities, whereas a fence-in rule is more supportive of other activities. The Paretian view of economic efficiency is generally indifferent to fence-in and fence-out rules. Both are perceived as efficient. Within the Paretian construct, the idea of choosing a rule structure with an objective of minimizing transactions costs or fencing costs is flawed.

Transactions and fencing costs should be included when a potential Pareto criterion is used to select a preferred rule. Potential Pareto criteria, which measure efficiency as the total benefits across all people, do exhibit a preference between fence-in and fence-out rules. However, neither rule is universally preferred. Loosely, a fence-out rule is preferred when ranching is predominant, and a fence-in rule is preferred when farming is predominant. Preference for one rule can switch to the other as economic conditions change. Changes in economic conditions, such as a heightened demand for recreational goods and natural habitats, strengthen the case for fence-in rules from a potential Pareto perspective. For some areas and selected third-world countries, application of grazing management strategies may recommend a change from a fence-out to a fence-in rule. In a similar way, enhanced crop production or changes in population, technology, or the economy may recommend changing to a fence-in rule.

Cost-sharing arrangements offer intermediate options between the polar fence-in and fence-out rules. While equity considerations can recommend cost sharing, the efficiency analysis offered here indicates that cost sharing cannot be desirable on either Pareto or potential Pareto grounds. Although the Pareto-based finding is not novel, it is intriguing that the transactions costs and implicit subsidy accompanying cost sharing result in reduced total welfare.

Our analysis differentiates harmful externalities from takings of things so that appropriate criteria may be used in selecting a desirable property or liability rule to protect property rights. Livestock trespass, as a harmful externality, is best addressed by giving property owners a possessory interest of being free of trespassing animals,

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[6] *Sweeney v. Murphy*, 39 AD2d 306, 334 NYS 239-42 (N.Y. App. Div. 1972).

[7] Herd districts are areas designed by a legislative branch of government that provide for fence-out (e.g., *Idaho Code*, Sections 25-2401 to 2404; 35-103, 1990, and Supp. 1996).

protected by a conventional liability rule (Kaplow and Shavell). As the fence-out rule does not conform to this condition, it generally does not provide a preferable solution. These findings offer guidance for areas in the United States with a fence-out rule and for third-world countries with open grazing.

The inquiry of a constitutional due process deprivation showed that absence of a legitimate public purpose (including changes in conditions nullifying a former public purpose) may mean that a cost-sharing or fence-out provision effects an unconstitutional deprivation of property. Given changes in conditions and the dynamics of grazing, it is possible that fence-out and cost-sharing provisions are unconstitutional burdens. The models set forth in this article offer economic evidence for advancing legislative reform and supporting a finding of a substantive due process deprivation. For fence rules, our joint economic and legal research may enable neighbors to regain the common law property right of enjoyment to be free of others' livestock denigrated by fence-out laws during the past three centuries.

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