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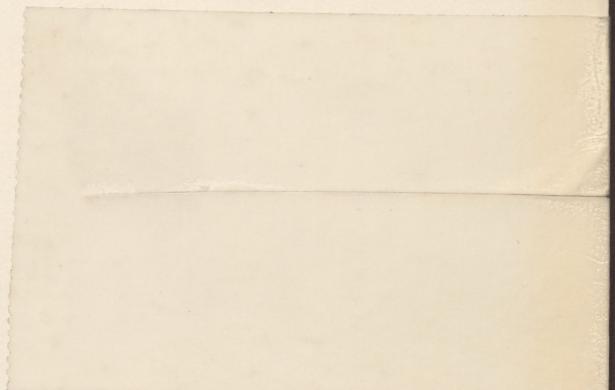
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Caution must be exercised in applying privatization arguments to Mexico's communal grazing lands. Ecological uncertainty may make a common property regime a rational choice while compensating coalitions can be formed to offset behavioral uncertainty within the village. On these marginal lands, the transaction and distributional costs of modifying a property regime must be compared to the expected benefits.

Introduction

Informal, exploratory discussions have been initiated in Mexico to explore the economic, social and political impact of privatization initiatives in the agricultural sector. There are two economic conditions which explain this action. First, Mexico is a net importer of agricultural commodities. In some years beans and corn, basic staples in the Mexican diet, must be imported to meet the demands of a burgeoning population. Secondly, 50 percent of the agricultural land in Mexico is controlled by organized community groups: *comunidades* and *ejidos*. *Ejidos*, groups which hold property in common, control approximately 40 percent of the agricultural land. On average these lands are two to three times less productive than comparable private farms and represent, according to some Mexican analysts, an opportunity for increased productivity through privatization (Yates, 1981).

The *ejido* is an important component in Mexico's culture and historical experience. Its revolutionary past, deeply rooted in the Mexican Revolution of 1910-1915, should give pause to the reformer who argues for privatizing these common property land holdings. Questions should be asked such as, what is the nature of the productivity breakdown on the *ejidos*? Can a general privatization policy be applied to a heterogeneous target: large, prosperous irrigated *ejidos* in the northwest-Sonora and Sinaloa, large extensive grazing operations in the north-Chihuahua, Nuevo Leon, Tamaulipas, Zacatecas and San Luis Potosí, and small subsistence *ejidos* in the central and southern regions of Mexico? Is the common property regime unredeemable or have some *ejidatarios* made strategic decisions which have enabled them to prosper within the uncertain institutional environment resulting from the common property regime of the *ejido* system? And, what are the transaction costs of preserving, improving or eliminating the current common property rights and replacing them with a private property regime? We have enjoined this debate by selecting a group of *ejidos* on the "extensive margin" and analyzing family-level decision making within an environment of ecological and behavioral uncertainty. We argue that agricultural production in semi-arid and arid zones requires resource mobility, particularly the freedom to graze livestock throughout a large, extensive land area. Common grazing lands therefore represent a hedge or insurance against uncertainty in rainfall patterns. We also conclude that the breakdown in *ejido* productivity on these extensive, livestock herding areas is due to a deterioration in property management at the community level.

Institutional and Ecological Context

The *Ejido*

A well-defined system of common property rights was operational in the countryside at the time of the Spanish conquest of the Aztecs in the early 16th century. The *calpulli* was a group or community of individuals, usually with family or lineage ties, which controlled a bounded area of land and operated it under individual usufruct (Sanderson, 1984). Spanish and Mexican rule destroyed this indigenous system through many years of land grants and concessions to a landed elite. Concentrated ownership of agricultural lands reached its zenith during the *Porfiriato*, a period between 1876-1910 when Porfirio Diaz served several terms as president of Mexico. *Haciendas*, large and extensive agricultural operations, were expanded in size and number during this period to meet increased food demand by a growing population.

By 1910 one-half of Mexico's rural population were indebted, agricultural laborers working on the *haciendas*. The cry for agrarian reform was one of the driving forces behind the Mexican Revolution and to this day continues to be one of the central pillars of Mexico's political stability, particularly in rural areas. The First Agrarian Reform Act of 1915 established the common property system of *ejidos*. Article 27 of the Mexican Constitution of 1917 gave the state the power of expropriation (with compensation, theoretically) or eminent domain over all the land and water resources in the Mexican republic. These constitutional powers were updated and made more inclusive by the Agrarian Regulations of 1922 which granted land to individuals living on abandoned *haciendas* and the Agrarian Code of 1934 which made *hacienda* workers eligible for land grants. Redistribution of substantial amounts of land occurred in the 1930s, subsided dramatically in the 40s and 50s, and experienced a resurgence in the 60s and 70s. The cyclical nature of land reform implementation closely follows a pattern of political pressure from landless rural people and the Mexican government's response to that pressure.

Semi-Arid Highlands

Ejidos own one-third of Mexico's rangelands or approximately 27 million hectares. One of these significant grazing areas is the northern highlands (*altiplano*) of the state of San Luis Potosi, approximately 600 kilometers north-northwest of Mexico City. The *altiplano* of San Luis Potosi, on the southern edge of the Chihuahuan Desert, covers 20,000 square kilometers and has a population of approximately 380,000 people. The topography of the region is characterized by north/south limestone mountain ranges separated by broad, undrained basins or valleys. Some agricultural activities are located on the mountain slopes but the most significant levels of production occur in the basins which have an average elevation of 1,700 to 2,000 meters. Soils derived from limestone are alkaline, fine-textured and thin, with an underlying layer of caliche which limits root growth. Precipitation is 150-550 millimeters per year with most of the rainfall occurring in the summer months during the monsoon-like season. Rains are variable with respect to both time and space across the region. Approximately fifty percent of Mexico's territory consists of arid and semi-arid lands which are similar to the *altiplano*.

The Open Access Dilemma

Proponents of privatization have argued that the common property regime, such as that found in Mexico, is inefficient and doomed to failure (Demsetz, 1967). Externalities are not internalized by the decision making units thereby creating free riders who dominate agents who exhibit cooperative behavior. Hardin's (1968) "tragedy of the commons" concludes that individuals, or *ejidatarios* in this case, enjoy the benefits of the common property regime but the group, or *ejido*, pays the full costs of the individual's behavior. Since costs are not internalized by the individual herder and his family, overgrazing is a rational decision in the short run, leading to the degradation of the rangelands. This dominant free rider behavior eventually creates the conditions, at least conceptually, for an institutional transition from a common property to a private property regime. It is assumed in these arguments that the *ejidatarios* will not, or can not, change the system of common property management.

Most critics of the "tragedy" argument point to the reliance by its proponents on the assumption of open and unregulated access to the commons or *ejido* grazing lands (Ciracy-Wantrup and Bishop, 1975; Bromley, 1989). Open access implies that there are no rules which govern the use of the resource and therefore no herder has an incentive to conserve rangeland. Under an open access regime herd size, grazing routes, and livestock mix are subject only to individual objectives and constraints. Yet common property is defined as the co-equal ownership of the rights to a bounded resource where community-established rules govern its use. Therefore an institutional structure is essential to the definition of common property. Without it, common property cannot be differentiated from open access and resource degradation is inevitable. But with an institutional structure providing rules to regulate individual and group behavior, history has shown that communal groups can cooperate successfully for the benefit of the community and the natural resource (McCay and Acheson, 1987).

We argue that few common property regimes can be placed at either the polar extremes of open access or effective, rule-based community management. This strict dichotomy of property regimes is unsatisfactory as an accurate description of grazing on the extensive margin. Rather, a continuum exists where communities evolve, due to technical, social and biological factors, to intermediate points along this measuring rod of cooperation. This is particularly evident in the case of the *ejidos* in the north-central highlands of Mexico. Variability in the distribution of rainfall over time and space, availability of irrigation water, off-*ejido* job potential, access to credit, effective leadership and remittance levels from relatives in large Mexican cities or the United States place and move the community along this continuum of cooperation. We hypothesize that the common property regime for the *ejidos* is moving towards open access for the individual herders primarily due to the breakdown in the ability of the local authorities to develop and enforce rights and duties associated with rangeland use.

Uncertainty on the Commons

Ecological Uncertainty

A strong argument can be made on ecological grounds for perpetuating the common property regime on rangelands in arid and semi-arid environments. With lands on the extensive margin, environmental variability is evident in the erratic nature of rainfall in both time and space. Drought conditions can occur in five out of ten years which eliminates any hope of establishing forage reserves on the range. Precipitation, the most scarce natural resource in this region, may fall in one area of the *ejido* while leaving another section completely dry. Privatization by parcelization of these *ejido* lands would reduce the individual's grazing area and increase the herder's uncertainty of survival. Therefore, joint access to an extensive grazing resource serves as insurance and an effective, uncertainty-reducing institution (Sandford, 1983; Bromley and Chavas, 1989).

Two common analytical relationships illustrate this joint-access advantage of common property. First, extensive grazing on the commons in a semi-arid environment allows the group to diversify its production geographically. Herds can be moved freely to areas with the most recent rainfall. Assuming the commons can be divided into two (i and j) of n potential grazing areas, total variability in rainfall, σ_T^2 , and hence forage production

$$\sigma_T^2 = \sigma_i^2 + \sigma_j^2 + 2\rho_{ij}\sigma_i\sigma_j. \quad \text{where } i \neq j \quad (1)$$

can be reduced over the entire *ejido* when the correlation coefficient, ρ_{ij} , between the two individual grazing areas is negative.

An analogous result is reached when the properties of aggregation are considered (Eisgruber and Schuman, 1963). For illustration purposes suppose that the variability in rainfall is the same in each grazing area

(i.e. $\sigma_i^2 = \sigma_j^2 = \dots = \sigma_n^2 = \sigma^2$) and that ρ is the arithmetic mean of all ρ_{ij} 's. The variability of precipitation over the *ejido* (σ_T^2) can be written as:

$$\sigma_T^2 = (\sigma^2 / n)[1 + (n - 1)\rho]. \quad (2)$$

Equation 2 implies that $\sigma_T^2 = \sigma^2$ only in the special case when $\rho = 1$. Otherwise aggregated rainfall variability is a function of the number of grazing areas and the correlation of rainfall between these areas. The variability in rainfall at the aggregate, *ejido* level declines relative to the individual grazing area variance as n increases and ρ declines. This relationship implies that the common property regime may be an effective risk-reducing strategy for the pastoral *ejidatario*. Parcelization of the commons would increase ecological variability for the herders since n=1.

Anecdotal, but revealing evidence supporting these arguments is available from the *altiplano* of San Luis Potosi. Typical goat and cow management practices include one or more herders guiding herds of 30-600 animals over the range. In some cases the herds return to the village at dusk; in other situations the herds remain on the distant range and the herders sleep in makeshift homes or range camps (*la majada*). Horses and donkeys are allowed to roam freely over the commons in search of forage. During periods of drought *ejidatarios* have noted that these latter animals have remained in relatively good physical condition while goats and cows have declined in body weight and productivity, and in some cases died. The superior physical condition of the freely roaming animals lends support to the geographic diversification and aggregation defenses of common property; yet it serves as an indictment of most *ejidatarios* for their failure to adapt their management practices and institutions to a progressively deteriorating natural environment.

Behavioral Uncertainty

The apparent failure of many *ejidos* to adjust to changing environmental conditions can be attributed to the lack of enforceable regulations governing grazing and the uncertainty surrounding the herding behavior of *ejidatarios* (Runge, 1981). A common property regime implies that rules and regulations are enforced which recognize the interdependent nature of the grazing choices made by individual herders. When these rules do not exist or are not enforced, the uncertainty of other's behavior increases and the level of compliance declines. This lack of assurance produces stocking rates and grazing practices which may evolve into an unsustainable, open access regime.

Insight into the assurance problem in the Mexican *ejidos* can be obtained by characterizing grazing decisions as a n-person prisoner's dilemma (Sen, 1967; Schelling, 1973). Suppose there are n+1 *ejidatarios* with two choices: cooperation (C) with *ejido*-regulated grazing practices, and non-cooperation (NC) with the prescribed grazing rules and regulations. We assume that the herders are in similar environmental surroundings. Each has the same ability of signaling their grazing intentions and perceiving the intentions of others. There are no comparative advantages between herders and no one herder has undue influence on another. We assume that the payoffs for each *ejidatario* are the same for selecting C or NC. The payoff level depends only on the number of herders choosing each alternative course of action. Therefore, each *ejidatario* has a best or dominant choice whatever the other herders decide to do.

This decision environment of binary choice with externalities is illustrated in Figure 1. Figure 1A models the multiperson prisoner's dilemma which generally deteriorates into the "tragedy of the commons" or open access. C represents the cooperative payoff to herder $n+1$ as more herders cooperate with the grazing plan. With few ($< x$) herders cooperating, the sacrifices made by herder $n+1$, such as herd-size reduction and time managed grazing, are reflected in negative payoffs. But payoffs become positive as more *ejidatarios* choose to cooperate with the plan. If all herders cooperate, which is what all *ejidatarios* would prefer, the *ejido* reaches an equilibrium at z . Yet this is a Pareto-inferior outcome because it is always in the best economic interest of herder $n+1$ to defect. Therefore cooperation is unstable and can be maintained only through enforcement.

The tenuous nature of a cooperative equilibrium is due to the overwhelming incentive for herders to defect, that is to choose NC. As more *ejidatarios* choose to cooperate, the payoffs to defecting increase because the defecting herder does not have to reduce herd size or follow grazing guidelines, yet benefits from improved forage levels due to the actions of others. These increasing positive externalities for the defecting herder are reflected in the positively-sloped NC curve. NC is said to dominate C because NC payoffs exceed those of cooperators (the dominated strategy) at all levels of cooperation. Since each herder is better off the more *ejidatarios* there are that choose their dominated strategy, there is no incentive to cooperate and the *ejido* trends towards an open-access equilibrium at 0.

The assurance or behavioral uncertainty problem arises with the perceived economic benefits associated with forming what we will call "compensating coalitions". These coalitions are two or more individuals (x) who recognize the failure of the *ejido* to reach z and in response form a group with enough structure to make a collective decision which benefits its members. The uncertainty of others' behavior is reduced in these coalitions which enables them to reach x or beyond but still short of the full cooperation level at n . *Ejidatarios*, x or more, all have made dominated choices and are better off than if they all had made dominant, NC choices. Level x is the minimum size of a compensating coalition that can gain by choosing a dominated strategy. The $n-x$ *ejidatarios* are free riders who recognize that it is profitable to join the coalition but more profitable to stay out.

In Figure 1B we have another n -person game but in this case there are multiple equilibria with two, nondominant strategies. This model more closely illustrates the biological and institutional impacts of cooperation and noncooperation on Mexico's pastoral *ejidos*. The payoff curve for cooperation reflects the degree of range improvement, and hence productivity, as more herders follow a coalition- or *ejido*-designed grazing plan. Marginal payoffs to each additional herder are low at first but then increase at an increasing rate until a critical mass of herders joins the cooperative group. Payoffs continue to increase with each additional cooperator but at a decreasing rate.

NC continues to dominate at low levels of cooperation in this revised model. But NC and C eventually converge as more people choose to make dominated choices in the hope of reaching a Pareto equilibrium (z). At y the two payoff curves intersect with C becoming the dominant strategy. If the compensating coalition can reach a size of y they can convince others to join because of the superior economic payoffs. The dotted lines for NC beyond y illustrate the hypothetical level of enforcement by cooperators on herders tempted to ignore the grazing plan. But of course there is no economic incentive for herders to choose the NC option at or beyond this point.

The concept of transaction costs can explain the difficulty for coalitions in the *ejidos* of reaching either x or y in Figure 1B ($0 < x < y < n$). These are the opportunity costs of achieving and maintaining assurance within a compensating coalition. Time to form coalitions is a scarce resource in this grazing system. Institution building takes valuable hours and days away from activities which have a higher probability of producing income. Lack of political sophistication, technical knowledge and entrepreneurial ability on the part of the herders are also critical components of these transaction costs. In addition, most herders are suspicious of cooperative programs in a large part due to the assurance problems discussed above. Their perceptions of NC and C would have to be clearer and the probability distributions of the critical values of x and y narrower if a compensating coalition were to be successful.

Cultural inertia is a final component of transaction costs. The personal cost of changing tradition-bound family (e.g. not sleeping in range camps) and grazing management (e.g. using children to herd goats) practices represents a serious obstacle for reaching z in Figure 1B. Can these transaction costs be lowered to an acceptable level which will enable the formation of compensating coalitions? How? The answer to the first question is yes and examples of how are discussed in the next section.

Compensating Coalitions

Some *ejidatarios* recognize the interdependence of their grazing activities. When local authorities fail or choose not to regulate grazing practices, these herders and their families form voluntary associations which enable them to manage ecological and behavioral uncertainties. These groups are of varying sizes but from our conceptual model we know that they are equal to or greater than the critical mass (x) in Figure 1B. We also know that these associations have not achieved a dominant status ($> y$)

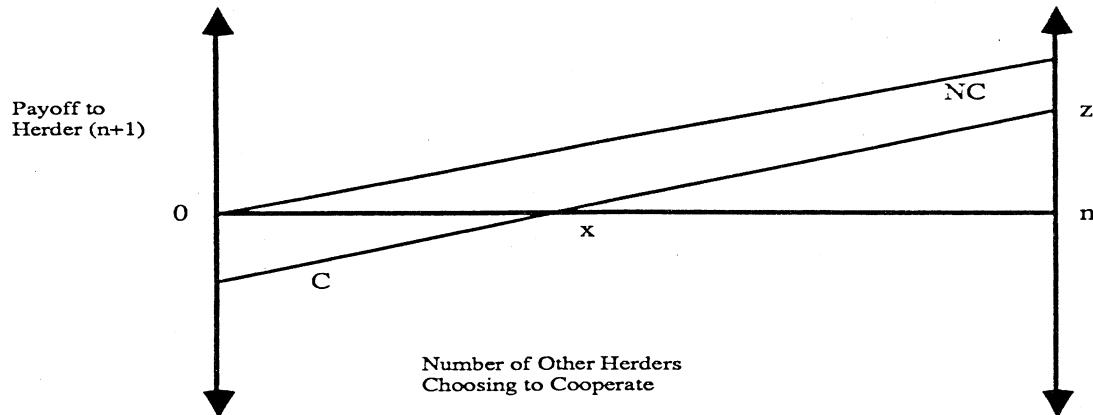
because their existence is an exception rather than the rule in the grazing areas of the northern *altiplano*. Free riding continues to represent the majority of the herding activity by *ejidatarios*.

Adaptive responses to the breakdown in commons management are centered on the use of range camps or *la majada*. These are distant grazing areas in the *ejido* that are not used by most of the herders because their distance from the village makes trips from and to the village in one day impractical. Yet some *ejidatarios* build rustic houses and corrals at these camps. Water harvesting catchment areas are developed to capture water for the herders and the livestock. Because there is less grazing pressure in these regions, forage quality and quantity is superior relative to the remainder of the *ejido*. In addition, herders have more time to intensively manage their animals as opposed to taking up to half a day to walk to and from the best grazing areas.

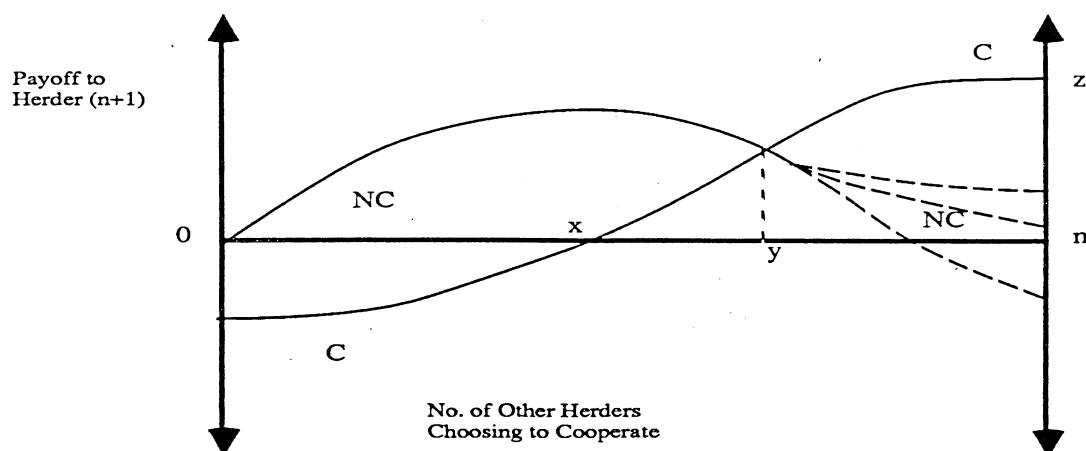
Compensating coalitions have several common features. First, coalitions are more easily formed when n is small. The *ejidos* of the northern *altiplano* range from five to 200 families, yet most would be considered small, neighborhood-type groups. Some form of compensating coalitions can be found in both small and large *ejidos*. Secondly, these voluntary associations generally occur in homogeneous groups, primarily within the structure of the family. Here the transaction costs of achieving and maintaining assurance is less of a problem, although most families still choose not to form compensating coalitions. A final common feature is leadership. Coalition maintenance is not costless and one or more individuals generally take the responsibility for seeing that conflicts and problems are resolved in a fair and timely manner.

Figure 1: Models of *Ejidatario* Behavior

A. Multiperson Prisoner's Dilemma



B. Multiple Equilibria with Nondominant Strategies



Intra-Family Coalitions

Two types of intra-family grazing coalitions are observed in the *ejidos*: nuclear and extended. The nuclear associations involve the immediate family: those individuals living in a single house and managing a single herd. Usually the husband, wife and one or more children form this most basic of all compensating coalitions. The extended family group generally includes the families of a father and sons or the families of brothers. The benefits or payoffs to these larger coalitions appear to offset the transaction costs of their establishment and maintenance.

The initial coalition-building step within the nuclear family is the recognition that the use of a range camp is critical for the survival of their livestock, and possibly their family. In this case the critical mass (x) is two to four individuals who recognize that they will be better off cooperating than acting as free riders. The husband, wife and older children agree to change their lifestyle in dramatic ways. In many cases the husband chooses to live at the range camp during the dry season, for a period of one to six months depending on forage availability for the livestock. Food is either carried to the camp daily (often by the older children) or the herder cooks his own meals. In some cases the entire family will move to *la majada*. Young school-age children may or may not remain with relatives in the *ejido* to pursue their elementary education. In this harsh ecological and economic environment families place more emphasis on survival than education.

The most sophisticated and promising intra-family association is the extended-family grazing coalition. Multiple families combine their livestock into one large herd (200-600 animals) and move the entire grazing operation to the range camp. Intensive grazing management is practiced with short grazing periods and hoof action contributing to a more sustainable and productive range resource. Only one or two herders and several dogs are needed to manage large herds. The owners take turns working the livestock. Sharing the herding responsibility results in a time commitment of one to six months each year, depending on the size of the coalition. This cooperative agreement frees the herder or herders to work in other economic activities the remainder of the year. Also, this release time from herding allows some of the cooperators to spend greater amounts of time in livestock marketing, veterinary care and range improvements. Children are encouraged to remain in school since they are not needed as shepherds or food carriers. The size of these extended-family grazing coalitions can reach a critical mass (x) of 30-50 percent of the families in the *ejido*. Yet we see no evidence in the *altiplano* that even a 50 percent assurance level is high enough to dominate ($=y$) free riding behavior by the other *ejidatarios*.

A Community Coalition

Ejidatarios may recognize the importance of fully utilizing distant range areas yet are unwilling to live in *la majada* without their wives and are unwilling to combine herds. One example of a compensating coalition under these conditions is the formation of a community boarding home or school. The herder and his spouse move to a range camp with their herd. They may remain in *la majada* for months at a time, or in some cases permanently. Children of these families reside in the village during the school year. Housing and food are provided for children by a local family. Mothers and fathers pay a maintenance fee for these services. Frequent trips are made by the parents, not the herds, to the village to see the children and take care of other family matters. Again this compensating coalition is located between x and y in Figure 1B since not all families in these *ejidos* take advantage of these childcare services.

Concluding Remarks

Why can't these voluntary, compensating coalitions be of such a size that they dominate free rider behavior? Based on this analysis, we hypothesize three reasons why these coalitions have fallen short of mobilizing entire communities. First, the transaction costs of obtaining high levels of assurance are prohibitive. Only within the family structure do the opportunity costs of forming coalitions reach acceptable levels for some *ejidatarios*. Otherwise the costs associated with overcoming suspicion and persuading other community members to join a coalition are substantial.

Secondly, we recognize that the central economic focus of some *ejidatarios* is outside of the community. Off-*ejido* employment may contribute more to a family's income than grazing activities. San Luis Potosi is one of six states contributing the most undocumented workers to the United States. Remittances from the U.S. and large Mexican cities (e.g. Monterrey, Mexico City) are significant in some families and in some *ejidos*. This external focus may weaken the sense of community, make *ejido*-based grazing plans insignificant economically, and discourage the formation of compensating coalitions.

The third constraint is the limited technical understanding within the *ejido* regarding the interdependence of individual grazing decisions and the impact these choices have on the range resource, and ultimately, on livestock productivity and human welfare. Local understanding of elementary soil-water-plant-animal relationships is rudimentary. As a result, there is a limited

supply of "institutional entrepreneurs" to champion the formation of compensating coalitions or *ejido*-wide grazing plans (Runge, 1984). This human capital or managerial constraint limits the *ejido*'s efforts to manage the common range resource in a productive and sustainable manner. Also, the Mexican government has not emphasized or encouraged the development of local management ability on the *ejidos* at the extensive margin.

Our analysis has indicated that Mexico's pastoral *ejidos*, at least those in the northern *altiplano*, range from non-sustainable regimes approximating open access to compensating coalitions that nearly dominate free rider behavior. To conclude that private property is "the answer" to low productivity and ecologically damaging grazing practices would be an unsatisfactory policy decision in any of these communities. Instead, in *ejidos* on the extensive margin, the advantages and disadvantages of each property regime should be compared using the following criteria: (1) the transactions costs of initiating a new regime (e.g. surveying, distributing, titling, enforcement) versus the costs of improving an existing one (e.g. human capital enhancement), (2) the probability of the property regime sustaining, over a long period, the productivity of a fragile ecological resource, and (3) the impact of the property regime on the distribution of resources, and hence the political stability of the nation. Analysts must recognize the heterogeneous nature of Mexico's *ejidos* in their formulation of modified or new land tenure policies. A sweeping, general privatization of property rights on extensive margin lands may lead to a modern day *hacienda* system.

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