



# The development of first-possession rules in US mining, 1872-1920: theory, evidence, and policy implications

David Gerard

Political Economy Research Center, 502 South 19th Avenue, Suite 211, Bozeman, MT 59718-6827, USA

This paper applies a property rights framework to federal mineral lands in the western United States from the enactment of the Mining Law in 1872 until the enactment of the Mineral Leasing Act for fossil fuels in 1920. There are two principal findings. First, the Mining Law appears to have been an effective means for assigning rights to mineral stocks on public lands (at least through 1920). This conclusion is supported by evidence from claim disputes in the West. Second, the impetus for the Mineral Leasing Act did not derive from the different physical characteristics of hardrock minerals and petroleum. The relevance of these conclusions to contemporary mineral policy is also discussed. © 1999 Elsevier Science Ltd. All rights reserved

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## Introduction

Federal lands in the western United States are a significant and often dominant source of domestic mineral potential. So it is puzzling that there is no uniform system for transferring mineral rights from public stewardship into private hands. Two important systems are the General Mining Law of 1872 governing hardrock minerals and the Mineral Leasing Act of 1920 governing fossil fuels.<sup>1</sup> There have not always been separate systems for hardrock minerals and petroleum. Between 1872 and 1920 rights to these minerals were both assigned using essentially the same system. Why did Congress enact a leasing system for petroleum, but not for hardrock minerals?

In this paper I address this question by examining the interaction and simultaneous development of legal institutions and industrial conditions in western mining during the late-nineteenth and early-twentieth cen-

turies. Although political maneuvering was prevalent during this era, the focus in this paper is the economic logic of the mineral land management system that emerged.<sup>2</sup> Specifically, the paper follows an economic analysis of institutions and property rights, with an emphasis on the model of Lueck (1998, 1995) for assigning rights through first-possession rules.

First possession is a natural place to begin an analysis of public mineral land policy.<sup>3</sup> These rules grant a legitimate ownership claim to the party that gains control before other potential claimants' (Lueck, 1995, p. 393), and therefore provide a strong incentive to search for new sources of wealth. Several sources of dissipation, however, can offset the benefits stem-

ming from this incentive. For instance, a race to claim rights to a stock often results in the wasteful duplication of investment. Therefore exclusive rights should be assigned early in the process, or through a means that restricts access to the stock (eg an auction). A second source of dissipation occurs where costs of enforcing rights to an *in situ* resource stock are prohibitive, and rights can only be secured by capturing the resource flow. This is often the case for migratory resources such as petroleum where rights to the stock are only secured when the oil is pumped to the surface. The potential consequences of capture are dissipation from rapid exploitation and/or damage from overuse of the stock.

The application of the framework to the development of mineral rights in the western US elicits two perhaps surprising conclusions. The first concerns hardrock mining and the Mining Law. The Mining Law has been viewed as an engine for litigation, and some authors have argued that a leasing system should have been enacted for hardrock minerals by 1920 (Lesby, 1987, pp. 289-297). Several pieces of evidence question the validity of this assertion. The emergence of the mineral prospector as a specialist in establishing property rights suggests that dissipation associated with racing should have been decreasing. Moreover, General Land Office<sup>4</sup> data show pronounced declines in the rate of claim disputes after 1900. My first conclusion is that the Mining Law remained intact through 1920 because it was an effective means of assigning private mineral rights to public lands.

A second conclusion concerns the economic logic behind the Mineral Leasing Act. It seems reasonable to assume that differences in mineral characteristics for hardrock and petroleum warrant two different systems (eg petroleum is migratory). These differences do not appear to account for the new law. One of the main effects of the leasing system was to relax the rules for assigning exclusive rights for petroleum exploration, thus limiting the duplication of exploration investment.<sup>5</sup> At the same time, however, the new law restricted tract sizes to prevent the monopolization of a single field. In this light, the second conclusion is that the first-possession model helps to explain the emergence of the Mineral Leasing Act, but not in the terms we might expect. Specifically, the lease system addressed the racing problem for pe-

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roleum resources, and only to a much lesser extent addressed the dissipation from capture.<sup>6</sup>

The analysis has implications for mineral policy on public lands today. Legal systems do not emerge from a vacuum, and federal land management characteristics today are consequences—both intended and unintended—of policies that have developed over the past century. Examining institutional and industrial developments in western mining between 1872 and 1920 will help us to understand the rules and laws of today. The application of the first-possession model also illustrates the types of tradeoffs that should be considered in any legislative changes to the present system.

The next section outlines the framework for analyzing property rights and first possession, and is followed by a description of the institutional setting of western mining. Next I examine industrial and institutional development in hardrock mining between 1848 and 1920, including the factors that led to a successful adaptation to the Mining Law. I then compare and contrast the situation in the hardrock mining and petroleum industries. The final section concludes.

## The economic analysis of property rights and first-possession rules

In recent years there has been a growing interest in the economic analysis of institutions and property rights.<sup>7</sup> Institutions are commonly referred to as the 'rules of the game' that provide the incentives for and constraints on economic actors, and the structure of property rights is the central component of the institutional setting. *Property rights* are a claim to the rental stream of an asset, and these rights can have several dimensions. First, user rights allow the holder to transform the asset physically. Second, agents can contract over terms with other individuals and groups to derive income from the asset. Third, agents can transfer control of rights to the asset (Barzel, 1989, pp. 2-4). Exercising control over property rights is often costly. Agents expend resources establishing and enforcing rights to assets (ie excluding others from using or contracting control). The costs of these activities are *transaction costs*. Institutions shape both the scope of property rights and the costs of securing these rights. Thus, the institutional setting is a key

<sup>1</sup>See (1976), Swanson (1968), Mayer and Riley (1985) have examined the political dimensions. For a recent critical examination of the causes and consequences of the conservation era see Nelson (1995).

<sup>2</sup>Economists have debated the efficiency implications of first possession in a number of case studies. Notably, Kirch (1977) compares the patent system for inventive activity to the Mining Law. There are also studies of nonrenewable oil and gas, water rights, the broadcast spectrum, and wildlife law. Lueck (1998, 1995) catalogs this literature. Coover and Ulen (1997, pp. 112-123) also introduce the topic.

<sup>3</sup>The General Land Office in the Department of the Interior was the principal land administration agency during the period under consideration. The Bureau of Land Management (BLM) was formed in 1946 through a merger of the Land Office and the Grazing Service.

<sup>4</sup>A more substantive issue for those interested in public choice, of course, was *SPRING*. Federal authorities, the administrative decision to assign rights. In a similar vein, Libecap (1984) argues that leasing was part of a jurisdictional dispute between the Department of Agriculture and the Department of the Interior.

<sup>4</sup>Until the 1920s there was a limited understanding of petroleum reservoirs, and the courts generally held that the rule of capture was the means for assigning rights to oil and gas. In 1920 the Mineral Leasing Act was amended to address some of the problems associated with small tract sizes.

<sup>5</sup>This has both been encouraged and reflected by the awarding of Nobel prizes to inventors in these areas. Ronald Coase and Douglas North. Theoretical underpinnings of institutions and institutions change are in North (1990) and Barzel (1989). I develop a structure for the economic analysis of property rights. Libecap (1989) provides a framework, and applications to many natural resource issues. For a broad sample of empirical work in this area, see the papers and commentary in Alston *et al.* (1996).

determinant in the generation (and distribution) of the mineral stream from that asset.

Mineral deposits on federal lands fit well into this construct. Rights to examine a site are necessary to encourage mineral exploration. Even if a viable deposit is identified, the property is only valuable if rights to extract, process, and sell the ore are in place. Of course, the property value will also be a function of the costs of securing these rights. Institutions change over time, and as a result the attendant property rights, transaction costs, and asset values will also change.<sup>8</sup>

First-possession rules are critical during the identification stage of a development sequence.<sup>9</sup> As a starting point, consider a stock where property rights are completely defined (ie the costs of establishing and enforcing rights are zero) and the owner optimally extracts the stock once rights are established. The stock value can be written:

$$V = \int_0^{\infty} R(t)e^{-rt} dt \quad (1)$$

where  $R(t)$  is the net flow of benefits at time  $t$ , and  $r$  is the rate of interest. This represents the 'first-best' solution.

Now consider the case where there is a single claimant that incurs a one-time cost of establishing rights,  $C$ . The calculation of the stock value follows directly from marginal analysis. The claimant chooses to establish rights at time  $t^*$  when the present value of the asset flow (marginal benefit) equals the present value of establishing rights (marginal cost). The value of the stock in the single-claimant solution is:

$$V_{\text{single}} = \int_{t^*}^{\infty} R(t)e^{-rt} dt - C e^{-rt^*} \quad (2)$$

$V_{\text{single}} < V$  because there are positive costs of establishing rights, and there are forgone benefits in periods 0 to  $t^*$ . Thus, as the costs of establishing rights increase, the stock value decreases.

Next consider a number of claimants that are homogeneous with respect to costs of identifying a stock and establishing rights (ie  $C = C_1/V_1$ ). In this case a race leads to the premature establishing of rights in time  $t^*$  where  $t^* < t^*$ . Moreover, duplication of investment reduces the economic value of the stock. As a result, the stock value is completely dissipated as the number of claimants increases. This, in effect,

<sup>8</sup>For a comprehensive application of the property rights framework applied to US mineral lands see Gerard (1997a, pp. 12-64). This discussion draws principally on Lueck (1998, 1999). A summary table of outcomes is in Lueck (1995, p. 432). I drop the growth term because I am only dealing with non-renewable resource stocks.

is a case of open access on the time dimension (Lueck, 1995, p. 399).

Where claimant costs of establishing rights differ, this dissipation is reduced. Consider two claimants,  $i$  and  $j$ , that have costs  $C_i, C_j$  with  $C_i < C_j$ . Claimant  $i$  will establish rights to the stock in period  $t_i$  and earn rents equal to the discounted value of the cost advantage:

$$V_{\text{Heter}} = \int_{t_i}^{\infty} (C_j - C_i)e^{-rt} dt \quad (3)$$

The stock value increases as claimant heterogeneity increases. (Notice that in the general case of  $n$  claimants,  $C_i$  and  $C_j$  represent the two lowest-cost claimants.) If claimants have perfect information about each other's costs, then the lowest-cost claimant is the only one to enter the race, and  $V_{\text{Heter}} = V_{\text{single}}$ . Thus, claimant heterogeneity reduces dissipation from racing.

To this point I have assumed that there are no costs of enforcing property rights. Where enforcement costs are prohibitive, however, rights are secured only through capture of the asset flow. The stock becomes either an open-access or a common-property resource, and the potential sources of dissipation under these conditions are well known.<sup>11</sup> In the case of petroleum, for example, excessive drilling or rapid pumping reduces the natural pressure and increases extraction costs. The solution to the capture problem is generally to define rules that limit access to the stock. For instance, auctions are an alternative to first-possession rules. If a state can establish and enforce rights at a low cost, the transfer of a stock to private hands becomes a choice between administrative and enforcement costs of auctions and dissipation from races yet to be identified, however, auction costs are generally prohibitive (Lueck, 1995, p. 403).<sup>12</sup>

On the other hand, if claimants can mitigate a cost disadvantage through investment, dissipation is again tamed. Lueck argues that investment is unlikely to overcome heterogeneity in many cases because of an exogenous distribution of talent and luck. In other cases, possession should be defined early to limit investments designed to compensate for cost advantages. The seminal piece is Coase (1960). The recent treatment with several examples see Leachery (1999). The difference between open access and common property concerns limitations on access to the stock. Under open access it is impossible to exclude outsiders from a group (community) of owners can exclude outsiders and regulate insiders.

In cases where the seller knows the value of the asset, the auction yields that information through a bidding process. However, such information will not be revealed if potential bidders have better information about the value of the asset. This is certainly the case for resources such as stolen treasure and future plausible inventories, and is likely to be the case for the initial stages of a hardrock mineral exploration program.

The implications from the model of first possession are important because the institutional structure sets the rules for when, how, and at what cost rights are established and enforced. To summarize:

- (1) First-best solutions are not possible where costs of establishing and/or enforcing rights are positive.
- (2) An increase in costs of establishing or enforcing rights reduces the value of stock.
- (3) A race to establish rights results in excessive investment and results in dissipation.
- (4) Heterogeneity of claimants reduces dissipation from racing.
- (5) Where costs of enforcing rights to a stock are prohibitive, capture is the result.

In the following sections we will see the importance of these implications in shaping the development of mineral rights in the western United States.

### Institutional setting

At the onset of the California gold rush in 1848, miners confronted open access conditions: gold rights were unassigned and there were no rules for assigning them. In response, mining associations formed and implemented extrajudicial systems for enforcing rights (even though miners were trespassers with no legal rights). The effect was to reduce open access dissipation and discourage episodes of violence. These associations did not prove to be effective on Nevada's Comstock Lode following its discovery in 1859. Unlike the California placer gold (dissipated one), Nevada silver was found in lodes (veins of ore in place) that often ran beneath the surface of a number of adjacent claims, and defining mineral rights based on surface claims was problematic. As a result, a formal legal structure emerged (the legislation and the development of case law), and these rules provided the foundation for the Lode Act in 1866. The Placer Act, which was based on mining camp codes from California and elsewhere, followed in 1870. These statutes were amended and codified as the General Mining Law in 1872.<sup>13</sup>

The Mining Law defined the rules for the initial allocation of rights to mineral deposits on federal lands, the enforcement of these rights, and the procedures for obtaining title to the land. Miners had free access to explore for minerals and establish claim rights on federal land (in other words, administrative consent was not required). Miners established rights by staking a claim and recording it with the county. These procedures were known as *locating* a claim.

<sup>13</sup>Swenson (1968), Lashy (1987), Lashy (1989) and a number of others have described the events leading to the enactment of the Mining Law. For a summary of the development of western mineral rights, see Umbeck (1981), Umbeck (1989), and (1997a).

and hence the system became known as the *location* system. The maximum size for any single claim was approximately 20 acres, but claimants could locate or consolidate blocks of claims. The completion of US\$100 of labor and improvements per claim was necessary to maintain claim rights from one year to the next, and these rights could be maintained indefinitely.<sup>14</sup> Miners could also acquire a mineral patent, and the patent conveyed outright (ie simple) title to the land from federal stewardship to the miner. Notably, a patent was not necessary to mine the land. These rules emerged in areas with limited federal presence, and predictably the government role was limited. The principal land management agency—the Land Office—had neither the incentive nor the drive to do more than process patent applications.<sup>15</sup> The agency did, however, adjudicate disputes between interests competing for rights to federal lands under the various land laws (eg disputes involving miners and homesteaders), and departmental decisions could be appealed to the Secretary of the Interior. These decisions established a body of administrative law that could be appealed in the federal courts.

### First possession: the rule of discovery

The discovery of a valuable mineral deposit was the first-possession rule for establishing claim rights. In other words, an agent had to make a discovery before locating a claim.<sup>16</sup> This was important because claim rights were valid both with respect to rival interests and to the federal government: a mining claim pertained under the law is property in the highest sense of that term.<sup>17</sup> Despite its importance, the meaning of *discovery* was not clear. During the early rushes, the time lag between finding evidence of mineral-

<sup>14</sup>This was known as assessment work. Failure to complete the work did not result in the automatic forfeiture of rights. The claimant only forfeited rights if a rival claimed the land in a year where the assessment work had not been done.

<sup>15</sup>A number of reasons help to explain why mineral lands were not a land office priority. The main source of Land Office revenue came from surveying, valuing, and processing land claims, and mining claims comprised a trivial portion of these receipts. In 1894, for instance, salaries and commissions of Land Office officials totalled US\$495 481. Commissions from original and final homestead claims accounted for US\$306 647 of this total, while fees from mineral patent applications totalled US\$15 080 (3% of receipts), invalidating the rights of a mining claimant would have provided no revenue to the Land Office and no commissions to its officials. Thus, the payoff of assuming a more activist role is not clear. Finally, even if administrators wanted to pursue a more activist role, such authority was not provided for in the text of the Mining Law. It was not until 1920 that it was clear that administrators had this right (*Conover v United States* 252 US 450).

<sup>16</sup>Of course, it was not possible to enforce the discovery rule *ex ante* because potential claimants did not have to notify the Land Office of their intention to locate a claim. *Ex post* enforcement was also difficult. Land Office officials (or any other challengers) could contest the validity of a discovery, but the legal presumption was that claim rights were valid. Therefore, the burden of proof was with the challenger to demonstrate that a discovery had not been made.

<sup>17</sup>*Beck v Magner* 104 US 279, 283 (1881).

ation and beginning development was limited, and the ambiguity of the meaning of discovery had little effect. Presumably a claimant that was profitably removing ore had discovered a valuable mineral deposit. The discovery became an issue as exploration began requiring more detailed examinations and longer time horizons.

Because exploration activity signalled a promising area, the absence of a clear first-possession rule had the potential to encourage excessive investment. The fundamental question that emerged was: What constituted *discovery*? Was it finding an outcropping that warranted further examination, or was it proving that the site contained a deposit worth exploiting? And if it was the latter, did the law provide any security during the site evaluation? If interests had to demonstrate that a deposit was commercially viable prior to establishing *any* rights, then the rule would encourage a race.

The House and Senate addressed the discovery issue in the early 1890s, and both the Interior Secretary and the Land Office Commissioner supported such legislation. However, the matter was resolved by an administrative decision. In 1894 the Secretary of Interior held that:

where minerals have been found, and the evidence is of such a character that a person of ordinary prudence would be justified in the further expenditure of his labor and means, with a reasonable prospect of success in developing a valuable mine, the requirements of the statute have been met.<sup>18</sup>

This *prudent person test* remained the rule of discovery for almost 75 years.<sup>19</sup> The decision clarified the rules for establishing rights, increasing the resource stock value.

Administrative attempts to verify the validity of discoveries were rare even during the patent process. The Federal law, incidentally, requires it, but in practice no proof of the fact is demanded unless non-discovery is alleged by a third party (Van Wagenen, 1918, p. 300). This was because in the era of large-scale federal land disposal the Mining Law was a costly way to obtain federal land. Consider that under the Timber and Stone Act individuals could purchase 160 acres of timberland for US\$2.50 per acre, and the Preemption and Homestead Acts allowed for the acquisition of 160 acres at US\$1.25 per acre (subject to residence requirements). To acquire the same amount of land through the Mining Law would have required locating at least eight claims, expending US\$500 per claim on development, incurring several

hundred dollars in administrative and legal costs,<sup>20</sup> and paying the premium price of US\$2.50–5 an acre.

Why did miners use the Mining Law instead of a cheaper alternative? This certainly happened before 1850, as federal officials sold three-quarters of the mineral lands in the Midwest at minimum prices as farmland (Swenson, 1968, p. 705). The Mining Law mitigated this possibility because rights established by discovery superseded those of the other federal land laws. Hence, discovery gave claimants the 'right to mine'. An agent that attempted to secure mineral rights through an alternate federal land law left himself vulnerable to being over-staked and losing rights to a mineral claimant. Thus, miners had the incentive to use the more costly alternative—the Mining Law.<sup>21</sup>

#### Hardrock mining and the Mining Law

Although the state of American metal mining technology at the onset of the California gold rush was quite rudimentary, by 1920 capital-intensive and technologically sophisticated firms dominated western mineral production.<sup>22</sup> There were a number of consequences of these developments. These included producer consolidation, the demise of small producers, and specialization in exploration by the small prospector.

Industrial trends can be seen in the description of a typical development sequence. In the first stage a prospector identified a promising site by looking for an outcropping ore body. Once a promising site was found, miners moved to the area and formed a camp. While individual and small-scale ventures often probably extracted very high-grade ore from a new site, handling lower-grade material generally required high fixed costs and technical expertise—scarce assets for small interests. Profitability of lower-value minerals depended on a high volume of output, and usually had significant requirements. In some cases prospectors used proceeds from an initial excavation to finance the development of the site, which was often the only financing option due to legal restrictions on

raising capital. Many stock exchanges, for instance, prohibited mining stock offerings. The prospector's alternative was to sell claim rights to a vendor or promoter, and these agents would either raise funds to examine the viability of the site and develop the project, or solicit the property to a producing interest (Navin, 1978, p. 27).

The early California and Nevada rushes are illustrative. In California the small-scale placer miner became obsolete with the depletion of high-grade gold deposits by the mid-1850s. He was replaced by capital-intensive hydraulic mining operations (Swenson, 1968, p. 710). Precious metal production in Nevada also initially consisted of small-scale operations, though larger operations eventually assumed control. The innovation and application of new technologies on Nevada's fabulous Comstock Lode gave it the moniker of the 'mining school to the world'. For instance, the introduction of square set timbering, which helped demonstrate the viability of deep metal mining, was first successfully applied in the US on the Comstock. Such technologies usually required significant capital. As a result, silver mining generally, and the Comstock specifically, tended the poor man's day in mining, and ushered in the era of the financier and engineer (Barger and Schurr, 1944, p. 101).

Even operations on the Comstock were small compared with what was to come for western mining. Consider copper mining.<sup>23</sup> By the turn of the century, copper dominated mining in many western states, and copper production was characterized by large capital outlays, technological innovations, and the integration of extraction, production, and refining processes. A more integrated production process allowed for the exploitation of lower ore grades (eg the transformation to non-selective mining methods). The expansion of copper output helped to cement the shift in extraction and production from small-scale enterprises to well-financed syndicates.

A consequence of these changes was that larger tract sizes were needed to exploit a deposit. Though maximum surface area of a single mining claim encompassed only 20 acres, claimants could stake blocks of up to 160 acres. The depletion of high-grade surface deposits led to the need for greater tract sizes in order to take advantage of economies of scale. A series of court decisions facilitated this need. Initially the courts liberalized the average requirement by allowing a single firm to acquire unlimited claims from other claimants. Later, the courts decided that there were no limits on the number of claims that an individual can stake and hold.<sup>24</sup>

<sup>18</sup>Harshbahl (1959, pp. 207–14224) gives a concise description of the state of technology before World War I, and Navin (1978) discusses the implications of capital availability to the copper industry.

<sup>19</sup>The last case was *St Louis Smelting and Refining Co. v. Kemp*, 104 US 656 668 (1881). The latter decision of the *United States v. Brockhite Ore Co.*, 242 F. 385 (D. Cal. 1917), Leahy (1987, Ch. 9) provides details of the multiple claims issue.

As small operations became less feasible, prospectors confined their role to the first stage of a development sequence—identifying promising sites and establishing claim rights. The Office of Technology Assessment (1979, p. 49) attributes over 90% of discoveries of major US metal mines prior to 1940 to conventional prospecting techniques. While large firms could have found the sites using these techniques, that was not the case for the copper industry; nearly all of today's leading American copper companies got their start by purchasing (not discovering) their orebodies. Until after World War II the major American copper companies did practically no exploration for new ore deposits. Even Newmont, which has historically regarded exploration as one of its primary functions, has bought most of its deposits (Navin, 1978, p. 18).

We have seen that the first-possession rule of discovery granted early and secure rights to hardrock minerals. It seems likely that prospector specialization developed because of differential costs of discovering and establishing rights. Lueck (1995, p. 417) explains the phenomenon:

Successful claimants are those with the lowest costs of determining the presence and valuation of unexploited mineral deposits; the source of the cost advantage may be unique talent, luck, or both.<sup>25</sup>

Thus, rights were established where claimant heterogeneity was greatest, which limited the dissipation associated with the race to claim a resource stock.

#### Cases of enjoying rights to the stock—*extralateral rights*

A second issue was enforcement costs. Because hardrock minerals are not migratory, it would seem that costs of enforcing rights to a stock would be low. Of course, those familiar with western mining history know this was not the case. One source of disputes involved lode deposits. Because lodes often extended under the surface of a number of claims, disputes arose when a firm thought that an adjacent producer was extracting ore from the same vein (thus, lode deposits were migratory relative to surface rights). Crudely put, the party that held rights to the area where the vein ran nearest to the surface (ie the apex) was granted exclusive rights to the vein. In theory this was a reasonable way to define mineral rights, as rights to a stock were established by discovery, not capture. In practice, enforcement was difficult because the owner of the surface rights to adjacent land could sink a shaft and tap into the vein. As a result, it was both difficult and extremely costly to sort out the questions that arose. Were the contesting parties exploiting the same vein? If so, which party

<sup>24</sup>Alternatively, the advantage may also arise if there is a small efficient search for exploration organizations. Snow and Maskowitz (1981) forward this view.

<sup>17</sup>*Cady v. Wemple*, 19 LD. 453 (1894).

<sup>18</sup>A restriction of Federal land to a priority, this test came to be known as the 'discovery' test. The Supreme Court in the *Supreme Court* case *United States v. Schuyler* (1897) held that the discovery test was required to establish discovery (*US v. Coleman*, 290 US 602 603 (1988)).

<sup>20</sup>An estimate from 1897 of administrative fees was US\$5740. This covered payments to the Deputy Mineral Surveyor (US\$75), Surveyor General office work (US\$330), application filing fee (US\$10), and publication and notice of application (US\$50). See Clark *et al.* (1897, p. 513). In addition, Van Wagenen (1918, pp. 315–316) comments that the costs of patenting are 'larger than they should be... mainly due to the fact that the procedure that has been prescribed is so unnecessarily complicated and antiquated that the services of a lawyer are generally required.'

<sup>21</sup>The right to mine continues to guide Mining Law critics. A recent manifestation was seen in the federal budget of claims in the vicinity of Yellowstone Park. If discovery had not provided enforceable rights, the federal government may have simply terminated substantial rights of mid-nineteenth century technology holders' until nearly the turn of the twentieth century. American prospecting reflected no great advancement beyond that of primitive ages (Young, 1970, p. 30), and 'descriptions of mining operations in this country prior to about 1850 uniformly respect a very primitive type of endeavor' (Barger and Schurr, 1944, p. 99).

had rights to the vein? And how much damage was due to the plaintiffs?

The difficulty of resolving these questions coupled with the dominance of mining in areas where disputes arose resulted in high profile, complex, and extremely costly litigation.

Obviously, if there were a number of top flight lawyers and experts, the cost of litigation might run high. It was reported that in a suit settled in the Helena district court in 1893 a total of 10 geologists and engineers were employed, and that their fees alone amounted to more than \$100,000. Another case, heard in Utah more than 20 years later, took more than 100 days at an estimated cost of \$2500 a day, including model construction, exploratory work in the mines, and fees for lawyers and experts (Spence, 1970, pp. 214-215).

These were cases with high enforcement costs, and clearly some degree of capture was occurring.

The spectacular nature of the apex litigation creates the impression that these were the most common forms of dispute. Colby (1917) questions this notion. First, of the 5808 cases reported in *Morrison's Mining Reports*, only 115 (2%) were apex suits.<sup>26</sup> Second, on average there were fewer than three annual cases involving apex litigation resolved through the courts between 1870 and 1916, and that rate was fewer than two per year for 1902 to 1916 (Colby, 1917, pp. 310-312).

Although firms could incur considerable expense prior to reaching an agreement, the potential litigation costs provided the incentive to find alternative solutions. Possibilities included consolidation and writing boundary contracts. For example, several mining districts simply circumvented the Mining Law with local ordinances stipulating subsurface boundary agreements based on surface rights. These included Bisbee and other Arizona copper districts; Leadville, Colorado; Santa Rita, New Mexico; and Tonopah and Goldfield in Nevada. Such agreements were not necessarily technically efficient, as several shafts would have to be sunk to exploit the same lode. These agreements may also have dampened exploration incentives if prospectors could not establish exclusive rights to the lodes they discovered (Colby, 1917, p. 329; Van Wegenen, 1918, pp. 297-299). Firms in these areas, however, must have believed that reducing the costs by mitigating the possible disputes outweighed the lower production costs of consolidation.

While a number of House and Senate bills were introduced between 1886 and 1921 either to revise or repeal the apex provision, there was no industry consensus on the matter (Spence, 1970, p. 224). By 1921, however, the last of the major apex cases was coming to a close. The cases dwindled because dis-

covered of rich lodes of ore were less frequent, and local ordinances, producer consolidation, and other private agreements reduced enforcement costs of preventing capture.

*Costs of enforcing rights to the stock—other evidence of claim disputes*

While it is clear that disputes were frequent in western mining, it is not clear how these data could be compiled for systematic analysis.<sup>27</sup> I have compiled data for disputed patent applications across the West for the period 1882 to 1932. Patent applications were subject to disputes from parties who believed they had established rights to the same land. Such an interest could file an *adverse claim* in the Land Office against part or all of the land included in the patent application. The contestant then had to bring the case to court in order to determine which party would obtain claim rights. Tables 1 and 2 contain summary statistics for patent applications and the ratio of adverse claims to patent applications in the western states.

Inferences from this evidence rest in part on the proposition that there was a strong relationship between the rate of disputes for unpatented claims and the rate of disputed patent applications. There was no immediate reason to acquire title because (1) a patent was not needed to mine, and (2) the patent process was costly. Even so, Table 3 provides evidence from Montana showing that many operations patented some or all of their holdings.<sup>28</sup>

The motivation to patent probably was that the patent provided a more precise delineation of property rights (see simple title), and claimants were willing to pay for this security. The net value of secure patented title was the difference in the present discounted value of the expected return from a patented and an unpatented claim. Full title may have discouraged nuisance suits, resolved boundary overlaps, or cleared a number of other ambiguities that may have prompted challenges. The patent may also have improved the chances of winning an apex suit (Costigan, 1908, pp. 306-307). As a result, a dispute over unpatented claim rights increased the value of a patented claim relative to an unpatented claim. Assuming that a trial that disputed unpatented claim rights would also be likely to dispute the patent application (ie file an adverse claim), then we should expect a positive correlation in the relationship between disputes of unpatented claims and disputes of patent applications.<sup>29</sup>

<sup>27</sup>The frequency of litigation is evident from the number of volumes of mining case law that were published between 1872 and 1920. These include *Barstow's, Burdick's, Clark, Copley, Costigan, Leadley, Martin, Morrison, Sturmi, Steel, Sweder, Wade, Weeks, and Wilson*.  
<sup>28</sup>Concomitantly, many of the larger operations such as American Smelting and Refining and Anaconda did not report their property holdings.  
<sup>29</sup>General (1998) provides a novel and empirical evidence supporting this proposition.

Table 1 Patent applications by state/currency, 1882-1932

	N	Mean	Std	Min	Median	Max
Arizona	45	31	24	0	26	111
California	51	68	43	0	38	165
Colorado	51	113	43	33	109	213
Idaho	51	420	387	17	335	1583
Montana	51	56	29	16	80	155
Nevada	51	138	78	9	142	307
New Mexico	51	57	62	4	37	273
Oregon	51	32	20	2	28	96
South Dakota	51	15	11	1	12	48
Utah	51	96	57	35	24	113
Washington	51	20	19	0	13	29
Totals	606	90	159	0	44	1583

Source: General Land Office.

Table 2 Ratio of adverse claims to patent applications, 1882-1932

	N	Mean	Median	Max*
Alaska	45	0.29	0.06	5.87
Arizona	51	0.10	0.06	1.00
California	51	0.88	0.07	0.25
Colorado	51	0.16	0.11	0.73
Idaho	51	0.12	0.10	0.33
Montana	51	0.10	0.10	0.24
Nevada	51	0.13	0.08	0.70
New Mexico	51	0.11	0.07	1.08
Oregon	51	0.69	0.00	2.00
South Dakota	51	0.13	0.06	0.61
Utah	51	0.17	0.15	0.58
Washington	51	-0.09	0.05	1.00
Totals	606	0.13	0.08	5.87

\*Millions values ranged from 0 to 0.02. Source: General Land Office.

Table 3 Nature of claim holdings for operators in Montana, 1935

Operator	Unpatented	Patented	Workers	Metal <sup>s</sup>
Thompson Gold Mining Co.	7	20	40	Ag, Au, Pb, Cu
Granite and Bismutic	0	262	35	Ag, Au, Pb, Cu
Lead King	5	30	30	Ag, Au, Pb, Cu
Trou	1	21	94	Ag, Au, Pb, Cu, Zn
Basin Monarch Tunnel Co.	144	46	95	Ag, Au, Pb, Cu, Zn
Jay Gould	0	20	25-60	Au, Ag
Spring Hill	22	9	65	Au, Ag
Insighton Gold Mining Co.	0	24	70	Au, Ag
Lilbury Montana Mining Co.	20	14	65	Au, Ag
Marjesta Montana Mining Co.	24	22	46	Au, Ag
Marjesta Mining and Milling Co.	3	60	21	Au, Ag
Jardine Mining Co.	5	27	75	Au, Ag, As, W

\*Includes all operations reporting 20 or more workers.  
<sup>s</sup>As, arsenic; Ag, silver; Au, gold; Cu, copper; Pb, lead; W, tungsten; Zn, zinc. Source: Montana Bureau of Mines and Geology, 1935.

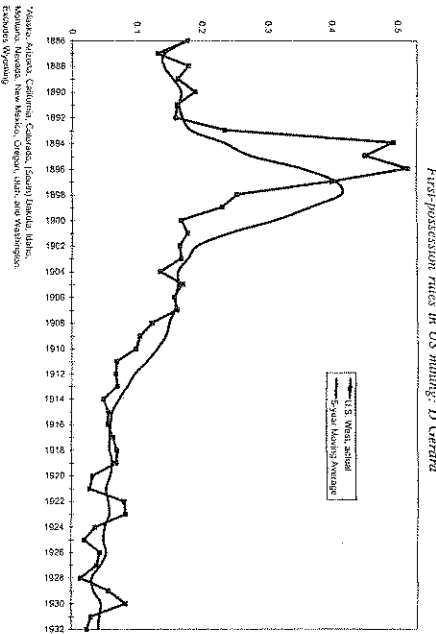


Figure 1 Rate of disputes in western states. Source: General Land Office

The decline in the rate of disputes over the course of the period was substantial. For the first half of the sample period, 1882–1906, the ratio of adverse claims to patent applications was 0.21; for 1907–1932 the ratio was 0.08. This represents a 64% decline in the rate of disputes.<sup>29</sup> This steep decline is evident in Figures 1 and 2. Figure 1 shows the ratio of adverse claims to patent applications for the western states.<sup>31</sup> Notice that the rate exceeded 0.1 for each year before 1910, but did not reach that level again during the sample period. The sharp increase recorded from 1894 to 1897 was largely a product of the situation in Colorado.<sup>32</sup> The 5-year averages for Colorado and several other major hardrock-mining states are presented in Figure 2. The rate of disputes in each of these states shows a marked decline after 1900.

<sup>29</sup>The states included are Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Washington. There are also observations from the Dakota territory through 1890, and from the state of South Dakota thereafter. In the first period there were 8225 adverse claims filed against 38 465 patent applications. In the second period 1269 adverse claims were filed against 16 336 applications. Wyoming is excluded from these figures, but is discussed in the following section.  
<sup>30</sup>More than one adverse claim could be filed against a given patent application, and thus the variable is an upper-bound for the rate of disputes. I retain *rate of disputes* for expositional simplicity. The moving average variable is calculated:  $\text{Rate of disputes } (t) = \frac{\sum_{i=t-4}^{t+4} \text{adverse claims}}{\sum_{i=t-4}^{t+4} \text{patent applications}}$ .

<sup>31</sup>There was a rapid increase in both applications and adverse claims in Colorado during the rush to Cripple Creek in the early 1890s, which coincided with the peak silver production in the San Juan and Cripple regions. By 1900 Colorado was the leading US producer of precious metals.

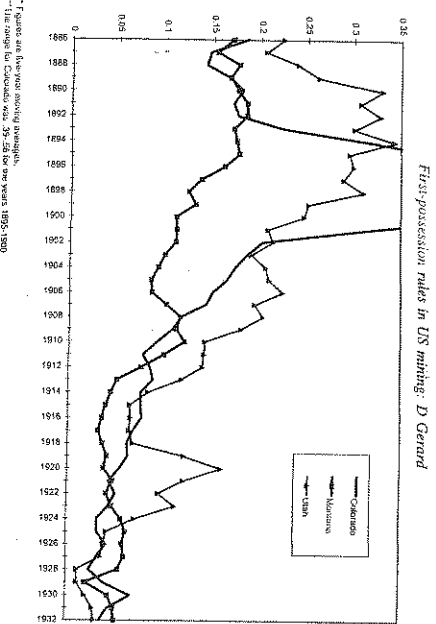


Figure 2 Rate of disputes in Colorado, Montana and Utah. Source: General Land Office

for western petroleum. This section examines why the paths of institutional change differed for hardrock mining and petroleum.

#### Establishing rights

There were several differences in industrial organization between hardrock mining and petroleum. In particular, the specialization that developed in hardrock mining did not carry over to petroleum exploration and production. In 1914, for instance, there were three major oil companies and approximately 400 small firms producing in California. Small and large firms each accounted for about half of the state output.<sup>33</sup> Small petroleum interests differed from hardrock prospectors in two respects. First, oil exploration was a capital-intensive venture requiring high fixed costs. Second, firms engaged in exploration generally continued to pump the oil after they made the discovery.

A consequence of these differences was that the discovery rule as defined by the prudent person test was an impractical first-possession rule for petroleum exploration. Because establishing rights required that minerals be uncovered—and simply identifying favorable site characteristics—firms had to strike oil first and establish claim rights second. Oil exploration was a conspicuous activity, and a firm that began exploration often triggered a race to discover a pool first. Thomas O'Donnell, a critic of the discovery rule, summarized the situation:

the placer miner looking for gold could go along with a shovel and turn over a little gravel, and he had then made the necessary discovery. But our petroleum in California is in many instances 4000 feet under the earth (Use, 1926, p. 298).

Duplication of investment was more wasteful than a race for a hardrock discovery because the search for petroleum required high fixed costs. The result was a race for property rights and damage of the stock.

The difficulty of securing patentable possession of claims sometimes led to physical threats and violence, and even when no violence arose, efforts of two different prospectors or drillers to find oil on the same claim involved a wasteful duplication of labor and expense. Furthermore, the necessity of making the discovery as soon as possible under such circumstances, led to hurried and reckless drilling, without proper regard for the production of oil sands (Use, 1926, p. 298).

The problems did not end with the discovery of the stock, as additional difficulties stemmed from the size of petroleum reservoirs and the migratory nature of oil. A limitation on the transfer of rights was a contributing factor. The Placer Act capped claim blocks at 160 acres, which was insufficient for petroleum producers. To skirt this acreage cap producers often tried to acquire exclusive rights to a deposit by hiring dummy entrymen to locate a number of claims. These efforts were largely unsuccessful (Use, 1926, pp. 298–306). As a result, dissipation from the competitive race was followed by dissipation from the rule of capture.

Excessive wells were dug along property lines to drain oil from neighboring acres, extracted oil was placed in surface storage (open reservoirs as well as steel tanks), where it was subject to evaporation, fire, and spillage; and rapid extraction rates reduced total oil recovery as subsurface pressures, necessary for

#### Petroleum and the Placer Law

The general result from the first-possession model is that the Mining Law emerged as an effective means for assigning hardrock mineral rights. First, the rule of discovery allowed claimants to establish rights early in the process, limiting duplicative investment. Second, claimant heterogeneity increased over the course of the period, implying that costs associated with competitive race were limited. Third, the demise of apex suits and the decline in the rate of disputed patent applications suggest that costs of enforcing rights to the stock were not prohibitive.

Petroleum production in the western states began in the late-nineteenth century, but as was the case in the infancy of western hardrock mining, there were no clear rules for assigning rights. Interior Department decisions in 1875 and 1883 had a straightforward solution: assign rights as placer deposits through the Mining Law. In 1896, however, the Secretary of Interior reversed that decision. Although the new secondary again reversed this decision in the following year, Congress was already in the process of enacting the Oil Placer Act of 1897. The text of the law was taken from the Placer Act of 1870, not the Mining Law, meaning that petroleum deposits were governed by the earlier act (Use, 1926, p. 296). By 1909 lands were being withdrawn from access, and in 1920 the Placer Act was replaced with the Mineral Leasing Act, which (as amended) remains intact today.

Given the extant institutional structure in 1897, a number of differences in industrial characteristics help to explain why the Placer Act was not workable

naturally expelling subsurface oil, were prematurely depleted (Jinbeag, 1984, p. 383).

Even when prices bottomed out, expansion of output was the only means to secure rights. In contrast, hardrock miners had legal resource to prevent capture—the extrajurisdictional rights provision. If a firm believed a rival was exploiting the same vein it could take its grievance to court.

On top of differences in industrial characteristics, there was also much greater interest in oil lands from federal officials, and federal intervention complicated the situation. President Taft began withdrawing large tracts of oil land from access under the Placer Law in 1909 as a means to preserve supplies of naval oil. The Pickett Act in 1910 legitimized these withdrawals, and in 1915 the Supreme Court upheld executive withdrawals made prior to the Pickett Act.<sup>53</sup> These events created havoc for claims made prior to the withdrawals, and by 1914 the government began to negotiate contracts with these claimants and other producers on the withdrawn lands. In other cases the government tried to eject producers from the oil lands and to recover the value of the oil that had been produced. Then, in 1920 Congress enacted the Mineral Leasing Act.

**Costs of enforcing rights**

One means for comparing the different enforcement costs between industries is to compare rates of disputed patent applications. The Land Office provides insight into the overall character of the difficulty of defending rights under the Placer Act.

The situation in Wyoming is complicated by reason of the fact that while active operations in the field are comparatively recent, yet a considerable number of locations were made many years prior to active operations, and adverse claims under section 2326 of the Revised Statutes have been filed against most of the applications for patent. Thus all action looking toward the issue of patent is stayed pending determination of the possessory title (United States Department of the Interior, 1920, pp. 7-8).

The fact that nearly every patent application was disputed indicates that there were high costs associated with establishing and enforcing rights under the Placer Act.

Figure 3 illustrates the situation. The number of wells drilled in Wyoming appears to be closely related to the 5-year moving average of the ratio of adverse claims to patent applications, which is plotted on the right-hand axis. Although the ratio variable is the same variable used in Figures 1 and 2, the case in Wyoming shows an order of magnitude several times

higher than for hardrock-producing states. The sharp decline coincides with the Supreme Court decision in 1915 that clarified the legitimacy of oil-land withdrawals, and then the enactment of the Mineral Leasing Act in 1920.

**The Mineral Leasing Act**

Was leasing a foregone conclusion for petroleum? Politically, the answer appears to have been yes. Although western congressmen generally did not support leasing, the implementation of some compromise was the only way to open withdrawn lands for development.<sup>54</sup> Several problems related to first possession in western petroleum also suggest that some alteration or overhaul of the Placer Law was inevitable. There was excessive investment because the system did not provide secure rights early in the process. Even where hand rights were established, costs of enforcing rights to the stock were prohibitive. The result was disinvestment from overuse and damage to the stock.

In contrast, different industrial and institutional characteristics minimized these problems for hardrock mining. The courts hierarchical acreage restrictions in response to changing industrial conditions, and evidence on claim disputes suggests that the costs of enforcing rights to the stock were declining. Although discovery worked reasonably well as a first-possession rule for hardrock exploration, the requirement was again loosened by the Supreme Court in 1919. Instead of discovery preceding location, claimants could establish and enforce rights by complying with the annual work requirement—a doctrine known as *pedis possessio*. Diligently exploring for minerals, not discovery, became the first-possession rule.<sup>55</sup>

How would similar changes in the legal structure have affected petroleum exploration and production? Consider the provisions of the Mineral Leasing Act for lands with *unknown* mineral characteristics. An applicant could obtain a permit on a non-competitive basis covering 2560 acres. To maintain rights, the firm had 6 months to begin drilling, and had to drill 2000 feet within 2 years. If a discovery was made, the firm could acquire a 20-year lease to one-fourth of the land in the permit. Although leasing is often

<sup>54</sup>The Mineral Leasing Act endowed the western states with a financial interest. Receipts from government royalties, rentals, and bonuses... are to go 10 per cent to the United States Treasury, 52.5 per cent to the reclamation fund, and 37.5 per cent to the states in which the lands are situated, for roads and schools (Ise, 1926, p. 351).

<sup>55</sup>*Union Oil v. Smith* 249 US 337, 346 (1919). Claimants can hold claims without making a discovery, but *pedis possessio* only grants rights against rival claimants. A pitfall for hardrock claimants is that a mineral lease can nullify rights if a discovery has been made.  
<sup>56</sup>The Mineral Leasing Act distinguished between land with known and unknown characteristics. Lands with known characteristics were auctioned to the highest bidder. The transfer in this case is between section and mining costs. In either case, acreage rights for land will favor characteristics did not mitigate the incentive to drain the pool quickly.

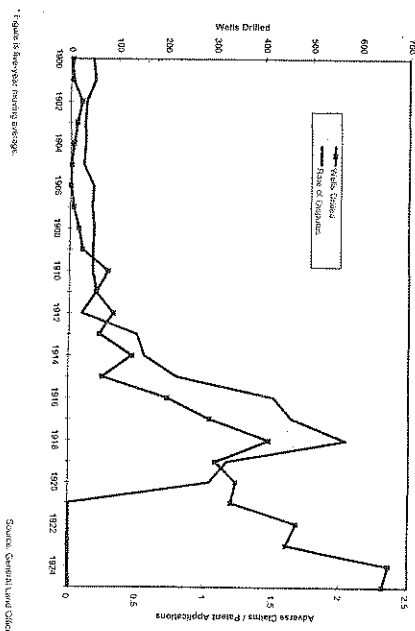


Figure 3 Rate of disputes in Wyoming

seen as a radical departure from the system where miners have free access, these provisions for unknown lands are very similar to the Mining Law. In effect, a firm could stake a 2560-acre claim on the basis of favorable mineral characteristics, and maintain claim rights through active exploration. What the Mineral Leasing Act did for petroleum exploration was *relax the first-possession rule*. Claimants established exclusive rights by being first to the Land Office to apply for a prospecting permit, which limited the problem of excessive exploration investment.

On the other hand, the Mineral Leasing Act only partially addressed the problem of capture. Although acreage allotments were greater than under the Placer Law, they were not great enough to harness benefits of unutilized production. Nevertheless, leasing supporters believed that acreage limitations were desirable (perhaps reflecting the limited knowledge of benefits of unutilized tracts). "The outstanding feature of the new law, and the feature which contrasts most decisively with the laws of most foreign oil-producing countries, is the smallness of the leases, suggesting, of course, our reliance upon competition" (Ise, 1926, p. 352). Lihceap (1984, p. 387), however, points out the defect in this logic: "Because the Mineral Leasing Act did not correct the small-tract problem, competitive drilling, and associated wasteful production practices continued on federal lands." Thus, the impetus for the Mineral Leasing Act was not prohibitive enforcement costs or the problems of capture. Instead, the change limited investment before rights were assigned. This, of course, could have been accomplished through modifications of the Mining

Law—loosening the first-possession rule and increasing the size of petroleum claims.<sup>57</sup>

**Conclusions**

The economic analysis of property rights provides several interesting implications for assigning mineral rights to public land resources. In particular, the distinction between stocks and flows is central to the analysis. By assigning exclusive rights early in a development sequence, a first-possession rule limits duplicative investments from claimants racing to establish rights to the stock. First-possession is less desirable where rights can only be established by capturing the resource flow. Placing limitations on access to the stock can mitigate dissipation associated with the capture problem. The model demonstrates that a first-possession rule is superior where (1) resources have yet to be identified, (2) there is heterogeneity in claimant costs of identifying stocks and establishing rights.

This paper applies the model to trace institutional developments for hardrock mining and petroleum for the period between 1872 and 1920, and draws two main conclusions. First, the Mining Law appears to

<sup>57</sup>I am not arguing that discretionary leasing is not an appropriate method for allocating rights to federal petroleum lands as restricting access to a stock, to mitigate potential dissipation from capture is a straightforward implication of the property-rights framework. Instead, I am repeating the *ad hoc* notion that the Mineral Leasing Act was enacted due to the different geological characteristics of petroleum and hardrock minerals (the flow v. stock).

have been an effective means for assigning rights to hardrock mineral lands. The evidence suggests that there was increasing claimant heterogeneity, as well as decreasing costs of enforcing rights—as evidenced by the overall rate of disputes. Whether the Mining Law is still an appropriate means for assigning rights to these minerals partly depends on whether there is a good degree of claimant cost heterogeneity (e.g. luck, skill, random advantage, etc.).

The second conclusion concerns the economic logic of petroleum leasing. While it is reasonable to attribute the enactment of the Mineral Leasing Act in 1920 to the migratory nature of petroleum, the system that emerged initially did little to address the different physical characteristics of hardrock minerals and petroleum. Moreover, restrictions to limit dissipation from capture could have been accomplished through modifications of the location system.

Lease systems place the decision to assign mineral rights into the hands of an administrative agency, and these systems typically place constraints on the timing of production. These factors were attractive to conservation interests that believed that public officials should exercise control over the timing of exploration and production. It was this expansion of administrative authority that was a radical departure from the status quo of the location system.<sup>28</sup> Not surprisingly, environmental groups continue to favor replacement of the Mining Law with a lease system as a means to expand their own role in public land use decisions.

The transfer of public mineral resources to private hands is a complicated matter. MacDonnell (1976); Lesby (1987); Wilkinson (1992); each forward arguments for replacing the Mining Law with a leasing system. Central issues of such arguments, as well as in the present policy debate, include environmental standards and 'fair return' issues. These considerations emphasize that 'efficiency' has to be evaluated in the context of an objective function that incorporates some desired level of mineral production (especially for strategic minerals), tax revenues, regional impacts, and environmental quality indicators.<sup>29</sup> If the major reason for implementing a leasing system for hardrock minerals is to expand public control over the timing of exploration and development, however, then such a proposition is unlikely to find theoretical or empirical support.

#### Acknowledgements

I am thankful for comments from Lee Alston, Thomas Nonnenmacher, and Thomas Ulen.

<sup>28</sup>The discretion to refuse to grant exploration privileges (i.e. 'issue a permit') under the Mining Law is not an administrative function. Rather, Congress or the president can limit land available to mineral prospecting (through wilderness designations). Miners can then not have the authority to mine a valid claim right (i.e. a claim valid a priori discovery). However, the 'discovery' standard (1970) provides an overview of the issues surrounding US Mining Law reform.

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