GOVERNMENT REGULATION AND
THE DEVELOPMENT OF PROPERTY RIGHTS
DURING AUSTRALIA'S GOLD RUSH

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Property rights institutions provide the basic framework within which individuals make decisions concerning investment, production, and exchange. Changes in property rights often produce major changes in the use of resources and, conversely, changes in economic conditions can place pressure on existing property rights institutions and cause them to erode or undergo substantial change. The discovery of gold and silver on federal lands in the American West during the mid-nineteenth century offered an opportunity to examine how property rights for minerals are initially established. Numerous studies (Hallagan 1978, Libecap 1978a, b, 1979, McCurdy 1976, Umbeck 1977a, b, 1981) have documented how, in the absence of governmental institutions, a private system of property rights quickly arose "to reduce potential conflict and uncertainty over claims" (Libecap, 1986, p. 236). As legal institutions developed with the establishment of territorial and state governments in Nevada and California, the process of dispute adjudication built on the existing system by delineating the privately established property rights in a more detailed and precise manner.

In this study I examine the formation and evolution of property rights to gold in Australia during the gold rushes of the 1850s. Unlike the American cases, property rights to minerals were not created by private contracting among miners, but were initially imposed by the colonial governments. After a rebellion in 1854 by miners in Victoria, the colonial government relaxed its control over mineral property rights and delegated to courts, elected by the miners, the definition and enforcement of particular rights structures. Thus the sequence of events in the American West was reversed in Britain's Australian colony of Victoria; this presents an opportunity to examine the course of institutional evolution in a second context where economic conditions are quite similar, but initial institutional parameters are quite different.

Gold was discovered in two of Britain's Australian colonies, New South Wales and Victoria, but this study confines its attention to Victoria's gold fields. Section I documents and analyzes the discovery of gold and establishment of property rights by the
colonial government. Section II covers the miners' rebellion at Ballarat and discusses the establishment of miners' courts and their enactment of a new set of property rights. Section III summarizes the paper's arguments and enumerates topics for future research.

I. The Early Australian Gold Rushes: 1851–1854

A. A Brief History

Gold was first discovered in New South Wales in April, 1851.\(^1\) This finding prompted exploratory activities in Victoria and the first discovery (at Clunes, approximately 70 miles from Melbourne) quickly followed, with news of the discovery announced in Melbourne during early July. Almost all lands in the colony were Crown lands, and by law, all mineral discoveries, whether on private or public lands, were the property of the crown.\(^2\) To establish the Crown's rights, Governor La Trobe instituted a licensing system adopted earlier in the year by the New South Wales government. A licence-fee of 30s. per month was required to search for gold, and licenses would be issued only to those who could show a 'certificate of discharge' from their last job.\(^3\) Commissioners were appointed to settle disputes, to keep order, to sell licenses, and to establish a set of rules for each gold mining area. Of equal importance to the licence-fee was the regulation declaring individual miners to be limited to claims only 8 feet square (8 x8).\(^4\) Parties of 4 miners or more were allowed a maximum area only 24 feet square at the Ballarat gold field. These regulations stood in stark contrast to California, where license fees were nonexistent and average claims were about 100 feet square per miner, or about 156 times larger than in Victoria.\(^5\)

By September, 1851, one of the richest fields of gold ever discovered, Ballarat, had approximately 800-1000 men digging; major discoveries at Bendigo, Castlemaine, and Mount Alexander in late 1851 sent the populace of Melbourne hurrying to the gold fields. By December, 1851, about 20,000 people (out of a total population of 97,000) were working in the gold fields. As the year ended, the government was barely functioning. \(^*\)On New Year's Day, 1852 only two of Melbourne's forty municipal constables remained on duty in
a city of reveling diggers" (Blainey, 1969, p. 36). Compounding the desertion of police and government officials was the scattering of diggers over a wide expanse of territory, making collection of the licence fee more costly.

Unsuccessful miners initially resisted paying the tax while successful miners paid the fee for fear of being dispossessed of their rich claims. In October, 1851, only 2,261 of over 6,000 miners at Ballarat paid the licence-fee, and in November, December, and January, "fewer than half the diggers paid the fee. Moreover, the regulation that those found without a licence had to pay one-tenth of the gold in their possession was almost entirely inoperative" (Serle, 1977, p. 24). Yet in the face of resistance by the diggers and inability by the government to collect the fee, the government announced on December 1, 1851, that the fee would double, effective January 1, 1852. The outcry against the increase was so loud that the government was forced to rescind its order, announcing on Christmas Eve that a gold export levy was being considered in lieu of a licence-fee increase.

The government's fortunes stabilized in early 1852 as increased pay for the civil service and an emergency force of 130 military pensioners from Van Diemen's Land (Tasmania) augmented the police available to gold field administrators. By April two-thirds of the 30,000 diggers in the fields were taking out licenses. During the first half of 1852, migrants from the other Australian colonies poured into Victoria, while beginning in August, 1852 migrants from Britain began to arrive in Melbourne. The population figures for Victoria (see Table 1) show continual annual increases throughout the 1850s. The increasing number of diggers and their mobility (due to the small size of claims, the unmarried status of many miners, and the small amount of tools and belongings to be moved) meant that the police were constantly struggling to keep up with the diggers and to enforce licence-fees.

In 1852 the government decided to share half of the proceeds from fines for illegal liquor sales and licence-fee evasions with the policeman who apprehended the violator. This gave policemen incentives to ignore their other duties (i.e., to enforce
law and order) and to pursue these violations more vigorously. Brutality characterized many of these enforcement actions, as "[m]any of the police-officers had been convict-superintendents long practised in savagery and sadism" (Serle, p. 97). Many of the gold commissioners criticized the licence-fee system during 1852, while some resigned. In 1853 the military pensioners were returned to Van Diemen's Land and a more professional mounted police was recruited, but the basic antagonisms between the diggers and the police over the licence system remained. Many diggers objected to the techniques used by police to check diggers for licenses. Others objected to the requirement that the digger travel to one of the two central licencing offices. The licence system was reconsidered three times (late 1851, 1852, and 1853) by the colonial government and the Legislative Council and was left intact on each occasion.

The burden of the licence-fee increased after 1852, as an index of average miner income fell (see Table 1) from 510 in 1852 to 361 in 1853 and then to 217 in 1854. This decrease occurred at the same time that wages in other occupations were increasing. The decrease was due to an exhaustion of the surface alluvial gold and to increasing numbers on the gold fields. In December, 1853 there were approximately 53,000 diggers in the field; by May, 1854 the number of diggers had grown to 80,000. Opposition may also have been fueled by a skewed distribution of returns. About one-tenth of the diggers left the fields having made their fortunes, another one-tenth made a comfortable living, while eighty percent of the diggers either made market wages or did not make enough to meet their expenses. Under these circumstances lump-sum taxation on prospecting and mining was sure to incite opposition from unsuccessful diggers, particularly as competition on the fields increased.

Diggers' meetings to protest the licence-fee system occurred throughout 1853, with a temporary licence boycott in Bendigo prompting the government to reduce the licence-fee for three months starting with September. In November, 1853, the Legislative Council passed a new Goldfields Management Act that reduced the annual licence fee from £18 per year to £8 per year. A £50 annual licence-fee for goldfield
shopkeepers was also enacted. While the fields were remarkably free of agitation during early 1854, by March there was a marked drop (from three-quarters or two-thirds to about one-half) in the number of diggers paying their licence fees.

B. Economic Analysis of Licence-Fee and Claim Size

Blainey (1962) has argued that the license fee and small claim size were attempts by the government to reduce the returns to mining and to discourage large numbers of workers from quitting their jobs and making the trek to the gold fields. If large numbers of workers were to leave the city, wages for many occupations would rise, and government, constrained by its revenues, would have trouble finding workers and maintaining law and order. In addition, squatters raising sheep, stock, and a variety of agricultural goods were the main constituency of the government; they would be hurt in the short run by increasing wages and surely favored measures by the government that would allow them to retain their workers at current wages.

The economic rationale for a lump-sum tax is two-fold. First, such a tax provides no incentive for a miner to reduce his effort or the number of hours worked; alternative taxes, such as a gold export duty, reduce the buying-price of gold and thereby affect worker incentives by reducing the marginal benefit to an additional hour of work. Second, a lump-sum tax on resource rents should reduce the number of people choosing to mine gold, as the returns to marginal miners fall, inducing them to choose alternative work. This argument is dependent, however, on individuals having ex ante information on their marginal status. Suppose that individuals are risk-neutral, that their prospects on the gold field are largely determined by their luck in choosing a claim, and that they are not earning rents in their present occupation. In this case, individuals choose to mine gold based on a comparison of the expected wages in gold mining with the wages in their present occupation. The impact of this tax depends on its magnitude and the expected average wage attained from gold mining. If the average gold mining hourly wage is substantially above most workers' wages, then a small lump sum tax is unlikely
to deter many people from entering gold mining. The average worker income on the fields during 1851 was approximately £5-7 per week which compares favorably with wages in other occupations. It is unlikely that a monthly licence-fee of 30s. (£1.5) would deter many potential workers from entering mining. As gold mining wages rose above other wages in 1852 and 1853, the licence-fee would not change the choice of a risk neutral worker. Given the lack of economies of scale in mining surface alluvial gold and the small amount of capital required to travel to the gold fields and to purchase minimal amounts of equipment, it is unlikely that the license fee would deter many workers from leaving their jobs. Moreover, the regulation stating that permission from employers was necessary to obtain a license was impossible to enforce due to the small number of police in the gold fields.

While the licence-fee was not an effective barrier for most workers, the regulation governing the size of the claim may actually have been counterproductive for the government. By permitting only very small claims, the government ensured that a single individual or group of individuals could claim only a trivial portion of any major new discovery. When word of a new discovery reached a gold field where the returns to surface alluvial gold mining were declining, miners knew that there would be room for thousands of new claims on the new fields and did not hesitate to pack up and move on.

Was the set claim size imposed by the government an efficient method of establishing property rights in alluvial gold? Anderson and Hill (1983) have hypothesized that “when the methods of defining and enforcing private rights are devised through residual claimant action there is a greater incentive to conserve on resources used in the process than when that process is imposed exogenously by non-claimants” (p. 439). They argue that government officials who are assigned the job of defining property rights in land will not have incentives to set allocation rules which minimize rent dissipation and that, regardless of the rules adopted, individuals will engage in rent-seeking activities to claim the property. In the American West rent dissipation occurred “because unnecessary resources had to be invested” to claim the land and “the
allowable size of holdings was far below that which was economically most efficient" (p. 447). Note that Anderson and Hill do not criticize individuals for pursuing their own self-interest, but are critical of the rules adopted by the government.¹⁰ The emphasis is, therefore, correctly placed on comparative institutional analysis.¹¹

Did the Australian system of defining mineral rights in the gold fields minimize rent dissipation? First, unlike land policy in the United States following the Civil War, particular investments which may not have maximized the value of the land were not required. The only requirement was that the claim be worked. A shovel in the middle of a claim would hold it for several days while the claimholder was purchasing supplies, renewing his licence or, perhaps, working another claim. As in California (Umbeck, 1977, p. 123) the miner had to work his claim several days per week, but "working a claim" was not defined. By requiring that claimants be present and working the claims, the number of claimants on the common pool resource was reduced, making it less difficult for miners and police to detect and enforce violations of mining rules and limiting rent dissipation.

Second, since claims were allocated on a first-arrival basis, a lack of information concerning the gold's location increased the advantage of "racing" to be first.¹² The advantage of racing was reduced, however, by the small size of the claim (8-12 feet square), a constraint which severely limited the gains from being the first-mover or even the second- or third-mover. While the first-mover in some cases was able to work a large claim (due to a lack of competitors), it was rare that other miners did not quickly detect their success and move to enforce the government rules specifying one small claim per miner. Third, small claims were often cited as a major cause of inefficient resource use in the American West. Small claims caused problems when there were economies of scale in using the resource and when the large numbers of claimants on the small claims made it more difficult to negotiate and enforce contracts to limit rent dissipation from "overuse" of the resource. However, mining of alluvial gold is generally not subject to major economies of scale. In California, free contracting led
2-4 workers to contract to work a claim. Since mining rules in Victoria allowed up to 4 miners to consolidate their claims, it is unlikely that the small claims prevented attainment of economies of scale. In the early years, shallow alluvial deposits were mined by opening the claims as a pit, "exposing the gold-bearing stratum, picking up any nuggets with a knife and handing the rich earth up in buckets" (Serle, p. 73). Deeper deposits required that a shaft be sunk and the sides of the shaft shored up by timbering. The rich earth would then be placed in a California cradle or a puddling-tub, combined with water, and worked until the earth washed away, and the gold was isolated.

Fourth, small claims may prompt faster extraction than otherwise and dissipate scarcity rents. The value of gold deposits that are costly to extract is often maximized if the gold is extracted in future periods when the gold price has increased; miners who are limited to small claims could decide to extract the gold today as they can not hold it in reserve. This argument probably does not apply to the early Australian rushes, as average rents attained from mining the first discoveries of surface alluvial gold were sufficient to warrant immediate extraction of the ore.

Finally, the small claims did not necessarily lead to a reduction of rents in total compared to a system with larger claims. Larger claims induce new entrants and small claimholders to compete for additional land by using violent methods. This is a particularly important consideration when the miner population is expanding, as the average size of claims decreases as the potential number of claimants increases. When new migrants are expected to enter gold mining, then small claims have the potential to reduce the use of violence in allocating land. Defensive expenditures dissipate rents in total and reduce the rents earned by large claimholders; if they can be avoided by reducing claim size, then the present value of rents earned by all claimholders may increase.

In sum, the government's initial specification of property rights does not appear to have resulted in the dissipation of rents that Anderson and Hill believe will occur when the process of defining and enforcing property rights is "imposed exogenously by
nonclaimants* (p. 439). Instead the small claims appear to have been a roughly efficient initial specification of rights. However, the lump sum tax appears to have created political discord and to have been unsuccessful in reducing the number of miners in the gold fields. By creating an ex post income distribution that encouraged individuals to resist the government gold field policies, rent dissipation was encouraged; such dissipation raises questions concerning the overall efficiency of the lump sum tax. Perhaps the best evidence that the imposition of the tax was a mistake is that it was, as we discuss below, quickly eliminated.

II. The Transition to Privately Defined Property Rights: 1854–1860

A. Rebellion and the New Miners Courts

On the eve of its rebellion in 1854, the Ballarat field was a particularly risky field for a digger staking a claim. The rivers which originally carried the field's gold were buried beneath layers of basalt, clay, and sand. The course of existing rivers and the lay of the land gave no clues concerning where the old rivers flowed, and the discovery of deep leads of gold could be attributed much more to luck than to skill.¹⁴ Miners in the first rushes to Ballarat in 1851 and 1852 found large deposits of surface alluvial gold, but miners in the later rushes (which began in spring 1852) found gold at depths of 50 to 180 feet. Shafts often passed through "zones of drifting sand from which water poured" (Blainey, 1969, p. 47). The water had to be continually bailed and the sides of the shaft reinforced. When the old river bed was finally hit, the miners would excavate a chamber under the full area of their claim. It usually took 5-9 months to dig the shafts and only a couple weeks to bring the gold-laden paydirt to the surface. This story assumes, wrongly, that most shafts struck gold-laden paydirt. Most shafts failed to hit their target, meaning that this form of mining was substantially more risky than that occurring on other fields. The probability of discovering gold on a particular claim was not much different than on other fields, but the amount of time put into a single claim was 5 to 10 times higher. Parties at Ballarat were larger than on other
fields as more labor and capital were necessary to dig the gold from such deep leads.

Disputes at Ballarat were also harder to settle, as they occurred deep underground where it was difficult to ascertain claim boundaries; they involved coordinated water pumping across several claims; and they often involved a form of free-riding known as "sheparding", where adjacent claimholders postponed exploration until the value of the claim was ascertained. Miners felt gold commissioners were arbitrary in their decisions and in September, 1854 formed a Gold Diggers' Association to press their grievances. Blainey states that "[t]he Ballarat mines had advanced beyond the capacity of the law and its representatives to control them" (1969, p. 51).

A new colonial governor, Charles Hotham, arrived in August, 1854, and was displeased at the amount of licence-fee evasion. The police were ordered to check licenses twice per week to increase the probability of catching and deterring evaders. A series of miners' demonstrations and incendiary incidents led the government to send soldiers to Ballarat. On December 3, 1854, approximately 1000 government soldiers charged into a stockade containing 120 miners, killing 30 miners and incurring 5 casualties of their own. The "Eureka Stockade" proved to be a classic instance of a government winning the battle but losing the war. Martial law was declared but lasted only a few days. Rebel leaders were brought back to Melbourne for trial but Melbourne juries refused to convict. Most importantly, the episode convinced the government to reform the goldfield laws. A Royal Commission was appointed to investigate the incident and to make recommendations for changes in goldfield management. The Commission recommended that the licence-fee be replaced by an export duty, as a duty "falls more equitably as regards the successful and the unsuccessful, and it is collected at much less cost, and without the occasions of social disturbance that seem inseparable from the present system."15 In June, 1855, the Legislative Council moved to implement many of the Commission's recommendations.

The monthly licence-fee of 30s. was replaced by a "miner's right", which enabled miners to vote in parliamentary elections, to dig gold, and to vote in elections for new
miners courts. A miner's right cost £1 per year. The lost revenue from the licence-fee was replaced by an export duty of 2s.6d. (approximately 3% of the price of gold) on each ounce of gold exported from Victoria. Without the licence-fee, many of the police and bureaucrats assigned to gold field administration were no longer needed and were removed from the fields. Most significantly, the new Gold Fields Act\(^\text{16}\) turned management of the gold fields over to the miners. Local courts to make rules and settle disputes consisted of 9 members elected by the miners every 6 months, one of whom was nominated by the Governor to serve as chairman. These courts had control over all aspects of working conditions. Administrative officers associated with the courts were known as "wardens." Serle remarks that "[t]he nature of these courts was highly unusual and a remarkable democratic experience" (p. 178). In 1857 the government removed judicial powers from the courts, and vested them with a new court of mines; cases were heard by a judge and miners served as assessors when damages were awarded. The original mining courts retained their legislative powers and became known as "mining boards."

Until these changes in the law were enacted, fewer than 1000 miners paid the licence-fee in the early months of 1855. Miner's rights were first issued in June, 1855, and by December over 50,000 miners had purchased the rights.\(^\text{17}\) In July, 1855, local courts were elected by a show of hands from those holding the miner's rights and attending the election meeting. Miners' courts in Bendigo and Ballarat acted quickly to relax claim sizes whenever water control or the great depth made larger claims more efficient (Blainey, 1969, p. 57). "Ballarat's court encouraged the mining of its deep leads by allowing miners to unite their claims and by permitting one man to hold shares in many claims. Its court and mining board were so liberal in difficult areas that by 1863 a man could hold 120 times the maximum area of a decade previously" (Blainey, 1969, pp. 57–8).

Miners' courts did not generally follow Ballarat's lead in liberalizing their mining regulations; instead, a wide array of regulations appeared which were generally tied to the mining techniques used in the district. Districts in which surface alluvial
gold was mined with a California cradle retained their rules virtually intact. Districts where surface alluvial gold was mined by puddlers adopted larger claims, while districts with deep lead mining defined their rules more precisely and changed them substantially.

Another major change after Eureka was the advent of company mining. In June, 1855, the Legislative Council passed legislation allowing limited liability mining companies to participate in gold mining. The power to grant leases to the companies was, however, retained by the individual mining districts and opposition among the miners to the companies remained strong throughout the mid-1850s. At an 1858 conference of mining boards representatives, the Governor lobbied for districts to allow large leases to be granted by the colonial government, but the board representatives were resolute in maintaining local mining board jurisdiction. The Ballarat, Bendigo, Maryborough, and Castlemaine districts all changed their policies in the summer of 1859, however, allowing large leases to be granted on old and new ground. By July, 1859, these four mining boards had approved 103 leases totalling 966 acres on alluvium and 105 leases for some 25,000 yards on quartz. By the end of 1861, 622 leases were issued, and in that year the government issued uniform leasing regulations for all fields.

B. Economic Analysis of the Export Duty and Mining Board Rules

The change from a lump-sum tax to an export duty went a long way towards restoring social stability and increasing government revenues. The Commission observed that "[t]he Gold Fields could not be patrolled for the more effectual suppression of crime so long as the police were thus employed in collecting the license fee. While from such causes, therefore, the police were rendered quite inefficient for the ordinary public service, the force itself was withal twice as numerous and twice as expensive as would have been necessary under a different system." In testimony before the Royal Commission investigating Ballarat, Mr. John Harrison, a digger, noted that the police were present on the fields to protect the Commissioners, not the diggers: "... it has become a bye-
word on the diggings that you will never see a policeman without being asked for a licence."¹⁸ This comment constitutes a succinct criticism of the lump-sum tax so often propounded by economists as an efficient tax. If the tax falls disproportionately on individuals unable or unwilling to pay, the increased expenditures required to collect the tax may outweigh the usual efficiency gains from a lump-sum tax. Moreover, the Commission was convinced that revenue and expenses will both decrease under an excise tax but that "in regard to the Gold Fields the general revenue will be left a gainer."¹⁹ Gross revenues from the gold fields declined from £460,000 in 1854 to £410,000 in 1857. Since the government had spent £224,000 on gold fields management in just the first half of 1853, it is quite possible that the reduction in the number of police on the gold fields after 1855 increased net revenue.²⁰

The change from exogenously imposed property rights to property rights determined and enforced by the residual claimant had major consequences. First, given the heterogeneous circumstances prevailing across the different gold fields, it came as no surprise that districts adopted a wide variety of rules to govern mining. Brough Smyth observes that "the extent of the area of land which a miner was to be allowed to occupy under his miner’s right ... [varied] ... according to the nature of the mining, whether alluvial or quartz, the wetness or dryness of the ground, its lying or not in the bed of a river, and generally according to the greater or less difficulty of mining in the ground occupied" (pp. 385-6).²¹ These factors are discussed below in the context of the different mining districts.

With the advent of mining boards, all gold districts began to distinguish between alluvial and quartz claims. Quartz claims differed from alluvial claims in that extensive machinery and power were necessary to smash the quartz rock and extract the embedded gold. A large amount of quartz was necessary in order to extract a small amount of gold. Quartz mining therefore required larger claim sizes or cooperation among small claim owners, to be profitable. Mining courts and, later, mining boards changed allowable claim sizes to adjust to the new technology. In Ballarat, "[u]pon a quartz
reef a single claim "shall be any area of ground 50 feet in length along the supposed course of the reef, and in proportion thereto for any greater number of claims by 500 feet in width." The Castlemaine mining board adopted special rules to govern tunnelling to reach quartz reefs, the removal of water from wet quartz claims, the timbering of shafts and tunnels, the use of explosives, and the width (60 feet in 1861) and length (100 on the surface, 600 feet underground) of claims. In Maryborough, the 1860 mining board bye-laws allowed lengths of 25 feet "along the course of the [quartz] reef" and "a width of 300 feet; 150 feet on each side from the centre of the reef." Claim consolidations of over 100 feet in length were not allowed. Maryborough rules on quartz mining also governed water bailing, tunnelling, and unworked claims; in some instances they required night work and the pumping of water from claims by steam engines. The Sandhurst mining board allowed larger claims than other districts. "Any (one) miner shall be entitled to hold thirty-five (35) yards on the supposed line of any quartz lead or vein by a width at right angles to said line of one hundred and fifty (150) yards, and any two or more miners may hold a claim on the line of any quart vein or lode to the extent of eighty (80) yards in length by a width ... of one hundred and fifty (150) yards." Claims could be temporarily amalgamated when the claimholders were searching for the path of the reef.

Allowable claim sizes for alluvial gold were also expanded by most districts after 1855. In addition, the claim size was usually allowed to vary with the characteristics of the alluvial land. In Ballarat, the frontage system was adopted for "claims on alluvial leads of a greater depth than 200 feet." A frontage claim is one for which the lateral boundaries are not fixed until the lead has been traced through it. The claims were set up as a series of concentric circles with the first claim at the center. Regardless of the course followed by the lead, the claimholders would have their allotted length upon the lead. The system has the effect of preventing "overinvestment" by competing parties. Without knowing where a newly discovered lead would flow, competitors to the party sinking the original shaft would sink additional shafts on
their standard "block" claims, hoping to strike the rich lead. If, however, the parties could cooperate and use the original shaft, the expenses of sinking additional shafts could be saved.26 Without a framework for facilitating cooperative behavior, the negotiating parties could have conflicts over the shares of costs and benefits, and in some circumstances may not reach agreement. The 1857 Commission found that 9 shafts were sunk over 200 yards, one to a depth of 350 feet,

"where one shaft would have been equally serviceable for mining purposes; and in fact much more so, for many of the newly sunk shafts have not struck the reef at all, having been only sunk by guess in its supposed strike, while if the reef had been followed by driving from the first successful shaft, no such uncertainty and loss could have occurred. Evidence was taken of a remarkable case at this spot of one mining party having offered the use of their shaft to another holding the adjacent claim a few yards off, for the sum of five hundred pounds (£500), with the understanding of mutual assistance in extracting the reef; but the agreement could not be made, and a fresh shaft, which to reach the reef would cost about three thousand pounds (£3000) was commenced."27

Ballarat's frontage claim system gave different lengths to frontage claimants depending on the depth of sinking. Table 2 presents the scale used by wardens to assign 5 to 6 additional feet to each claim's length for each additional 20 feet of depth in the entry shaft. Castlemaine did not use frontage claims, but it did expand the amount of land granted to miners working alluvial claims. "Shallow sinking" claims meant all shafts less than 40 feet in depth, while "deep sinking" claims applied to all shafts more than 40 feet in depth. Shallow claims were allotted thirty feet square for each miner employed, while deep claims were allotted forty feet square for each miner employed.28 In July, 1861, Castlemaine changed its bye-laws again to increase claim sizes: "To encourage combined action among miners and the introduction of machinery on the gold fields, any party of miners shall be entitled to hold a claim of one acre for every four miners employed, but in no case shall a greater area than twenty acres be allowed in one claim".29 The Maryborough Mining Board allotted to one miner working an alluvial claim 28 feet square and to two miners 40 feet square.30 If the claim involved wet sinking ("where slabbing [reinforcing the shaft's walls with stone slabs] may be necessary on account of water"), then 4 miners were allotted 80 feet square.31 This is over 11 times
the allotment that a miner received prior to the Eureka Stockade. Sandhurst used an alluvial claim allotment rule which was a combination of the rules found in Maryborough and in Ballarat. The extent of the claim varied with both the number of miners in the party and with the depth of sinking. The Sandhurst rules are set forth in Table 3. Once again, note that the land allotted for shallow claims was 8.5 times larger than under the government's original 1851 rules and over 17 times larger for deep claims.

Special provisions were also made for "puddlers" in some districts. Puddling involved a mechanized version of the California cradle, thereby enabling larger quantities of paydirt to be processed more quickly. Profitable use required the purchase of horses and a puddling machine (£25-50 in total) as well as the use of larger tracts of land, as the technique allowed gold to be extracted from otherwise marginal alluvial soil. Much ground in Bendigo which could not be profitably mined using the cradle method became profitable with the advent of the puddling technique. Sandhurst allowed puddlers "to claim and occupy one acre [208.71 feet square] of ground, exclusive of the site for his mill dam, road, and other appurtenances to his machine." Thirty-two Maryborough bye-laws do not refer to puddling, while Castlemaine granted one quarter of an acre to puddlers. Thirty-three Puddling constituted only a small percentage of mining activity in Ballarat (with its deep leads) and the Ballarat Bye-Laws contained no special claim size provisions for puddlers. Thirty-four

Earlier it was observed that frontage claims were adopted to prevent overinvestment in shaft sinking. In contrast, the original property rights imposed by the government had incentives for underinvestment in other activities. Miners who discovered major new leads received the same claim sizes as the miners who followed them. Prospecting is a risky activity, however, and new discoveries were often preceded by many shafts that failed to strike a lead. While a new discovery could be kept a secret for a short time, once the information leaked out the discoverers were confined to standard size claims. For miners to have proper incentives to prospect for new discoveries, the reward for prospecting had to be increased. Ballarat did not grant
larger claims to prospectors, but other districts had specific bye-laws which increased the gains to successful prospectors. Castlemaine's Bye-Laws stipulated that "[a]ny party prospecting for alluvial gold deposits shall be entitled to four hundred feet square, provided the claim be at a distance of not less than five miles from any gold workings." Parties making new "shallow" discoveries that were more than 100 yards from a payable claim were granted 10,000 square feet, while "deep" discoveries were allotted 20,000 square feet. Maryborough had the most elaborate bye-laws governing prospecting, with higher awards specified for dry alluvial sinking, wet alluvial sinking, quartz reefs, and rules elaborated for the cooperation of competing prospectors. The combination of rules that increased the incentives for prospecting and also decreased the incentives for rent dissipation in a race to be first are analogous to the combination of patent and patent pooling laws; patent laws create an incentive to be the first to discover and specify a process/product, while "patent pooling" laws create incentives for potential competitors to cooperate and minimize the rent dissipation resulting from the "racing" competition from patents.

Resistance of miners to new technologies rested on whether the new technologies displaced the alluvial miners or whether alluvial gold had already been exhausted. The cheapest gold to mine was extracted first by the diggers. Once this gold was exhausted, additional mining required a change in technique and a larger claim size. However, prior to the exhaustion of surface alluvial gold, small-scale miners correctly perceived that larger claims would not only enable companies to begin more capital-intensive mining, but it would also allow them to appropriate remaining surface alluvial gold discoveries. Since company mining is characterized by wage payments to miners, rents would be appropriated by the new companies rather than by the individual miners.

Ballarat, where surface alluvial gold was exhausted in the fall of 1852, provides some support for this proposition, as it was the first district in which company mining was encouraged under the miners' courts and mining boards.
III. Conclusions and Suggestions for Future Research

The gold rushes in Victoria during the 1850s provide a test of newly developed propositions concerning the definition and enforcement of property rights. Anderson and Hill have contended that "methods of defining and enforcing property rights" will be less efficient when they are imposed by parties who are nonclaimants to the resource's rents. Victoria's gold rushes were characterized in their initial stages by property rights imposed by the government; after the 1854 rebellion at the Eureka Stockade, the rights to define and enforce property rights were transferred to institutions controlled by the majority vote of miners. It is tempting to view the change in the institutional framework in terms of comparative statics, but such an analysis would be flawed, as ceteris paribus conditions have not been maintained.

First, the exhaustion of surface alluvial gold on many of the gold fields would probably have prompted a change in property rights, as small claims were becoming less efficient. Perhaps the lesson to be learned from the Eureka Stockade concerns the ability of the government to react efficiently and quickly to changing circumstances. As the initially specified small claims became less efficient, it is surprising that the government did not act to alter the definition and enforcement of rights, as it was, via the lump-sum tax on gold field workers, a residual claimant to the resource rents. Recommendations concerning gold fields management and the licence-fee system were made by government commissions in 1852 and 1853, which anticipated the changes made in 1855 after the Eureka Stockade. Perhaps the requisite changes were not made earlier because of the government's secondary goal of restricting the number of workers who choose to become diggers. If this goal had not been held, it is easy to envisage a gold fields governance mechanism which would maximize government revenue. First, the government would have incentives to choose a property rights structure which, given a set of taxes, maximizes rents for the claimholders on the gold fields. Following Anderson and Hill, this could best be accomplished by allowing the residual claimants to define and enforce the property rights in gold. Second, given the maximization of rents, it would endeavor
to tax them in a manner that generated maximum net revenue for the government. If the government had not had secondary goals, it probably would have chosen a system of taxation that required smaller expenditures on enforcement.

Second, the variety of rules governing mining across the various mining districts reminds us that a centralized property rights regime, no matter how efficient on its own terms, is likely to neglect the unique circumstances encountered by heterogeneous mining districts. Rules that were efficient in Ballarat with its deep shafts would have been inefficient in other districts where reprocessing of low-grade surface deposits became profitable.

Finally, several topics for future research are evident. First, the transition from individual/small cooperative mining to company mining deserves more attention. Companies were treated very differently by the various mining districts and their success may be directly related to the mining district bye-laws governing their formation and operation. Second, the lump-sum taxation of workers on the gold fields deserves more attention. The situation is analogous to taxing entrants to a lottery rather than taxing the winners of the proceeds of the lottery. A formal model which derives differences in individual behavior across the two regimes would help to contribute to an understanding of digger behavior. Finally, mining law in Australia was recognized at the turn of the century to be very detailed and superior to mining law in other countries. The judicial decisions of the Victorian mining judge, Robert Molesworth, and the decisions of the district mining boards left a corpus of law which has not been carefully analyzed by economists. Given the democratic character of the mining boards and the court of mines, this body of law deserves more attention by economic historians interested in the evolution of property rights.
REFERENCES


(1865), Mining Board Bye-Laws. Melbourne: John Ferres.


Withers, W.B. (1887), History of Ballarat. Ballarat: xxxx.

NOTES


2. Very little land had been sold or granted to private parties. The 1855 Report of the Commission investigating the Eureka Stockade (see Section II) found that "up to the end of 1854, after more than three years of gold digging, only 80,000 acres of land in the vicinities of the Gold Fields had been brought forward for sale; and that of this quantity, the land being in some places very poor, there had been actually sold but 44,000 acres, for a population that during all that times may have about as many individuals" (p. xiv).

3. The government instructed its commissioners to collect fees only from those able to pay the fee from their gold field earnings. It later announced that fees would not be collected for September.

4. In 1853 the government increased the claim size to 12 feet square.

5. See Umbeck (1981), Table 8.1. Wet claims average 105 feet square, gulch claims 139 feet square, and flat claims 451 feet square. Umbeck's sample represents about 35 percent of the estimated placer (alluvial) districts formed in California between 1848 and 1866 (p. 103).


8. At the same time that wages were rising, the demand for labor-intensive government services was growing, as the diggers were spread over a large area. Providing law and order over a larger area to the same number of people is usually more costly for a government compared to the case when the same number of people are geographically concentrated. Moreover, the miners had demands for additional public goods such as roads and sanitation.

9. Although in the long run migration would benefit them by expanding the domestic market and reducing wages.

10. See Roumasset and La Croix (1988) for a discussion of the government's incentives to limit rent-seeking.

11. The weakness in their analysis is that they fail to identify all relevant constraints.

12. The small claims discouraged racing, but they also discouraged prospecting. Contemporary observers believed that the discovery of the field was often undercompensated, that the first few arrivals made fortunes, and that relatively late arrivals did not make expenses. For example,...


14. A lead, or vein, of gold is a long, roughly continuous trail of gold deposits.

16. cite new Act.

17. Serle (1977, p. 179) notes that 100,000 people were on the gold fields, but many were not engaged in mining and miners working for companies did not have to take out the miner's right.


20. Source of data.

21. Local court legislation also covered a variety of additional topics such as "the manner in which the miner was formally to occupy and define the area of his claim...; the prevention of unlawful interference with claims; the requiring that a person who insisted upon a rights to a claim in possession of another, ..., should establish that right by legal process, and not, as was a common practice, by taking forcible possession of the claim, or, in goldfield phraseology, by "jumping" it; the modes of working so as to prevent collisions; the obligation to work so as to check the system of "shepherdings," ...; the determination of what should be a ground of forfeiture of a claim; the conditions under which water was to be used for mining purposes; the special privileges to be granted to successful "prospectors" or discoverers of new goldfields; and the protection from injury or nuisance by mining to public or private property" (Brough Smyth, p. 386).


26. Umbeck (1981, p. 89) observes that construction of dams on the American river in the California gold fields was subject to similar problems. Several ... river mining groups began operations in 1849 on the north fork of the American River. Each company dug a ditch about 300 yards long. Then a dam was built at an estimated cost of $8,000 which diverted the water from its natural course into the ditch. After 300 yards, the water was returned to its original bed, whereupon another company would build a dam and a ditch and again divert the water. This process was repeated at least 9 times, with 9 separate companies each claiming that part of the river bed they drained. The group size varied from 8 to 16 members. There was apparently no technological reason why these groups could not have constructed just one dam upriver from the area to be mined, dug 1 long ditch equal in length to the sum of the separate ditches, and saved all of the costs of constructing 9 separate dams. However, this was not observed.


34. There are, however, specified water allowances for puddlers. See *Mining Board Bye-Laws*, Schedule 30, p. 132.


36. See Yu (1981) for a detailed analysis of prior contracting in innovation.
### Table 1
DEMOGRAPHIC AND ECONOMIC STATISTICS OF VICTORIA

<table>
<thead>
<tr>
<th>Year</th>
<th>Victoria Population (thousands)</th>
<th>Goldfield Population (thousands)</th>
<th>Miner Wage Index</th>
<th>Composite Wage Index</th>
<th>Gold Output (oz. in thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1850</td>
<td>76</td>
<td>--</td>
<td>100</td>
<td>125</td>
<td>--</td>
</tr>
<tr>
<td>1851</td>
<td>97</td>
<td>19.3</td>
<td>510</td>
<td>341</td>
<td>4,194</td>
</tr>
<tr>
<td>1852</td>
<td>168</td>
<td>33.8</td>
<td>196</td>
<td>382</td>
<td>2,927</td>
</tr>
<tr>
<td>1853</td>
<td>222</td>
<td>52.8</td>
<td>217</td>
<td>228</td>
<td>3,489</td>
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<tr>
<td>1854</td>
<td>284</td>
<td>65.7</td>
<td>217</td>
<td>274</td>
<td>2,747</td>
</tr>
<tr>
<td>1855</td>
<td>347</td>
<td>109.7</td>
<td>179</td>
<td>194</td>
<td>2,527</td>
</tr>
<tr>
<td>1856</td>
<td>390</td>
<td>115.3</td>
<td>179</td>
<td>177</td>
<td>2,281</td>
</tr>
<tr>
<td>1857</td>
<td>457</td>
<td>132.5</td>
<td>179</td>
<td>177</td>
<td>2,157</td>
</tr>
<tr>
<td>1858</td>
<td>496</td>
<td>147.4</td>
<td>179</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>1859</td>
<td>521</td>
<td>139.2</td>
<td>179</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>1860</td>
<td>538</td>
<td>144.4</td>
<td>179</td>
<td>177</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Goldfield population is from Brough Smyth (1977); Victoria population is from Australian Demography Bulletin (1949), p. 154; wage indexes are from Maddock and McLean (1984); gold output is from Coghlan (1918), vol i, p. 587. The composite wage index takes average wages in each sector of the economy and weights them by the industry share in the economy. Gold miner wages are included in the composite wage.
### Table 2
FRONTAGE CLAIMS SIZE FOR ALLUVIAL LEADS

<table>
<thead>
<tr>
<th>Depth of Sinking</th>
<th>Length of a Single Claim</th>
</tr>
</thead>
<tbody>
<tr>
<td>200-220 feet</td>
<td>36 feet</td>
</tr>
<tr>
<td>220-240</td>
<td>40</td>
</tr>
<tr>
<td>240-260</td>
<td>45</td>
</tr>
<tr>
<td>260-280</td>
<td>50</td>
</tr>
<tr>
<td>280-300</td>
<td>55</td>
</tr>
<tr>
<td>300-320</td>
<td>61</td>
</tr>
<tr>
<td>320-340</td>
<td>67</td>
</tr>
<tr>
<td>340-360</td>
<td>73</td>
</tr>
<tr>
<td>360-380</td>
<td>79</td>
</tr>
<tr>
<td>380-400</td>
<td>85</td>
</tr>
<tr>
<td>400-420</td>
<td>91</td>
</tr>
<tr>
<td>420-440</td>
<td>97</td>
</tr>
<tr>
<td>440-460</td>
<td>103</td>
</tr>
<tr>
<td>460-480</td>
<td>109</td>
</tr>
<tr>
<td>480-500</td>
<td>115</td>
</tr>
<tr>
<td>500 feet and upwards</td>
<td>120</td>
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</tbody>
</table>

The table is reproduced from, *Mining Board Bye-Laws*, p. 125, schedule 2.
<table>
<thead>
<tr>
<th># of miners</th>
<th>Feet Square</th>
<th>Square Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35 x 35</td>
<td>1,225</td>
</tr>
<tr>
<td>2</td>
<td>50 x 50</td>
<td>2,500</td>
</tr>
<tr>
<td>3</td>
<td>60 x 60</td>
<td>3,600</td>
</tr>
<tr>
<td>4</td>
<td>70 x 70</td>
<td>4,900</td>
</tr>
<tr>
<td>5</td>
<td>80 x 80</td>
<td>6,400</td>
</tr>
<tr>
<td>6</td>
<td>85 x 85</td>
<td>7,225</td>
</tr>
<tr>
<td>7</td>
<td>95 x 95</td>
<td>9,025</td>
</tr>
<tr>
<td>8</td>
<td>100 x 100</td>
<td>10,000</td>
</tr>
</tbody>
</table>

Depth of sinking is greater than 50 feet

<table>
<thead>
<tr>
<th># of miners</th>
<th>Feet Square</th>
<th>Square Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>70 x 70</td>
<td>4,900</td>
</tr>
<tr>
<td>3</td>
<td>85 x 85</td>
<td>7,225</td>
</tr>
<tr>
<td>4</td>
<td>100 x 100</td>
<td>10,000</td>
</tr>
</tbody>
</table>