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The Evolution of Water Rights in the Nineteenth Century: The Role of Climate and Asset Type*

ABSTRACT

Adoption of a hybrid approach to water rights (the California doctrine) in some western states of the United States (U.S.) and Australia creates some doubt as to what factors drive water rights evolution. To date, commentators have argued climate is the only variable that affects this progression. However, climate alone cannot explain why the hybrid approach, persisted in nine of seventeen arid U.S. states and two Australian colonies. This paper shows that in addition to climate, the type of asset investment in water intensive sectors impacts water evolution via the mobility constraint. This study presents a predictive framework combining climate and asset type to determine the net effects on water scarcity and determine when and where riparian and/or appropriative water rights will evolve. In this article empirical evidence from several countries is used to verify the predictive capabilities of the framework. The findings indicated that the combination of variables included in the framework could better explain water rights evolution than climate alone.

I. INTRODUCTION

Theoretically, scarcity causes the evolution of property rights along a linear spectrum from open access to private property by its impact on asset values.¹ Specifically, as scarcity rises, asset values increase. In turn, the benefits of defining and enforcing rights at more margins start to outweigh the costs. As the asset values increase the returns from clear property rights also rise, encouraging the move toward private property. In the context of water rights, studies have found that scarcity

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1. Cf. Harold Demsetz, *Toward a Theory of Property Rights*, AM. ECON. REV., May 1967, at 347, 348.

is determined by climate.² The main climatic factor determining water scarcity is rainfall. Therefore, by considering climate alone, the expectation is that water rights will evolve to favor either riparian³ or appropriative rights rather than a combination of the two, quite distinct, legal approaches. For example, because southern Australia and U.S. states west of the 100th meridian are arid, water is scarce and theoretically appropriative rights to water should evolve.

However, during the nineteenth century, only a handful of arid U.S. states (and no Australian states) exclusively applied appropriative rights to water (the prior appropriation doctrine).⁴ The remaining U.S. states and Australian colonies, although arid, used the hybrid California doctrine that combined the use of riparian and appropriative rights.⁵ Economists and legal historians have extensively analysed the doctrine's evolution and impacts, particularly in the U.S.⁶ However, no studies have considered why scarcity in many of these locations did not lead to exclusive reliance on appropriative rights. As a result, the widespread adoption of this hybrid approach implies factors other than climate must

2. For examples of studies that have found that scarcity is determined by climate, see Terry L. Anderson & P. J. Hill, *The Evolution of Property Rights: A Study of the American West*, 18 J.L. & ECON. 163 (1975); Robert G. Dunbar, *The Significance of the Colorado Agricultural Frontier*, 34 AGRIC. HIST. 119 (1960); Gary D. Libecap, *The Assignment of Property Rights on the Western Frontier: Lessons for Contemporary Environmental and Resource Policy*, 67 J. ECON. HIST. 257 (2007); Mark T. Kanazawa, *Efficiency in Western Water Law: The Development of the California Doctrine, 1850–1911*, 27 J. LEGAL STUD. 159 (1998); T. E. Lauer, *The Common Law Background of the Riparian Doctrine*, 28 MO. L. REV. 60 (1963); Charles W. McCurdy, *Stephen J. Field and Public Land Law Development in California, 1850–1866: A Case Study of Judicial Resource Allocation in Nineteenth-Century America*, 10 LAW & SOC'Y REV. 235 (1975–1976); Donald J. Pisani, *Enterprise and Equity: A Critique of Western Water Law in the Nineteenth Century*, 18 W. HIST. Q. 15 (1987).

3. *Ripa* means the banks of a watercourse that gives rise to the term riparian. Only those individuals who owned land that came in contact with the water source could acquire riparian rights. See Lauer, *supra* note 2, at 60.

4. Exclusive adherence to prior appropriation is referred to as the 'Colorado doctrine.' States that apply this approach are: Colorado, Wyoming, Montana, Idaho, Nevada, Utah, Arizona, and New Mexico.

5. U.S. states that use the California doctrine are Washington, Oregon, California, Nebraska, North Dakota, South Dakota, Oklahoma, Kansas, and Texas. In Australia, New South Wales (NSW) and Victoria adopted the California doctrine.

6. For examples of the analysis, see Eric T. Freyfogle, *Lux v. Haggin and the Common Law Burdens of Modern Water Law*, 57 U. COLO. L. REV. 485 (1985–1986); Kanazawa, *supra* note 2; Lauer, *supra* note 2; Douglas R. Littlefield, *Water Rights During the California Gold Rush: Conflicts over Economic Points of View*, 14 W. HIST. Q. 415 (1983); McCurdy, *supra* note 2; J. W. Milliman, *Water Law and Private Decision Making: A Critique*, 2 J.L. & ECON. 41 (1959); Harry N. Scheiber & Charles W. McCurdy, *Eminent-Domain Law and Western Agriculture, 1849–1900*, 49 AGRIC. HIST. 112 (1975); Pisani, *supra* note 2; Carol M. Rose, *Energy and Efficiency in the Realignment of Common-Law Water Rights*, 19 J. LEGAL STUD. 261 (1990).

influence scarcity in any given context. These factors will counteract scarcity brought about by an arid climate.

This paper shows that scarcity is affected by climate and asset type. Considered individually, climate and asset type impact scarcity in different ways; combined, they provide a more concise explanation of water rights evolution by allowing us to determine their net effects on scarcity. This paper proposes a predictive framework that takes into account asset type, and will predict where riparian and appropriative water rights will be applied. This framework provides a better understanding of water rights evolution. The framework proposed in this article predicts that in arid climates with non-deployable asset investment appropriative rights will evolve; in arid climates with deployable asset investment riparian rights will evolve; in climates that are not arid with non-deployable asset investment riparian rights will be adopted; and the same outcome will occur in the presence of climate that is rainfall abundant and deployable assets dominate.⁷

Appropriative rights evolved in the presence of an arid climate with non-deployable asset investment in California and Colorado's gold mining and irrigation sectors, and the Australian gold mining sector. Riparian rights evolved in the presence of a rainfall abundant climate with non-deployable asset investment in the Eastern U.S. and England. Riparian rights also evolved where the climate was arid but deployable assets dominated in the Australian sheep grazing industry. These findings indicate that adding investment type to climate and determining the net effects on scarcity can provide a more complete story of water rights evolution in different historical contexts.⁸

7. Deployable assets are those that can be moved between alternative production locations at low cost, for example, livestock. Non-deployable assets cannot be moved between production locations because their physical features make them costly to install and remove. See Bradford L. Barham, Jean-Paul Chavas & Oliver T. Coomes, *Sunk Costs and the Natural Resource Extraction Sector: Analytical Models and Historical Examples of Hysteresis and Strategic Behavior in the Americas*, 74 *LAND ECON.* 429, 430 (1998).

8. To simplify the analysis, supply side issues are ignored, specifically the supply of common or private property rights. The main analysis focuses on the fact that these rights are supplied not *how* this takes place. As a result, there is no distinction made between common and statutory law in regard to the evolution of water rights. This is because the aim is to illustrate that asset type plays an important role in water rights evolution that has, to date, been overlooked. The argument is primarily concerned with showing why this variable improves current understanding of the process of evolution rather than analyzing the pathways via which it occurs. Of course, these pathways may affect the timing and direction of change and that is the subject of a vast literature. For examples of this literature discussing the affect on timing and direction of change, see Lauer, *supra* note 2; Anderson & Hill, *supra* note 2; McCurdy, *supra* note 2; Dunbar, *supra* note 2; Pisani, *supra* note 2; Kanazawa, *supra* note 2; Libecap, *supra* note 2.

The remainder of this paper is set out as follows: section II outlines the origins of both prior appropriation and riparian rights in the U.S. and Australia. Section III presents a predictive framework that establishes how aridity and asset type interact to determine the type of water rights that will be applied in a given setting. Section IV applies the framework developed in section III to several empirical examples to determine its predictive power. Section V offers some concluding remarks.

II. HISTORY: PRIOR APPROPRIATION AND RIPARIAN RIGHTS

Before outlining the predictive framework and testing this against the empirical evidence, the context in which prior appropriation and riparian rights evolved in both the U.S. and Australia warrants some discussion.

A. Prior Appropriation in the United States

Prior appropriation's basic premise was "first in time is first in right." In other words, water rights adhered to the principle of first possession. Several additional characteristics were also present. Seniority ruled so that, in the presence of a water shortage, later (junior) claimants were required to reduce or cease using water to provide sufficient volumes for more senior claimants.⁹ Non-use would lead to forfeiture and rights could be traded. Over time, the doctrine was refined to require appropriators to put water to beneficial use or lose their right.

The application and subsequent codification of prior appropriation in the U.S. is well known and has undergone extensive examination.¹⁰ Initially, miners applied the doctrine to allocate water on the gold fields during the late 1840s and early 1850s. Both courts and state legislators later endorsed these rights.

9. Using evidence from early Colorado mining codes it has been argued that the idea of seniority is a misinterpretation of prior appropriation and in fact equity was the main aim of this water allocation rule. See David B. Schorr, *Appropriation as Agrarianism: Distributive Justice in the Creation of Property Rights*, 32 *ECOLOGY L.Q.* 3, 10–11 (2005). This issue is discussed in more detail in section IV.

10. For examples of the examination, see Anderson & Hill, *supra* note 2; Freyfogal, *supra* note 6; Milliman *supra* note 6; Kanazawa, *supra* note 2; Lauer, *supra* note 2; Littlefield, *supra* note 6; Libecap, *supra* note 2; Dean Lueck, *The Rule of First Possession and the Design of the Law*, 38 *J.L. & ECON.* 393 (1995); McCurdy, *supra* note 2; Pisani, *supra* note 2; Rose, *supra* note 6; Scheiber & McCurdy, *supra* note 6; Samuel C. Wiel, *Public Policy in Western Water Decisions*, 1 *CALIF. L. REV.* 11 (1912–1913); Samuel C. Wiel, *Fifty Years of Water Law*, 50 *HARV. L. REV.* 252 (1936–1937).

B. Prior Appropriation in Australia

The application and subsequent formalization of prior appropriation in southern Australia has received much less attention. In fact, there are no studies analyzing the circumstances leading to its application in Australia despite the strikingly similar conditions under which the doctrine arose. Like the U.S., appropriation in Australia evolved from water use on the goldfields in the 1850s. Gold Fields Commissioners, who were appointed to manage and administer gold mining licences, later sanctioned prior appropriation rules. The first recorded use of the doctrine took place on Victoria's Beechworth Goldfield in 1853.

The doctrine was based on the premise of first possession so first in time was first in right; and many of the characteristics present in the U.S. approach were applied in Australia, including seniority rule, forfeiture for non-use, and tradability.¹¹ The main divergence apparent in the evolution of appropriation in these two countries was the mechanism by which these informal rules were transformed into formal rights. As noted, in the U.S. this happened primarily via courts. In Australia, it happened via legislation.¹²

Australian colonies relied on legislation to formalize appropriative rights because the courts refused to sanction informal prior appropriation rules for two main reasons. First, it was considered that all diversions were illegal under gold mining regulations.¹³ Second, Mining Courts found it impossible to deal with the idea of priority water rights because they believed such rights lacked legal foundation. While giving evidence at a Royal Commission investigating the administration of the Victorian goldfields, one judge plainly stated: "It is a thing unknown in law, a first right, a second right, or a third right, and I did not know how to deal with them."¹⁴ What is surprising about this interpretation by Aus-

11. However, there were a number of important differences in the doctrine's application on Australian goldfields, specifically: volumes claimed under appropriation were limited; and control over return water (referred to as tail water) was prohibited. See generally R. BROUGH SMYTH, *THE GOLD FIELDS AND MINERAL DISTRICTS OF VICTORIA: WITH NOTES ON THE MODES OF OCCURRENCE OF GOLD AND OTHER METALS AND MINERALS*, 397-409 (1869) (discussing the supply of water to the gold fields).

12. See *An Act to Amend the Law Relating to the Gold Fields 1857*, 20 VICT. NO. 29 (colonial legislation in New South Wales); see also *An Act to Amend the Laws relating to the Gold-fields 1855*, 18 VICT. NO. 37 (colonial legislation in Victoria).

13. See *Court Reporter, Beechworth Court of Mines*, OVENS AND MURRAY RIVER ADVERTISER, August 18, 1858 at 2 ("even after the [Gold Field's Act] came into force no water right would be held with any legal title till the Mining Board had passed Bye-la[w]s").

14. Gold Fields Royal Commission of Inquiry, VICTORIAN PARLIAMENTARY PAPERS 10, at 33 (1862-1863) (on file with author).

tralian courts is that prior appropriation had its origins in English common law.

C. Prior Appropriation in England

England was governed by the riparian doctrine, which evolved during the 1700s, but prior appropriation principles applied only to riparian rights owners. This approach to water rights did not have its foundations in court rulings. Rather, it was espoused in legal treatise.¹⁵ Judges later cited these doctrines in their judgments as authoritative rules. In the late eighteenth century, the eminent legal writer, Blackstone, stated that rights to flowing water should follow occupancy, or first possession.¹⁶ Prior appropriation theory replaced ancient use and natural flow principles, the previous doctrines used to determine water rights disputes.¹⁷ The English prior appropriation rule resembled the prior appropriation doctrine subsequently adopted in the U.S. and Australia in the nineteenth century. Under this rule, rights remain conditional on any prior rights that exist for a given water source; rights are limited to the volumes originally utilized; no rights could exist unless water was beneficially used; and non-use would result in forfeiture.

Prior use did not alter *who* could obtain water rights; it merely dictated *how* disputes between group members would be settled.¹⁸ However, in England, prior appropriation was a secondary claim for owners who had riparian rights by virtue of the fact that they occupied land in contact with the watercourse.¹⁹ In England, prior appropriation was a test applied to disputes *between* owners who had rights under riparian law, by virtue of the position of their land, and was not a doctrine used

15. Many important aspects of eighteenth century land and water law were developed by treatise rather than judicial decision. Moreover, judges in leading cases cited Blackstone's treatise as a direct authority on questions of water law. For this reason, it is a justifiable to claim that a treatise laid the foundations for nineteenth century land and water use. See JOSHUA GETZLER, *A HISTORY OF WATER RIGHTS AT COMMON LAW* 204 (2004).

16. *Id.*; see also Rose, *supra* note 6, at 275.

17. See generally GETZLER, *supra* note 15, at 193–267 (discussing the move from natural use to appropriative use in the English common law over this period).

18. Under common law when individuals occupy land bordering a river or stream the boundary of ownership extends to the bed of the river. In this way, individuals own land *ad medium filum aquae* (to the 'middle thread'). This gives them rights to use the water flowing over this land. These rights were the same type of property that existed in wild animals where title arose "by a man's *reclaiming* and making them tame by art, industry, and education; or by so confining them within his immediate power, that they cannot escape and use their natural liberty. . . [this property] may be destroyed if they resume their ancient wildness, and are found at large." GETZLER, *supra* note 15, at 176 (quoting William Blackstone).

19. See GETZLER, *supra* note 15, 207–17.

to determine access (as in the U.S. and Australia). Specifically, the rule was used to determine what actions would be considered acceptable given the shared right of all riparians to make use of the resources on their land. Individuals occupying land that did not come into contact with the watercourse were unable to obtain water rights and therefore, they could not appropriate the resource.

As a result, in England water use rights were obtained by a group of individuals based on their land occupancy. This group of right holders were permitted to make use of water to the exclusion of all others—a characteristic typically associated with common property. The appropriation rule assigned each group member a right to the flow of services from the asset. However, the flow did not have to be equally shared between users; rather, the first user would be entitled to unencumbered use rights compared with subsequent users. For example, assume a river has two riparian owners, A and B, and contains 100-megaliters of water. In period one, A utilizes 50 megaliters for her mill; in period two, B begins to utilize 60 megaliters for his mill. Applying the appropriation rule, a court would find A has a prior use right to 50 megaliters and therefore B can only ‘appropriate’ the volume not being exploited by A—50 megaliters.²⁰

D. Riparian Law

Riparian law was and is used in England. As mentioned above, riparian law was used to determine rights while prior appropriation was used to resolve disputes between those right holders. By the nineteenth century, English courts (and those in the eastern states of the U.S.) had replaced the appropriation rule to resolve disputes between riparian rights holders with reasonable use. Reasonable use dictated that actions by water users were reasonable if and only if they did not devalue the common right held by all water right owners along the watercourse. This test has influenced modern tenets of riparian law.

In both the U.S. and Australia, riparian law had its origins in English common law. California courts were bound by English common law after 1850 when the legislature passed “[a]n Act adopting the common law.” However, it is unlikely that early legislators recognized that adoption of English common law meant simultaneously accepting riparian elements and the reasonable use test as the basis for settling disputes.²¹ Riparian water law was thus adopted in California alongside

20. A court would find that B had infringed on A’s right under tort rules of trespass or negligence. The remedy would be either an injunction or damages.

21. See *Wood v. Waud*, (1849) 3 Exch. 748, 154 Eng. Rep. 1047 (adopted reasonable use as English common law); see also *Palmer v. Mulligan*, 3 Cai. R. 307 (N.Y. Sup. Ct. 1805)

appropriative rights and this combination gave rise to the California doctrine which created complications for courts determining riparian-appropriator conflicts that occurred with increasing frequency from the 1880s.

Australia initially adopted riparian law when they the adopted British common law in 1828 under the Australian Courts Act.²² Section 24 of this legislation explicitly granted colonial courts the right to diverge from established precedent by stating that English law applied only where it was deemed suitable given the conditions of the colony. Australian judges generally considered English law appropriate only where it furthered the peace, welfare, and good governance of the colony.²³

By virtue of section 24, Australian courts could have refused to adopt or modify aspects of riparian law if they believed colonial circumstances warranted this deviation. Moreover, courts had deviated from English common law in other areas suggesting the flexibility granted under section 24 would be exercised. For example, in *Rex v. Farrell, Dingle and Woodward*,²⁴ the court found that applying English rules of evidence forbidding convicts from giving testimony was unworkable in a penal colony.²⁵ Nevertheless, despite the obvious climatic deviations between Australia and England and the relative flexibility given to Australian courts, the reasonable use test was applied to determine riparian conflicts in the colonies.²⁶ As a result, common law riparian rights and reasonable use were applied alongside legislation supporting prior appropriation on the goldfields—thus establishing the use of the California doctrine in Australia.

The very clear sectoral demarcation of the two water rights systems is unique to Australia. Legislation applied prior appropriation only

(application of reasonable use in the eastern states of the U.S. preceded English courts by at least four decades); Kanazawa, *supra* note 2, at 162–65.

22. Australian Courts Act 1828 9 Geo 4 c 83 (UK) (repealed) (adopting common law in Australia).

23. Edwynna Harris, *The Economic Implications of Law: Nineteenth Century Legal Innovation in New South Wales, the Case of the Wool Lien and Stock Mortgage* (2012) (unpublished manuscript) (on file with author).

24. *Rex v. Farrell*, 1 Legge's Sup. Ct. Cases (1825–1862) 5, 34 (N.S.W. 1831) (published 1896).

25. Individual judges would also exercise flexibility under this rule, particularly when considering decisions by British courts of coordinate jurisdiction. See generally BRUCE KERCHER, *AN UNRULY CHILD: A HISTORY OF LAW IN AUSTRALIA* 82–102 (1995) (discussing the Australian judicial system and its attachment to England).

26. Riparian rights and the reasonable use test were applied in several cases in NSW and Victoria during the nineteenth century. In NSW these cases were: *Cooper v. Corporation of Sydney* (1853) 1 Legge 765 (NSW); *Hood v. Corporation of Sydney* (1860) 2 Legge 1294 (NSW); *Pring v. Marina* (1866) 5 NSWSCR (L) 390; *Howell v. Prince* (1869) 8 NSWSCR (L) 316; *Lomax v. Jarvis* (1885) 6 NSWLR (L) 237. In Victoria, one case was *Newstead v. Flannery* (1887) 8 ALT 178 (Vic).

on the gold fields so that no water users outside this sector could assert or defend claims based on first possession. Riparian rights and reasonable use were applied in all other areas, including the largest sector of the colonial economies—the pastoral industry. This divergence from theory can be rationalized using the framework from section three.

III. A FRAMEWORK TO EXPLAIN WATER RIGHTS EVOLUTION

A. Principles That Affect Water Rights Development

Theoretically, scarcity leads property rights to evolve in a linear spectrum from open access (an absence of property rights) to common property (limited group property rights) and finally, private property (individual rights).²⁷ Initially open access exists when there is little competition and scarcity is low. Scarcity increases as competition intensifies through actions such as factor price or technology changes that increase exploitation. Private property rights will reduce the losses associated with racing that result in the familiar tragedy of the commons.²⁸ Initially, because the group of expropriators is relatively small and homogenous, common property rules can serve to limit the racing incentive, protect claims, and support productive investment. The creation of common property is dependent on organization and exclusion costs. In the first instance, common property will arise only so long as the group can overcome the public good problem of collective action.²⁹ Shared social norms provide a foundation for such organization, highlighting the importance of homogeneity in supporting the rise of such regimes.³⁰ In the presence of cultural homogeneity where the costs of formal sanctions are high—for example, at the frontier—the supply of common property rights will rely, in part, on norms. Norms lower coordination costs by creating focal points that, prior to the play of the game, have mutual significance to

27. Cf. Demsetz, *supra* note 1, 350–53.

28. The tragedy of the commons was first postulated in 1968. The tragedy arises whenever property is used in common and remains open access because this creates an incentive for individuals acting alone to over use the resource. Overuse is the result of the non-excludable nature of a common pool resource. Non-excludability means that no one individual can prevent another actor from using the common pool. Thus, competition is characterized by a race, which is accompanied by over capitalization as each resource user tries to maximize current returns. The outcome is twofold: over use leads profits to fall to zero while underinvestment in future stocks reduces the long-run rents accruing from exploitation. For a more in depth discussion of the theory of the tragedy of the commons, see generally Garrett Hardin, *The Tragedy of the Commons*, 162 *Sci.* 1243 (1968).

29. Thráinn Eggertsson, *Open Access Versus Common Property*, in *PROPERTY RIGHTS: CO-OPERATION, CONFLICT, AND LAW* 73, 84 (Terry L. Anderson & Fred McChesney eds., 2003).

30. Lee J. Alston, Edwyna Harris & Bernardo Mueller, *The Development of Property Rights on Frontiers: Endowments, Norms, and Politics*, 72 *J. ECON. HIST.* 741, 746 (2012).

players based on past experiences.³¹ This establishes an equilibrium that all players expect, which increases the likelihood of cooperation in a prisoner's dilemma game.³² Individual members of a group monitor and enforce norms because it is in their interest to do so.³³ This is because there are greater gains from cooperation than conflict. Internalizing these gains relies on continuing the behavioral pattern established by shared norms. Actors will therefore have an explicit incentive to monitor and enforce norms because any breach is an indirect threat to them and the rental stream they derive from the collective good.³⁴ In other words, norms reduce organizational costs faced by a group. Once organization costs are overcome, exclusion costs are ongoing and require continued investment by group members to prevent encroachment. However, because each group member has an incentive to maintain exclusivity in order to maximize rents accruing to them, the marginal costs of defense per member are lower than in the absence of the common property arrangement. Internal governance costs also exist in these arrangements to prevent over-exploitation by limiting free riding and restricting use. It is assumed that where groups are small, homogenous, and share social norms, the costs of internal governance will be low.³⁵

Typically, in common property regimes margins exist in which rights go undefined because the costs of definition outweigh the benefits. For example, rights of riparian owners were determined by the reasonable use test that was based on reference to a common right held by all riparians. An activity by one riparian owner would be deemed reasonable if and only if it did not devalue the common right. Similar imprecision may exist for other resources subject to common property rules, such as land where use of common pastures dictates only the number of animals each member can graze rather than their location on the pasture. By leaving undefined the area on which animals owned by individual members can graze, there is the potential for conflicts when common

31. See Richard O. Zerby Jr. & C. Leigh Anderson, *Culture and Fairness in the Development of Institutions in the California Gold Fields*, 61 J. ECON. HIST. 114, 120–21 (2001) (defining focal points as expectations about behavior, including what is fair, and first possession rules that underpin the formation of property rights). See also ROBERT AXELROD, *THE EVOLUTION OF COOPERATION* (1984); ROBERT C. ELLIKSON, *ORDER WITHOUT LAW: HOW NEIGHBOURS SETTLE DISPUTES* 123–136 (1991); Robert Sugden, *Spontaneous Order*, J. ECON. PERSP., Autumn 1989, at 85, 95–96 (discussing the impact of norms on property rights and coordination costs).

32. The classic prisoner's dilemma game demonstrates that individuals may choose sub-optimal strategies when their payoffs are conditional on the behavior of another individual.

33. ELLIKSON, *supra* note 31, at 123–136.

34. Sugden, *supra* note 31, at 96.

35. See Eggertsson, *supra* note 29, at 84–85.

pastures are relatively large and have variations in feed quality. The probability of conflict can be reduced if rules requiring pooling of output are adopted to ensure returns to each member are equal regardless of individual animal production. Common property predominantly prevails when it is too costly to divide the resource stock between individual owners³⁶ because there are net gains from assigning individual shares in the flow of services from the asset to group members.³⁷ Common property arrangements can be relatively stable and long lasting where groups are small, productive technology used by members is unchanged, and the group is able to capture the full benefits associated with the delineation of rights.³⁸

B. Incomplete Framework to Explain Water Rights Evolution

Under conditions of increased scarcity, general property principles predict that common property will give way to private property because scarcity creates higher costs of maintaining the former set of rights compared with the latter. Rising costs of common property enforcement are brought about by an increasing number of heterogeneous expropriators that lead to rising marginal costs of defense for incumbents.³⁹ Once defense costs are prohibitively large, the common property system will collapse.⁴⁰ For example, consider a case where output prices for the product of a common pasture are rising, thereby increasing the returns from grazing. New entrants will have an incentive to move into the grazing sector to capture part of the growing rental stream available, thereby increasing enforcement costs for common property owners. Once defense costs exceed the benefits of common property,⁴¹ economic pressures will encourage a move to private property.⁴²

Aside from economic pressures technological change can also reduce the costs of dividing the stock of a commonly owned resource between owners leading to the dismantling of a commons arrangement

36. Lueck, *supra* note 10, at 405–409.

37. See Eggertsson, *supra* note 29, at 74.

38. Rose, *supra* note 6, at 273; see also Lee J. Alston, Edwyna Harris & Bernardo Mueller, *De Facto and De Jure Property Rights: Land Settlement on the Australian, Brazilian and U.S. Frontiers* 5 (Nat'l Bureau of Econ. Research, Working Paper No. 15264, 2009).

39. Eggertsson, *supra* note 29, at 76–77.

40. *Id.* at 76.

41. This occurs when the marginal costs of preventing encroachment outweigh the marginal benefits of group membership.

42. The form that private rights take depends on the interaction between norms, politics, and economics. See Alston, Harris & Mueller, *supra* note 38, at 5. Further, extant common property owners may not have their rights legitimized so that the prevailing private rights may allocate goods to other actors. *Id.*

and adoption of private property. Consider the following example, in the first period, the cost of dividing the stock is high because the technology does not exist for low cost enforcement of individual rights. For instance, during the early settlement of the U.S. Great Plains, the absence of low priced fencing materials increased the costs of enforcing private rights to large land claims required for cattle grazing.⁴³ Returns from enforcing land rights for a small group of ranchers were high. Ranchers formed associations with each member having a right to the flow of services from the land.

In the second period, there was an exogenous technological shock with the introduction of barbed wire. Barbed wire, a low cost fencing technology, decreased the costs of enforcing individual rights to the land. As a result, land owned in common in period one was divided among ranchers as private property.

Similar to the general property principles, empirical studies analyzing water rights evolution highlight the vital role of scarcity in moving from open access to private rights.⁴⁴ These studies argue that climate alone determines scarcity, and therefore the type of water rights that evolve in a given setting. Climate acts to affect scarcity in the following ways. If competition exists but remains constant in the short-run and rainfall is abundant, scarcity is low. In arid climates, scarcity is high. Therefore, *ceteris paribus*,⁴⁵ in rainfall constrained climates water rights evolution would tend toward private rights, while in rainfall abundant climates common rights will prevail.⁴⁶

However, climate alone cannot explain the rise of the California doctrine where riparian and appropriative law were applied to the same resource. By considering only the Californian climate, in general it would be considered arid, therefore exclusive use of prior appropriation should have evolved. This did not happen and instead a hybrid approach was adopted. Moreover, the hybrid approach used in California evolved in other U.S. states and Australia suggesting there must be additional factors that effect the nature of water rights evolution that have not been identified in the relevant literature.

43. Cf. ERNEST STAPLES OSGOOD, *THE DAY OF THE CATTLEMAN* 135-49 (1929); R. Taylor Dennen, *Cattlemen's Associations and Property Rights in the American West*, 13 *EXP. ECON. HIST.* 423, 423-24 (1976).

44. For examples of studies analyzing water rights, see Freyfogle, *supra* note 6; Kanazawa, *supra* note 2; Littlefield, *supra* note 6; Rose, *supra* note 6.

45. *Ceteris paribus* in common economics language means 'all things remaining equal.' In practice this means that all but one variable in a model remain constant allowing the analyst to isolate the effects of changes in just one factor on economic outcomes.

46. The timing of these events is ignored, but it is recognized that this evolution may happen over varying time frames given different contexts.

C. New Framework to Explain Water Rights Evolution

In order to provide a more comprehensive framework to make sense of these empirical outcomes, careful re-examination of factors affecting scarcity is critical. It is the contention of this paper that in addition to climate, the type of asset investment in water intensive sectors affects water scarcity and, therefore, the water rights that evolve in a given setting. Like climate, asset investment influences scarcity in specific ways. Further, by combining asset investment and climate, it is possible to predict where and when riparian and/or appropriative rights will prevail.

If aridity was the main driver of water scarcity in California and Australia then it would be expected that courts would have abolished riparian rights in favor of exclusive reliance on prior appropriation as Colorado had done.⁴⁷ The fact that the courts did not act to eliminate riparian rights is surprising, particularly in the California context, given the general contention that these courts were particularly innovative and undertook doctrinal change that reflected climate conditions.⁴⁸ For example, the California Supreme Court codified informal miners' rules, including prior appropriation, indicating they were willing to adopt rules suited to the nature of resource use.⁴⁹ The fact that no study offers a framework by which to rationalize the broader application of the California doctrine in arid climates such as Australia indicates a gap in the literature regarding the path of water rights evolution in any given setting.

Asset investment is the key to this new framework because it addresses the gaps in the old framework. Assets are divided into either deployable or non-deployable assets. Deployable assets such as sheep or cattle can be moved at little or no cost because they are mobile. Non-deployable assets are unable to be moved from one location to another at low cost because their physical features make them costly to install, remove, and relocate,⁵⁰ like a channel to move water to a gold mine.

Putting aside climate, consider the impacts of asset investment on scarcity. If you assume constant competition in the short-run, asset investment affects scarcity in the following way: where deployable assets

47. See Freyfogle, *supra* note 6, at 495 (citing *Coffin v. Left Hand Ditch Co.*, 6 Colo. 443 (1882) and *Yunker v. Nichols*, 1 Colo. 551 (1872)).

48. See generally Lauer, *supra* note 2; McCurdy, *supra* note 2; Pisani, *supra* note 2; Schieber & McCurdy, *supra* note 6; Wiel, *supra* note 10.

49. *Irwin v. Phillips*, 5 Cal. 140 (1855), was the first case in which the California Supreme Court recognized the right of first possession and diversion. Recognition of first possession was at the core of the prior appropriation doctrine that was repeatedly upheld in later cases.

50. Barham, Chavas & Coomes, *supra* note 7, at 430.

are the main form of investment, scarcity is low; conversely, where non-deployable asset investment prevails, scarcity is high. The mechanism by which asset investment influences scarcity is through the mobility constraint. For simplicity, assume the mobility constraint is either zero or one.⁵¹

At zero, an asset is fully mobile; that is, the mobility constraint does not bind and movement costs are also zero. Conversely, at one the mobility constraint binds and movement costs are equal to one. If the mobility constraint is zero in any period, it is not binding and assets are fully deployable, which increases the availability of alternative productive locations and makes scarcity low. For example, in the face of district drought, sheep or cattle are not confined to one site. They can be moved at low costs to alternative production locations where inputs are unaffected. The costs of moving these assets are positively related to the distance travelled, where a greater distance increases relocation costs by causing the death of smaller animals and a reduction in wool and/or meat quality of the flock or herd.⁵² However, if you assume that distance travelled is small, movement costs approach zero.⁵³ As a result, the costs of mobility are not so high as to decrease the returns from movement to zero.

A further complement to a non-binding mobility constraint for livestock is the ability to slaughter animals in the face of region or state wide drought. Drought limits the availability of both feed and water for existing flocks or herds. Slaughter reduces competition for all inputs. In other words, marginal adjustments to animal numbers can be made given the climatic variations experienced over time. Once a drought breaks, natural increases in numbers can be relied upon to rebuild flocks or herds to pre-drought levels. Nevertheless, at some point, slaughtering costs will approach one, such as where flock or herd numbers are reduced to such a point that only key breeding animals remained. At this point, the cost of slaughtering would be outweighed by the costs of replacing animals, which is the cost of going to market to buy new stock.

As a result, there are diminishing marginal returns to slaughtering because at some point the costs of continued slaughter will be higher than the benefits. There may be cases where the mobility constraint is non-binding, or close to zero, but returns to movement are zero. This would

51. Of course, the mobility constraint may have a value anywhere between zero and one, reflecting the corresponding costs of relocation.

52. One could easily assume that relocation costs are a function of transportation costs for instance, the costs of hiring labor and a truck suitable for asset redeployment. However, this would not alter the outcome of the analysis because transportation costs are also positively related to distance.

53. Costs are positive but at very low levels.

happen if, for example, relocation causes the death of an entire flock or herd. Under these conditions, asset mobility is associated with prohibitively high costs so actors will not relocate under any conditions. As a result, while these assets would be considered deployable in the first instance, deployment costs are approaching or equal to one so in fact non-deployable characteristics dominate. This will increase water scarcity.

When the mobility constraint is equal to one, it is binding and movement costs are prohibitively high. Under this circumstance, assets are non-deployable and scarcity is high. To summarize, the effects of asset investment type is, *ceteris paribus*,⁵⁴ when investment in deployable assets dominates, water rights evolution will tend toward riparian rights; and, *ceteris paribus*, when non-deployable asset investment dominates, water rights evolution will tend toward private rights. By combining climate and asset investment, predictions as to when and where either riparian or appropriative water rights apply can be established (Table 1).

Table 1 illustrates that in arid climates where investment is in non-deployable assets, scarcity is high, and prior appropriation will be applied.⁵⁵ However, where climate is arid and investment is in deployable assets, scarcity is counteracted by a non-binding mobility constraint and riparian rights will be used to allocate water supplies. In a non-arid climate where non-deployable asset investment dominates, a relative abundance of rainfall will counteract the binding mobility constraint effects on scarcity leading to the adoption of riparian rights. When climate is not arid with investment in deployable assets, the combination of rainfall abundance and a non-binding mobility constraint will mean low scarcity prevails and riparian rights will be utilized.

IV. APPLICATION OF THE NEW FRAMEWORK FACTORS USING EMPIRICAL EVIDENCE

This section uses empirical evidence to explain the effect of different types of assets on the evolution of water rights in Australia and the U.S. If the framework proposed in this article is correct, water rights evolution in each case should conform to the property rights predictions. The empirical examples presented support expected outcomes that common rights were adopted in the following cases: when aridity was accompanied by deployable assets (Australia), or where rainfall was

54. *Ceteris paribus* in common economics language means 'all things remaining equal.' In practice this means that all but one variable in a model remain constant allowing the analyst to isolate the effects of changes in just one factor on economic outcomes.

55. Literature suggests that reliance on common property arrangements for water in arid environments may be fleeting or skipped altogether as a result of climate constraints. See Rose, *supra* note 6, at 262.

abundant but asset investment was non-deployable (Eastern U.S. and England). In the cases where aridity was combined with non-deployable assets, appropriative rights evolved (Australia and Western U.S.).

A. Climate and Asset Investment Factors Applied in Australia

Before applying the predictive framework from section two, the new factor of asset investment and its interplay with climate need to be considered. Australia is arid, with much of New South Wales (NSW) and Victoria receiving less than 200-300mm (8–12 inches) annually, similar to the U.S. Great Plains and far west.⁵⁶ Australian economic development in the nineteenth century was underpinned by pastoral sector expansion and growth of the wool industry. By the 1830s, Australian wool producers were critical suppliers of the British textile industry. By 1865, total sheep numbers in NSW and Victoria were 16.5 million and by the end of the century, numbers exceeded 50 million.⁵⁷ Pastoralists used water for two main activities: for washing wool prior to transport to reduce its weight⁵⁸ and for sheep to drink. During much of the nineteenth century pastoralists relied almost exclusively on surface water supplies to maintain sheep flocks. Substantial ground water supplies were available, particularly in NSW, below which lays the Great Artesian Basin. The Great Artesian Basin is one of the largest groundwater basins in the world. However, until the 1880s, pastoralists limited their use of groundwater.⁵⁹ From the 1880s, there was greater investment in locating potable groundwater in order to substitute for highly variable surface water supplies. Nevertheless, anecdotal evidence suggests pastoralist attempting to locate groundwater supplies suffered from uncertainty and high cost.⁶⁰

1. Scarcity

NSW and Victorian pastoralists faced relatively high levels of water scarcity brought about by limited rainfall and an absence of low

56. John Whittington & Peter Liston, *Australia's Rivers*, in 85 YEAR BOOK AUSTRALIA 449, 449 (Austl. Bureau of Stat's. ed., 2003).

57. Bruce Davidson, *Agriculture*, in AUSTRALIANS HISTORICAL STATISTICS 70, 81 (Wray Vamplew ed., 1987).

58. N.G. BUTLIN, INVESTMENT IN AUSTRALIAN ECONOMIC DEVELOPMENT, 1861–1900 72 (1964).

59. Butlin, *supra* note 58 at 79–80; see also James Jervis, *The Western Riverina*, 38 J. ROYAL AUSTR. HIST. SOC'Y 1, 13 (1952); C.J. LLOYD, EITHER DROUGHT OR PLENTY: WATER DEVELOPMENT AND MANAGEMENT IN NEW SOUTH WALES 60–61 (1988). The Great Artesian Basin is estimated to contain close to 65 billion megaliters of water. QUEENSLAND DEPARTMENT OF ENVIRONMENT AND RESOURCE MANAGEMENT, THE GREAT ARTESIAN BASIN (2011) (factsheet), available at <http://www.nrm.qld.gov.au/factsheets/pdf/water/w68.pdf>.

60. LLOYD, *Id.*

cost surface water substitutes. This was counteracted by a non-binding mobility constraint in the pastoral industry. Complementing this, pastoralists scattered their land claims over large areas to lower the cost of district level drought.⁶¹ Given these conditions, using the predictive framework proposed by this article that takes into account the mobility of assets, it is expected that riparian rights would have been adopted to govern water allocation in the pastoral sector during the nineteenth century—and in fact, this did occur.

In the case of wool production, where asset investment was deployable, the riparian doctrine had several advantages compared with prior appropriation. Land owners or occupiers that acquired riparian rights did not lose these rights during periods of non-use. The riparian doctrine created a right of access rather than a right to a specific quantity of water, and interpretation as to what constituted reasonable use was fluid across time and space.⁶² Retention of water rights during non-use periods complemented grazing, where the optimal location for profit maximization was subject to inherent seasonal variation and land claims were scattered over large areas to include summer and winter properties, providing better drought protection.⁶³ Retaining water rights even during non-use periods decreased monitoring and enforcement costs of water access. Further, it conferred on pastoralists the net gains from assigning individual shares to the flow of services from the resource to group members.

For graziers to take advantage of the non-binding mobility constraint prevailing in livestock investment, one or more of three conditions needed to prevail. First, substantive groundwater had to be accessible. Second, non-seasonal large rivers had to be available and third, rainfall had to vary across holdings. As explained, vast groundwater supplies did exist but uncertainty and high cost meant very few squatters tried to exploit this source. Moreover, Australia's river systems are typically characterized by low flows and high variability. Geogra-

61. On average pastoralists claimed 34,000 acres in NSW and 24,000 in Victoria. STEPHEN H. ROBERTS, *THE SQUATTING AGE IN AUSTRALIA* 362 (2d ed. 1964).

62. Non-use of water rights on the gold fields resulted in forfeiture of rights under clause 40 of the 1861 'Gold Fields Act' regulations. *An Act to Amend the laws relating to the Gold Fields 1861*, 25 Vict. No. 4 ("privileges not upheld and used for a period of 14 days in the case of alluvial mining and for a week in the case of river working shall be held to be forfeited, unless abandonment can be explained to the satisfaction of the commissioner"). This act noted that non-use during periods of drought could not be grounds for forfeiture.

63. In each district, land claims were enforced by a Crown Lands Commissioner under the 1836 'Squatting Act' and by the physical presence of employees. *An Act to Restrain the Unauthorised Occupation of Crown Lands 1836*, 7 Will. No. 4 (allowing for the appointment of a Crown Land Commissioner to enforce land claims).

phers use coefficient variation of annual flow (CVR) to calculate flow variability in river systems.⁶⁴ Australia's CVR has been estimated at 1.12 compared with the world average of 0.33. These findings were consistent across both large and small catchments.⁶⁵ Assuming this level of variability persisted in the nineteenth century, graziers did not have access to large non-seasonal rivers.⁶⁶ Australian rainfall is both temporally and spatially variable, therefore rainfall patterns over squatters' holdings would fluctuate somewhat. Using annual rainfall data to assess whether empirical evidence supports this expectation, first difference correlations are estimated between paired rainfall stations.⁶⁷

To estimate the correlation coefficients, annual rainfall data was collected from statistical records of the Australian Bureau of Meteorology for the period being considered.⁶⁸ There are several important points that need to be highlighted before the statistical analysis is undertaken. Rainfall data collection began in the mid-1860s, but only for a very limited number of locations; until the mid to late 1870s, many locations records were incomplete.⁶⁹ Because months were missing, it was impossible to calculate annual precipitation. Moreover, even from the 1870s, the number of rainfall stations for which data are available is small com-

64. Whittington & Liston, *supra* note 56, at 449.

65. B.L. Finlayson & T.A. McMahon, *Australia v the World: A Comparative Analysis of Streamflow Characteristics*, in *FLUVIAL GEOMORPHOLOGY OF AUSTRALIA* 17, 22 (Robin F. Warner ed., 1988).

66. Although widespread, systematic river gauging was not undertaken in Australia prior to the mid to late twentieth century. There is very little reason to assume this highly variable pattern of river flows did not persist during the squatting period circa 1830–1880. Moreover, the effects of such significant variation would have been far more pronounced than today because extensive construction of artificial storages on river systems were almost non-existent.

67. First difference correlation estimations subtract the value of one observation from the previous observation and calculate the linear association between two variables that are assumed to be random. ROGER PORKESS, *COLLINS DICTIONARY OF STATISTICS* 61–62 (2d ed. 2004).

68. Australian Bureau of Meteorology, *Climate Data Online*, BUREAU OF METEOROLOGY <http://www.bom.gov.au/climate/data/> (last update Aug. 16, 2012) (web-based data calculator for rainfall).

69. The Australian Bureau of Meteorology explains why rainfall records may be incomplete in the following way: "Historically, if a station moved a relatively short distance (within about 1 to 2 km) it may, but not always, have continued to use the same station number. Changes may have occurred in instrumentation and/or observing practices over the period included in a dataset, which may have an effect on the long-term record. In recent years many stations have had observers replaced by Automatic Weather Stations, either completely or at certain times of the day." Australian Bureau of Meteorology, *About Rainfall Data*, BUREAU OF METEOROLOGY, <http://www.bom.gov.au/climate/cdo/about/about-rain-data.shtml> (last update Apr. 28, 2010). This webpage also provides for further details of the limitations of historical rainfall data.

pared with today's standards.⁷⁰ These data constraints affected the approach to the statistical analysis by limiting the number of observations that could be included. In total there were 26 stations throughout NSW and Victoria. These were then divided into 13 pairs.⁷¹ Given the extent of graziers land holdings during this period, a range of distances in square kilometres (km^2) was calculated from historical evidence to determine appropriate pairings. The lower bound of this range for both NSW and Victoria was 64km^2 , which is equivalent to 25m^2 and was the limitation government imposed on individual claims under The Occupation Act (1861).⁷² The upper bound for the two colonies differed based on the average claims size of 138km^2 in NSW and 97km^2 in Victoria.⁷³ The aim in pairing rainfall stations was to match two sites that were within these distance ranges for each colony.⁷⁴ Appendix 1 shows the average distance between each station pairing was 93 km^2 (NSW) and 76 km^2 (Victoria).⁷⁵

Simple first difference correlation estimations for each station pair are reported in Table 2 (below). The table indicates that rainfall is highly correlated between most stations in the sample. Correlation coefficients below 0.80 are the result of either the direction or distance between the station pair. For example, for pairs located in an East-West line a lower correlation indicates they are likely to be located in different average rainfall belts.

Further, there is an inverse relationship between correlation and distance for rainfall: the further apart sites are, the lower the correlation coefficient.⁷⁶ The correlations shown in Table 2 suggest that on much of the land occupied by a grazier rainfall was highly correlated so that if there were a reduction in rainfall, the entire location in which claims were situated may have been affected. As a result, there would be little gained from the mobility advantages of sheep grazing and deployable

70. *Id.*

71. This total was made up of six pairs from NSW and seven from Victoria. The pairings are listed in Appendix 1.

72. *An Act for Regulating the Occupation of Crown Lands 1861*, 25 Vict. No. 2., para 14.

73. Original estimates were recorded in acres. Here, these estimates have been converted to km^2 to make the distance between stations and claim size comparable.

74. These distances are $64\text{--}138\text{km}^2$ for NSW and $64\text{--}97\text{km}^2$ for Victoria.

75. Average annual rainfall totals in Australia predominantly run North-South so that stations within the same North-South belt would have a greater probability of higher correlation coefficients than those located East-West. See, e.g., *YEAR BOOK AUSTRALIA* (Sheridan Roberts, ed., Australian Bureau of Statistics 2012), available at <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1301.0~2012~Main%20Features~Australia's%20climate~143>.

76. J. R. Anderson, *Rainfall Correlations in the Pastoral Zone of Eastern Australia*, 18 *AUS. MET. MAG.* 94, 94 (1970).

assets would lose their explanatory power in the framework. However, pastoralists treated alternative locations on their holdings as substitutes rather than complements, so the fact that the correlations estimated are not one suggests there was a variation across holdings that allowed pastoralists to exploit the rainfall differences over geographically dispersed plots.

2. Asset Investment

Mobility counteracts scarcity brought about by aridity. Evidence from Australia's pastoral zone supports this claim so that "[t]he situation of some establishments in a chain enjoying favourable seasons whilst others are subject to poor or disastrous seasons . . . thus [provides] the scope for stock movements between establishments . . ." ⁷⁷ In addition, mobility became the mechanism of drought risk management for squatters where they not only fanned sheep over large areas but also routinely shifted the location of stocks to less affected areas. ⁷⁸ Individual constraints on mobility, such as boundary fences, were few. ⁷⁹

Moreover, two critical rules for temporary occupation of a third-party's traveling stock on graziers' private claims evolved in the Australian colonies. First, drovers were required to give an owner 12 hours notice of entry to their property and the flock of sheep had to enter within 48 hours. Second, graziers were expected to let travelling sheep drink at one waterhole provided the stock had walked the minimum distance of six miles in the preceding 24 hours. ⁸⁰ As a result, the response to drought during the period of grazier occupation was "intermittent transhumant pastoralism." ⁸¹ During widespread drought, reducing sheep numbers via slaughtering could combat supply constraints—further reducing the costs of scarcity brought about by aridity.

Furthermore, riparian rights provided an advantage over prior appropriation for wool production because interpretation as to what was a reasonable use was fluid across time and space. When lack of rainfall reduced supply, courts could redefine reasonableness in order to limit

77. *Id.* at 94–95 (defining the pastoral zone as areas that receive less than 20 inches of rain on average and where the most important industry of the zone is wool production).

78. COLIN WHITE, *MASTERING RISK: ENVIRONMENT, MARKETS, AND POLITICS IN AUSTRALIAN ECONOMIC HISTORY* 71 (1992).

79. *See, e.g.,* Butlin, *supra* note 58, at 72; *see also* John Pickard, *The Transition from Shepherding to Fencing in Colonial Australia*, 18 *RURAL HIST.* 143, 155 (2007).

80. R. W. M. Johnson, *Squatters, Drovers, and Property Rights*, 62 *REV. MKTG. AGRIC. ECON.* 423, 424 (1994).

81. White, *supra* note 78, at 71 (quoting G.W. Raby, *Aspects of the Impact and Response to Drought in New South Wales 1821–1849* (1980) (unpublished Masters thesis, La Trobe University)).

the concentration of losses on one individual. In the absence of a water market in which users have identical profit functions, riparian rights have an allocative efficiency not attained by appropriative rights.⁸² In cases where heterogeneous profit functions exist, such as in mining, appropriative rights retain their allocative efficiency.

As has been established, Australia is arid and nineteenth century pastoralists faced a non-binding mobility constraint. Now, consider asset investment on the goldfields in NSW and Victoria. Water was a critical input for mining and was primarily used to wash gold bearing gravel. Water use often took place at a distance from the water source. In order to convey the resource to the primary mine site, various ditches and channels were constructed. In Australia, these were referred to as 'races'.⁸³ Investment in diversion infrastructure was a non-deployable asset so the mobility constraint was binding. Specifically, the mobility constraint was close or equal to one. As a result, it is expected that private rights would be used to allocate water on the goldfields—and this did occur.

In this context, appropriative rights had two advantages over riparian rights: diversion capacity was constructed based on the amount of water claimed, so seniority guaranteed a return on investment costs and, in the presence of non-deployable assets, forfeiture for non-use made prior appropriation superior to riparian rights when applied to mining. Several commentators identify the importance of these characteristics of prior appropriation.⁸⁴ For example, Blackstone stressed that monopoly rights under prior appropriation should be protected in the presence of "sunk costs and public goods to be protected."⁸⁵ Prior appropriation gives users rights to an exclusive volume of water, reducing competition for that volume that creates monopoly rents. The doctrine can be interpreted as a rule to ensure an adequate share of the resource to each appropriator in order to create a return on sunk investment costs.⁸⁶

82. H. Stewart Burness & James P. Quirk, *Appropriative Water Rights and the Efficient Allocation of Resources*, 69 AM. ECON. REV. 25, 26 (1979); H. Stewart Burness & James P. Quirk, *Water Law, Water Transfers and Economic Efficiency: The Colorado River*, 23. J.L. & ECON. 111, 121 (1980).

83. Smyth, *supra* note 11, at 83.

84. See generally Getzler, *supra* note 15, at 193–267; see also Frank J. Trelease, *Policies for Water Law: Property Rights, Economic Forces, and Public Regulation*, 5 NAT. RESOURCES J. 1, 27 (1965); A. Dan Tarlock, *Prior Appropriation: Rule, Principle or Rhetoric?* 76 N.D. L. REV. 881, 884, 890 (2000).

85. Getzler, *supra* note 15, at 171.

86. See *id.* at 162.

Secure water rights aid the attainment of maximum benefits for the community by encouraging investment.⁸⁷ Investment will ordinarily be made only if the investor can evaluate the risk of losing capital. Uncertainty with regard to entitlement brought about by a flexible use rule, like reasonable use, may therefore lower investment in fixed assets. Lost permanent investment in facilities that cannot be transferred to other uses can be avoided by giving water rights for a sufficient length of time to permit the investor to recapture the value of the investment through amortization. In addition, the expectation of the realization of opportunities is the entrepreneur's most valuable asset.⁸⁸ The core idea of prior appropriation is protection of investment-backed expectations from the risks of variable water supply years.⁸⁹

One limitation of private rights established under prior appropriation was that seniority created efficiency losses if junior appropriators, forced to reduce or cease water use during a shortage, were more productive at the margin. However, junior appropriators, by definition, claim water at a later date. Assuming they can acquire information as to how much water at a particular source is unclaimed at the time of entrance, they would construct diversion capacity based on this information. The carrying capacity, and, therefore, the size of their diversions would be equal to the amount of water available given other appropriators claims. The effects would be to mitigate the risk faced during shortage because of incentives for later entrants to limit diversion size, and, therefore, capital investment. This would reduce losses brought about by idle capacity in times of shortage. The ability to trade rights under prior appropriation would further act to reduce losses borne by junior appropriators due to insufficient supply. Theoretically, in the presence of a market, junior appropriators who value water more highly than senior appropriators will bargain around the priority allocation system. Junior appropriators would value water more highly if they had information that their mines had higher marginal productivity, in terms of payable gold, than senior appropriators.

Compare the application of riparian rights to non-deployable assets with the application of riparian rights to deployable assets. Recall, slaughtering is a complement to the non-binding mobility constraint when deployable assets dominate. Therefore, where input supplies are limited by drought, livestock numbers can be adjusted downward to combat this shortage. Further, slaughtering provides an alternative source of income for pastoralists because the meat, tallow, and hides of

87. Trelease, *supra* note 84, at 25.

88. *Id.* at 26.

89. Tarlock, *supra* note 84, at 884.

sheep provide them with a revenue stream in addition to wool.⁹⁰ In this way, productive capacity is adjusted in line with resource availability, so the extent of idle capacity and foregone production is decreased. In turn, this complements the prohibition on trading that exists under the riparian doctrine.

Prior appropriation was superior to riparian rights when applied to mining because of forfeiture for non-use. Gold mining was subject to ex ante information asymmetries where productivity of claims was unknown prior to investment of mining effort. In this way, before any effort was expended, the marginal benefit of water was equal across claims, and uniform returns from water use prevailed. It was only once effort was expended that the relative value of any one site compared with another was known. At this point the marginal benefit of water would diverge, so that miners at sites with greater quantities of payable gold would place a higher value on water. Forfeiture ensured maximum expenditure of effort, including full utilization of inputs to maximize returns across the sector until productivity information could be acquired. If individuals were permitted to claim but not utilize water, this would limit the quantity available for other miners thereby reducing aggregate output and wealth.

In the case of the pastoral sector where productivity information was known ex ante because output per animal was close to uniform, the marginal benefit of water remained equal across all users.⁹¹ In this way, equal sharing rules adopted under riparian rights and the reasonable use test allowed individuals to maximize profits given water availability, thereby maximizing returns across the sector. Moreover, because the pastoral sector was subject to seasonal location changes, the loss of water rights due to non-use would have undermined expansion because of uncertainty regarding rights to this input. The very nature of grazing circumvented any need for the definition of water rights based on quantity because animal numbers could be reduced in the face of limited supplies and substitutes existed. Animals could obtain moisture from feed, so if water supply was limited, but grass was not, part of the moisture requirements of flocks could be obtained by increasing grass consumption.

90. Fluctuations in wool prices also provide an incentive for slaughtering to capture this alternative revenue stream. For example, pastoralists in NSW and Victoria undertook extensive slaughtering for meat and tallow when wool prices dropped dramatically during the depression of the early 1840s. K. L. Fry, *Boiling down in the 1840s: A Grimy Means to a Solvent End*, 25 LABOR HIST. (Nov. 1973).

91. Output may have been uniform but prices varied based on the quality of wool from each flock. At shearing, wool classers would grade each individual sheep output as a certain level of quality, the wool would then be sold at auction under this quality grade. The higher the grade of wool, the higher the price received.

Gold mining lacked substitutes for water so the absence of a forfeiture rule would reduce output across the sector as new entrants would be unable to secure supplies to work their mines. Forfeiture ensured optimal investment of effort by all miners, maximizing returns across the sector. In the absence of such a rule not only would investment in effort fall, thereby reducing overall productivity, but inefficiencies would be created through potential monopoly pricing. First possession will be chosen over other allocation methods when important resources are yet to be discovered.⁹² The evolution of prior appropriation on the gold fields in the U.S. and Australia but not in Australian sheep grazing conforms to this predication.

In addition to these economic incentives for forfeiture for non-use, social norms, particularly perceptions of fairness, may also have contributed to prior appropriation's adoption on the gold fields.⁹³ Justice Field, a pre-eminent California and U.S. Supreme Court judge, noted, "[customs] were so framed as to secure all comers, within practicable limits, absolute equality of right and privilege in working the mines."⁹⁴ Forfeiture circumvented the potential for miners to claim quantities they could not utilize within a certain time period, ensuring equal opportunities for all entrants to access a key input. This does not suggest that equal sharing was the rule under the U.S. appropriation doctrine; it is simply illustrating that if an individual claimed more water than could be productively employed within a certain time frame, forfeiture would make the surplus supplies available for another claimant who could put the water to productive use. Individuals may well have claimed different volumes of water, but these volumes had to be fully utilized. The beneficial use criteria that developed over time in the U.S. created a second method by which to prevent claimants from under-utilizing a scarce resource. In Australia, equality of opportunity in access to water was incorporated into legislation that restricted volumes claimed under appropriation. For instance, Victorian regulations limited water right claims to three box sluice-heads.⁹⁵ Volume restrictions were used in addi-

92. Dean Lueck, *The Rule of First Possession and Design of Law*, 38 J.L. & ECON. 393, 410 (1995).

93. Schorr, *supra* note 9, at 69.

94. *Jennison v. Kirk*, 98 US 453, 457 (1878); McCurdy, *supra* note 2, at 239, 266 (describing Justice Field's election to the California Supreme Court in 1857, his role as Chief Justice of that court from 1859 to 1863 and his commission to the United States Supreme Court in 1863).

95. A sluice-head was a box fixed at the head of a water race (channel) to gauge or measure the quantity of water diverting from a river or stream. Miners were permitted to divert the number of sluice-heads provided under regulation or gold mining district by-laws. See Smyth, *supra* note 11, 622).

tion to forfeiture rules.⁹⁶ This supports the view that equality of right existed under some forms of appropriation—particularly those adopted in Colorado.⁹⁷ Moreover, volume restrictions and forfeiture rules reduced the racing incentive that existed under prior appropriation.⁹⁸ As a result, productivity was more likely to be maximized across the gold mining sector.

3. *The Affect of Legislation on Asset Investment*

Changes in land allocation policies in both NSW and Victoria initiated a sequence of events that would alter the nature of water rights for pastoralists over a period of approximately twenty years. The reallocation of land away from pastoralists toward more permanent forms of agriculture led asset investment to shift from deployable (sheep) to non-deployable (crops). In light of this change, the framework would predict that this alteration would be accompanied by a shift toward appropriate water rights. This is what occurred in Australia between 1860 and 1885.

By the end of the 1860s, the supply of alluvial gold in both NSW and Victoria fell given the technology and capital input required for smaller miners to locate sub-surface supplies. As a result, unemployment increased because of the lack of employment opportunities in the under-developed industrial sectors. Miners then began to demand changes to land legislation to allow them access to agricultural land monopolized by pastoralists.⁹⁹ Land reform legislation was passed in both colonies in the early 1860s, allowing individuals to select land up to a maximum of 320 acres anywhere in the colony. Generally, land reform was considered a failure in both NSW and Victoria because pastoralists evaded redistribution by employing three tactics: dummyming, peacocking, and forcing an auction.

96. In Victoria, local Mining Courts which were constituted under *An Act to amend the Laws relating to the Gold Fields 1855*, 18 Vict. No. 37, determined the period of non-use required for forfeiture. Further, several districts' regulations did not require immediate forfeiture for non-use but instead instituted monetary penalties for miners not using their water rights. In these districts the uniform claim requirements may have reduced the necessity for absolute forfeiture. This would be more likely in districts with smaller mining populations where competition for water was not as great as at larger fields. See Smyth, *supra* note 11, 572–595).

97. Cf. Schorr, *supra* note 9, at 11–20 (discussing the role of equality in the development of the Colorado doctrine).

98. See Milliman, *supra* note 6, at 47–51; see also Burness & Quirk 1979, *supra* note 82, at 25–26.

99. Alston, Harris & Mueller, *supra* note 30, at 754 (describing how the extension of franchise in the mid-1850s meant miners' demands for land policy reform led to a more rapid political response).

"Dummying," involved pastoralists contracting with agents, often employees, to select part of their property, register the claim with the Department of Lands (often under false names), and then sell it back to the pastoralist for a small fee. Legislation made this possible because, up until 1880, a farmer could transfer their claim after only one year of residence. Pastoralists' wealth advantage over smaller farmers permitted them to undertake this practice on a large scale, increasing the likelihood that they retained large portions of their original holdings. Data pertaining to the number of selections transferred in NSW from 1862 to 1882 shows close to 60 percent of original claimants sold their land.¹⁰⁰ In itself, this does not suggest that all these transfers were from dummies to pastoralists; some transfers could have been the result of arid conditions that caused agriculture to fail. Moreover, the blocks of land allocated under reform legislation were far too small for these settlers to graze sheep, suggesting the arid climate may have led to farmlands being transferred.

"Peacocking" was another method by which pastoralists avoided redistribution of their estates. Peacocking was a practice used primarily by dummy farmers who would pick the vantage points out of a pastoralist's property so as to render the intervening land useless.¹⁰¹ The information advantage held by pastoralists and their employees as to land quality assisted them in this practice.

Forcing an auction was the final means by which pastoralists could avoid redistribution of their holdings. In this case, wool producers would either select the same area as a *bona fide* farmer or would employ agents to select multiple parcels and then forfeit the claims.¹⁰² Between 1862 and 1882 in NSW, on average, 12 percent of land selected by farm-

100. For anecdotal evidence on the extent of dummying, *see generally* SELECT COMMITTEE ON THE ADMINISTRATION OF LAND LAWS, MINUTES OF EVIDENCE, 2ND PROGRESS REPORT, LEGISLATIVE ASSEMBLY, VOTES AND PROCEEDINGS, 1872/3 (N.S.W.); SELECT COMMITTEE ON THE ADMINISTRATION OF LAND LAWS, MINUTES OF EVIDENCE, 3RD PROGRESS REPORT, LEGISLATIVE ASSEMBLY, VOTES AND PROCEEDINGS, 1873/4 (N.S.W.); BOARD OF INQUIRY INTO PROCEEDINGS IN RELATION TO CERTAIN LAND SELECTION IN THE WIMMERA DISTRICT, LEGISLATIVE ASSEMBLY, VOTES AND PROCEEDINGS, 1873 (Vict.); CROWN LAND DEPARTMENT BOARD OF INQUIRY, LEGISLATIVE ASSEMBLY, VOTES AND PROCEEDINGS, 1874 (Vict.).

101. STEPHEN H. ROBERTS, HISTORY OF AUSTRALIAN LAND SETTLEMENT 1788-1920, 240 (1968).

102. The inaccuracy of many district maps created information asymmetries with regard to what land had been the subject of a previous claim under either selection or pastoral pre-emption and lease rights leading to multiple claimants. In cases where two different parties claimed the same parcel of land, legislation required the plot to be auctioned. Pastoralists were far wealthier than competing selectors and therefore, could easily outbid other claimants at auction. *See* Alston, Harris & Mueller, *supra* note 38, at 24-27. (explaining how the inaccuracy of many district maps created information asymmetries).

ers was forfeited.¹⁰³ However, this may have included farmers who forfeited their holdings because climatic and economic conditions were not suited to permanent agriculture.

Forfeiture was also less prominent than dummyming. Nevertheless, forfeiture allowed pastoralists to evade redistribution to some extent because, at auction, capital-constrained farmers were unable to outbid pastoralists.¹⁰⁴ All three evasion methods resulted in limited reallocation of land under the 1860s reform legislation. For instance, by the middle of the 1880s on average, only 27 percent of farmers remained on the land.¹⁰⁵ Thus, land reform had resulted in “[u]nintelligible chaos, in which the rights and interest of all mainly concerned have been the sport of accident, political interest, and departmental disorder.”¹⁰⁶

In NSW land reform failure was far more pronounced than in Victoria, in part because the former had a relatively smaller mining population than the latter.¹⁰⁷ In turn, the continued dominance of the pastoral industry with its non-binding mobility constraint led to a persistence of riparian water rights in that sector. Figure 1 (below) illustrates the importance of pastoral sector contribution to NSW GDP from the mid-1860s to 1910. The figure shows that even after land reform the pastoral sector continued to outstrip agriculture in terms of GDP contribution, and during this period riparian rights remained dominant. As the agricultural sectors contribution to GDP began to increase, post-1902 irrigation became a more prominent farming method.¹⁰⁸

In turn, there was a growth in non-deployable asset investment. The new framework proposed in this article predicts that once irrigation expands, water rights will evolve toward private rights. Outcomes in NSW conform to this prediction with the Irrigation Act abolishing riparian rights in 1912. This legislation replaced riparian rights with state ownership. In turn, state agencies allocated water use rights to individuals with a guarantee that these rights would be available in most “ordinary” rainfall years. As a result, in line with the predictive framework,

103. AUGUSTUS MORRIS & GEORGE RANKEN, REPORT OF THE INQUIRY INTO THE STATE OF PUBLIC LANDS AND THE OPERATION OF THE LAND LAWS (1883).

104. See generally Alston, Harris & Mueller, *supra* note 38, at 27 (providing a more detailed discussion on evasion methods used by pastoralists to avoid redistribution).

105. MORRIS & RANKEN, *supra* note 103, at 15.

106. *Id.*

107. Cf. J. C. Caldwell, *Population*, in AUSTRALIANS HISTORICAL STATISTICS 26, 27 (Wray Vamplew ed., 1987) (colonial population data).

108. In part, this was the result of the 1902 drought that caused widespread crop losses across the state and Figure 2 reflects these losses showing a consistent fall of the agricultural sector’s contribution to GDP post 1902 which only began to recover in 1906/07.

once non-deployable asset investment increased, water rights evolved toward private rights.¹⁰⁹

Due to the relative increase in farming population under 1860s land reform, Victoria experienced a growth in irrigation earlier than NSW. This was accompanied by a move from riparian to appropriative rights three decades before NSW. Private investment and experimentation in irrigation expanded from the late 1870s onward. Figure 2 (below) shows the increasing value of the agricultural sector compared with pastoral sector from the late 1870s onward, when growth in the former was underpinned by an expansion in irrigation. As has been established, irrigation requires investment in non-deployable assets so that the development of this farming method creates a binding mobility constraint. Paralleling this, the framework in section three predicts there should be a move toward private water rights; this did occur in Victoria.¹¹⁰ Riparian rights in that colony were abolished in 1882 under the Water Conservation Act. Moreover, like NSW, albeit at an earlier juncture, government ministries became responsible for allocating water to individual users. In other words, as predicted, water rights evolved toward private rights once investment in non-deployable assets created a binding mobility constraint. The next section illustrates the outcomes of water rights evolution in the U.S. As will be demonstrated, the empirical outcomes conform to the predictive framework in section three, where aridity combined with non-deployable assets led to private rights being adopted (California and Colorado).

109. The other major sectors of the colonial economy of both NSW and Victoria were manufacturing and construction. Manufacturing was concentrated on ports in urban areas and focused on the processing of raw materials as well as making building materials. Water use in these industries was regulated under legislation that only applied to urban areas and was similar to the New South Wales *Water Act 1912* and *An Act to provide for the conservation and distribution of water throughout Victoria 1881*, 45 Vict. No. 716. Riparian rights were abolished, and state authorities allocated water to users: the Metropolitan Water Supply and Sewerage Board in Sydney, NSW, and the Melbourne Metropolitan Board of Works in Melbourne, Victoria. The historical evolution of water rights in these two colonies shows a clear demarcation of urban and rural supply with water rights in urban areas moving to private rights more quickly than in rural areas. In part, this was because of the need to provide domestic supplies and sanitation in the rapidly growing cities. Further, this evolution conforms to the predictive framework because binding mobility constraints in manufacturing and domestic supply led to private water rights being adopted.

110. Edwyna Harris, *Colonialism and Long-run Growth in Australia: An Examination of Institutional Change in Victoria's Water Sector During the Nineteenth Century*, 48 *AUSTL. ECON. HIST. REV.* 266, 275 (2008).

B. Climate and Asset Investment Framework Applied in California and Colorado

As noted, there are two distinct regimes applied across the arid western states of the U.S.: the hybrid system known as the California doctrine; and 'pure' prior appropriation, known as the Colorado doctrine. For simplification, the analysis presented will focus on the two states where these doctrines originated: California and Colorado. However, where appropriate, examples from other states that adopted these doctrines will be used to highlight the durability of the framework's predictive capacity.

Before applying the predictive framework, the type of climate and asset investment undertaken needs to be established. All states that adopted either of these approaches lie west of the 100th parallel and are arid, receiving between eight and 12 inches of rainfall per annum.¹¹¹ During the nineteenth century, several sectors utilized water: gold mining, irrigation, and cattle grazing. Since climate in both regions is arid, the framework proposed in this article predicts appropriative rights will evolve in the gold mining and irrigation sectors while riparian rights will be applied in cattle grazing. Empirical evidence from both cases supports these predicted outcomes.

1. *The California Doctrine in California*

The California doctrine meant irrigators and cattle graziers in California could assert water rights based on either appropriation or riparian rights.¹¹² Given that California is arid and the dominant forms of water use in mining and irrigation were accompanied by non-deployable asset investment, the proposed framework predicts the adoption of appropriative rights. During the 1880s, as irrigated agriculture expanded, the presence of aridity combined with non-deployable asset investment should have accelerated a move away from riparian rights to appropriative rights. For the predicted shift to prior appropriation legislation, the Civil Code or an independent act of parliament could have effected the change. This did not occur. Although the framework proposed in this article predicts a complete shift to prior appropriation, a breakdown of the history of water rights in California shows an evolution towards more private prior appropriation rights. This validates the framework proposed in this article.

111. Cf. Libecap, *supra* note 2, at 283.

112. See generally *Duckworth v. Watsonville Water and Light Co.*, 150 Cal. 520, 89 P. 338 (1907) (holding that while appropriators could claim a right to waters not otherwise claimed by another party's riparian right, they could not supersede them).

California courts did apply prior appropriation rules that overcame potential rigidities imposed by riparian rights. In this case, it was used to determine conflicts between riparian users. Specifically, it allocated rights to the flow of services from the asset (water) to a defined group of users—those that owned or occupied riparian lands. In turn, the appropriation test created individual rights to the amount initially utilized. Subsequent uses were conditional on the availability of these volumes without interference. As a result, individual group members that had access to the resource stock did not have equal right to the flow of services from the assets.

This can be compared with the reasonable use test that made individual use conditional on the equal rights held by other users. Each right holder had an obligation not to interfere with other group members' rights to utilize water. In turn, a later arrival could prevent extant users from continuing certain activities if they negatively affected his ability to make use of the water, either by reducing quality or quantity.¹¹³ The result was that individuals had equal right to the flow of services from the asset. Reasonable use therefore created a greater degree of commonality between users than did the appropriative test. Importantly, the test courts applied to determine water conflicts defined the degree to which individual rights to the resource were private compared with correlative (held in common). At the aggregate level, property rights may reflect common property characteristics. However, at the individual level, rights may resemble private rights. If the appropriation test is applied to all users, not just a small group—for example, those with riparian rights—then this will create rights that are akin to private rights rather than correlative. Evidence from the California Supreme Court shows it consistently applied the appropriation test in water disputes.

Prior to the late 1870s few water disputes came before the court, but in those that did the courts generally supported the first in time, regardless of whether the first in time asserted claims based on riparian or appropriative rights.¹¹⁴ However, by 1886, in the famous *Lux v. Haggin*,¹¹⁵ the court upheld riparian rights. This signaled an intention to up-

113. At common law this was subject to previous users not having redress to claim prescriptive rights. Prescription allowed individuals to assert uninterrupted occupation and use of a resource for 20 years implied a title had been granted, but had subsequently been lost. For example, if A had continuously diverted 50 per cent of a stream flow for 20 years and B took no action against this use, under common law A would have prescriptive rights to continue her use even if at some later date B objected.

114. See generally Freyfogle, *supra* note 6, at 501–504.

115. *Lux v. Haggin*, 69 Cal. 255, 4 P. 919 (1886).

hold the doctrine in spite of California's arid climate.¹¹⁶ Previous studies have ignored one important aspect of this case—Lux's water use predated Haggin's. The outcome, therefore, is more consistent with the court's previous approach. Moreover, at no point did the court rule Haggin was not to use the water source in question. The court simply found that if he interfered with the extant users prior rights, he would infringe on their legal rights to a defined volume. This was the very basis of the appropriation test.

Subsequent California Supreme Court rulings from 1890 to 1910 continued to apply the appropriation test regardless of whether a plaintiff asserted rights under the riparian doctrine or prior appropriation. During this period, 24 water disputes came before the court. Of these, the court adhered to the appropriation test in 20 (refer to Appendix 2 for a list of cases). In all 20, while either the plaintiffs or defendants may have owned or occupied land by which they acquired riparian rights, the court found for the prior user. For example, in *Wutchum Water Co. v. Pogue* the court stated: "as to the plaintiff's title to the water, it is indisputable that [his diversion ditch] was constructed . . . prior to the time that Pogue acquired any of his rights either as an owner of riparian lands or an appropriator."¹¹⁷ In *Huffner v. Sawday* the court found: "the plaintiffs, whether as riparian proprietors or as prior appropriators of all the waters ordinarily flowing in the stream, had a right superior to that of the defendants . . ."¹¹⁸

Furthermore, the court adopted another aspect of the appropriation test: limiting a riparian's rights to the volume that could be beneficially utilised.¹¹⁹ The court also acted to limit application of the riparian doctrine via two methods. It permitted diversions of water not being utilized by riparians¹²⁰ while also narrowing the circumstances by which

116. See generally M. Catherine Miller, *Riparian Rights and the Control of Water in California, 1879–1928: The Relationship Between an Agricultural Enterprise and Legal Change*, 58 AGRIC. HIST. 1 (1985); See generally Freyfogle, *supra* note 6; See generally Kanazawa, *supra* note 2; See generally Pisani, *supra* note 2. In this case, Lux was attempting to secure an injunction by asserting riparian rights to prevent Haggin from diverting water for irrigation that had significant impacts on flow, particularly during drought years. Lux was a grazing company known as Miller and Lux. Catherine Miller notes the Miller-Lux Company formed a riparian rights association with a group of cattlemen in order to prevent 'threatened interference' from upstream canal companies. The association's immediate goal was to stop Haggin from diverting water that the cattlemen felt had exacerbated the effects of the severe 1877 drought on their lands.

117. *Wutchum Water Co. v. Pogue*, 151 Cal. 105, 111, 90 P. 362, 363 (1907).

118. *Huffner v. Sawday*, 153 Cal. 86, 94, 94 P. 424, 427 (1908).

119. *Senior v. Anderson*, 130 Cal. 290, 296–97, 62 P. 563, 566 (1900).

120. *Modoc Land and Livestock Co. v Booth*, 102 Cal. 151, 156–57, 36 P. 431, 432–33 (1894); *Fifield v Spring Val. Waterworks*, 130 Cal. 552, 554–55, 62 P. 1054, 1055 (1900).

individuals could obtain riparian rights. In *San Joaquin v. Fresno Flume*, the court reaffirmed its opinion that: "It seems clear that in no case should a riparian owner be permitted to demand, as of right, the intervention of a court of equity to restrain all persons who are not riparian owners from diverting any water from the stream at points above him . . ."¹²¹ Narrowing the conditions by which individuals could claim riparian rights was attained, in part, by preventing acquisition of rights on once contiguous blocks for which the government had issued separate titles.¹²² Combined, these circumstances show the Californian common law tended to evolve toward private water rights, conforming to the expected evolutionary pattern outlined in section three.

This shift occurred as irrigation and corollary investment in non-deployable assets expanded, while deployable asset investment fell. Using oat production as a proxy for irrigation expansion, Figure 3 shows growth in acres harvested of oats from the 1890s, while the number of cattle in the state was falling.¹²³ Combined with the evidence from the state Supreme Court, the progression of water rights conforms to the predictions outlined in section three: that in the presence of aridity and non-deployable asset investment, private rights will evolve.

C. Climate and Asset Investment in Colorado

In Colorado, water rights evolved to create exclusive reliance on prior appropriation. Like California, water used in Colorado from the mid to late-1800s was for mining, irrigation, and livestock. Mining codes from the late 1850s supported prior appropriation.¹²⁴ Early irrigators also applied this doctrine. Consequently, in 1860, the first legislature enshrined appropriation rules in irrigation laws.¹²⁵ In 1876, the Colorado constitution exclusively incorporated appropriation as the rule for water allocation in the state, with no mention of riparian rights. Subsequently, the Colorado Supreme Court applied prior appropriation in the key case

121. *San Joaquin & Kings River Canal & I. Co. v. Fresno F. & I. Co.*, 158 Cal. 626, 629, 112 P. 182, 183-84 (1910).

122. *Boehmer v. Big Rock Creek Irr. Dist.*, 117 Cal. 19, 26-27, 48 P. 908, 910 (1897).

123. See *infra* Figure 3. Although oats are not a perfect proxy given many early irrigators produced alfalfa, statistics for which are not available, it does serve to illustrate the main point.

124. Gold was discovered in Colorado in May 1859. By June of that year there were 5,000 people at the Gregory diggings (named after the first discoverer), northwest of Denver. Schorr, *supra* note 9, at 12. Given the migration of many "forty-niners" from California to Colorado, application of prior appropriation in the latter state's mining districts is not surprising. See Dunbar, *supra* note 2, at 120-21.

125. Cf. Dunbar, *supra* note 2, at 121.

of *Coffin v. Left Hand Ditch Company*.¹²⁶ The case involved conflict between two groups of irrigators. Justice Helm rejected out of hand the plaintiff's assertion that their riparian rights had been infringed upon by upstream irrigators and declared the riparian doctrine had never existed in Colorado.¹²⁷ The framework proposed in this article predicts that in arid states where water use requires investment in non-deployable assets (mining and irrigation), private rights will evolve.

However, prior appropriation was also applied to the cattle industry in Colorado, which gained prominence from the late 1870s. Once this industry is incorporated into the analysis, the framework appears to lose its predictive power. Because cattle are deployable and Colorado is arid, it is expected that riparian rights would be utilized in this sector; but this did not occur. This apparent deviation from the expected outcome can be explained by taking into account one important characteristic of the Colorado cattle industry during the 1870s and 1880s: the industry faced a binding mobility constraint.

The formation of Cattleman's Associations in response to market demands strictly limited the mobility of livestock. During the nineteenth century, most land in Colorado remained in the hands of the Federal government and was therefore public land.¹²⁸ Cattle graziers occupied vast tracts of this land underpinned by first possession principles. In the early years of this occupation, limited competition meant graziers had to invest little in definition and enforcement of their land and water rights. However, as cattle prices increased and railroad infrastructure was extended, bringing frontier land closer to markets, competition rose. As scarcity increased, so too did the returns from investment in definition and enforcement of property rights. In turn, because of the absence of low cost fencing technology, such as barbed wire, graziers established commons arrangements via Cattlemen's Associations. Cattlemen's Associations protected members' rights to use land and water available on the common range, preventing encroachment and over-grazing that would have resulted if open access conditions had been retained.¹²⁹ Once

126. *Coffin v. Left Hand Ditch Co.*, 6 Colo. 443, 446-47 (1882).

127. *Id.* at 446.

128. A proportion of public land had been transferred to private ownership. See Homestead Act, ch. 75, 12 Stat. 392 (1862); see also Timber Culture Act, ch. 277, 17 Stat. 605 (1873); Desert Land Act, ch. 107, 19 Stat. 377 (1877); Timber and Stone Act, ch. 151, 20 Stat. 89 (1878).

129. Aside from the economic incentive for cattlemen to avoid overuse of the commons, two other factors encouraged cooperation by associations: the need to enforce individual ownership of cattle and the need for a roundup. Ownership to individual cattle was achieved via the use of brands registered with associations, and later under state law. Roundup activities faced economies of scale problems, increasing incentives for collective

a range was considered fully stocked, the association would advertise that it was closed. After closure was advertised, it was impossible for new entrants to use the range or participate in the bi-annual roundup, unless they bought range rights from an existing association member. Range rights were acquired by buying cattle on their usual range. With cattle came good will and the privilege of using the range for grazing.¹³⁰

Range closure imposed both land and water constraints on association members. The constraints on water inputs transformed cattle into non-deployable assets, creating a binding mobility constraint. Because a majority of ranges were subject to claims by different associations, cattle owners were unable to move their livestock to water located outside the boundaries of their associations' range. On each range, water sources were limited to the rivers or streams that flowed through the common pasture. If individual graziers could move their herds, each association had the same incentive to prevent new comers by advertising range closure. As a result, there would have been very few, if any, opportunities to make use of cattle mobility.

One way cattlemen may have overcome this constraint was to hold rights on several ranges simultaneously. Evidence of branding registration suggests this may have been done.¹³¹ Nevertheless, it may not have been a frequent practice given the cost of acquiring range rights, which has been estimated, exclusive of cattle and land, at approximately \$200,000 (USD).¹³² Further, in order to move cattle and utilize multiple range rights to counter water shortages, an owner would have to roundup their cattle that were intermingled with others on one range in order to move them to another location.

Roundups did not enhance mobility as one would think. There were two main drawbacks for individual roundups. The activity was labor intensive, making it costly for an individual compared with a group so that there were economies of scale in having one roundup rather than

action to establish rules and administration of the bi-annual activity. Only members of each Cattlemen's Association could participate in the roundup on a given range. This created another method by which exclusion from the range could be accomplished. These economic incentives for cooperation and creation of informal rules of use in the absence of formal law led to Cattlemen's Associations being the main form of organization for graziers in many Western states during the nineteenth century. See generally Osgood, *supra* note 43; Dennen, *supra* note 43, at 424; Terry L. Anderson & Peter J. Hill, *Cowboys and Contracts*, 31 J. L. Studies S489, S500 (2002); TERRY L. ANDERSON & PETER J. HILL, *THE NOT SO WILD, WILD WEST: PROPERTY RIGHTS ON THE FRONTIER* (2004).

130. See generally Valerie Weeks Scott, *The Range Cattle Industry: Its Effects on Western Land Law*, 28 MONT. L. R. 155, 182 (1967).

131. Cf. Osgood, *supra* note 43, at 135-39.

132. Dennen, *supra* note 43, at 434.

several. In addition, a roundup was stressful on cattle.¹³³ Individual roundups also had costs for the collective because they created the potential for stealing, and this increased monitoring costs. As a result, the incentives facing individuals and associations would have discouraged movement from range to range even in the face of water shortages. In turn, cattle in Colorado were transformed from deployable to non-deployable assets because of the Cattleman's Associations.

This was a different outcome compared to the Australian pastoral sector.¹³⁴ Australia adopted riparian rights, the opposite of the Colorado doctrine, even though the climate was similar; this had to do with the fact that the assets in Australia were deployable, unlike the Colorado cattle, which were limited by the Cattleman's Associations. Two factors reduced the Australian need for associations of the type used in Colorado's cattle grazing sector so that sheep retained full mobility. First, private occupancy rights to land occupied by pastoralists were granted via a license system established in the 1830s. Second, sheep did not have to be cooperatively rounded up because on the open range shepherds controlled them.¹³⁵

Under the license system, pastoralists could occupy as much land as they wanted for £10 per annum. They scattered land claims over a wide geographical area to combat water supply extremes and seasonal patterns of feed availability. Private land rights reduced the likelihood that flocks would intermingle, thereby reducing the costs of enforcing ownership to stock; legislation also required registration of sheep brands. Consequently, licenses were an effective defense of individual rights against all parties but the Crown.¹³⁶ Further, norms evolved to restrict the number of sheep to 520 per shepherd to maximize returns from

133. Alston, Harris & Mueller, *supra* note 38, at 30.

134. On and around gold fields certain locations were designated for local residents to graze sheep, horses, and cattle. These pastures were subject to commons rules devised by local committees and approved by the Governor in Council. The rules established had all the features of common property including: limits on who could utilize the commons; restrictions on the number of animals an individual was permitted to graze; charges for using the commons; the use of registered brands to identify animals permitted to graze (and therefore, any trespassing animals); and appointment of herders to protect stock. See generally J. J. Casey, *Regulations for a Common*, VICTORIA GOVERNMENT GAZETTE, August 28, 1874, at 1592 (example of regulations establishing the aforementioned arrangement); see also J. F. Levien, *Regulations for a Common*, VICTORIA GOVERNMENT GAZETTE, August 28, 1885, at 2484. Outside these areas occupational licenses conferred private rights to land.

135. Anderson & Hill, *supra* note 129, at S505.

136. Shepherds prevented encroachment by other individuals or natural predators (for instance, native dogs) reducing costs of enforcing ownership.

their efforts.¹³⁷ Combined, the nature of the sheep grazing and land settlement policies acted to maximize the inherent benefits brought about by livestock mobility. As a result, in Australia sheep producers faced a non-binding mobility constraint, while in Colorado the need for cattlemen to cooperate created a binding constraint.

Prior appropriation remained in Colorado despite the decline of the mobility constrained cattle industry because irrigation grew at the same time. Figure 4 (below) illustrates the importance of the cattle grazing industry in Colorado from the mid-nineteenth century until about 1908/09. In order to make the figure comparable to Figure 3 (above), oat production has been included as a proxy for irrigation expansion. The dominance of the cattle industry serves to indicate why Colorado legislators adopted the "pure" appropriation doctrine early in the state's history. Moreover, with the growth of irrigation output after the first decade of the twentieth century, the continued application of prior appropriation conforms to the predicted outcomes in the framework proposed by this article.

In the absence of cattle grazing, adoption of the Colorado doctrine in states such as Arizona, New Mexico, and Utah was the result of non-deployable assets investments in irrigation and/or gold mining. In Arizona and New Mexico, for example, appropriation has its origin in Mexican irrigation custom (and Spanish law).¹³⁸ In Utah, early Mormon settlers diverted water for irrigation that recognized prior use as the basis for allocations.¹³⁹ The framework developed here predicts this outcome in the states that bypassed common rights entirely, since irrigation was dominated by non-deployable asset investment.

D. The Eastern U.S. and England

Eastern U.S. states and England refined the riparian doctrine by including prior appropriation principles of reasonable use in their water rights. This trend towards reasonable use does not alter the validity of

137. This norm was the result of three factors. First, areas in which sheep first grazed in NSW were scrubby, creating the potential for large losses due to the inability for one shepherd to manage a flock larger than 520. See EDWARD M. CURR, RECOLLECTIONS OF SQUATTING IN VICTORIA, THEN CALLED THE PORT PHILLIP DISTRICT (FROM 1841 TO 1851) 38 (1883). This norm was adopted in Victoria even though sheep grazed on flat pastures. Second, if flocks numbered over 520 it was believed that pastures over which flock travelled would be wasted and stronger sheep would consume the bulk of the grass. Alston, Harris & Mueller, *supra* note 38, at 12. Third early shepherds were convicts and they had little incentives to prevent sheep losses.

138. 3 WELLS A. HUTCHINS, WATER RIGHTS LAWS IN THE NINETEEN WESTERN STATES 163, 386 (1977).

139. *Id.* at 536-38

the framework in this article because riparian rights remained entrenched despite some minor tweaking. This section will explain the riparian theories in the eastern U.S. and England, and will also explain that riparian rights were modified not because of climate or asset development, but rather because the courts needed a more flexible approach to resolving disputes due to their heavy case load.

The eastern U.S. and England developed riparian rights because they were not arid, and water use was dominated by the textiles industry that relied on hydropower to drive cotton spindles. Mills are non-deployable assets. Mills included the construction of weirs, dams, river widening, sluices, bridges, and mill channels.¹⁴⁰ Furthermore, in both the eastern U.S. and England, as mills developed, water conflicts were intra-group—specifically between mill owners. As a result, the framework proposed in this article would predict that because these areas were not arid with investment in non-deployable assets, riparian rights would evolve—and this did occur despite some differences in interpretation as explained below.

Courts in the eastern U.S. and England applied the reasonable use test to determine intra-group riparian conflicts that established the degree to which individual rights to the resource were common compared with private. Reasonable use established equal sharing rules between riparian owners thereby creating a greater degree of commonality between riparians than alternative tests, such as the appropriation test. Once courts in England and eastern U.S. jurisdictions adopted reasonable use, they created a more precise set of common property rights to water dictating that each member of the group was equal in both right and obligation. However, the degree to which interference would be tolerated differed in each setting so that English courts appear to have adopted a more narrow interpretation of what would be considered reasonable compared with eastern U.S. jurisdictions.

The basis for the reasonable use test was founded in the U.S. Federal Court case *Tyler v. Wilkinson*.¹⁴¹ In this case Justice Story clearly laid out the test as it would be applied in the U.S. stating:

When I speak of this common right, I do not mean to be understood, as holding the doctrine, that there can be no diminution whatsoever, and no obstruction whatsoever, by a riparian proprietor, in the use of the water as it flows; for that would be to deny any valuable use of it. There. . . must be allowed of that, which is common to all, a reasonable use. The true test of the principle and extent of the use is, whether it is to the injury

140. See generally, Getzler, *supra* note 15, at 22–27.

141. *Tyler v. Wilkinson*, 4 Mason 397, 24 F.Cas 472 (1827).

of other proprietors or not. There may be a diminution in quantity, or a retardation or acceleration of the natural current indispensable for the general and valuable use of the water, perfectly consistent with the existence of the common right. The diminution, retardation, or acceleration, not positively and sensibly injurious by diminishing the value of the common, is an implied element in the right of using the stream at all. The law here. . . acts with a reasonable reference to public convenience and general good, and it is not betrayed into a narrow strictness, subversive of common sense, not into an extravagant looseness, which would destroy private rights.¹⁴²

This was a far more liberal version of what would be considered reasonable than was adopted in England in *Embrey v. Owen*.¹⁴³ In this case, Parke B, citing U.S. precedent noted:

In America. . . a very liberal use of the stream for the purposes of irrigation. . . is permitted. . . in England it is not clear that [a] user to that extent. . . would be in every case deemed a lawful enjoyment of the water, if it was again returned to the river with no other diminution than that which was caused by absorption and evaporation attendant on the irrigation of lands of the adjoining proprietor. This must depend upon the circumstances of each case. On the one hand, it could not be permitted that the owner of a tract of many thousands acres of porous soil, abutting on part of the stream, could be permitted to irrigate them continually by canals and drains, and so cause a serious diminution of the quantity of water, though there were no other loss to the natural stream than that arising from the necessary absorption and evaporation of the water employed for that purpose; on the other hand, one's common sense would be shocked by supposing that a riparian owner could not dip a watering-pot into the stream, in order to water his garden, or allow his family, or his cattle to drink it. It is entirely a question of degree. . .¹⁴⁴

The predictive framework in this article is not constructed to explain the nature of the tests applied under either riparian or appropriative rights. These tests or 'rules of thumb' evolved to determine disputes *between* users that acquired rights under either riparian, appropriative, or the hybrid doctrine adopted in each location. In England, the reasonable use test was adopted because it provided flexibility in the court's ap-

142. *Id.* at 472.

143. *See generally* *Embrey v. Owen*, 6 Exch. 353, 155 Eng. Rep. 579 (1851).

144. *Id.* at 371-72.

proach to resolving water disputes that could be adapted given the specific context in which these conflicts took place. At the time, this flexibility in English common law was crucial because of industrialization.

During nineteenth century industrialization, the costs of administering justice based on reliance on detailed factual pleadings became prohibitively high. The use of appropriative tests to determine riparian disputes was extremely fact sensitive, increasing the costs to judges because of parallel efforts to reduce the discretion of juries. In consequence, there was a greater drain on judges' time by relying on factual pleadings at a time when the judicial system faced increasing conflicts. This prompted a simplification of common law intention-based concepts that emphasized the objectivity of user rights exemplified by tests such as 'reasonableness' of uses. Reasonable use allowed courts to adjust their findings given the circumstances of a dispute. Circumstances influenced by norms and repeat transactions established a pattern of expected behavior from users of the common pool. As a norm enforcer, the common law used the reasonable test, founded on the party's own conduct, to restrain destructive competition of the common pool resource. In turn, the common law paid careful attention to agreements, understandings, and the practices of parties using the water resource—something that would vary over time and space.

V. CONCLUSION

The empirical examples presented in this paper conform to the expected outcomes given the alternative combinations of climate and asset type as outlined in Table 1. Specifically, five cases have been identified in which three of the cells have been explained. Appropriative rights evolved in an arid climate with non-deployable asset investment, as illustrated in the cases of California and Colorado gold mining and irrigation and the Australian gold mining sector. Riparian rights evolved in a climate that was not arid with non-deployable asset investment, as shown in the case of the eastern U.S. and England. As expected, riparian rights also arose where an arid climate was combined with deployable asset investment, as demonstrated in the Australian pastoral sector.

Property rights will evolve from open access to private rights as scarcity increases. Water scarcity is affected by two main factors: climate and investment type. These two variables will determine where and when riparian or appropriative rights are expected to evolve. By combining these two variables, the framework developed here leads to four expected outcomes that have been confirmed by the empirical evidence presented in this paper. First, in arid climates where non-deployable assets dominate, scarcity is high and appropriative rights will be adopted.

This prediction is supported by evidence from nineteenth century California gold mining and irrigation, Colorado gold mining and cattle grazing, and Australia gold mining. Second, in arid climates where deployable investments dominate, scarcity brought about by lack of rainfall will be counteracted by a non-binding mobility constraint so that riparian rights will evolve. Outcomes in the Australian pastoral sector provide evidence that conforms to this prediction. Third, in climates that are not arid where investment in non-deployable assets dominates, scarcity will be low and riparian rights will evolve. This prediction is supported by evidence from the eastern U.S. and England. Finally, in climates that are not arid where investment in deployable assets dominates, scarcity will be very low and theoretically it is expected riparian rights will evolve. There is a lack of empirical evidence to support this outcome. However, the durability of the framework has been sufficiently demonstrated so as to support these theoretical expectations. The findings here suggest that asset type combined with climate may be better able to explain how and why water rights evolve toward riparian or appropriative rights at certain times and in particular locations. Application of the framework to a greater number of empirical examples is necessary to strengthen the findings presented here.

TABLE 1 Framework for water rights evolution

		Asset type	
		<i>Non-Deployable</i>	<i>Deployable</i>
Climate	<i>Arid</i>	<i>Appropriative rights</i>	<i>Riparian rights</i>
	<i>Not Arid</i>	<i>Riparian rights</i>	<i>Riparian rights</i>

TABLE 2: Rainfall correlation coefficients, NSW and Victoria, 1878-1910¹⁴⁵

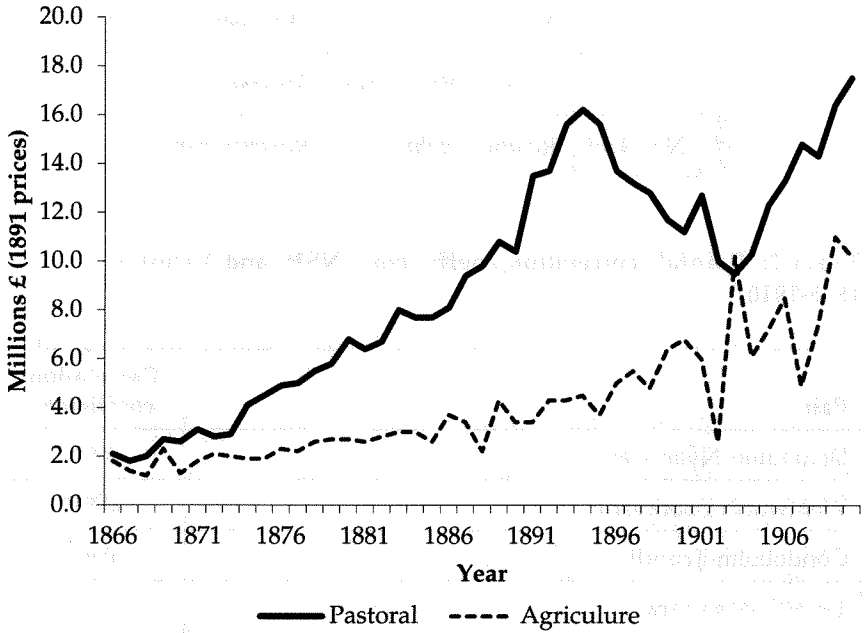
Pair	Correlation coefficient
Deniliquin-Nyan Gay	0.92
Wentworth-Pooncarrie	-0.51 ^b
Condobolin-Trundle	0.85
Trundle-Manildra	0.71 ^b
Moama-Conargo	0.65 ^b
Yamba-Casino	0.69 ^a
Albury-Wangaratta	0.85
Rochester-Shepparton	0.87
Kerang-Charleton	0.82
Barraport-Coonooer Bridge	0.91
Wickliffe-Beaufort	0.90
Rochester-Bendigo	0.88
Barraport-Swan Hill	0.10 ^a

^a Stations located in an East-West direction.

^b Stations with greater distances between them (refer to Appendix 1).

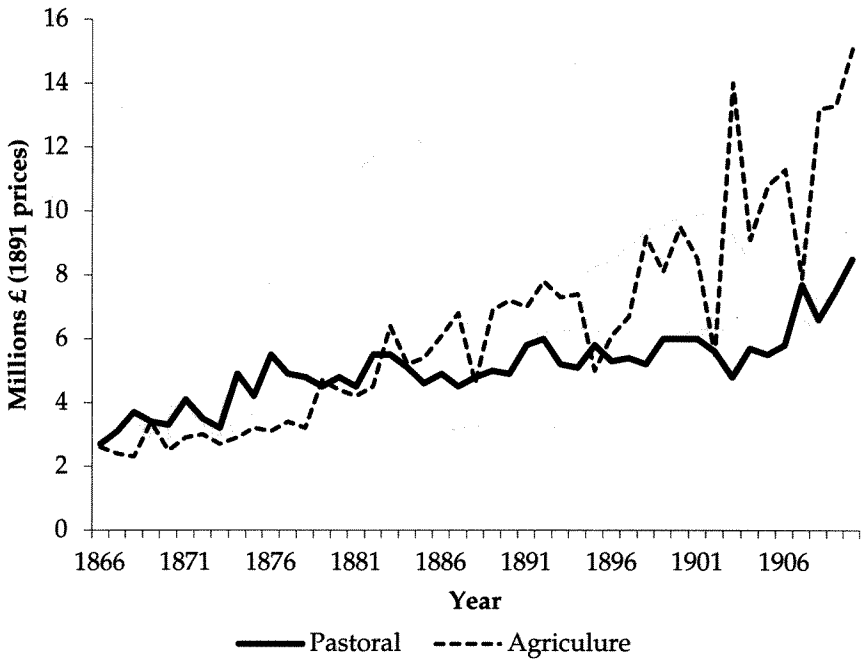
145. Data available at: Bureau of Meteorology, *Climate Data Online*, AUSTRALIAN GOVERNMENT, <http://www.bom.gov.au/climate/data> (last visited March 30, 2013).

FIGURE 1 Contribution of pastoral sector and agriculture to NSW GDP 1861 to 1910¹⁴⁶



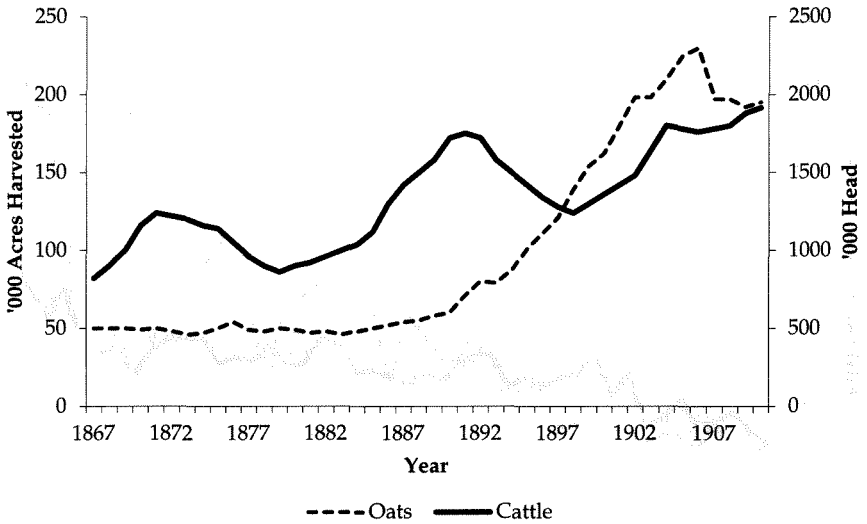
146. See Brian Haig, *New estimates of Australian GDP 1861–1948/49*, 41 *Aus. Econ. Hist. R.* 1, 31–32 (2001) (table A3).

FIGURE 2 Contribution of the pastoral sector and agriculture to Victorian GDP 1861 to 1910¹⁴⁷



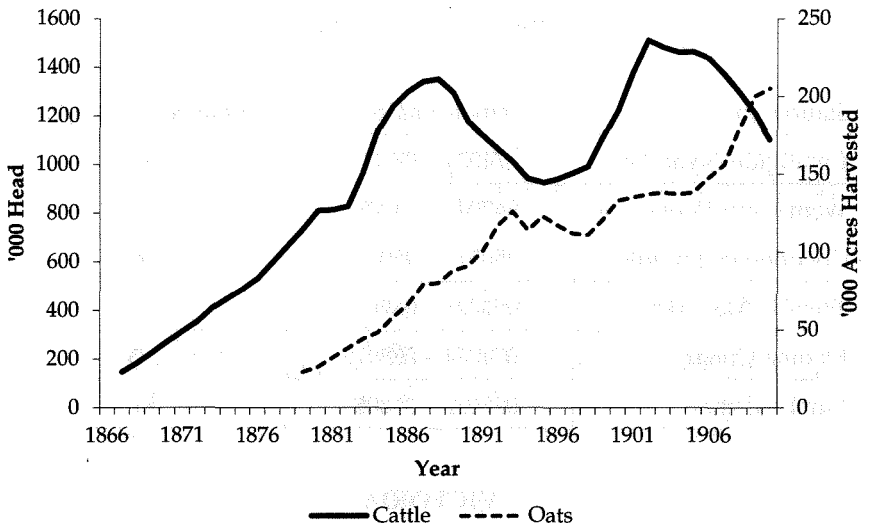
147. *Id.* at table A4.

FIGURE 3 California oat production and cattle numbers, 1867 to 1910¹⁴⁸



148. See Nat'l Agric. Stat. Serv., *California Oats, 1867–2011*, U. S. DEP'T OF AGRIC., http://www.nass.usda.gov/Statistics_by_State/California/Historical_Data/Oats.pdf (last visited March 30, 2013); see also Nat'l Agric. Stat. Serv., *Cattle and Calves, Inventory by Class, January 1, 1867–2011*, U. S. DEP'T OF AGRIC., http://www.nass.usda.gov/Statistics_by_State/California/Historical_Data/CattleByClass.pdf (last visited March 30, 2013).

FIGURE 4 Colorado oat production and cattle numbers, 1866 to 1910¹⁴⁹



149. Adapted from the US Department of Agriculture, National Agricultural Statistics Service, www.nass.usda.gov [January 8, 2010].

APPENDIX 1 Paired Rainfall Stations 1878 to 1910¹⁵⁰

NEW SOUTH WALES

Station pair	Station numbers	Distance apart (km ²)
Deniliquin-Nyan Gay	074074 - 075013	80
Wentworth-Pooncarrie	047045 - 047033	117
Condobolin-Trundle	050014 - 050028	64
Trundle-Manildra	050028 - 065022	109
Moama-Conargo	074074 - 075075	109
Yamba-Casino	058012 - 058063	81

VICTORIA

Station pair	Station numbers	Distance apart (km ²)
Albury-Wangaratta	072001 - 082053	70
Rochester-Shepparton	080081 - 081044	72
Kerang-Charleton	080023 - 080006	89
Barraport-Coonooer Bridge	077062 - 080009	69
Wickliffe-Beaufort	089033 - 089005	76
Rochester-Bendigo	080081 - 081003	67
Barraport-Swan Hill	077062 - 077042	86

150. Data available at: Bureau of Meteorology, *Weather Station Directory*, AUSTRALIAN GOVERNMENT, <http://www.bom.gov.au/climate/data/stations/> (last visited March 30, 2013) (Rainfall station names, numbers, and distance apart are available or can be calculated).

**APPENDIX 2 Water Cases heard by the California Supreme Court
1890 to 1910**

Case Name	Citation Information	Appropriation Test Applied
Last Chance v Heilbron	25 Pac. 415 (1890)	Yes
Conkling v Pacific Improvement Co.	25 Pac. 899 (1890)	Yes
Riverside Water Co. v Gage	26 Pac. 889 (1891)	Yes
Mott v Ewing <i>et al</i>	27 Pac. 194 (1891)	Yes
Spargur <i>et ux</i> v Heard <i>et al</i>	27 Pac. 198 (1891)	Yes
Modoc Land and Live-Stock Co <i>et al</i> v Booth <i>et al</i>	36 Pac. 431 (1894)	Yes
Vernon Irrigation Co. v City of Los Angeles <i>et al</i>	39 Pac. 762 (1895)	Yes
Hargrave <i>et al</i> v Cook <i>et al</i>	41 Pac. 18 (1895)	Yes
Boehmer v Big Rock Creek Irrigation District <i>et al</i>	48 Pac. 908 (1897)	No
San Luis Water Co. v Estrada <i>et al</i>	48 Pac. 1075 (1897)	Yes
Gould v Eaton <i>et al</i>	49 Pac. 577 (1897)	Yes
Bathgate <i>et al</i> v Irvine <i>et al</i>	58 Pac. 442 (1899)	No
Senior <i>et al</i> v Anderson <i>et al</i>	62 Pac. 563 (1900)	Yes
Fifield v Spring Valley Waterworks	62 Pac. 1054 (1900)	Yes
Newport <i>et al</i> v Temescal Water Co.	87 Pac. 373 (1906)	Yes
Anaheim Union Water Co. <i>et al</i> v Fuller <i>et al</i>	88 Pac. 978 (1907)	No
Duckworth <i>et al</i> v Watsonville Water and Light Co. <i>et al</i>	89 Pac. 338 (1907)	Yes
Wutchumna Water Co. v Pogue	90 Pac. 362 (1907)	Yes
Montecito Valley Water Co. v City of Santa Barbara <i>et al</i>	90 Pac. 935 (1907)	Yes
Cohen v LA Canada Land and Water Co. <i>et al</i>	91 Pac. 584 (1907)	Yes
Huffner <i>et al</i> v Sawday <i>et al</i>	94 Pac. 424 (1908)	Yes
Miller and Lux v Madera Canal and Irrigation Co.	99 Pac. 502 (1909)	Yes
Miller v Bay Cities Water Co. <i>et al</i>	107 Pac. 115 (1910)	No
San Joaquin and Kings River Canal and Irrigation Co v Fresno Flume and Irrigation Co.	112 Pac. 182 (1910)	Yes