

CONSOLIDATION AND LAND USE CHANGES ON NATIVE AMERICAN
RESERVATIONS: AN ANALYSIS OF THE LAND BUY-BACK PROGRAM FOR TRIBAL
NATIONS

by

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ABSTRACT

Native American land has experienced the proliferation of undivided ownership interests through a process known as fractionation, a consequence of generations of Federal Indian policy. From 2012 to 2022, the federal government's Land Buy-Back Program for Tribal Nations (LBBP) spent \$1.9 billion consolidating fractional interests into tribal ownership across 47 reservations, representing the largest federal land reconsolidation effort in U.S. history. This analysis uses a triple-difference design to compare the change in land use within treated reservations with reservations identified for participation but not consolidated before the program expiration, as well as comparing with their five-mile surrounding border rings. This analysis finds no statistically significant effect of the program on intensive-margin crop changes or broad extensive-margin land cover outcomes. These results are consistent with a theoretical framework in which consolidation into tribal ownership replaces the coordination failures of fractionated ownership with a principal-agent problem. The findings suggest that centralized consolidation programs such as the LBBP are insufficient on their own to generate systematic changes in reservation agricultural outcomes, and that effective reform will require changes to the institutional environment governing land use after consolidation occurs.

CHAPTER 1

INTRODUCTION

The federal trust framework governing Native American reservation land has long been linked to variation in economic outcomes across reservations, including agricultural productivity, investment, and income growth. (Anderson and Lueck 1992; Akee and Jorgensen 2014; Anderson and Parker 2008) A growing body of research connects these outcomes to the institutional constraints inherent in trust ownership which shape how land can be used, transferred, and developed by tribal members and landowners.

Among the most consequential of these constraints is fractionation. Because trust land faced significant restrictions on sale and transfer, when a landowner died their ownership interest was typically divided among heirs rather than consolidated. The American Indian Probate Reform Act of 2004 (AIPRA), which took effect in 2006, sought to curtail this pattern by standardizing probate rules for trust land and limiting further subdivision of small interests. (Pub. L. No. 108-374, 118 Stat. 1773 [2004]) Over successive generations, a single parcel may accumulate hundreds of undivided ownership interests, raising the transaction costs associated with coordinating the consent required to lease, develop, or invest in the land. From 2012 to 2022, the federal government's Land Buy-Back Program for Tribal Nations (LBBP) spent \$1.9 billion purchasing fractional interests and consolidating them into tribal ownership in an effort to address this problem directly, ultimately consolidating roughly 27% of total fractionated interests across Indian Country. (U.S. Department of the Interior 2023)

Whether consolidation of this kind actually changes how land is used is an open empirical question where the theoretical predictions are ambiguous. On one hand, consolidation reduces the coordination problems created by fractionated ownership by lowering the number of interest holders involved in land-use decisions. Unified tribal ownership may also allow tribes to internalize the economic gains associated with scale and spatial contiguity that are difficult to realize under highly fragmented ownership. On the other hand, two other primary mechanisms may limit effects.

First, consolidation does not remove the broader trust framework. The administrative requirements, federal oversight, and jurisdictional constraints that govern reservation land use remain in place after purchase. Second, the transfer of interests from individual owners to tribal entities shifts decision-making authority to Tribal Governments. This can be consequential because tribes may face a different set of incentives and priorities than individual landowners who depend directly on a parcel's productivity, as discussed in greater detail in later sections of this analysis.

This paper provides the first econometric analysis of the Land Buy-Back Program, using a triple-difference (DDD) design to estimate its effect on land use. I compare reservations that consolidated interests through the Land Buy-Back Program to reservations that were identified for participation but not consolidated before the program's expiration, using the five-mile border surrounding each reservation as a counterfactual. The results indicate no significant change in land use, including investment in high-value crops, attributable to the program. These findings suggest that centralized consolidation programs, such as LBBP, are insufficient to generate measurable changes in land investment behavior.

My study contributes to the literature in three main ways. First, it is the only econometric analysis of the Land Buy-Back Program. There have been a number of policies addressing the fractionation problem, but the Land Buy-Back Program was the most concerted effort at land interest purchases across the United States. There has been a robust discussion about the merits of the program, but until now it has been entirely speculative or theoretical. The results from this study can help augment the conversation regarding the program with empirical analysis and thus help to inform future fractionation policy.

This study also contributes to the literature on the long-run effects of historical institutions. A substantial body of research argues that differences in property-rights regimes, colonial governance structures, and institutional arrangements generate persistent effects on contemporary economic outcomes. Seminal contributions demonstrate that colonial strategies shaped institutional trajectories that continue to influence income levels and development paths today (Acemoglu, Johnson, and Robinson 2001; Banerjee and Iyer 2005). More recent empirical work pro-

vides additional evidence of these mechanisms, showing how extractive institutions altered land tenure systems, public goods provision, and local governance in ways that endure long after formal policy regimes ended (Dell 2010). Taken together, this literature suggests that institutional shocks can set economies on durable paths through their effects on incentives, political authority, and property-rights enforcement.

Finally, this paper contributes to the broader literature on global land consolidation. While consolidation is generally associated with productivity gains, the comparative evidence suggests these effects are conditional on the legal and administrative framework within which consolidation occurs (Sikor et al. 2009).¹ This paper extends that conversation into the distinctive setting of Native American reservations, where layered federal trusteeship and jurisdictional complexity create institutional constraints that standard consolidation frameworks may not anticipate.

1. Much of the land consolidation literature models fragmentation as a spatial inefficiency that increases production costs and impedes mechanization as opposed to considering their institutional context, thereby motivating policies that reorganize parcels to capture scale efficiencies (Hiironen et al. 2016).

CHAPTER 2

BACKGROUND

Prior to colonization, Native American communities maintained complex and resilient institutions shaped by their own culture, geography, and economic environment. Far from operating under a uniform system of undifferentiated communal ownership, Indigenous societies developed diverse property regimes that varied across tribes and ecological contexts. Many recognized individual, family, or clan-based rights in land and other resources, and these systems frequently allowed for transfer, inheritance, and adaptation over time (Bobroff 2001). Property institutions were embedded within broader political and social structures, reflecting tribal governance systems and cultural norms rather than a lack of institutional development.

Over time, however, these locally grounded systems were progressively displaced by policies imposed by the United States federal government. In particular, nineteenth-century reformers justified allotment and related policies on the claim that Native Americans lacked familiarity with private property and required individualized landholding in order to become “civilized” (Hoxie 2021). Yet historical evidence demonstrates that this narrative was misguided: allotment did not introduce private property where none had existed, but instead replaced numerous functioning tribal property systems with a single federally designed and inflexible regime (Bobroff 2001). Once imposed, this centralized system limited tribes’ ability to modify their own land tenure rules in ways that are locally adapted.

In addition to historical evidence, Terry Tatsey, who has served in many roles with Blackfeet Nation and Blackfeet Community College, explains in an interview (2026) that the imposed property-rights structure of trust ownership was foreign to individual Native Americans, and the institutional structure that accompanied this system was incompatible with their traditional ways of land management. Tatsey explains that “[federal policies] weren’t written by us and they weren’t in our best interest because they were all market related... they didn’t really follow our old ways of common use and care.” (2026). Thus, federal policy eliminated previous institutional structures

in such a way that destroyed systems of common ownership which were locally adapted and had been successful for many generations prior.

Although policymakers framed these reforms as necessary for assimilation and economic advancement, the institutional restructuring largely produced the opposite result. By disrupting tribal governance structures, fragmenting landholdings, and weakening locally adapted property institutions, federal policy contributed to long-term economic constraints and social dislocation within many Native communities (Bobroff 2001; Carlson 1981).

U.S. federal Indian policy that is most relevant in the context of this paper traces its legal foundations to the early nineteenth century. During this period, Chief Justice John Marshall authored a series of Supreme Court decisions, collectively known as the Marshall Trilogy, that laid the foundation for the legal relationship between Native American tribes and the federal government. The first of these cases, *Johnson v. McIntosh* (1823), arose from a dispute over land originally purchased by Thomas Johnson from the Piankeshaw Tribe. (21 U.S. 543 [1823]) After Johnson's death, William McIntosh obtained a federal land patent for the same property. When Johnson's heirs challenged McIntosh's claim, the Court ruled against them, holding that under the doctrine of discovery the United States possessed ultimate sovereignty over all Indian lands. As a result, only the federal government, and not tribes or private individuals, could lawfully authorize the transfer of Native American land (Ruppel 2008).

The Marshall Court further delineated the relationship between Native American tribes and the federal government in *Cherokee Nation v. Georgia* (1831). In this case, the Cherokee Nation sought an injunction against the state of Georgia, arguing that Georgia's laws violated Cherokee sovereignty and contravened treaties the Nation had entered into with the federal government. (30 U.S. 1 [1831]) The Court declined to hear the case on the merits, holding that it lacked original jurisdiction because the Cherokee Nation did not constitute a "foreign nation." Instead, the Court characterized the Cherokee Nation as a "domestic dependent nation," thereby formalizing a legal

relationship between tribes and the federal government analogous to that of a ward to its guardian.²

The final case in the Marshall Trilogy, *Worcester v. Georgia* (1832), arose when a missionary named Samuel Worcester was arrested by the state of Georgia for residing on Cherokee land without state authorization.³ Worcester challenged his conviction before the Supreme Court, and the Marshall Court ruled in his favor. The decision affirmed that Native American tribes are distinct political communities with inherent sovereignty and held that state laws have no force within tribal territories. *Worcester v. Georgia* established a foundational legal precedent recognizing tribal sovereignty and limiting state jurisdiction over Indian nations (Ruppel 2008).

For much of the 19th century following the Marshall Trilogy, the U.S. government enacted a series of removal policies, pushing many Native Americans westward and establishing reservations. However, these reservations were to change dramatically by the end of the century. In 1887, Congress passed the General Allotment Act, also known as the Dawes Act, which divided Native American Reservations into allotments of approximately 80 acres for individuals, 160 acres for families, or 320 acres for grazing land. The remainder of the Native land, designated as "surplus" by the federal government, a characterization that reflected the non-Native assumption that tribes held more land than they needed, was sold to white settlers (Egbert 2024). During this time, Native Americans lost about two thirds of their land to homesteaders, comprising approximately 90 million acres (Miller et al. 2025; Dippel 2021).⁴

Allotment had two main purposes: to open up land for settlers who desired to migrate west and to aid in the assimilation of Natives into the broader American culture by encouraging farming and the associated "habits of thrift, industry and individualism" (Carlson 1978, 1983). However, economic historians point out that this policy was not effective in achieving the latter. Although the intent was to replace Indian "communism" with a property rights structure that would foster

2. *Cherokee Nation v. Georgia* (30 U.S. 1 [1831]). Marshall intended the "ward-guardian" analogy in a protective sense, reflecting a duty of care owed by the federal government to tribal nations, not to imply tribal incompetence and used to justify paternalistic federal oversight (Ruppel 2008).

3. *Worcester v. Georgia* (31 U.S. 515 [1832]).

4. The land retained by tribes following allotment was and continues to be legally referred to as "Indian land," a term defined under federal law to encompass land held in trust by the United States for the benefit of an Indian tribe or individual Indian, as well as land held by Indians subject to restrictions on alienation. See 25 U.S.C. § 2201.

more productive economic behavior (Franken 2012), these policies were not effective. Instead, allotment had the opposite effect. Due to a series of institutional changes resulting from allotment, Native Americans actually reduced their involvement in agriculture and were subjected to greater constraints on their economic development (Carlson 1981).

One feature of the Dawes Act was the trust ownership status assigned to allotted land. Initially, allotted land was held in a 25 year trust period by the federal government until the land-user was deemed “competent” and “capable” of managing the land without federal supervision. (Burke Act 1906, 34 Stat. 182) This policy remained in place until the Indian Reorganization Act of 1934 nullified the 25 year expiration of trust status. (General Allotment [Dawes] Act of 1887, 24 Stat. 388) The resulting land ownership structure combining trust land and fee-simple land throughout the nation persists to this day, although as of 2018 only eight percent of reservation land was held in fee-simple title. (Bureau of Indian Affairs 2019)

One major consequence of federal trust status is the restriction it places on how land may be passed to heirs. For the first twenty-three years after the passage of the Dawes Act, the federal government did not recognize Native Americans’ ability to write wills because legal title to allotted lands remained in trust (Ruppel 2008). This changed in 1910, when Congress enacted probate reforms granting individual Indians the right to draft wills. Even so, the reform was slow to affect many communities. The concept of a written will was unfamiliar within numerous Native cultural traditions, and the administrative requirement that the Secretary of the Interior approve each will imposed additional bureaucratic and financial barriers (Stratmann 2014; Shoemaker 2017).

When an original owner dies intestate, allotted land is divided among heirs according to state probate law. Over generations, this process compounds, sometimes resulting in a single parcel containing more than 1,000 undivided interests (Stratmann 2014; Shoemaker 2017). This repeated subdivision of ownership interests over generations is known as fractionation. While fractionation can theoretically occur off reservations as well, it presents unique challenges in Indian Country for two main reasons. First, reliance on state probate courts to determine heirship limits tribal communities’ ability to develop institutions aligned with their own cultural practices and governance

systems. Although the American Indian Probate Reform Act (2004) created legal pathways for Tribes to adopt their own probate law, few Tribes have received approval and successfully enacted their own systems. Second, federal trust restrictions on the alienation or encumbrance of inherited land constrain heirs' ability to pursue common solutions such as selling the property or consolidating ownership through buyouts that are typically available to co-owners elsewhere in the United States (Royster 1995).

Subsequent federal reforms attempted to mitigate some of these dynamics, most notably through the Indian Land Consolidation Act (ILCA) and later amendments such as the American Indian Probate Reform Act. These reforms created mechanisms intended to facilitate consolidation of fractionated interests, including granting co-owners a right of first refusal to purchase interests before they pass to other heirs. (see Indian Land Consolidation Act, 25 U.S.C. §§ 2201–2221, particularly § 2213 for purchase option at probate) In principle, such provisions allow existing interest holders or tribes to consolidate ownership shares. In practice, however, the broader legal structure governing trust land often limits the effectiveness of these tools. Transactions involving trust land typically require approval from the Department of the Interior and must navigate a complex bureaucratic network involving three jurisdictions: federal, state and tribal. As a result, even when statutory pathways for consolidation exist, the underlying system remains highly technical and bureaucratic, making voluntary consolidation costly and slow. The overarching complexity of the federal trust land tenure system including overlapping jurisdictions and extensive administrative oversight continues to impede efficient land transactions and discourage active land management by owners (Shoemaker 2017).

In an interview (2026), Robin and Ronnie Johnson, ranchers and landowners on the Blackfeet Reservation who have first-hand experience navigating the trust bureaucracy, explained that it is not enough to have a will. Instead, they describe the necessity of having a "strong" will that is robust to the dense regulatory environment. In Robin Johnson's words: "The day that the Bureau protects our land is gone. There is no protection anymore." In order to pass on land holdings according to the wishes of the landowner, professional legal assistance is usually required, which

is often too costly to be feasible for reservation landowners. (2026)⁵

In 1928, the Institute for Government Research, at the request of the Secretary of the Interior, commissioned Lewis Meriam to examine the conditions of Native Americans on reservation land. His work, *The Problem of Indian Administration*, was among the first recognitions of the link between trust ownership of Indian land and the proliferation of undivided ownership interests.⁶ The undivided ownership of land parcels is among the most serious barriers to economic development across reservation land.

Although the fractionation problem was identified almost immediately after allotment, Congress did not formally recognize the problem until two decades later when they enacted probate authority over Native lands in 1910 (Ruppel 2008). Over seventy years after this official recognition, Congress passed the first major effort to address fractionation with federal policy: the Indian Land Consolidation Act of 1983. The original intent of this law was that any undivided interests accounting for over two percent of the total tract could be purchased by tribal governments as long as a majority of co-owners consent to the sale. Any tracts accounting for less than two percent of the total tract were deemed negligible and would immediately be inherited by the tribe as opposed to individual heirs. (see Indian Land Consolidation Act of 1983, 96 Stat. 2517)

The Indian Land Consolidation Act did not remain intact in its original form for long. In two landmark cases, the Supreme Court ruled that the involuntary escheat of Indian land interests without compensation constituted an unconstitutional taking of private property. (*Hodel v. Irving* [481 U.S. 704, 1987]; *Babbitt v. Youpee* [519 U.S. 234, 1997]) In response, Congress amended the law through experimental reforms in 2000 and again with the passage of the American Indian Pro-

5. Throughout this paper, terms such as "Indian land" and "Indian country" are used not as cultural descriptors but as quasi-legal terms embedded in federal law and adjacent institutional contexts appearing, for example, in statutory definitions, agency designations such as Individual Indian Money (IIM) accounts, and the formal title of Federal Indian Law itself. The use of the term "Indian" in this context is unavoidable when engaging with the legal and administrative framework governing Native American land tenure, and is not intended to carry any derogatory connotation.

6. Concerns about the effects of allotment on Native land ownership appeared earlier in congressional debates and administrative reports, including the minority report opposing early allotment proposals in the House of Representatives. See H.R. Rep. No. 1576, 46th Cong., 2d Sess. (1880). However, Lewis Meriam's study, *The Problem of Indian Administration* (Institute for Government Research 1928), is often regarded as the first comprehensive federal investigation documenting the broad economic and administrative consequences of federal Indian policy across reservations nationwide.

bate Reform Act of 2004. (American Indian Probate Reform Act of 2004, 118 Stat. 1773) While some of these reforms recognized the rights of individual Indian landowners, many provisions continued the broader historical pattern in federal Indian law of prioritizing federal and tribal governance interests over individual property rights (Franken 2012). For example, formal inheritance restrictions such as primogeniture rules for very small fractional interests and informal barriers arising from culturally unfamiliar legal terminology and procedures can limit the effectiveness of the reforms in practice.

The final form of Indian land consolidation policy up to this point focused largely on reforming probate law in order to slow the expansion of fractionation. These reforms, however, were met with significant criticism from Indian Country regarding both the complexity and underlying goals of the legislation (Franken 2012). For some Tribal representatives, the reforms appeared designed primarily to reduce administrative burdens on the federal government rather than to strengthen the property rights of individual Indian landowners. (see, e.g., Stainbrook 2003) Such criticisms reflect a broader theme frequently seen in the history of federal Indian law: the tendency for federal policy to prioritize federal and tribal administrative interests over those of individual Native landowners. As Vine Deloria, Jr. famously observed, “what is missing in federal Indian law are the Indians.” (see Deloria 1989, 205)

In addition to the institutional challenges of land management under fractionation, the federal government has a well-documented record of mismanaging trust assets on behalf of allottees. In 1996, five litigants including Elouise Cobell filed a class action lawsuit seeking to hold the government to account for the alleged mismanagement of billions of dollars belonging to approximately 500,000 American Indians and their heirs, contending that the government had failed to fulfill its trust responsibility to collect and disburse revenues generated by mining, oil and gas extraction, timber, and grazing. (U.S. Department of the Interior 2023) After numerous appeals, the case settled in 2009 for \$3.4 billion, with \$1.5 billion allocated for direct payments to plaintiffs and \$1.9 billion allocated to establish the Trust Land Consolidation Fund.

The Trust Land Consolidation Fund gave rise to the LBBP, administered by the Bureau of

Indian Affairs and representing the largest federal effort ever undertaken to consolidate fractionated reservation land. However, the program's budget was acknowledged from the outset to be insufficient: former Deputy Secretary David Hayes testified before Congress that while the \$1.9 billion would make a significant impact, full resolution of fractionation would likely require \$6 - 8 billion, and former Secretary Sally Jewell later reiterated that the value of remaining fractionated land would still likely be several billion dollars at the program's conclusion in 2022. (U.S. Department of the Interior 2023) Operating under both a binding budget constraint and a ten-year time limit, the LBBP was ultimately unable to address the full scope of fractionation across Indian Country, reflecting many of the same administrative limitations that have characterized prior federal Indian land policy. A visual timeline of major Federal Indian Policy regarding land tenure is shown in Figure 1:

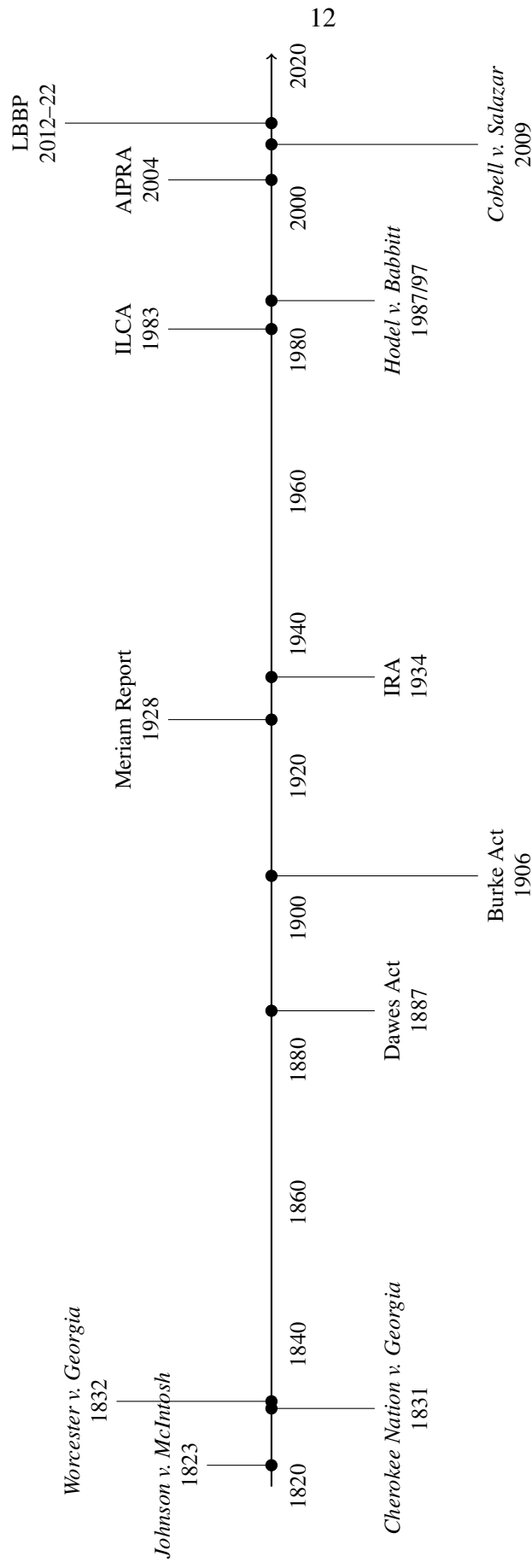


Figure 1. Federal Indian land policy timeline, 1823-2022. ILCA = Indian Land Consolidation Act; AIPRA = American Indian Probate Reform Act; IRA = Indian Reorganization Act; LBBP = Land Buy-Back Program.

The Bureau of Indian Affairs highlights that the total number of fractionated interests decreased from 2.6 million to 1.9 million through the duration of the program, as presented in Figure 2, citing this as evidence of how “program purchases affected the growth trend in fractionation” (U.S. Department of the Interior 2023). However, this figure is misleading without broader context. Fractionation grows exponentially over time, meaning any reconsolidation effort is in a race against a compounding process. Not all treated tracts were fully consolidated, and many new fractionated tracts continued to result from the probate process throughout the program’s duration. The trajectory of fractionation on the reservations with the longest historical record illustrates this clearly. Among the first systematic accountings of fractionation on reservation land was a 1992 Government Accountability Office (GAO) report regarding twelve major reservations.⁷ As Stratmann notes, from 1992 to 2010 the number of fractionated tracts on these twelve reservations increased from 36,134 to 43,770. (Stratmann 2016) The Land Buy-Back Program began consolidation efforts in 2014 and made purchases on all twelve of the original GAO reservations. Yet as of the program’s completion in 2022, the number of fractionated tracts on these twelve reservations had still increased to 49,997. This number would be larger still in the absence of reconsolidation efforts, but the trend makes clear that the LBBP was unable to solve the fractionation problem at scale.

7. Earlier heirship studies had recognized the problem of fractionation prior to the 1992 GAO report. See Comm. on Interior and Insular Affairs, 86th Cong., *Indian Heirship Land Study* 27 (Comm. Print 1960); *Indian Fractionated Land Problems: Hearings on H.R. 11113 Before the Subcommittee on Indian Affairs of the House Committee on Interior and Insular Affairs*, 89th Cong. 6, 31–32, 35 (1966).

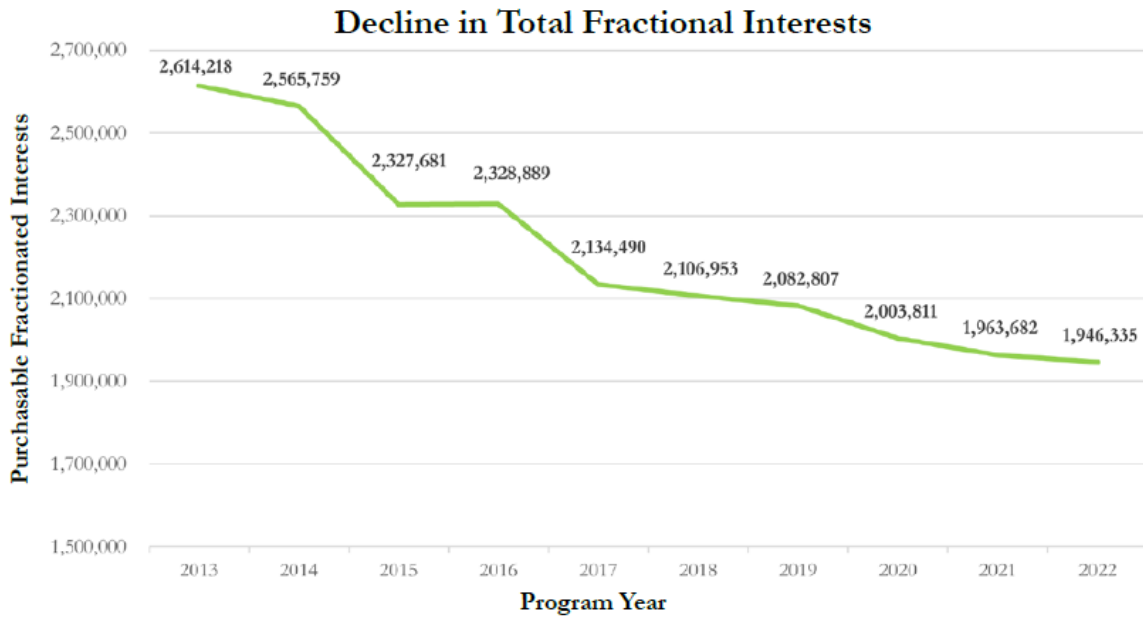


Figure 2. Total number of fractionated interests over time. Reported by the U.S. Department of the Interior in the *Land Buy-Back Program for Tribal Nations: Ten Years of Restoring Land and Building Trust, 2012-2022 Final Implementation Report*.

Despite limitations on resources and inability to meaningfully address fractionation at scale, the Land Buy-Back Program succeeded in consolidating fractionated interests from 123,000 individuals into the control of Tribal governments. (U.S. Department of the Interior 2023) The ways in which tribes chose to deploy consolidated land varied considerably and reflected local priorities rather than a uniform development strategy. The Navajo Nation used consolidation to resolve fractionated ownership barriers that had prevented road paving in the Casamero Lake Chapter. At Pine Ridge, consolidation facilitated tribal leasing and supported livestock water and conservation improvements. The Confederated Tribes of the Umatilla Indian Reservation consolidated ownership in a tract adjacent to a community school for planned recreation and housing development. Other tribes pursued utility infrastructure, as in the case of the Gila River Indian Community, and shellfish habitat protection, as with the Squaxin Island Tribe. (U.S. Department of the Interior 2023) Across cases, consolidation expanded tribal discretion over land allocation, but these changes were project-specific and idiosyncratic rather than reservation-wide shifts in land use.

The Land Buy-Back Program began by working with 147 participating tribes, all of whom

experienced high levels of fractionated ownership. After determining their offer schedule, the BIA appointed a Tribal Relations Advisor (TRA) to each tribe in order to act as the primary point of contact for the tribe. Each tribe submitted a preliminary list of land acquisition priorities based on their own unique goals which was subject to administrative approval prior to mailing official offers. Through a variety of methods including physical mail and call centers, the Tribe then worked alongside the BIA to mail offers to individual landowners regarding selling their own undivided interest. (U.S. Department of the Interior 2023)

The specific dollar amount of each offer was determined by the Appraisal and Valuation Services Office (AVSO) based on their estimate of fair market value based on data from the BIA's Trust Asset Accounting Management System (TAAMS). In 2015, The Appraisal Foundation (TAF) released an independent review of appraisal methodologies used for purchase offers. Despite this evaluation, acceptance rates remained relatively low, with a final acceptance rate of 30.75%. For individuals who did accept their offer, their undivided interest was then transferred to Tribal control and the BIA terminated their Individual Indian Money (IIM) account. (U.S. Department of the Interior 2023)

Although the elimination of large swaths of IIM accounts reduced the administrative burden of the BIA, the closure of these accounts is itself consequential for individual landowners. An IIM account serves as the mechanism through which individual Indians receive revenue generated by their trust land including lease payments, royalties, and other proceeds, meaning that its closure does not merely eliminate a bookkeeping entry but severs the individual's formal claim to future income streams from that land.⁸ Many within Indian Country expressed concerns over lingering fiduciary debts that would no longer have any mechanism for resolution and the future revenue streams that would be lost by this elimination. Grant Stafne of the Tribal Executive Board on the Fort Peck Reservation expressed this concern in a House of Representatives Oversight Hearing, saying,

8. IIM accounts are interest-bearing accounts held by the federal government on behalf of individual Indian trust beneficiaries, through which revenues derived from the use of trust land are collected and disbursed. See 25 U.S.C. § 4001 et seq.

Unless Congress acts now to require meaningful consultation, it appears that the Interior Department intends to use the Buy-Back Program as nothing more than a vehicle for closure of Individual Indian Money Accounts. Surely Congress intended more when it appropriated nearly 2 billion dollars to the Land Consolidation Fund.⁹

Despite the potential benefits of consolidating undivided interests into Tribal control, it comes at the cost of further removing individual Native Americans from their land.

Other criticisms of the LBBP, specifically from individuals directly affected by these policies, criticized the program for the way that it eliminated the individual Native American from the conversation. In fact, this critique came from Elouise Cobell herself. According to close friends and colleagues,

[Cobell] opposed the program because it seemed to assume that what is best for tribal governments is best for individual Indians - that their interests, after more than a century of federal policy intended to break apart tribal communities, were still one and the same. (Crane-Murdoch 2016)

Similarly, while interviewing Terry Tatsey (2026), he explained conversations with Cobell in which she lamented that “historically, the BIA has not managed our lands to the best interest of the owners.” (2026) Instead of ignoring the contextual knowledge of local communities, Tatsey explains that “one of the things that [Cobell] was adamant about was... if we could do some demonstrations of how and when to graze animals using our historical practices and knowledge... that maybe eventually the tribe or BIA would adopt. That’s what we really want to see.” (2026) Despite potential benefits of the LBBP, Tatsey highlights Cobell’s concerns regarding the alienation of individual Native Americans from the management of reservation land.

It is worth noting that the LBBP represented a significant departure from the original intent of the litigation that created it. The *Cobell* suit was a class action brought on behalf of individual Indian trust beneficiaries, not tribal governments — yet the program it gave rise to directed consolidated land into tribal ownership rather than back to individuals. Cobell herself and other tribal leaders expressed concern that this outcome further centralized control over valuable land,

9. Grant Stafne, Member, Fort Peck Tribal Executive Board, Testimony before the U.S. House of Representatives Committee on Natural Resources, Subcommittee on Indian and Alaska Native Affairs, April 3, 2014

distancing individual Native Americans from land management rather than restoring their position within it.¹⁰ For these critics, the Land Buy-Back program failed from the outset to enable land use decisions compatible with the goals and desires of individual Indians.

Terry Tatsey also touches on this issue during his interview, saying “any time you get something under Tribal management, then the Government can have an influence. Especially during political season.” (2026) As an alternative mechanism for consolidation, Tatsey proposed exchange mechanisms as a way to ensure inclusion of individual landowners. When asked about the impact of the LBBP on the Tribe¹¹, he said “if you’re talking about Tribal needs as a whole, the Tribe benefited by getting a lot more control of property. If you’re talking about individual tribal members...if you could look at, instead of selling your undivided shares, if you could look at trading it for a consolidated piece of property. Our people are so needy and unemployment is so high that they couldn’t look beyond the money that they so desperately needed at the time that offers were made.” (2026) Tatsey’s remarks suggest that the LBBP’s reliance on voluntary sales, while effective at expanding Tribal land control in aggregate, may have foreclosed more durable alternatives for individual landowners whose immediate economic circumstances left them little choice but to sell.

10. See, e.g., testimony of Russell Begaye (President, Navajo Nation) before the U.S. Senate Committee on Indian Affairs, *Oversight Hearing on the Department of the Interior’s Land Buy-Back Program for Tribal Nations*, 114th Cong. (2015), emphasizing that landowners needed additional options and protections if they chose to sell fractional interests: “There needs to be more options available to our people...if they want to sell that land, they want to make sure that they can remain there...given automatic homesite leases, grazing leases, and perhaps business site leases...so that they don’t sell and then the government comes back and says you need to move because it no longer belongs to you.” See also testimony from tribal leaders discussing concerns about balancing consolidation goals with the interests of individual Indian landowners in U.S. Senate Committee on Indian Affairs. (Oversight Hearing on the Implementation of the Cobell Settlement, 112th Cong. [2011])

11. It is worth noting that the term “the Tribe” is frequently used in ways that conflate two distinct referents: the Tribe as a formal governing body or sovereign nation, and the tribe as a community of people. The distinction matters considerably in the context of land consolidation, where benefits accruing to tribal government and benefits accruing to individual tribal members may diverge. This conflation is common in both casual usage and policy discourse, often reflecting imprecision rather than intentional ambiguity.

CHAPTER 3

LITERATURE REVIEW

A large body of economic research emphasizes the central role of institutions and property rights in shaping development outcomes. From foundational theories of transaction costs and property-rights evolution to modern institutional economics, scholars have argued that institutions are an essential component of investment and economic growth. Federal Indian policy represents a distinctive institutional regime within the United States, one in which property rights, governance authority, and jurisdictional control have historically been structured through federal trusteeship and administrative oversight rather than Tribal and individual sovereignty.

This literature review proceeds in four parts. First, it outlines the general theoretical foundations of property-rights and institutional economics. Second, it examines how scholars in law and economics have applied these frameworks to federal Indian policy. Third, it surveys the applied empirical literature on land use, agricultural productivity, and land consolidation programs on Native American reservations. Finally, it outlines historical examples of land consolidation programs outside the United States.

Theoretical Foundations

One of the first economists to systematically emphasize the importance of institutions in resource allocation was Ronald Coase. In “The Problem of Social Cost” (1961), Coase challenged the prevailing Pigouvian view that externalities necessarily require corrective taxation or regulation. Instead, he demonstrated that when property rights are clearly defined and transaction costs are sufficiently low, parties can bargain privately to internalize externalities and reach efficient outcomes regardless of the initial allocation of rights. The critical implication of this argument is not that transaction costs are unimportant, but rather the opposite: once transaction costs are positive, as they are in most real-world settings, the legal and institutional structure of property rights becomes central to economic performance. The assignment, enforceability, and transferability of rights determine who must negotiate with whom, at what cost, and under what constraints.

Coase's insight thus shifted attention toward the institutional environment within which exchange occurs. In doing so, he laid the intellectual groundwork for later developments in the New Institutional Economics, where property rights, governance structures, and legal rules are treated as endogenous determinants of economic outcomes rather than neutral background conditions.

Building directly on Coase's insight that transaction costs and property rights shape economic outcomes, Harold Demsetz advanced a theory of how property rights themselves emerge. In "Toward a Theory of Property Rights," Demsetz argues that property rights are not fixed or exogenously given. Instead, they evolve when the gains from internalizing externalities exceed the costs of defining and enforcing those rights (Demsetz 1964, 1967). As resource values rise or technologies change, previously tolerable externalities may become costly, creating incentives for communities to clarify, privatize, or otherwise restructure ownership arrangements. Property-rights systems, in this view, are adaptive institutional responses to changing economic conditions (Demsetz 1966, 1967, 2002).

Demsetz illustrates this mechanism through the case of the Montagnes (Innu) in northeastern Canada during the fur trade (Demsetz 1967). Prior to sustained European contact, hunting territories were organized largely through informal and overlapping use claims. Because population density was low and game was relatively abundant, the externalities associated with overhunting were limited. However, the expansion of the European fur trade sharply increased the value of beaver pelts. As the commercial value of furs rose, the incentive to hunt intensified, and unregulated access created the risk of overexploitation. According to Demsetz, this increase in the value of the resource altered the cost-benefit calculus of defining exclusive hunting territories. In response, the Montagnes developed more clearly demarcated family-based hunting territories, effectively privatizing access in order to internalize the externality of overhunting (Demsetz 1967). The institutional change was not imposed externally but arose organically from changing economic incentives.

Demsetz's contribution is crucial because it shifts the analysis from the static question of whether property rights matter to the dynamic question of why particular ownership regimes

develop over time in the first place (Demsetz 1967). His framework implies that institutional arrangements persist when they are economically functional given prevailing costs and benefits, but may become inefficient if legal or political constraints prevent adaptation to new conditions (Demsetz 1966, 1967, 2002). In contexts where property-rights evolution is restricted by external authority or administrative control, the institutional adjustment process he describes may be slowed or distorted. This insight provides an important theoretical bridge to later discussions of federal Indian policy, where land tenure systems were often imposed or constrained by federal law rather than allowed to evolve endogenously based on local economic contexts.

While Demsetz explains how property rights may emerge endogenously in response to changing economic incentives, Douglass North shifts the focus to the broader political and institutional environment within which such rights are defined and enforced. North defines institutions as the “rules of the game” in a society including formal rules such as laws and constitutions and informal norms that structure human interaction (North 1991). For North, economic performance depends not simply on the existence of property rights, but on the stability, predictability, and enforcement of those rights (North 1971, 1991). Institutions can improve economic outcomes by reducing uncertainty in expectations about how others, including the state, will behave (North 1991). Where institutional frameworks are unstable or subject to arbitrary revision, uncertainty rises and long-term investment becomes less attractive (North 1991).

This insight is developed more sharply in North’s joint work with Barry Weingast in “Constitutions and Commitment” (1989). In this paper, the authors argue that sustained economic development requires credible commitment by political authorities not to expropriate private wealth after it has been invested. The core problem is one of time inconsistency: governments may promise secure property rights in order to encourage investment, but once capital is sunk, they have an incentive to alter taxation, regulation, or ownership rules to extract greater revenue. Anticipating this possibility, rational investors will underinvest unless political institutions constrain discretionary state action. North and Weingast identify England’s post-1688 constitutional settlement as a historical example in which parliamentary supremacy, legal constraints on the King, and strengthened

judicial institutions enhanced the credibility of property rights, thereby lowering borrowing costs and encouraging capital formation (North and Weingast 1989).

Taken together, North's broader institutional framework and the North-Weingast credible commitment argument extend the logic of Coase and Demsetz in an important direction. Coase highlights how the allocation of rights affects bargaining under transaction costs; Demsetz explains how rights may evolve to internalize externalities; North and Weingast demonstrate that the effectiveness of those rights ultimately depends on political constraints that limit opportunistic state behavior. Even well-defined property rights may fail to promote development if they are embedded within a political system that retains the ability to revise, condition, or override them unpredictably. Economic growth, in this account, requires not only clarity of ownership but institutional arrangements that make commitments durable over time.

While North and Weingast emphasize the political conditions necessary for secure property rights, Armen Alchian provides a microeconomic explanation for why the structure of ownership matters for economic performance. In "Some Economics of Property Rights" (1965) and later work with Harold Demsetz, Alchian argues that efficiency depends critically on the alignment between decision-making authority and residual claimancy, or who ultimately captures the gains and bears the losses from resource use. Private ownership tends to concentrate residual claims in a single decision maker, sharpening incentives to economize, invest, and respond to price signals. When ownership rights are partitioned across multiple parties, restricted in transferability, or subject to external approval, the linkage between action and consequence weakens. Separation of residual claim from control generates agency problems and reduces the incentive to make long-term, productivity-enhancing investments.

Alchian's framework is particularly useful for analyzing institutional environments in which ownership is formally defined but practically constrained. If land users cannot effectively transfer, collateralize, or fully control the asset, the residual returns to investment may be diluted or uncertain. In such settings, even absent outright expropriation, inefficient property rights can lead to systematic underinvestment. Alchian thus complements North and Weingast: while credible

political commitment protects property rights from state opportunism and encourages investment, concentrated residual claimancy ensures that individuals have strong incentives to use resources efficiently once those rights are secured.

Where Alchian focuses on incentives within ownership structures, William A. Niskanen turns attention to the incentives of bureaucratic actors within public institutions. In *Bureaucracy and Representative Government* (1971), Niskanen models bureaucrats not as neutral maximizers of social welfare but as rational actors who seek to maximize agency budgets, staffing, and influence. Because bureaucrats typically possess informational advantages over legislators and face weak profit incentives, public agencies may expand beyond socially optimal levels of output. This public choice perspective suggests that regulatory bodies may pursue institutional growth and administrative control even when decentralization or privatization would increase efficiency.

Together, Alchian and Niskanen deepen the institutional analysis of property rights through their discussion of incentives. Alchian explains why dispersed or restricted ownership weakens investment incentives, while Niskanen highlights how bureaucratic agencies may have institutional incentives to maintain or expand control over assets under their jurisdiction. These insights converge on a common implication for the study of the LBBP. Fractionated ownership, as a Coasean problem, generates prohibitively high transaction costs: when a single tract is held by hundreds or thousands of co-owners, the costs of reaching agreement on land use, negotiating leases, securing consent, or coordinating development may exceed the gains from any productive activity, leaving land idle.

Consolidation of fractional interests should, in theory, reduce these transaction costs and enable more productive use. Whether the LBBP achieved this in practice, however, depends on the form that consolidation takes. Because the program transferred purchased interests to Tribal governments rather than to individual landowners, the relevant question becomes whether that ownership structure restored productive incentives or simply replaced one set of institutional constraints with another. Additionally, because the broader trust framework persists after consolidation, it is possible that the most binding constraints to productive land use changes remain in place. The

empirical literature surveyed in the sections that follow engages directly with these questions.

Theory in the Context of Federal Indian Policy

Understanding why the Land Buy-Back Program was designed as it was requires first understanding the legal architecture it was meant to address. The foundational work of Felix S. Cohen laid out the trust doctrine, plenary congressional power, and the unique political status of tribes as domestic dependent nations. Cohen's *Handbook of Federal Indian Law* highlights that much reservation land is held in trust by the federal government, with tribes or individual Indians retaining the beneficial interest in that land but facing restrictions on alienation and transfer.¹² Although Cohen's objective was primarily doctrinal and constitutional rather than economic, his work formally articulated the divided title structure and centralized federal authority that shape land governance on reservations. (Cohen 1942) In doing so, he provided a clear description of the institutional architecture within which economic activity on reservation land must occur.

The historical consequences of this institutional architecture and the path dependence that makes it difficult to undo are central to evaluating any consolidation effort like the LBBP. Charles F. Wilkinson traced the development of federal Indian policy through the allotment era and its aftermath, emphasizing how policies such as the Dawes Act fragmented tribal land bases and embedded federal administrative oversight into everyday land management. Wilkinson documented how restrictions on alienation, Secretarial approval requirements, and jurisdictional complexity became durable features of reservation land tenure. (Wilkinson 1987) While framed primarily in terms of sovereignty and paternalism, this scholarship highlighted structural characteristics such as fragmented ownership, centralized veto authority, and path-dependent institutional design that any consolidation program would need to contend with.

12. The language of "beneficial use" appears in Cohen at page 84, where occupancy of trust land is conditioned on its beneficial use by the Indian occupant. In contemporary federal Indian law, this concept is sometimes described as the "beneficial interest" retained by tribes and individual Indians in trust land, meaning the right to use, occupy, and receive the proceeds of the land, as distinct from the legal title held by the federal government in its capacity as trustee. See U.S. Department of the Interior, Office of Natural Resources Revenue, *Native American Lands: Ownership and Governance*, available at revenuedata.doi.gov; Indian Land Tenure Foundation, *Glossary of Indian Land Tenure Terms*, available at iltf.org. This beneficial interest constitutes a legally recognized form of ownership, and the assumption that Native Americans don't really own their land conflates the trustee's legal title with the absence of Indian ownership, a conflation that has historically been used to justify paternalistic federal oversight.

Taken together, this legal literature establishes that the institutional constraints the LBBP was designed to address are not incidental features of reservation land tenure but deeply embedded products of over a century of federal policy. By clarifying the legal rules governing reservation land such as who holds title, who exercises control, and under what conditions land may be transferred, these scholars established the foundation for later economic analyses of whether trust status translates into measurable differences in land use and agricultural productivity, and whether consolidation programs can meaningfully alter those outcomes.

A separate strand of legal scholarship expands concerns about reservation land tenure by highlighting how the institutional environment associated with Native land constrains the capacity for autonomous land use decisions. In this way, consolidation programs such as the LBBP, which fail to implement deeper institutional reform, may be insufficient to improve the capacity for self-determination among Indigenous landowners. Among the most influential critics was Vine Deloria Jr., whose work in the 1960s and 1970s challenged the premise that federal oversight was either neutral or protective. Deloria argued that trusteeship and plenary power displaced indigenous governance institutions and undermined tribal self-determination. In his account, federal Indian law did not merely regulate Native communities, it structured them within a hierarchy of political authority that limited their capacity to make autonomous decisions regarding land and economic organization. (Deloria and Lytle 1983; Deloria 1969) This critique raised institutional concerns directly relevant to evaluating whether a program that transfers land into Tribal trust rather than to individual owners can meaningfully improve the capacity for individual self-determination.

The path-dependent nature of these institutional constraints helps explain why the LBBP faced structural limitations that no single consolidation program could easily overcome. Charles F. Wilkinson's historical analyses emphasize how policies such as the Dawes Act fragmented tribal land bases, generated fractionated heirship over successive generations, and embedded federal approval requirements into ordinary land transactions, highlighting their cumulative rather than episodic character. (Charles F. Wilkinson 1987, 2005) The resulting institutional environment characterized by divided title, centralized oversight, and jurisdictional complexity became a durable

feature of reservation land tenure that the LBBP inherited rather than dissolved.

These legal critiques did not seek to measure productivity or model incentives formally, but they identified the structural features of trust status that economists would later connect to land use outcomes. Ronald Trosper was among the first to make this translation explicit, applying property-rights and incentive theory directly to reservation economic performance. Writing in 1978, Trosper intervened in a debate in which lower ranching productivity on reservations was sometimes attributed to cultural or racial differences. Rejecting such explanations, he argued instead that trust status creates structural constraints on land use that comparable non-reservation land does not face including suboptimal plot size, impediments to consolidation, restricted collateralization, and federal approval requirements that raise borrowing costs and production costs alike. (Trosper 1978) Trosper's analysis thus provides one of the first formal economic links between the institutional architecture described by legal scholars and the land use outcomes that the LBBP was ultimately designed to improve.

The institutional constraints identified by Trosper extend beyond land tenure itself to the governance of resource development more broadly, a dimension directly relevant to evaluating whether consolidation under the LBBP translated into more productive land use. Judith V. Royster's work on tribal energy, mineral, and environmental resources demonstrates how the trust doctrine and federal oversight shape not only ownership but also decision-making authority over development. By analyzing leasing regimes, Secretarial approval requirements, and federal regulatory layering, Royster shows how institutional design can limit tribal flexibility in resource management. (Royster 1994, 1995) Although framed within the language of federal Indian law and environmental regulation, this scholarship implicitly engages with transaction costs and incentive effects: when development requires multiple layers of approval and coordination between tribal, federal, and sometimes state actors, the cost and uncertainty of investment increase. In this sense, federal trusteeship operates not merely as a protective doctrine but as a governance structure that shapes the economic feasibility of resource development which the LBBP left intact even after consolidation.

Robert T. Anderson's work reinforces this point by showing that jurisdictional fragmentation, not just ownership fragmentation, is an independent source of institutional constraint on reservation land use. His analysis of overlapping authority, federal approval requirements, and fragmented land ownership documents how these features generate delays and uncertainty in commercial transactions that have no clear parallel in fee-simple land markets. (Anderson 2002, 2012) Taken together, Royster and Anderson's work could suggest that even where the LBBP successfully reduced the number of fractional interests, the administrative and jurisdictional complexity surrounding trust land use remain a binding constraint on productive outcomes.

Jessica Shoemaker's scholarship brings these threads together in a way that speaks more directly to the institutional environment the LBBP was designed to operate within. Her work emphasizes that reservation land tenure functions within a uniquely layered legal regime combining trust ownership, federal administrative oversight, tribal authority, and fractionated individual interests. This layering is not merely descriptive but actively shapes the incentives facing landowners and tribal governments. In particular, Shoemaker highlights how allotment-era policies produced a landscape of highly fractionated ownership that complicates land use decisions and raises transaction costs associated with leasing, development, or consolidation. She further argues that subsequent federal reforms, including the Indian Land Consolidation Act and the American Indian Probate Reform Act, attempted to mitigate these problems but often introduced additional administrative complexity. The result is what Shoemaker describes as "complexity's shadow," in which overlapping legal regimes, divided title structures, and federal approval requirements persist as binding constraints on land governance. (Shoemaker 2017, 2019) For the purposes of this paper, Shoemaker's framework raises a pointed question: if the LBBP itself was administered within this same layered regime, to what extent could it reduce the complexity it was originally intended to address?

Whether consolidation under the LBBP could improve land use outcomes ultimately depends not only on ownership structure but on the quality of the governing institutions that manage consolidated land, a question Cornell and Kalt's research places at the center of reservation eco-

conomic development. Drawing on North's institutional framework, Cornell and Kalt argue that sustained economic development on reservations depends on credible governing institutions that are both stable and legitimate. They emphasize that institutions must constrain arbitrary political interference, align decision-making authority with accountability, and reflect a cultural match between formal governance structures and community norms. (Cornell and Kalt 1992, 2000, 2007) Cornell and Kalt explicitly link institutional quality to measurable development outcomes, suggesting that the land use effects of the LBBP may vary systematically across reservations depending on the strength of tribal governance institutions into which consolidated land was transferred.

Public choice analysis adds a further complication for evaluating the LBBP: if the Bureau of Indian Affairs has institutional incentives to maintain administrative control over trust land, then consolidation efforts administered by that same agency may face structural pressures that work against their stated objectives. McChesney's examination of the BIA suggests that agency budgets and authority may expand with the scope of land and population under federal management, implying that trusteeship is not merely a legal doctrine but an institutional arrangement that generates its own self-reinforcing incentives (McChesney 1990). From this perspective, the persistence of federal oversight over consolidated land is not simply a product of historical legacy or protective intent, but may also reflect the bureaucratic interests embedded within the administrative structure through which the LBBP itself operated.

If federal institutions may be resistant to relinquishing control, the effectiveness of consolidation in improving land use outcomes may depend substantially on the capacity of tribal institutions to exercise meaningful authority over newly acquired land. Fletcher's work on tribal constitutional reform, separation of powers, and governance capacity within Native Nations speaks directly to this question. His scholarship analyzes how tribes construct credible and stable governing institutions under conditions of partial sovereignty. (Fletcher 2006, 2008, 2011) Fletcher's framework may suggest that the land use effects of the LBBP are unlikely to be uniform across reservations; where tribal institutions are more capable and constitutionally stable, consolidated land may be more effectively put to productive use, while weaker governance capacity may limit

the program's impact regardless of how many fractional interests were purchased.

Miller's work reiterates the concern that successful consolidation of fractional interests could still intact a hierarchical structure of federal authority that conditions the durability of any property rights reform. In Miller's account, tribal land rights have historically been nested within federal supremacy such that ultimate authority over land disposition and governance rests with Congress. (Miller 2006, 2010) This hierarchical structuring of sovereignty has significant institutional implications for land use outcomes: even where tribes exercise substantial autonomy in practice, the background presence of federal plenary power influences the durability and scope of property rights, potentially dampening long-term investment regardless of how ownership is structured at any given moment.

Judicial doctrine compounds this uncertainty by introducing an additional source of institutional instability that land consolidation programs cannot address. Frickey's examination of Supreme Court jurisprudence demonstrates how shifting judicial interpretation of tribal sovereignty, federal power, and jurisdiction can alter the institutional rules of the game" in ways that affect economic and political organization on reservations. (Frickey 1996, 1999) From this perspective, the stability of property rights on consolidated land depends not only on the administrative design of the LBBP but on a broader and less controllable institutional environment shaped by ongoing judicial interpretation.

Carpenter and Riley introduce a further consideration that bears directly on how the outcomes of the LBBP should be evaluated: that efficiency in land use is not the only relevant metric for assessing institutional reform on reservations. Their work cautions against reducing questions of trust status and collective governance to a simple calculus of transaction costs and investment incentives, emphasizing that these arrangements also serve functions of cultural preservation, political identity, and community cohesion. (Carpenter and Riley 2019) This is a meaningful caution for the present analysis: to the extent that the LBBP transferred land into Tribal trust rather than to individual owners, its success cannot be evaluated on productivity grounds alone, and outcomes that appear suboptimal from a narrow efficiency perspective may reflect institutional commitments

that communities have reasons to value.

Taken together, this body of legal and institutional scholarship establishes that the LBBP operated within a layered institutional environment shaped by federal trusteeship, plenary congressional power, judicial interpretation, and tribal governance capacity. Whereas earlier legal scholarship documented the structural features of this environment, later contributions increasingly framed them in terms of the economic mechanisms that this paper seeks to examine empirically: incentive alignment, transaction costs, credible commitment, and the institutional foundations of productive land use. It is against this backdrop that the applied empirical literature on reservation land use and consolidation programs becomes directly relevant.

Empirical Analysis of Federal Indian Policy

The applied economic literature regarding land use policy on Native American Reservations focuses on a few primary areas. First, a series of papers examine the impact of property rights systems on agricultural outcomes. Terry Anderson and Dean Lueck use a linear regression model to estimate the differences in agricultural productivity between trust-owned reservation land and adjacent fee-simple parcels, estimating that tribal-trust land is about 85–90% less productive than fee-simple land (Anderson and Lueck 1992). Similarly, a 2018 case study showed that a similar result holds when using a spatial regression discontinuity design to analyze the Uintah Reservation in Utah. Comparing trust land to fee-simple land on either side of the reservation border, the authors found that tribal land is about 18% less likely to be irrigated than non-tribal land (Edwards, Ge, and Akhundjanov 2018).

Another important finding in the literature is the way that federal trust status impacts business investment on reservations. Using variation in property rights structures between the Agua Caliente tribe and non-Indians in Palm Springs, CA, Randall Akee and Miriam Jorgensen find that federal trust is insufficient to explain differences in business investment (Akee and Jorgensen 2014). This is an important finding because it highlights the limitations of defining property rights in economic development. Property rights are only one aspect of the set of crucial institutions that

can lead a nation down a path of economic growth, and these authors point out that policy makers who seek to improve business development on reservations will likely need to look at this broader set of institutional factors. Some such potential institutional factors include political legitimacy, the jurisdictional environment, and human capital development (Akee and Jorgensen 2014).

There are also indirect effects of property rights. In 2014, Fernando Aragon points out that there are positive spillover effects of property rights into other areas of the economy for First Nations Tribes (Aragon 2014). Using First Nation's treaties to measure the strength of property rights for certain tribes, he found positive impacts on real income, real wages, and housing costs that he attributes to positive demand shocks created by private property rights (Aragon 2014). Aragon and Anke Kessler provide additional evidence in 2020, using confidential census data to show that private ownership has positive impacts on income, homeownership rates, housing conditions and the band's public spending (Aragon and Kessler 2020).

While the econometric literature applied to Native American reservations is relatively limited in scope, similar institutional analysis is much more common in other development contexts. A few papers in particular lend strong empirical evidence to the broad notion that colonial institutions are destructive in the development process. Daron Acemoglu, Simon Johnson, and James Robinson show that the colonial origins of some European nations were accompanied by institutions which led to persistently high mortality rates (Acemoglu, Johnson, and Robinson 2001). These authors provide evidence that countries with stronger institutions, property rights, and less distortionary policy making tend to invest more in factors that drive economic development such as human capital (Acemoglu, Johnson, and Robinson 2001; Acemoglu and Johnson 2005). Channels such as human capital are crucial for development and cross-country institutional analysis has also provided strong evidence for the importance of social capital (Knack and Keefer 1997). Similarly, Abhijit Banerjee and Lakshmi Iyer show that the colonial land revenue system established by the British in colonial India saw lower rates of investment and productivity (Banerjee and Iyer 2005). Colonial land in this region was owned by appointed landlords and managed by natives, which led to poor institutions and incentives that were detrimental to development (Banerjee and Iyer 2005).

Poor institutions which benefit some at the expense of the socially optimal outcomes are difficult to fix. Melissa Dell points out that the associated institutions of colonial nations tend to result in the persistence of poverty (Dell 2010). The author argues that institutions which seek to extract wealth from the population instead of respecting the rights and property of individuals tend to prevent economic growth even long after colonial reign formally ends (Dell 2010). One major implication of this research is that, even with reforms and humanitarian aid, economic growth can still be significantly stunted by the persisting impacts of extractive institutions.

Other studies within the literature focus on a major subset of institutions: property rights. One major study in the literature examines the connection between the security of property rights and investment incentives by comparing regions in Ghana (Besley 1995). The author points out that Ghana is experiencing a transition from community-based land rights to individual-based land rights. The novelty of this study is that he contends with the endogeneity of property rights, as farmers are also incentivized to improve their land in order to improve their ownership rights. In order to circumvent this endogeneity and the possible reverse causality of his independent variable, he uses a set of instruments for property rights (Besley 1995). Although he finds significant variation in his estimates depending on the model, all of his estimates indicate a positive relationship between strengthened property rights and investment (Besley 1995).

Markus Goldstein and Christopher Udry provide additional evidence for the role of property rights in Ghana by showing that individuals with greater degrees of political power, who consequently have greater control and stronger property rights over their land, also make greater investments in agricultural productivity (Goldstein and Udry 2008). A farmer's expectations over his ownership of the rents resulting from his production are a crucial pathway to development. When farmers believe that their rents will be expropriated by those with political power, they will tend to invest less in their land. In the same way that Native American land owners subject to federal trust ownership tend to invest less in their agricultural land, the same economic mechanisms seem to reduce agricultural productivity in Ghana.

Global Land Consolidation Programs

Many of the land tenure challenges observed on Native American reservations are not unique to the United States. Comparative evidence from other countries shows that land fragmentation, restrictions on alienation, administrative oversight, and coordination failures often arise from distinct but structurally similar institutional arrangements. In a variety of settings, policy choices intended to promote equity, stability, or social cohesion have had unintended economic consequences. These settings include redistribution regimes, land-to-the-tiller reforms, inheritance systems under civil law, and hybrid customary-statutory tenure systems. Over time, such policies have generated long-run constraints on parcel size, market fluidity, and investment incentives. Although these institutional trajectories differ in historical origin and political context, they frequently produce economic patterns that mirror aspects of reservation land tenure: divided ownership, restricted alienation and encumbrance rights, coordination problems across parcels, and layered authority over land use decisions. Examining these global consolidation programs provides a useful comparative lens through which to evaluate how different institutional mechanisms address fragmentation and scale inefficiencies and how political, legal, and administrative structures condition their success.

A large body of empirical work from Asia, Europe, and Africa examines how governments have attempted to address structural constraints through land consolidation programs. In many cases, fragmentation emerged from redistributive reforms, partible inheritance regimes, or hybrid customary-statutory systems that divided ownership across multiple claimants. Subsequent consolidation initiatives sought to reorganize landholdings to improve agricultural productivity, reduce coordination costs, or modernize rural economies. The comparative experience of these programs provides insight into how institutional design, administrative capacity, and incentive structures condition the effectiveness of consolidation efforts. By examining these global cases, it becomes possible to distinguish between consolidation programs that enhanced productivity and those that displaced effective locally adapted institutional structures, offering a broader institutional context for evaluating land policy reforms in the United States.

Across much of Asia and Eastern Europe, contemporary land fragmentation traces its origins to mid-twentieth-century land redistribution reforms. “Land-to-the-tiller” programs in countries such as China, Vietnam, Taiwan, and Japan dismantled landlord systems and redistributed agricultural land across large numbers of rural households (Deininger and Jin 2006; Tan et al. 2006). While these reforms advanced egalitarian objectives, they often produced small and spatially scattered plots, generating highly fragmented farm structures. In China, post-collectivization reforms allocated land relatively equally across households under the Household Responsibility System, further contributing to fragmented holdings that later prompted government-led consolidation efforts (Tan et al. 2006). Empirical studies suggest that such consolidation can produce measurable productivity gains. For example, Liang and Zhou analyze fourteen major land consolidation projects implemented between 2007 and 2013 and find that they increased total agricultural output by 13.6 percent and per-unit yields by 4.2 percent (Liang and Zhou 2015). Similarly, Zhao et al. employ a difference-in-differences framework in Central China and show that consolidation reduced rural household vulnerability, indicating effects that extend beyond crop yields alone (Zhao et al. 2018). Finally, Wang et al. show that farmer participation in consolidation programs depends heavily on incentive compatibility, indicating that the design of compensation and participation mechanisms plays a critical role in determining whether consolidation efforts succeed (Wang et al. 2019).

Vietnam provides complementary panel evidence on the relationship between fragmentation and productivity. Nguyen and Warr characterize land consolidation as a form of technical change, finding that plot consolidation improved farm productivity by enabling more efficient input use (Nguyen and Warr 2020). Do et al. using household panel data, show that consolidation facilitated economies of scale and supported broader agricultural transformation (Do, Nguyen, and Grote 2023). Finally, Tran, Vu, and Goto analyze Vietnam’s plot-exchange policy and find that it substantially reduced labor allocated to crop production, although its effect on land productivity was statistically insignificant (Tran, Vu, and Goto 2022). Together, this literature indicates that redistribution-induced fragmentation can be partially reversed through institutional reforms that

enable exchange, clarify tenure, and reduce coordination constraints.

European cases illustrate similar dynamics, though rooted in different historical institutions. The Napoleonic Civil Code replaced primogeniture with partible inheritance, promoting equitable division among heirs but embedding progressive subdivision across generations (Grigg 1980). Medieval strip-farming systems in Germany and the Netherlands generated spatially scattered holdings that contributed to persistent land fragmentation (Sklenicka 2016). Administrative consolidation programs such as Germany's *Flurbereinigung* and the Netherlands' *Ruilverkaveling* sought to reconfigure parcel boundaries to create contiguous and economically viable holdings (Van den Noort 1987; Vitikainen 2004). These programs demonstrate that consolidation requires detailed cadastral systems, sustained administrative coordination, and legal mechanisms capable of restructuring ownership patterns.¹³

A number of economists have provided theoretical foundations for the possibility that land fragmentation may be adaptive under certain institutional and technological conditions. Early work in agricultural economics and economic history emphasized that fragmented holdings can function as a rational response to risk and land heterogeneity rather than simply reflecting inefficiency. Johnson argued that dividing land into multiple parcels can allow farmers to diversify production risk when plots differ in soil quality, irrigation access, or exposure to weather shocks (Johnson 1970). Similarly, McCloskey's analysis of European open-field agriculture demonstrated that the strip-based distribution of land across villages was not merely a historical accident but an institutional arrangement that allowed households to spread risk and participate in collective farming systems under conditions of uncertain yields and limited technology (McCloskey 1975). In these contexts, fragmentation could reduce the variance of farm output even if it imposed additional coordination or travel costs.

Later empirical and theoretical work reinforced the interpretation that land fragmentation

13. The claim that a functioning cadastral system is a prerequisite for land consolidation is broadly asserted in the land administration literature. Vitikainen (2004) documents the centrality of cadastral data across all procedural stages of consolidation in Germany and the Netherlands. This claim is also attributed to Williamson (1984) and cited in Bullard (2007).

may arise as a rational response to environmental and institutional conditions rather than simply reflecting inefficiency. Blarel et al. show that fragmentation can represent a response to variation in soil quality and production risk, noting that farmers may maintain multiple plots in order to diversify across land with different characteristics (Blarel et al. 1992). In such settings, dispersed holdings allow households to manage risk and exploit differences in land quality across plots, even though fragmentation may increase certain coordination or travel costs. From this perspective, policies that treat fragmentation as purely inefficient may overlook the locally adapted institutional and ecological factors shaping farmers' land-use decisions. Evidence from post-socialist Albania also illustrates this dynamic. Sikor, Müller, and Stahl find that fragmented landholdings often function as a strategy for spreading risk across plots that differ in soil quality and environmental conditions, and they caution that consolidation policies can misinterpret these adaptive practices when they assume fragmentation is simply a structural inefficiency (Sikor, Müller, and Stahl 2009).

In Rwanda, a related but distinct pattern emerged following colonial and post-colonial changes to land tenure institutions. Colonial statutory overlays altered customary tenure systems, and partible inheritance under conditions of rapid population growth contributed to increasing subdivision of holdings (Pottier 2006; Musahara and Huggins 2005). Evidence from Rwanda's Land Tenure Regularization Program (2004-2013) suggests that the productivity advantage of smaller farms largely reflects differences in labor allocation rather than intrinsic efficiency.¹⁴ In another paper, Nilsson finds a positive association between land-use consolidation policies and crop yields, though the estimated gains are concentrated among farms larger than one hectare, well above the national average farm size, and appear to depend on complementary inputs such as fertilizer and irrigation (Nilsson 2019).

Finally, Taiwan provides an example of how fractional ownership and coordinated land use can coexist within a single institutional arrangement. Vander Meer's case studies show that jointly owned plots can be consolidated operationally even when legal ownership remains divided

14. Using detailed plot-level data, Ali and Deininger show that once family labor is valued at market wages, profit per hectare is essentially identical across farm sizes, implying that policies such as subdivision restrictions or involuntary consolidation may generate few efficiency gains (Ali and Deininger 2015).

among multiple shareholders. Farmers sometimes allocate cultivation rights among co-owners so that divided shares are farmed as contiguous operational units, allowing agricultural production at scale without eliminating divided property rights (Vander Meer 1975). This arrangement illustrates that fragmentation in legal title does not necessarily imply fragmentation in agricultural production when institutional mechanisms allow coordinated management among co-owners.

Across these global cases, fragmentation frequently emerged from institutional reforms intended to promote equity or political stability. Consolidation programs have improved productivity in some settings, particularly where tenure is secure, participation is incentive-compatible, and administrative capacity is strong. In other contexts, however, consolidation efforts have failed to consider pre-existing cooperative arrangements. The comparative experience underscores that the economic consequences of land tenure systems depend less on formal redistribution alone and more on how legal, political, and administrative structures shape incentives for coordination, investment, and reorganization.

Synthesis and Research Gap

Taken together, the literature reviewed above highlights a consistent theme: institutions governing property rights play a central role in shaping economic incentives, land use decisions, and long-run development outcomes. Foundational contributions in institutional economics emphasize that clearly defined and enforceable property rights align incentives for investment and can support efficient resource allocation. Subsequent work provides evidence that these mechanisms operate not only through formal ownership structures but also through the broader institutional environment in which property rights are embedded, including political constraints, governance capacity, and administrative oversight.

Legal scholarship on federal Indian policy has documented how the trust doctrine, plenary congressional authority, and layered jurisdictional structures have produced a distinctive institutional environment for reservation land. These studies emphasize the historical and legal foundations of trusteeship and highlight the ways in which federal oversight shapes land governance,

resource management, and tribal sovereignty. Building on this legal framework, economic analyses have begun to translate these institutional features into measurable incentive effects, focusing particularly on agricultural productivity, capital constraints, and the transaction costs associated with trust land management.

The applied empirical literature provides evidence that property-rights structures influence economic outcomes on reservations. Studies comparing trust and fee-simple land often find lower levels of irrigation, investment, and agricultural productivity on trust land, suggesting that restrictions on alienation, collateralization, and land transfer may affect incentives for capital formation and scale efficiency. At the same time, other work highlights that property rights alone are insufficient to explain development outcomes, pointing to the importance of governance quality, political legitimacy, and institutional capacity in shaping economic performance within tribal nations.

Comparative evidence from land consolidation programs around the world adds an additional dimension to this discussion. In many countries, land fragmentation emerged from institutional reforms designed to promote equity or political stability, such as redistributive land reforms or partible inheritance systems. Governments have frequently responded with consolidation programs intended to reorganize parcels and improve agricultural productivity. While these initiatives sometimes generate measurable gains, their success varies substantially across institutional environments. The effectiveness of consolidation programs depends on factors such as tenure security, administrative capacity, incentive compatibility, and the broader governance framework within which land transactions occur.

Despite the breadth of this literature, several important gaps remain. First, much of the applied empirical research on reservation economies treats allotment and trust status as broad institutional categories. This work has pointed out that reservation land tenure differs in important ways from fee-simple property regimes, but it has generally been less precise about which specific features of the trust system drive empirical results. In particular, relatively little econometric work isolates fractionated ownership and the restrictions created by intestate heirship as distinct mechanisms through which the allotment system affects land use, investment, and productivity. These

features are central to the long-run operation of allotted land because they directly shape parcel-level decision costs, coordination problems among owners, and the feasibility of consolidation.

Second, while the comparative land-consolidation literature provides some evidence on consolidation programs in other institutional settings, this framework has rarely been brought into direct conversation with empirical work on Native American reservations. As a result, the reservation case is rarely analyzed alongside the broader empirical literature on land fragmentation and consolidation.

Finally, despite the policy significance of the *Cobell v. Salazar* settlement and the federal Land Buy-Back Program for Tribal Nations, there is no econometric evidence on the effects of the program itself. Existing discussions of the program have been primarily speculative or theoretical and have often focused on its administrative design, normative implications, or relationship to tribal sovereignty. What remains largely unanswered is whether the program measurably altered land use, agricultural outcomes, or other economic indicators in the areas it affected. This gap is particularly notable because some scholars and policy commentators have already begun advocating for renewed or expanded consolidation initiatives modeled on the program. For example, legal scholars have argued that Congress should authorize a successor program or extend federal buy-back authority in order to continue addressing the problem of fractionated heirship on reservation lands. (See, e.g., Conrad 2016) Without systematic empirical evaluation of the program's economic effects, however, these policy debates necessarily proceed with limited evidence regarding the conditions under which consolidation programs generate measurable improvements in land use or development outcomes for the individual Native Americans who are the residual claimants of land productivity.

The present study contributes to this literature by engaging with each of these gaps. Rather than treating reservation land tenure as a single undifferentiated institutional category, it focuses on a more specific mechanism within that system: fractionated ownership and the restrictions associated with heirship under trust tenure. It also brings the reservation case into closer dialogue with the broader literature on global land fragmentation and consolidation, emphasizing that the effects

of consolidation depend on the institutional environment in which it occurs. Finally, it provides an econometric analysis of the Land Buy-Back Program itself. By situating the program within both the institutional economics of property rights and the comparative literature on land consolidation, this paper seeks to clarify how institutional design shapes the economic consequences of attempted land reorganization on Native American reservations.

CHAPTER 4

THEORY

Institutional Tradeoffs and Persistent Underinvestment

This section develops a theory of land investment under alternative ownership and governance regimes. The central claim is that underinvestment can persist even when the tragedy of the anticommons is mitigated, because resolving coordination failures through institutional consolidation may introduce a distinct source of inefficiency: a principal-agent problem. In this sense, policies that replace fragmented individual ownership with centralized tribal ownership may trade one institutional inefficiency for another, rather than eliminating underinvestment altogether.

Under fractionated ownership, productive land use requires coordination among multiple undivided interest holders. While cooperative agreements could arise, such arrangements are limited by the transaction costs of organizing collective action. These coordination costs include negotiating agreements, enforcing commitments, and sustaining cooperation, which increase as the number of owners rises.

Coordination costs also arise from the need to secure consent among owners who may evaluate land-use changes differently. Depending on the proposed land use change, there are administrative requirements that require anywhere from majority to unanimous consent. Thus, even when bargaining complexity alone is not prohibitive, differences in perceived risk, expected returns, or preference heterogeneity can raise the costs of reaching agreement when each owner holds an exclusion right. In such settings, the exercise of veto power based on heterogeneous preferences may delay or block value-enhancing investments despite positive net surplus.

As emphasized in the anticommons literature, underinvestment therefore reflects the presence of positive transaction costs in coordinating among dispersed exclusion rights, rather than the absence of productive opportunities. When agreement is required, underinvestment emerges as a stable outcome that would disappear only in a world of costless bargaining.

This theory compares investment incentives across three institutional benchmarks. First,

under uncoordinated fractionated ownership, individual owners choose investments non-cooperatively, internalizing only a share of the marginal returns and underinvesting relative to the unified ownership benchmark. Second, under centralized tribal ownership, consolidation reduces coordination failures but delegates land-use decisions to tribal decision-makers who do not fully internalize residual returns, introducing agency costs that may distort investment incentives. Third, a unified owner internalizes all marginal benefits and costs, providing the first-best investment benchmark.

By contrasting these regimes, the model highlights how underinvestment may persist even after ownership consolidation. Eliminating coordination failures does not guarantee efficient land use if incentive alignment between residual claimants and decision-makers remains incomplete.

Potential Social Gains From Consolidation into Tribal Ownership

This framework abstracts from the possibility that consolidation alters the underlying technology set or expands the feasible set of land-use projects. Formally, let the production technology be represented by a value function $V(X)$, where X denotes aggregate investment intensity. The technology is assumed to be a smooth, convex function that is independent of parcel configuration, ownership contiguity, or coordinated management across adjacent tracts. Ownership structure affects incentive provision but does not change the attainable production frontier.

All costs and benefits are assumed to be fully internalized by a unified decision-maker. That is, there are no unrealized gains from consolidating adjacent parcels which may be feasible through land consolidation programs but not by individual coordination. Under these assumptions, incomplete ownership primarily generates incentive distortions (e.g., underinvestment due to coordination failures or agency costs) but does not eliminate socially valuable projects from the feasible set. Consolidation can therefore mitigate investment distortions but cannot generate new sources of surplus.

These assumptions may fail in environments with complementarities across parcels, non-convexities in production, or externalities that are difficult to contract upon. If production exhibits complementarity across adjacent tracts, or if certain land uses require minimum scale or unified

planning, fragmented ownership may shrink the implementable set of projects rather than merely distort investment intensity. For instance, in the presence of transaction costs, bargaining may fail to realize cross-parcel benefits, leading to inefficient non-adoption of socially valuable projects. (Coase 1960)

In such cases, consolidation into tribal ownership may relax contracting frictions, expand the implementable set of land uses, and generate net social gains even if agency costs persist. While consolidation could, in principle, increase total surplus by enabling coordinated land use, the empirical results of minimum extensive margin land use changes seen in Table 5 suggest that any such gains are not large relative to program costs in the context examined here.

Fractionation and Underinvestment

Consider a parcel of land jointly owned by $n \geq 2$ individuals, indexed by $i \in \{1, \dots, n\}$. Each owner chooses an investment level $x_i \geq 0$ in land improvements that raise the productive value of the parcel. Total land quality is

$$X = \sum_{i=1}^n x_i.$$

Land quality generates stochastic net returns. Let realized output be

$$y = V(X) + \varepsilon,$$

where ε captures exogenous productivity shocks (e.g., weather, prices, etc.) and $E[\varepsilon] = 0$. Since agents maximize expected payoffs, expected output is $E[y] = V(X)$, so the stochastic component does not affect optimality conditions. Assume

$$V'(X) > 0, \quad V''(X) < 0,$$

so investment raises expected returns with diminishing marginal benefits.

Ownership shares are equal, so each owner receives $1/n$ of output. Each owner bears the full cost of their own investment $C(x_i)$, with

$$C'(x_i) > 0, \quad C''(x_i) \geq 0.$$

Individual Optimization under Fractionation

Investment decisions are modeled as a simultaneous-move game among co-owners. Each owner chooses investment taking the decisions of all other owners as given, so a Nash equilibrium is therefore defined as a profile of investments $\{x_i\}_{i=1}^n$ such that no owner can increase expected payoff by unilaterally changing their own investment choice. Existence and uniqueness of an equilibrium are ensured under the maintained assumptions that $V(x_i)$ is increasing and strictly concave, $C(x_i)$ is increasing and weakly convex, and strategy sets satisfy $x_i \geq 0$.

Owner i chooses x_i taking the investment of others, x_{-i} , as given:

$$\max_{x_i \geq 0} E[u_i(x_i, x_{-i})] = \frac{1}{n} V \left(\sum_{j=1}^n x_j \right) - C(x_i).$$

For an interior solution, the first-order condition is

$$\frac{1}{n} V'(X) - C'(x_i) = 0,$$

or

$$C'(x_i) = \frac{1}{n} V'(X).$$

In a symmetric fractionation equilibrium where $x_i = x^F$ for all i , total investment is $X^F = nx^F$ and the equilibrium condition becomes

$$C'(x^F) = \frac{1}{n} V'(nx^F).$$

Unified Ownership

A unified owner chooses $\{x_i\}_{i=1}^n$ to maximize expected total surplus:

$$\max_{x_1, \dots, x_n \geq 0} E[W] = V \left(\sum_{i=1}^n x_i \right) \left(- \sum_{i=1}^n C(x_i) \right).$$

The first-order condition for each i is

$$V'(X) - C'(x_i) = 0,$$

so

$$C'(x_i) = V'(X).$$

Under symmetry ($x_i = x^U$ for all i), $X^U = nx^U$ and

$$C'(x^U) = V'(nx^U).$$

Underinvestment from Fractionation

Comparing the fractionated equilibrium and the unified ownership benchmark,

$$C'(x^F) = \frac{1}{n} V'(nx^F) \quad \text{versus} \quad C'(x^U) = V'(nx^U),$$

each owner internalizes only a $1/n$ share of the marginal benefit created by their investment. As n increases, private marginal benefits shrink relative to social marginal benefits, strengthening free-riding incentives and reducing equilibrium investment.

With diminishing marginal benefits and non-decreasing marginal costs, this implies

$$x^F < x^U, \quad X^F < X^U.$$

Thus, fractionated ownership with lack of coordination leads to systematic underinvest-

ment in land improvements, and greater fractionation (larger n) increases the severity of underinvestment.

Agency Costs under Tribal Ownership

To compare fractionated ownership to tribal ownership, let $X \geq 0$ again denote land improvement intensity. Expected land returns remain $V(X)$.

Under tribal ownership, X is chosen by a centralized tribal government, denoted TG , that is not necessarily the residual claimant.

Actors and Payoffs

The tribal government (TG) chooses X at cost $C(X)$. Tribal members are the residual claimants and receive expected land returns net of administrative and governance costs.

Let s denote a fixed component of compensation and let $\beta \in [0, 1]$ capture the extent to which the tribal government internalizes improvements in land value. The parameter β reflects institutional features such as political accountability, administrative incentives, and the degree to which decision-makers benefit from improvements in land productivity.

The council's effective payoff can therefore be written as

$$U_{TG} = s + \beta V(X) - C(X).$$

Tribal Government's Problem

Taking the institutional environment (s, β) as given, the tribal government chooses investment according to

$$\max_{X \geq 0} s + \beta V(X) - C(X),$$

with first-order condition

$$\beta V'(X^{TG}) = C'(X^{TG}).$$

Agency-Induced Underinvestment

Comparing the tribal government's first-order condition,

$$\beta V'(X^{TG}) = C'(X^{TG}),$$

to the unified ownership benchmark,

$$V'(X^U) = C'(X^U),$$

shows that tribal ownership is equivalent to unified ownership only when $\beta = 1$. In that case, the government fully internalizes marginal land returns and $X^{TG} = X^U$.

When $\beta < 1$, political, administrative, or institutional constraints weaken the link between land productivity and decision-maker payoffs. As a result, the government internalizes only a fraction of the marginal benefit from investment, implying

$$X^{TG} < X^U.$$

Thus, consolidation into tribal ownership may mitigate coordination failures associated with fractionation, but it can replace these distortions with agency-induced underinvestment.¹⁵

Comparison Across Institutional Structures

Across the different ownership structures, investment incentives depend on how strongly the decision-maker internalizes marginal returns to land quality. Under fractionated ownership, individual owners internalize only a fraction of the marginal benefit, leading to diluted incentives and underinvestment that worsens with increased fractionation. Under tribal ownership, coordination failures are reduced, but investment remains inefficient unless the tribal government fully

15. As a simplification, this model assumes that fractionated shares are fully consolidated prior to transfer into Tribal Government ownership. In reality, most tracts are only partially consolidated. Thus, it is likely that most tracts experience compounding underinvestment through the anticommons tragedy of fractionated ownership *and* the principle-agent problem of Tribal Government ownership.

internalizes land returns ($\beta = 1$). By contrast, a unified owner internalizes all marginal benefits and costs, achieving the first-best outcome.

Taken together, these results show that consolidation alone does not guarantee efficient land use, as shown in Figure 3. Fractionation generates underinvestment through coordination failures, while centralized governance may generate underinvestment through agency costs. Efficient land investment therefore requires not only the reduction of coordination costs, but also institutional arrangements that align decision-making authority with residual claimants.

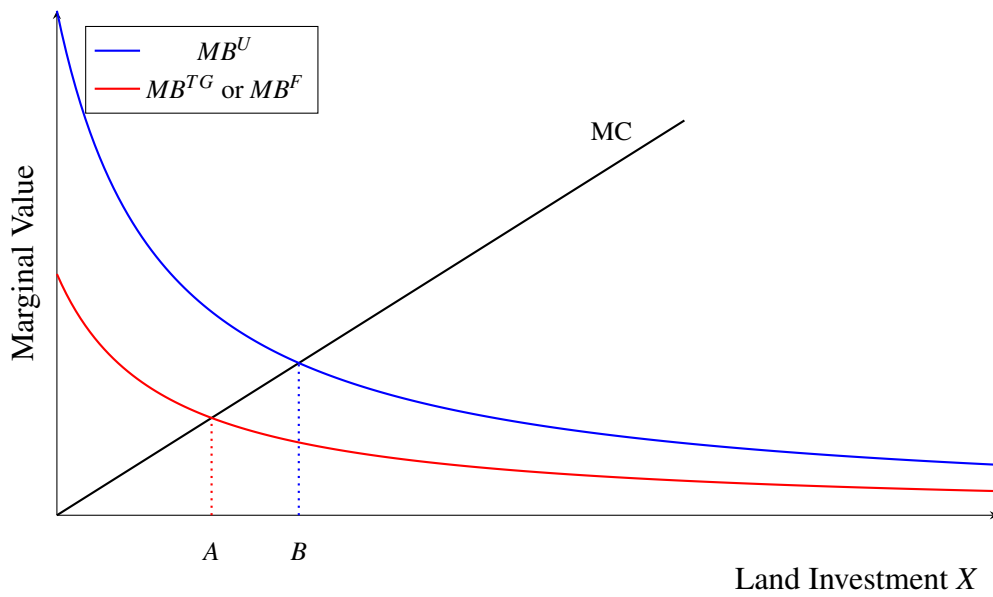


Figure 3. Graphical Illustration of Underinvestment

Figure 3 Interpretation

In Figure 3, Both MB curves are downward sloping and approach zero as investment increases. Point A denotes the equilibrium investment level under tribal government ownership (MB^{TG}) or fractionated ownership (MB^F), where the effective marginal benefit is lower due to agency costs or coordination failures. Point B denotes the higher equilibrium investment level achieved under unified ownership (MB^U), where the full marginal benefit of land investment is internalized. The gap between A and B illustrates the investment distortion introduced by either fractionation or incomplete incentive alignment under centralized governance.

Trust Status and the Marginal Cost Curve

Finally, it is important to note that the marginal cost curve itself is shaped by institutional constraints that raise the cost of investment on trust land relative to fee-simple land. Under the federal trust system, many land-use decisions require administrative approval. This approval process introduces delays, uncertainty, and compliance costs that effectively increase the marginal cost of implementing improvements (Royster 1994; Anderson 2002; Shoemaker 2017). In addition, trust land is substantially restricted in its use as collateral, limiting access to credit and raising the effective cost of borrowing for investment (Trosper 1978). Capital-intensive improvements therefore become more expensive or infeasible relative to comparable investments on fee-simple land. A range of additional bureaucratic constraints including lease approval requirements, regulatory reviews, and administrative oversight further increase transaction and implementation costs (McChesney 1990).

In the model, these factors can be interpreted as increasing the slope of the marginal cost curve, thereby reducing investment even when marginal benefits are unchanged. Consequently, underinvestment may persist not only because decision-makers fail to fully internalize returns, but also because institutional arrangements governing trust land directly raise the cost of investment itself. Even under unified ownership, one would expect a lower level of land investment on reservations relative to non-reservation land as a consequence of the transaction costs imposed by the federal government and BIA.

CHAPTER 5

DATA

This analysis combines data from the Land Buy-Back Final Implementation Report produced by the Bureau of Indian Affairs with spatial land cover data from the Cropland Data Layer. The unit of analysis is reservation-year, combining the equivalent acres purchased on each reservation with land cover percentages for the years 2008-2023 in order to measure the impact of land consolidation on changes in high-value crop percentages.

Outcome variables are constructed using the Cropland Data Layer (CDL), an annual, satellite-based land-cover raster providing crop and land-use classifications at 30-meter spatial resolution across the United States. These raster data are spatially intersected with reservation and trust-land boundaries obtained from TIGER/Line shapefiles and associated geographic databases for American Indian areas produced by the U.S. Census Bureau. This spatial overlay assigns land-cover classifications to areas within reservation boundaries for each year. Pixel-level classifications are then aggregated to the reservation level to compute the relative percentage of land allocated to each land-use category, forming the reservation-year outcome measures used in the analysis. Aggregating to the reservation level is a necessity driven by reservation-level reporting in the Land Buy-Back Program Final Implementation Report (U.S. Department of the Interior 2023), but also addresses a potential concern about selection at the parcel level: because the LBBP consolidates specific fractional interests rather than randomly selected parcels, parcel-level outcomes could reflect compositional differences in which tracts were targeted for purchase. By averaging land-use outcomes across the entire reservation, the analysis avoids conflating treatment-induced land-use changes with pre-existing differences in the characteristics of consolidated parcels.

The outcome variable, high-value crops, are defined as being above the median market value defined by the USDA National Agricultural Statistics Service. "High-value crops" generally include crops such as fruit and nuts, while "low-value crops" tend to include crops such as grains and corn. Specific crop baskets can be found in Table 12. I also conducted my analysis after re-

defining my high-value crop basket to include the “Three Sisters” crops (corn, beans, and squash), which hold cultural significance across many Native American communities. The results of triple difference regressions on culturally significant crop baskets are reported in Table 13 and reflect similar results as crop baskets defined by market value.

The Bureau of Indian Affairs (BIA) organizes federally recognized reservations into twelve administrative regions. One of these regions, Alaska, is excluded from the analysis as this paper only examines reservations contained within the contiguous United States. These regions are not arbitrary geographic divisions; rather, they reflect long-standing administrative jurisdictions used for federal oversight, resource management, land administration, and service delivery. Regional groupings correspond to historical agency boundaries, including areas such as the Great Plains, Northwest, Pacific, Southwest, and Navajo regions. Because these designations structure how reservations are governed and supported at the federal level, they provide a natural starting point for examining regional heterogeneity in policy effects.

Figure 4 displays reservations grouped according to their original BIA regional classifications. Using the BIA’s administrative boundaries allows for estimates that align with the federal government’s operational structure. Reporting results at this level provides insight into whether treatment effects differ across the administrative regions that directly manage tribal lands and programs. However, as discussed below, substantial variation in the number of participating reservations across BIA regions necessitates broader aggregation for econometric reliability.

Although the BIA maintains twelve administrative regions, many contain too few participating reservations to support reliable region-specific estimation. In particular, some regions include only a single reservation in the analytic sample. For example, the Navajo BIA region consists solely of the Navajo Nation. Full regional sample sizes are found in Table 1. When a region contains only one treated unit (or very few treated and untreated units observed over time) the Callaway-Sant’Anna (2021) difference-in-differences (DiD) framework cannot generate stable or credible treatment effect estimates. Small sample sizes lead to imprecise estimates and make it difficult to distinguish regional effects from reservation-specific characteristics.

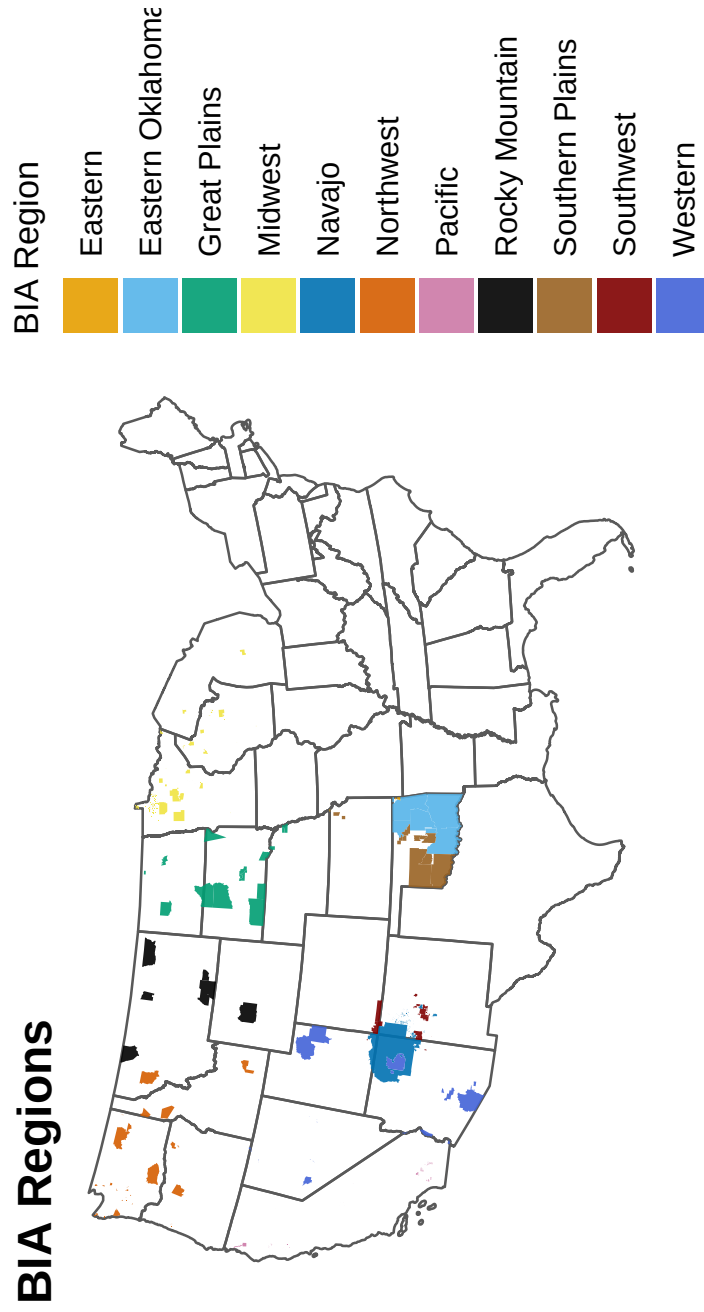


Figure 4. BIA Regions

Table 1. Regional Sample Sizes

Region	Total	Treated	Untreated
Broad Regional Categories			
Pacific Northwest	59	21	38
SW + Southern Plains/OK	45	7	38
Northern Plains	39	24	15
BIA Regions			
Pacific	31	7	24
Northwest	28	14	14
Midwest	19	4	15
Great Plains	14	14	0
Southern Plains	12	3	9
Western	12	1	11
Eastern Oklahoma	7	2	5
Southwest	7	0	7
Eastern	5	0	5
Rocky Mountain	6	6	0
Navajo	1	1	0
Total	143	52	91

Notes: “Treated” indicates reservations with any Equivalent Acres Purchased (EAP) > 0 in the panel (ever treated).

To address this limitation, reservations are aggregated into broader regional categories, as shown in Figure 5. Regions with similar land characteristics, production systems, and geographic proximity are combined into three broader groupings: Northern Plains; Pacific Northwest; and Southwest and Southern Plains/Oklahoma (SW + Southern Plains/OK). This aggregation increases within-region sample sizes, ensuring adequate numbers of treated and untreated reservations across cohorts while preserving meaningful geographic and economic variation. Certain BIA regions are excluded entirely from the analysis when they contain no reservations participating in the LBB Program. This broader classification therefore balances administrative relevance with the statistical requirements necessary for credible regional inference.

Broad Regional Groupings

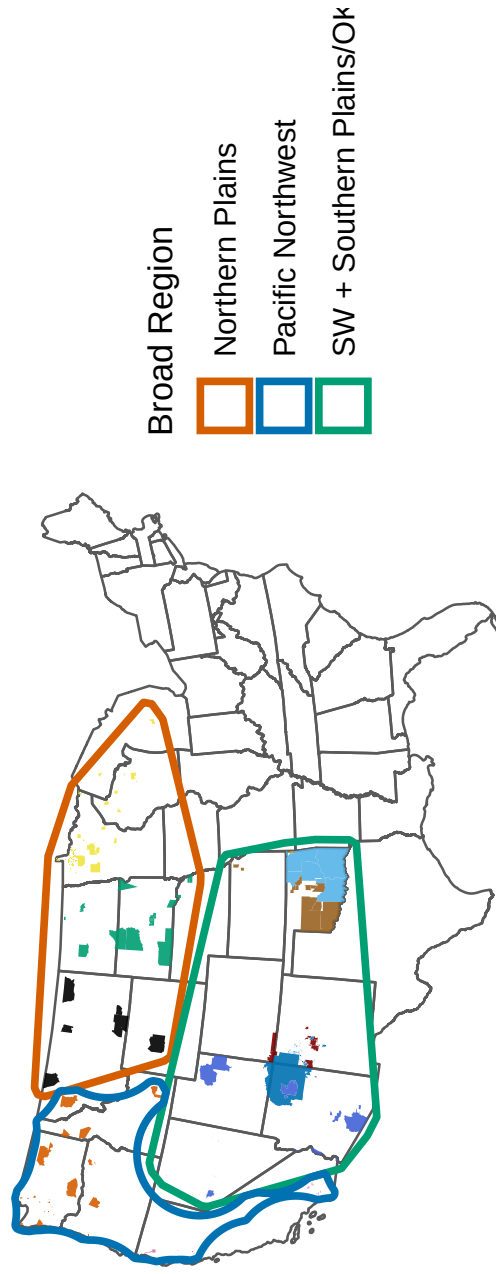


Figure 5. Broad Region Groups Used in Analysis

Independent variable construction relies on the Bureau of Indian Affairs Land Buy-Back Program Final Implementation Report, which identifies reservations targeted for ownership consolidation and reports program outcomes. The analysis uses the report's measure of Equivalent Acres Purchased (EAP) to assign treatment status to participating reservations. The report identifies 143 reservations as priority locations for consolidation, but only 52 ultimately received purchases due to time and resource constraints. EAP measures the effective acreage consolidated by scaling the acreage of acquired tracts by the fraction of undivided ownership interests sold, thereby estimating the extent to which fractionated ownership was actually reduced rather than simply the gross acreage transacted.

Treated reservations are grouped into two treatment cohorts, those treated in or before 2016 and those treated after 2016. This cohort structure reflects data constraints, as the Final Implementation Report does not provide exact treatment years for reservations that were consolidated only once. However, annual BIA LBB program status reports exist for 2014-2016, allowing identification of whether treatment occurred prior to or after 2016 and enabling implementation of a Callaway-Sant'Anna (2021) staggered difference-in-differences framework. The 2016 threshold also aligns with the adoption of appraisal reform recommendations issued by The Appraisal Foundation, providing a plausibly exogenous timing break that permits examination of how changes in valuation practices may have influenced consolidation patterns and subsequent land-use responses.

The Land Buy-Back Program Final Implementation Report (U.S. Department of the Interior 2023) acknowledges 146 Tribal governments that participated in consultations or program implementation activities. Because the spatial analysis in this paper is conducted at the reservation boundary level, the empirical sample is defined in terms of reservation polygons rather than Tribal governments. In a small number of cases, multiple federally recognized tribes share a single reservation boundary. The most prominent example is the Wind River Reservation in Wyoming, which is jointly inhabited by the Eastern Shoshone Tribe and the Northern Arapaho Tribe. In the consultation list these tribes appear as separate governments, but they correspond to a single reservation unit in the spatial data. Consequently, the consultation list cannot be mapped one-to-one to

reservation-level observations.

After reconciling Tribal government names in the Final Implementation Report with reservation boundaries in the Census Bureau's TIGER/Line American Indian Area shapefiles, the spatial dataset contains 143 unique reservations within the contiguous United States that appear in the Land Buy-Back program records. These reservations form the base panel for the empirical analysis.

The intensive margin outcome variables require that cropland be present within the reservation boundary in order to compute crop shares. Because these measures are ratios of crop area to total cropland area, the share is undefined when cropland is equal to zero. One reservation in the spatial dataset, Blue Lake Rancheria in California, contains no cropland pixels inside the reservation boundary in any year of the Cropland Data Layer. As a result, the high-value crop share cannot be computed for this reservation. Blue Lake Rancheria is therefore excluded from intensive-margin specifications that rely on cropland shares.

CHAPTER 6

EMPIRICAL STRATEGY

Identification Framework

This section outlines an empirical strategy designed to isolate the causal effect of the LBBP on agricultural land-use decisions. Identification relies on a triple-difference (DDD) framework that exploits variation across time, space, and treatment status to separate consolidation effects from broader agricultural trends.

The DDD specification differences outcomes over time (pre vs. post), across treatment status (treated vs. untreated reservations), and across space (inside reservation boundaries relative to a 5-mile surrounding border). Under the identifying assumptions discussed below, this design isolates changes in crop composition attributable to institutional consolidation rather than to underlying land quality, regional agricultural shocks, or pre-existing trends.

Identifying Assumptions

Since the triple-difference specification is implemented on the inside-outside land use percentage gap, identification rests on four assumptions, each of which is discussed in turn and assessed using available evidence.¹⁶

Assumption 1: Parallel trends in the inside–outside gap across treated and untreated reservations.

The first assumption requires that, absent the LBBP, the trajectory of the high-value crop gap Z_{it} on treated reservations would have evolved along the same path as on untreated reservations. This is stronger than a standard parallel trends assumption: it requires not merely that inside outcomes trend similarly, but that the *difference* between inside and outside does so.

16. These identifying assumptions generally follow the logic of the triple-difference framework developed by Gruber (1994). In a DDD design, identification relies on the same conditions required for standard difference-in-differences. Most importantly, the absence of differential shocks and parallel trends, while the additional differencing dimension is intended to remove confounding factors that vary along one dimension of the data. In this setting, comparing outcomes inside reservations to those in nearby border areas helps difference out regional agricultural shocks, while untreated reservations provide a counterfactual for broader time trends affecting reservation agriculture.

Figures 6 - 13 present event-study estimates of the dynamic triple-difference coefficients relative to the year prior to initial consolidation on the intensive margin. The pre-treatment coefficients fluctuate around zero and are statistically indistinguishable from zero across leads. There is no evidence of a systematic upward or downward trend in the inside-outside high-value gap prior to treatment. This absence of pre-trends supports the parallel trends assumption.

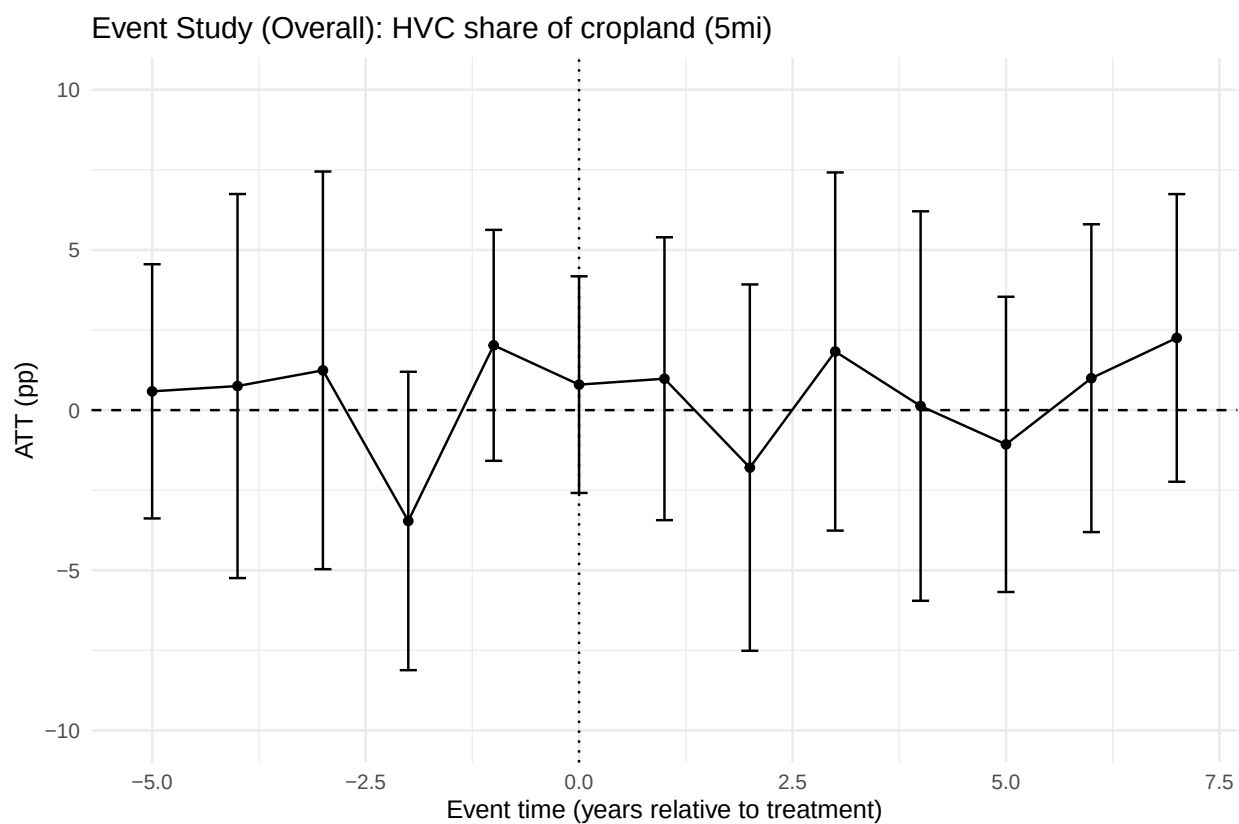


Figure 6. Triple Difference Event Study on High-Value Crop Gap. Coefficients in the pre-period (years < 0) are statistically indistinguishable from zero, supporting the parallel trends assumption required for a causal interpretation of the post-period estimates.

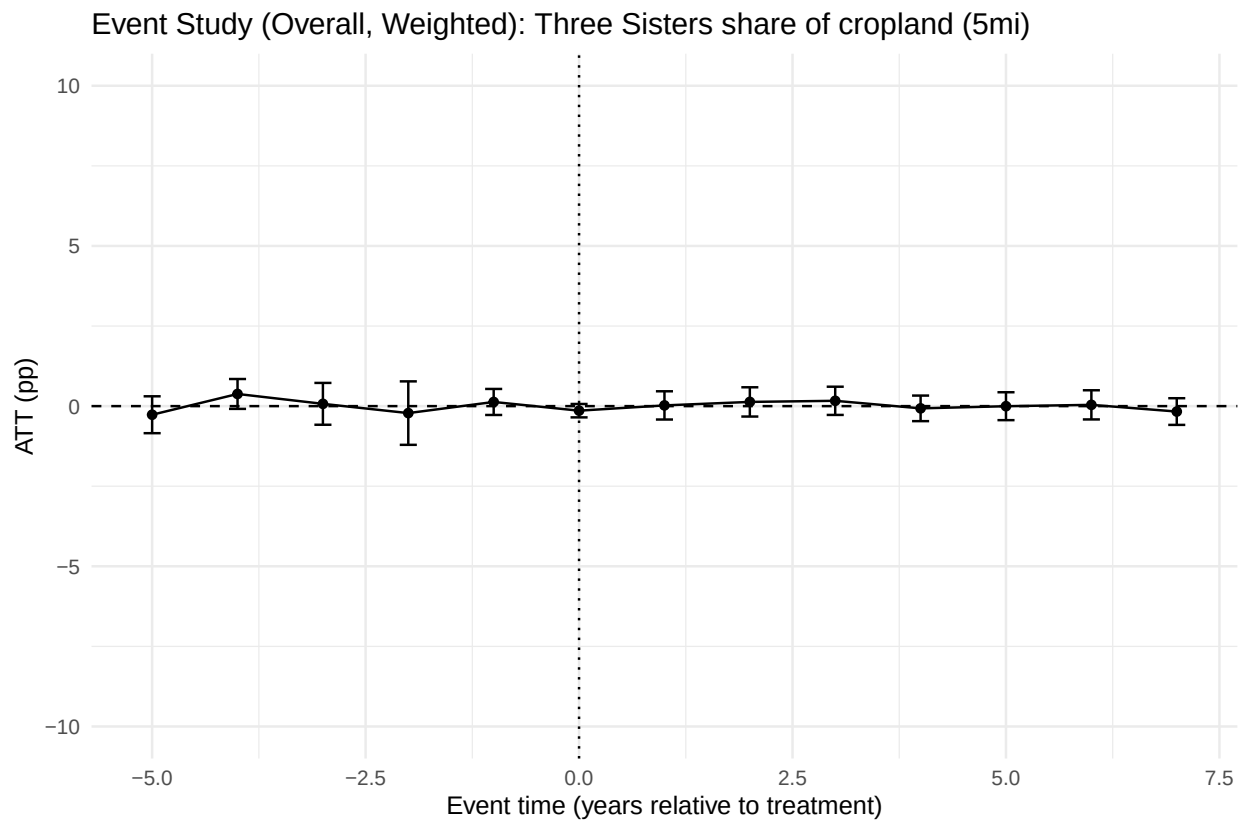


Figure 7. Triple Difference Event Study on “Three Sisters” Crop Gap. Coefficients in the pre-period (years < 0) are statistically indistinguishable from zero, supporting the parallel trends assumption required for a causal interpretation of the post-period estimates.

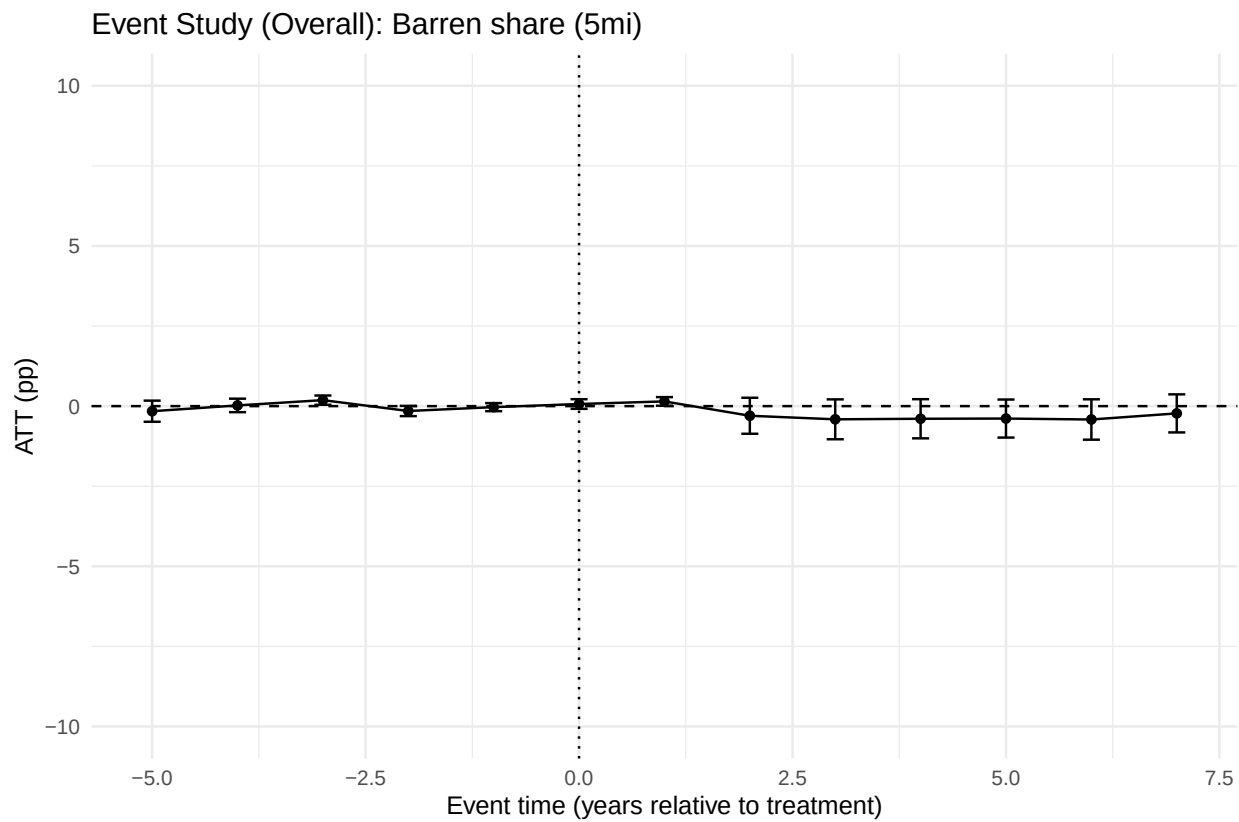


Figure 8. Triple Difference Event Study on Barren Land Gap. Coefficients in the pre-period (years < 0) are statistically indistinguishable from zero, supporting the parallel trends assumption required for a causal interpretation of the post-period estimates.

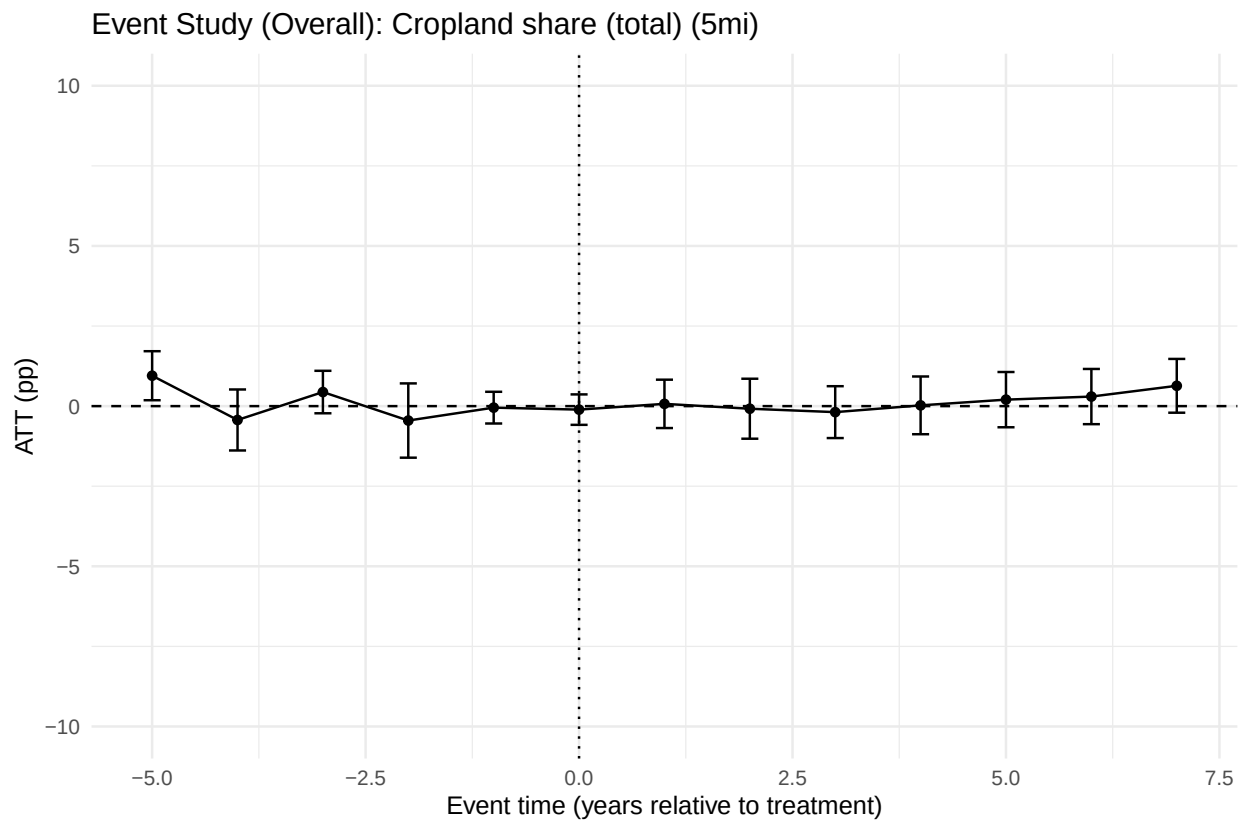


Figure 9. Triple Difference Event Study on Total Cropland Gap. Coefficients in the pre-period (years < 0) are statistically indistinguishable from zero, supporting the parallel trends assumption required for a causal interpretation of the post-period estimates.

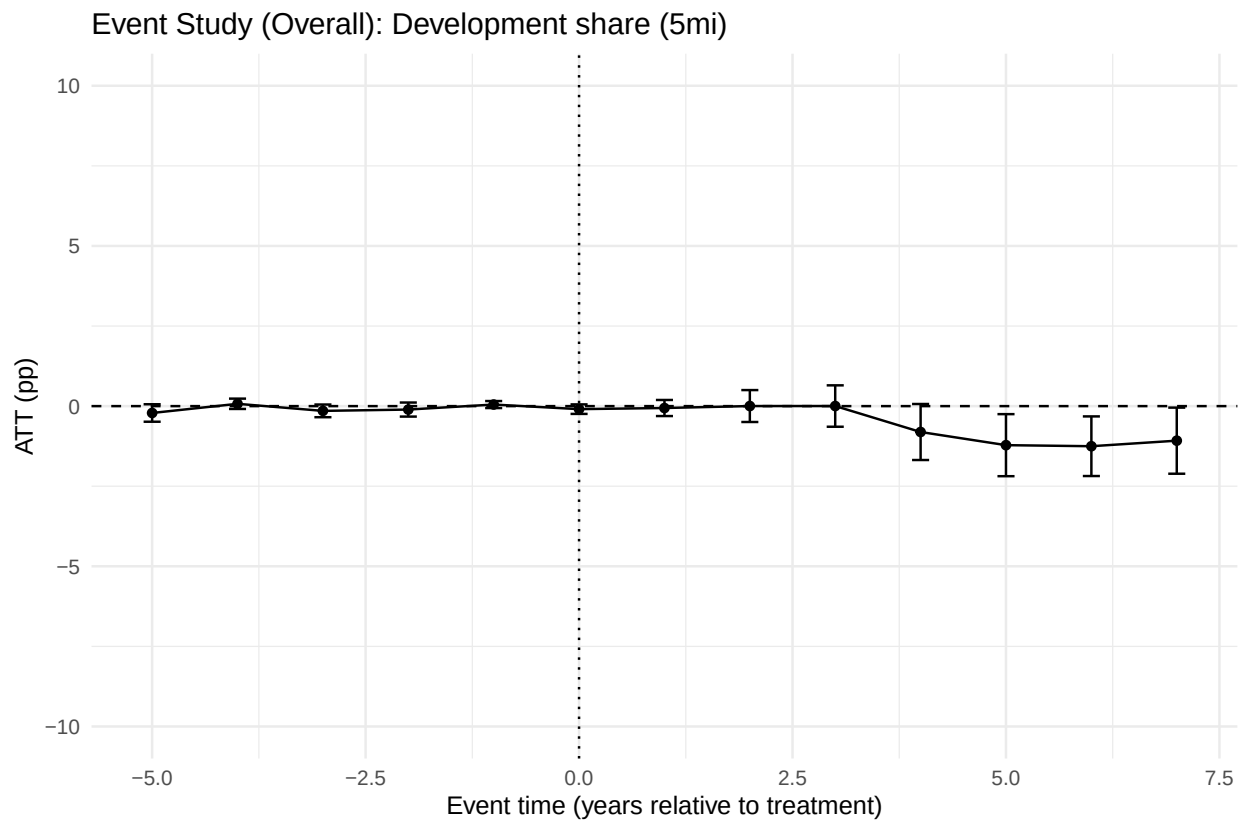


Figure 10. Triple Difference Event Study on Developed Land Gap. Coefficients in the pre-period (years < 0) are statistically indistinguishable from zero, supporting the parallel trends assumption required for a causal interpretation of the post-period estimates.

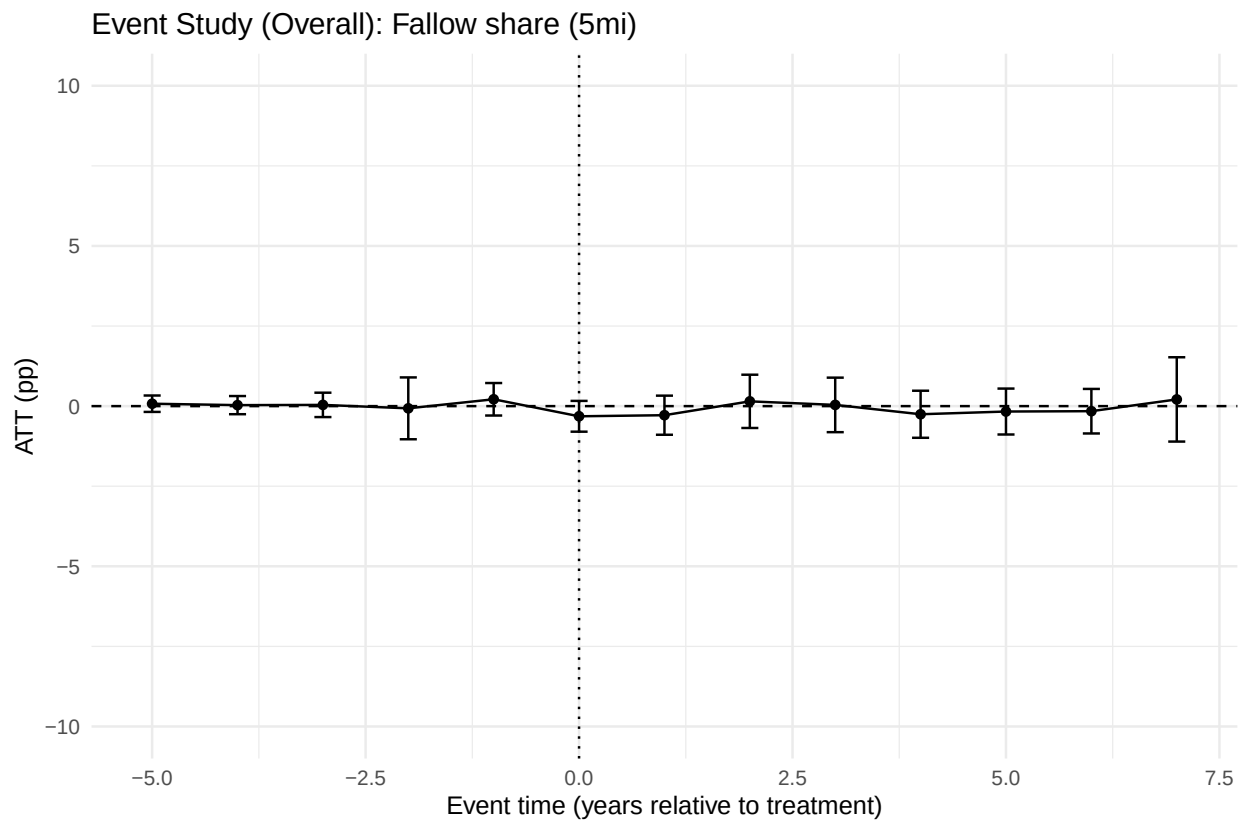


Figure 11. Triple Difference Event Study on Fallow Land Gap. Coefficients in the pre-period (years < 0) are statistically indistinguishable from zero, supporting the parallel trends assumption required for a causal interpretation of the post-period estimates.

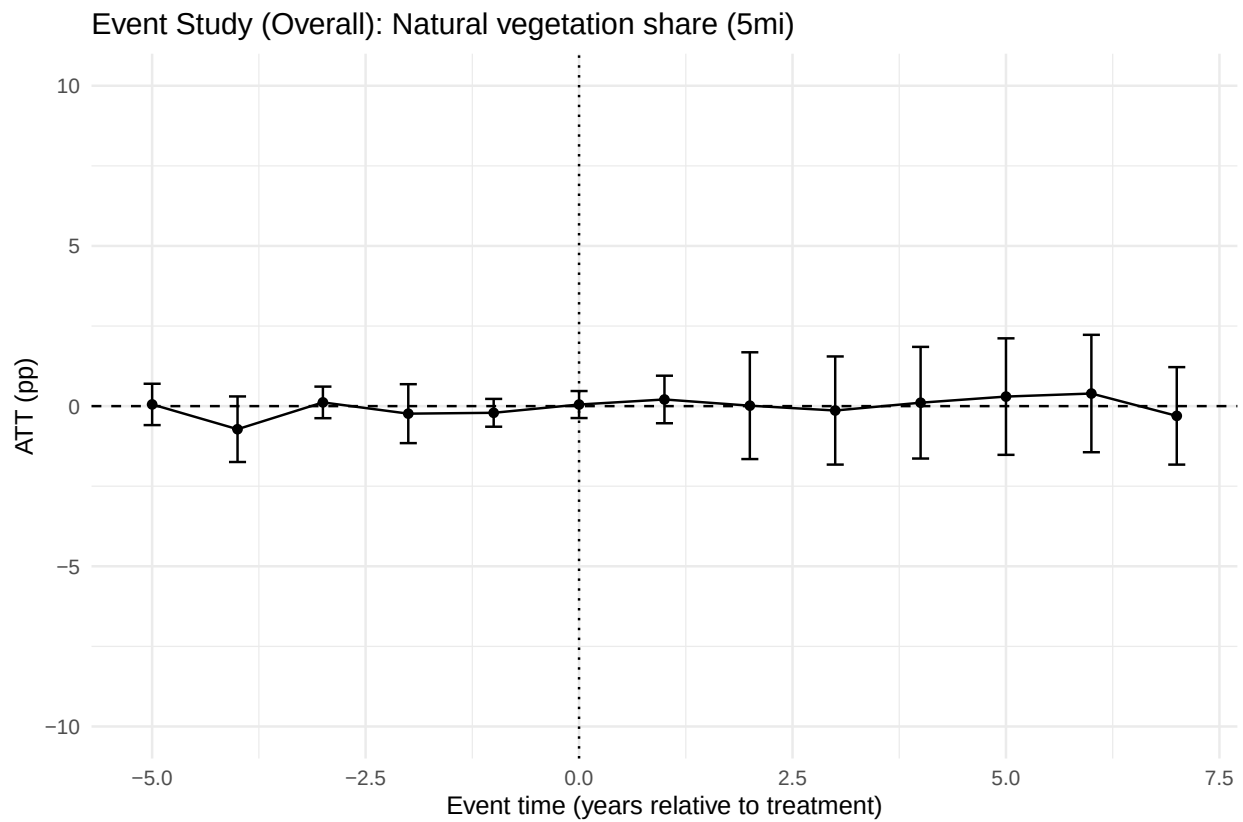


Figure 13. Triple Difference Event Study on Natural Vegetation Gap. Coefficients in the pre-period (years < 0) are statistically indistinguishable from zero, supporting the parallel trends assumption required for a causal interpretation of the post-period estimates.

Assumption 2: Untreated reservations serve as valid counterfactuals for treated reservations.

Identification requires that untreated reservations credibly represent what would have happened to treated reservations in the absence of consolidation. A key threat would arise if the Bureau of Indian Affairs selected reservations for early consolidation based on anticipated agricultural trajectories. Table 2 evaluates this condition using pre-treatment characteristics and reports standardized differences in means between treated and untreated reservations.¹⁷

A potential concern is that treated reservations exhibited substantially higher baseline fractionation than untreated reservations, with a standardized difference of 0.68 in the share of acres held in fractionated ownership. However, this difference is less problematic than it might initially appear if transaction costs of land-use coordination are nonlinear in fractionation severity, such as if coordination costs rise steeply as fractionation increases but flatten once ownership reaches a threshold where coordination becomes effectively impossible regardless of the precise fractionation level. Under this view, what matters for land-use outcomes is not the exact degree of fractionation but whether a reservation has crossed into a high-transaction-cost regime in which consolidation of any meaningful scale would be necessary to restore productive use. The BIA's own administrative process provides support for this interpretation: untreated reservations were explicitly identified as requiring intervention, indicating that they too had approached the threshold at which fractionation severely constrains coordination. The difference between treated and untreated reservations is then best understood as one of degree within a shared condition of severe fractionation, rather than a qualitative difference in land-tenure regime.

Aside from pre-existing levels of fractionation, differences in underlying ownership structure are modest. The shares of land held in individual fee, restricted, and trust status display standardized differences ranging roughly from 0.05 to 0.24. Critically, the distinction between restricted and trust status is of limited institutional relevance here: both tenure types impose similar

17. Standardized differences in means provide a scale-invariant measure of balance between treated and control groups and are commonly used in causal inference to assess comparability of baseline characteristics. Following Austin (2009), absolute standardized differences below approximately 0.1 are typically interpreted as negligible imbalance, while values between 0.1 and 0.25 indicate small differences and larger values suggest more substantial imbalance.

constraints on alienation and encumbrance, and fractionation operates similarly under each. The more meaningful comparison is therefore between fee and trust/restricted land, where differences are small.

Fractionation levels do differ substantially across treated and untreated reservations. However, this difference cuts in a predictable direction: treated reservations entered the program with more severely fractionated ownership, meaning the estimated effects likely represent an upper bound on policy effectiveness relative to reservations with lower baseline fractionation.

Land-use composition are also compared. While treated reservations, on average, tend to experience lower levels of high-value crops, this also suggests that estimated effects are an upper bound of policy impacts.

Taken together, these patterns support the interpretation that untreated reservations provide a plausible counterfactual for the evolution of land use in the absence of the Land Buy-Back Program.

Table 2. Selected Summary Statistics: Treated vs. Untreated Reservations

Variable	Treated Reservations					Untreated Reservations					Standardized	
	Mean	Median	Min	Max	SD	Mean	Median	Min	Max	SD	Diff. in Means	
% of Acres Fractionated Pre-Treatment	19	17	0	81	16	9	3	0	88	14		0.68
Ownership % – Individual (Fee)	4	2	0	35	6	4	1	0	44	7		0.05
Ownership % – Individual (Restricted)	6	0	0	51	13	4	0	0	49	11		0.17
Ownership % – Individual (Trust)	23	16	0	70	18	17	7	0	85	24		0.24
Ownership % – Tribal (Fee)	0	0	0	2	0	0	0	0	6	1		-0.04
Ownership % – Tribal (Restricted)	1	0	0	15	2	1	0	0	47	6		-0.07
Ownership % – Tribal (Trust)	66	70	9	96	23	73	85	0	100	29		-0.28
Share of All Land: Crops (%)	14	8	0	80	18	7	0	0	69	14		0.47
Share of All Land: Fallow/Idle (%)	1	0	0	31	3	1	0	0	62	3		0.19
Share of All Land: Development (%)	5	3	0	38	6	11	5	0	95	17		-0.54
Share of All Land: Natural Veg. (%)	77	84	16	99	20	79	89	4	100	22		-0.10
Share of All Land: Barren (%)	1	0	0	15	2	1	0	0	45	3		-0.04
Within Crops: High-Value (%)	46	45	0	100	27	60	63	0	100	32		-0.47
Total Acres	1,007,792	251,709	1,837	15,452,557	2,262,404	497,722	34,313	70	6,969,956	1,243,342		0.28

Notes: The final column reports the standardized difference in means, calculated as the treated mean minus the untreated mean divided by the square root of the average of the two group variances.

Assumption 3: The outside ring is unaffected by consolidation (no spillovers).

The design treats the 5-mile surrounding ring as a stable benchmark. This assumption would be violated if consolidation triggered broader regional land market effects that altered cropping patterns on adjacent land. Model 3 estimates an outside-only difference-in-differences. A null effect in this specification reinforces confidence that the border remains a valid control.

Assumption 4: Crop composition changes reflect the intensive margin.

Because the outcome is defined as the high-value share conditional on cropland, identification requires that changes reflect reallocation within agriculture rather than conversion of non-crop land into crops. Figure 14 plots mean cropland share inside reservation boundaries for treated and untreated reservations over the full sample period. Two features of this figure support the intensive-margin interpretation. First, cropland shares are stable over time for both groups. Neither exhibits a trend break around the onset of the program in 2014, indicating that the program did not meaningfully alter the total extent of agricultural land. Second, the pre-treatment trajectories of treated and untreated reservations are closely parallel, lending support to the parallel trends assumption underlying the difference-in-differences design. Together, these patterns suggest that any detected changes in high-value crop share are more plausibly driven by reallocation within existing cropland than by conversion of non-agricultural land into production.

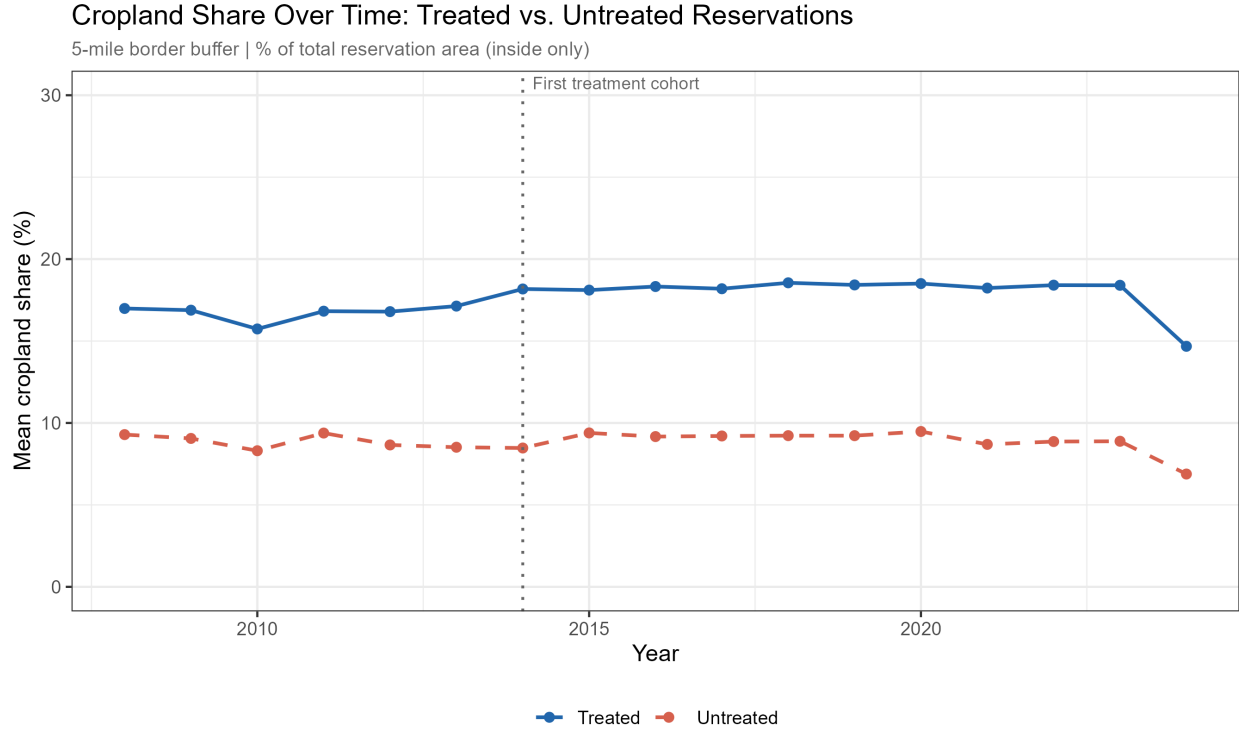


Figure 14. Cropland Share of Reservation Area Over Time

Regression Framework for Triple-Difference Estimation

This section formalizes the empirical framework used to estimate the causal effect of the LBPP on agricultural land-use decisions.

Unit, time, and spatial zone definitions

Let i index reservations and t index calendar years. Land-cover outcomes are measured (i) inside reservation boundaries and (ii) in a surrounding 5-mile outside ring. Let $z \in \{\text{in}, \text{out}\}$ denote the spatial zone. Define Y_{it}^{in} = High-value crop share inside reservation i in year t , Y_{it}^{out} = High-value crop share in the 5-mile outside ring of reservation i in year t .

High-value crop share (intensive margin).

For each zone (inside or outside), the HVC outcome is constructed as an intensive share with a crop-land denominator:

$$Y_{it}^z = 100 \times \frac{\text{HVC area share}_{it}^z}{\text{All crop area share}_{it}^z}, \quad z \in \{\text{in}, \text{out}\},$$

where “all crops” excludes non-crop land-cover categories (e.g., developed land, water, barren, and natural vegetation classes). This ensures that the dependent variable reflects changes in crop composition rather than shifts in total cropland. Detailed land use categories are described in Appendix B, Table B.1.

Treatment timing

Let EAP_{it} denote Equivalent Acres Purchased for reservation i in year t . Define the first treatment year

$$G_i = \min\{t \mid \text{EAP}_{it} > 0\},$$

with G_i undefined for never-treated reservations. Define the treatment-group indicator

$$\text{Treat}_i = 1\{G_i \text{ is defined}\},$$

and a post indicator that accommodates staggered adoption:

$$\text{Post}_{it} = 1\{t \geq G_i\},$$

with $\text{Post}_{it} = 0$ for never-treated reservations for all t .

Define the inside-zone indicator $\text{Inside}_z = 1\{z = \text{in}\}$.

Main Outcome Estimation

The main outcome used for the border-based design is the border gap:

$$Z_{it} = Y_{it}^{in} - Y_{it}^{out}. \quad (1)$$

Taking the difference of (3) between $z = \text{in}$ and $z = \text{out}$ eliminates terms that are common across zones, yielding a difference-in-differences in the gap Z_{it} . This is the preferred implementation in Model 1 below.

Treatment cohorts and staggered adoption

The Land Buy-Back Program was not implemented simultaneously across reservations. Instead, consolidation occurred in different years depending on administrative capacity, funding availability, and program sequencing. To accommodate staggered adoption in the Callaway and Sant’Anna (2021) framework, reservations are grouped into two treated cohorts and a never-treated group:

$$G2_i \in \{0, 2016, 2017\},$$

where

- $G2_i = 0$ if reservation i is never treated ($EAP_{it} = 0$ for all t),
- $G2_i = 2016$ if $G_i \in [2014, 2016]$ (“Early” cohort),
- $G2_i = 2017$ if $G_i \geq 2017$ (“Late” cohort).

Cohort Assignment

The use of ‘early’ and ‘late’ cohorts, rather than yearly treatment cohorts, is driven by limitations in publicly available data. The LBBP Final Implementation Report (2023) documents treatment timing only for reservations that received purchases in more than one year, leaving single-year treated reservations without explicit timing information. For the first three years of

the program, however, spanning 2014 to 2016, the BIA published annual status reports that enable treatment timing to be identified, partially offsetting this limitation for the earlier period.

Why staggered timing matters.

In settings with staggered treatment timing, conventional two-way fixed effects (TWFE) estimators can produce biased estimates when treatment effects are heterogeneous over time or across cohorts (Goodman-Bacon 2021; Sun and Abraham 2021). The source of the bias is that TWFE implicitly combines multiple two-by-two difference-in-differences comparisons, including comparisons in which already-treated units serve as controls for later-treated units.

These so-called “forbidden comparisons” arise because, after the early cohort is treated, it may be used as a control group for the late cohort prior to the late cohort’s treatment. If treatment effects evolve over time, the early cohort is no longer a valid counterfactual once treated, and such comparisons contaminate the estimated average effect. Moreover, the implicit weighting scheme in TWFE can assign negative weights to certain cohort-time comparisons, meaning that some treatment effects enter the overall estimate with the opposite sign.

To avoid these issues, I adopt the group-time average treatment effect framework of Callaway and Sant’Anna (2021). This approach constructs $ATT(g, t)$ by comparing each treated cohort g in period t only to units that are not yet treated (or never treated) in that period. Already-treated units are never used as controls. This ensures that all comparisons are between treated and untreated potential outcomes, eliminating negative weighting and forbidden comparisons.

Group-time treatment effects under staggered adoption

For each treated cohort $g \in \{2016, 2017\}$ and year t , the estimand of interest is the group-time average treatment effect on the treated:

$$ATT(g, t) = E[Y_{it}(1) - Y_{it}(0) \mid G2_i = g]. \quad (2)$$

Identification relies on comparing treated units to a control group composed of never-

treated and not-yet-treated reservations at each point in time. Formally, for a cohort treated in year g , units treated in years $g' > g$ serve as valid controls in periods $t < g'$, since they have not yet been exposed to consolidation. This design preserves the logic of difference-in-differences while ensuring that treatment effects are not contaminated by post-treatment outcomes from earlier-treated cohorts.

Aggregation and interpretation.

Following Callaway and Sant'Anna (2021), I summarize the collection of group-time treatment effects into a single pooled estimand:

$$ATT^{\text{pooled}} = \sum_{g \in \{2016, 2017\}} \sum_{t \geq g} w_{g,t} ATT(g, t),$$

where weights $w_{g,t}$ are proportional to the number of treated observations in cohort g observed in period t and satisfy $\sum_{g,t} w_{g,t} = 1$.

Because the estimator averages only valid treated-versus-untreated comparisons, the pooled ATT retains a straightforward causal interpretation as the average effect of consolidation on treated reservations, free from the negative-weight pathologies that can arise under TWFE with heterogeneous treatment effects.

Estimated Empirical Models

The empirical design is implemented on three related dependent variables: the border gap Z_{it} defined in eq:gap, the inside outcome Y_{it}^{in} , and the outside outcome Y_{it}^{out} .

Model 1 (Preferred): Border-gap difference-in-differences

The primary specification uses the border-gap outcome Z_{it} from eq:gap:

$$Y_{it} \equiv Z_{it}. \tag{3}$$

Because Z_{it} is already an inside-outside difference, this approach has a natural triple-difference interpretation: it differences over time (pre vs. post), across treatment status (treated vs. control), and across space (inside vs. outside).

Model 2: Inside-only difference-in-differences

To isolate changes occurring inside reservation boundaries, the design is also estimated using the inside outcome alone:

$$Y_{it} \equiv Y_{it}^{in}. \quad (4)$$

Model 3: Outside-only difference-in-differences

Analogously, the design is estimated using the outside-ring outcome:

$$Y_{it} \equiv Y_{it}^{out}. \quad (5)$$

This provides a geographically proximate comparison that can reflect local shocks or potential spillovers and represents a placebo treatment effect. A null result for Model 3 supports the assumption that the outside ring is unaffected by consolidation and validates its use as a spatial control.

Dynamic Effects (Event-Study)

To assess treatment dynamics and pre-trends, event-time effects are estimated for the border-gap outcome Z_{it} defined in eq:gap. Let event time be $e = t - g$. The dynamic estimand is

$$ATT_e = E[Z_{i,g+e}(1) - Z_{i,g+e}(0) \mid G2_i = g], \quad e \in \{-5, \dots, 8\}. \quad (6)$$

Leads ($e < 0$) serve as a diagnostic for differential pre-trends in the gap outcome, while lags ($e \geq 0$) trace the evolution of treatment effects over time.

Pooled and Region-Specific Estimation

All models are estimated both (i) pooled across the main analysis regions and (ii) separately by region group. This allows treatment effects to vary across geographic contexts while maintaining a consistent identification strategy.

Inference and Clustered Standard Errors

All regressions are estimated using standard errors clustered at the reservation level. Clustering at this level is appropriate because treatment is assigned at the reservation level and varies only across reservations and over time, not across spatial zones within a reservation. Consequently, observations for the inside and outside zones of the same reservation in a given year are likely to share unobserved shocks and measurement error, and outcomes within a reservation may also be serially correlated over time. Failure to account for within-reservation correlation would lead to understated standard errors and over-rejection of the null hypothesis (Bertrand 2004). In the present setting, the error term ε_{itz} in Equation 3 may be correlated across zones z and across years t within a reservation i , reflecting persistent institutional, geographic, or market characteristics that are not fully absorbed by the differencing structure. Clustering at the reservation level therefore allows for correlation of the error term within each reservation over time and across spatial zones, and aligns the inference procedure with the level of treatment assignment.

Standard errors and confidence intervals are computed using the multiplier bootstrap procedure implemented in the `did` package for R. Rather than resampling observations, the multiplier bootstrap draws a fresh set of random weights at each estimation call and uses these to approximate the sampling distribution of the aggregated ATT. This approach is robust to arbitrary within-unit serial correlation because the entire time series for each reservation moves together in each bootstrap draw, implicitly accounting for the same within-reservation dependence that motivates clustering. All reported standard errors are based on 999 bootstrap draws with a fixed random seed to ensure reproducibility.

As a robustness check, I also report results with standard errors clustered at the regional

level in Appendix D, Table D.1. The similarity of inference across clustering levels supports the validity of the main results.

Cropland Weighting for Intensive Margin Outcomes

The intensive margin outcomes in this paper measure the share of cropland devoted to particular crop categories, such as the share of cropland planted in high-value crops. Because these outcomes are constructed as ratios, observations based on very small amounts of cropland can exhibit large mechanical variation even when the underlying acreage change is economically trivial. For example, a small absolute change in acreage on a reservation with very little cropland can produce a large change in the share measure, while the same absolute change on a reservation with a large cropland base produces a much smaller change in the share. Treating all observations equally in this context would therefore give disproportionate influence to reservation-year cells in which very little cropland is present.

To address this issue, the intensive-margin regressions are estimated using weights equal to the total cropland area underlying each observation. Let r index reservations and t index years. For the inside and outside reservation areas, define the high-value crop shares as

$$HVCShare_{rt}^{in} = 100 \times \frac{HVC_{rt}^{in}}{Cropland_{rt}^{in}}, \quad HVCShare_{rt}^{out} = 100 \times \frac{HVC_{rt}^{out}}{Cropland_{rt}^{out}},$$

where HVC_{rt}^{in} and HVC_{rt}^{out} denote acres planted in high-value crops, and $Cropland_{rt}^{in}$ and $Cropland_{rt}^{out}$ denote total cropland acres, inside and outside the reservation boundary, respectively.

The triple-difference specification uses the inside-outside gap

$$Gap_{rt} = HVCShare_{rt}^{in} - HVCShare_{rt}^{out}.$$

For the cropland-weighted regressions, the weights are defined as

$$w_{rt}^{in} = Cropland_{rt}^{in}, \quad w_{rt}^{out} = Cropland_{rt}^{out}, \quad w_{rt}^{gap} = Cropland_{rt}^{in} + Cropland_{rt}^{out}.$$

Accordingly, the inside-only specifications are weighted by inside cropland acreage, the outside-only specifications are weighted by outside cropland acreage, and the gap specification is weighted by the total cropland acreage represented in the inside-outside comparison.

This weighting scheme gives greater influence to observations representing larger agricultural areas while reducing the impact of observations where the cropland base is small and the share measure is inherently noisier. Conceptually, weighting by cropland ensures that the estimated treatment effects reflect changes in the allocation of cropland across crop types rather than changes driven by small or marginal agricultural areas. In this sense, the estimates can be interpreted as the average effect on cropland allocation for the average acre of cropland, rather than the average effect across reservation-year observations regardless of their agricultural scale.

As an additional robustness check, the intensive-margin regressions for high-value crops are also estimated on subsamples defined by minimum cropland thresholds at the reservation level. Specifically, the sample is progressively restricted to reservations where cropland represents at least a specified share of total reservation land area. This addresses the related concern that crop-share outcomes may be less economically meaningful in reservations where agriculture constitutes only a very small fraction of overall land use. By restricting the sample to reservations with higher baseline cropland shares, the analysis focuses on areas where agricultural production represents a more substantial component of land use. The resulting estimates are reported in Appendix C, Table C.1, while the corresponding sample sizes for each threshold are reported in Table C.2.

CHAPTER 7

RESULTS

This section reports estimated effects of the Land Buy-Back Program (LBBP) on the broad extensive margin land cover changes and the intensive margin of relative high-value crop (HVC) share within agricultural land.

The preferred analysis uses a 5-mile border ring to define the exterior comparison area. This width strikes a practical balance between proximity and comparability: it is close enough to plausibly share local agronomic conditions, market access, and growing seasons with on-reservation parcels, while still providing sufficient land area to yield stable exterior outcome measures. Importantly, the substantive conclusions are not sensitive to this choice. Appendix A, Tables A.1 - A.7 report estimates across alternative border widths (1, 3, 7, and 10 miles) and shows that the results are qualitatively similar, indicating that inference is robust to reasonable changes in the buffer definition.

Intensive Margin: High-Value Crop Share (Pooled)

I begin by estimating pooled cropland-weighted Callaway-Sant’Anna (2021) (CS) average treatment effects on the treated (ATTs) for the intensive margin outcome of HVC measured inside reservation boundaries and in the surrounding 5-mile border ring. Table 3 reports pooled CS ATTs for these two outcomes alongside the preferred triple-difference estimate. Unweighted estimates are reported in Table 3 and are qualitatively consistent with the preferred specification.

The inside-only estimate is small and imprecise (-0.605 percentage points; $p = 0.215$) and the outside-only estimate is similarly small in magnitude and negative (-0.393 percentage points; $p = 0.567$); neither are statistically significant at conventional levels.

While the separate interior and exterior estimates are informative, they do not directly address whether treatment alters land use inside reservations relative to nearby land outside the reservation boundary. To isolate this relative effect, I estimate the preferred specification using the interior-exterior gap Z_{it} defined in equation (1). The preferred estimator applies cropland-weighted

Callaway-Sant’ Anna DiD directly to Z_{it} , comparing changes in this gap for treated reservations to changes for the not-yet-treated control group.¹⁸

Table 3. Pooled Triple-Difference Estimates (Intensive Margin)

	Interior DiD	Exterior DiD	Triple Difference (Z_{it})
<i>Panel A: Cropland-Weighted (Preferred Specification)</i>			
ATT	−0.605	−0.393	0.298
SE	(0.488)	(0.687)	(0.715)
95% CI	[−1.561, 0.351]	[−1.741, 0.954]	[−1.103, 1.699]
<i>p</i> -value	0.215	0.567	0.677
<i>Panel B: Unweighted</i>			
ATT	0.985	0.635	0.350
SE	(2.485)	(2.954)	(1.910)
95% CI	[−3.886, 5.857]	[−5.155, 6.425]	[−3.393, 4.094]
<i>p</i> -value	0.692	0.830	0.855

Notes: Entries report Callaway-Sant’ Anna (2021) average treatment effects on the treated (ATTs) using never-treated and not-yet-treated reservations as controls, with a 5-mile border ring as the exterior comparison zone. Panel A reports the preferred cropland-weighted specification; Panel B reports unweighted estimates. Interior reports the CS-DiD on the inside outcome Y_{it}^{in} ; Exterior on the outside outcome Y_{it}^{out} ; Triple Difference reports the CS-DiD applied directly to the interior-exterior gap $Z_{it} = Y_{it}^{in} - Y_{it}^{out}$. Outcomes are measured in percentage points of high-value crop share among cropland. Standard errors in parentheses are clustered at the reservation level.

Intensive-Margin Results Interpretation

The preferred cropland-weighted estimate of the effect of treatment on the interior-exterior gap in high-value crop share reported in Table 3 show that the point estimate is positive (0.298 percentage points), but it is not statistically significant at conventional levels ($p = 0.677$). The 95% confidence interval is wide and includes zero, ranging from −1.103 to 1.699 percentage points. Therefore, the data do not allow rejection of the null hypothesis of no effect.

18. The analysis includes 142 of the 147 unique reservation units identified in the Land Buy-Back Program Final Implementation Report. Three discrepancies reflect data consolidations in which two participating Tribes map to a single reservation boundary: the Eastern Shoshone and Northern Arapaho tribes share the Wind River Reservation; the Absentee-Shawnee Tribe and Citizen Potawatomi Nation are treated as a single joint unit; and the Wichita and Affiliated Tribes, Caddo Nation, and Delaware Nation are consolidated as Caddo-Wichita-Delaware. The remaining two exclusions stem from limitations in the 2019 TIGER/Line American Indian/Alaska Native/Native Hawaiian Areas (AIANNH) shapefile. Cloverdale Rancheria and California Valley Miwok are absent from the shapefile entirely.

To aid interpretation, the estimated effects can be mechanically translated into acreage units using the median cropland area of treated reservations (19,768 acres). The 95% confidence interval for the preferred cropland-weighted estimate ranges from -1.103 to $+1.699$ percentage points of the high-value crop share, which corresponds approximately to a change of -218 to $+336$ acres of high-value crops on the median treated reservation. Conservatively assuming that the true estimate lies on the upper bound of this interval, the \$1.9 billion cost of the Land Buy-Back Program would imply that the average cost per acre of improved land is about \$110,119 across the forty-seven treated reservations. Assuming that the true estimate is zero land use change, the \$1.9 billion cost of the Land Buy-Back Program would imply that the average cost of the program is roughly \$40,425,532 per reservation across the forty-seven treated reservations.

Since the estimate is imprecisely estimated and statistically indistinguishable from zero, this acreage range should be interpreted only as a scale translation of the confidence interval rather than as evidence of a meaningful or reliable treatment effect. Overall, the preferred specification provides inconclusive statistical evidence of any change in high-value cropping within treated reservations relative to surrounding border areas. However, confidence intervals are meaningfully small, suggesting limited effects of LBBP consolidation on land use changes.

Extensive Margin: Land Cover Shares (Pooled)

In addition to crop composition, I estimate treatment effects on extensive-margin land cover outcomes measured as shares of total reservation area. These outcomes capture whether the LBBP is associated with changes in broad land use categories (e.g., total cropland, rangeland/pasture, development), rather than shifts in crop mix within cropland. Table 4 reports pooled Callaway-Sant'Anna estimates for the preferred triple-difference specification, which applies the estimator to the interior-exterior gap Z_{it} for each land cover outcome, alongside the separate interior and exterior DiD estimates.

Table 4. Pooled Triple-Difference Estimates (Extensive Margin)

	Interior DiD	Exterior DiD	Triple Difference (Z_{it})
<i>A. Agricultural Land</i>			
Cropland share (total)	0.245 (0.546)	0.188 (0.248)	0.056 (0.361)
Fallow share	-0.277 (0.587)	-0.150 (0.265)	-0.127 (0.334)
<i>B. Developed and Built-Up Land</i>			
Development share	-0.660* (0.308)	-0.146 (0.116)	-0.514 (0.303)
<i>C. Natural and Semi-Natural Land</i>			
Natural vegetation share	0.338 (1.092)	0.223 (0.891)	0.115 (0.643)
Rangeland share	0.472 (0.992)	-0.274 (0.864)	0.746 (0.479)
Barren share	-0.414 (0.387)	-0.172 (0.264)	-0.242 (0.198)
<i>D. Water and Other</i>			
Water and ice share	-0.006 (0.083)	-0.026 (0.054)	0.020 (0.062)

Notes: Entries report Callaway-Sant’Anna (2021) ATTs using never-treated and not-yet-treated reservations as controls, with a 5-mile border ring as the exterior comparison zone. All outcomes are measured as shares of total reservation area (percentage points). Interior reports the CS-DiD on the inside outcome Y_{it}^{in} ; Exterior on the outside outcome Y_{it}^{out} ; Triple Difference reports the CS-DiD applied directly to the interior-exterior gap $Z_{it} = Y_{it}^{in} - Y_{it}^{out}$. All specifications are unweighted. Standard errors in parentheses are clustered at the reservation level. * $p < 0.05$, $\cdot p < 0.10$.

Interpretation of Extensive-Margin Results

The triple-difference estimates for broad land cover categories measured as shares of total reservation area seen in Table 4 show that, across all extensive-margin outcomes, the estimated effects are small in magnitude and statistically indistinguishable from zero at conventional levels.

The estimated effect on total cropland share is essentially zero (0.056 percentage points; $p = 0.876$), indicating no detectable change in the overall fraction of land allocated to agricultural production inside reservations relative to nearby border areas. Similarly, the fallow land share shows a small and imprecise negative estimate (-0.127 percentage points; $p = 0.704$), suggesting no systematic shift between actively cultivated and idle cropland.

The development share exhibits a negative point estimate (-0.514 percentage points; $p = 0.089$) that is marginally significant at the 10% level, consistent with a modest reduction in developed land inside treated reservations relative to their border rings. However, the confidence interval includes zero and the interior-only estimate (-0.660 ; $p = 0.032$) is statistically significant at the 5% level, suggesting this pattern partly reflects trends inside reservations rather than a differential interior-exterior shift. Natural vegetation, barren land, and water/ice shares likewise show no statistically meaningful changes. The rangeland/pasture gap estimate is positive in magnitude (0.746 percentage points; $p = 0.119$) but remains imprecisely estimated and cannot be distinguished from zero with confidence.

Taken together, the extensive-margin results provide no strong evidence that the LBBP induced systematic reallocation of land across major land cover categories. The absence of detectable changes in total cropland or natural vegetation shares suggests that the program did not measurably alter broad patterns of land use at the reservation level. Combined with the intensive-margin findings, these results indicate that the program neither shifted crop composition within cropland nor meaningfully changed the overall allocation of land across production, development, or conservation uses during the study period.

CHAPTER 8

RESULTS BY REGION

This section reports regional heterogeneity in estimated effects of the LBBP on both the intensive and extensive margins of land use. All specifications use the preferred cropland-weighted estimator for the intensive margin and unweighted estimates for the extensive margin. Unweighted regional intensive-margin estimates are reported in Table 6, Panel D.

Intensive Margin: High-Value Crop Share (Regional)

Table 5 reports region-specific cropland-weighted estimates of the effect of treatment on the interior-exterior gap in high-value crop share among cropland, alongside the underlying interior and exterior DiD estimates.

Table 5. Triple-Difference Estimates by Region (Intensive Margin)

	Northern Plains	Pacific Northwest	SW + S. Plains/OK
<i>Panel A: Interior DiD, Cropland-Weighted</i>			
ATT	0.209	0.031	−0.875
SE	(0.237)	(2.897)	(0.481)
<i>Panel B: Exterior DiD, Cropland-Weighted</i>			
ATT	0.091	−1.510	0.337
SE	(0.099)	(3.825)	(0.333)
<i>Panel C: Triple Difference Gap Z_{it}, Cropland-Weighted (Preferred)</i>			
ATT	0.093	2.913	−0.917
SE	(0.218)	(3.369)	(0.676)
95% CI	[−0.335, 0.520]	[−3.690, 9.516]	[−2.242, 0.408]
<i>p</i> -value	0.671	0.387	0.175
<i>Panel D: Triple Difference Gap Z_{it}, Unweighted</i>			
ATT	0.117	1.371	−1.063
SE	(0.103)	(4.929)	(1.187)
95% CI	[−0.085, 0.319]	[−8.291, 11.032]	[−3.390, 1.264]
<i>p</i> -value	0.256	0.781	0.371

Notes: Entries report region-specific Callaway-Sant’Anna (2021) ATTs using a 5-mile buffer. The sample is restricted to the three high-value crop regions: Northern Plains, Pacific Northwest, and SW + Southern Plains/OK. Panels A-B report cropland-weighted interior and exterior DiD estimates respectively. Panel C reports the preferred cropland-weighted triple-difference; Panel D reports the unweighted triple-difference for comparison. Standard errors in parentheses are clustered at the reservation level. $p < 0.10$.

Extensive Margin: Land Cover Shares (Regional)

Table 6 reports region-specific estimates for extensive-margin land cover outcomes, measured as percentage points of total reservation area, using the same interior-exterior gap specification.

Table 6. Triple-Difference Estimates by Region (Extensive Margin)

Outcome	Northern Plains			Pacific Northwest			SW + S. Plains/OK		
	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap
<i>A. Agricultural Land</i>									
Cropland share	0.762* (0.373)	0.755*** (0.181)	0.007 (0.455)	−0.833 (1.258)	−0.540 (0.518)	−0.293 (0.899)	0.808 (0.675)	0.399 (0.742)	0.408 (0.250)
Fallow share	−0.613 (0.372)	−0.449 (0.343)	−0.164 (0.138)	−0.618 (1.348)	−0.101 (0.571)	−0.517 (0.723)	−0.051 (0.312)	−0.073 (0.262)	0.022 (0.217)
<i>B. Developed and Built-Up Land</i>									
Development share	0.342 (0.312)	−0.003 (0.100)	0.346 (0.304)	−1.328 (0.721)	−0.218 (0.238)	−1.110 (0.665)	−0.698* (0.315)	0.057 (0.336)	−0.755 (0.611)
<i>C. Natural and Semi-Natural Land</i>									
Natural veg. share	0.594 (1.056)	0.931 (1.070)	−0.337 (0.481)	−1.852 (2.082)	−2.087 (1.364)	0.235 (1.408)	1.584 (1.354)	1.693 (1.304)	−0.108 (0.706)
Rangeland share	−1.900* (0.959)	−1.834 (1.186)	−0.066 (0.369)	3.693* (1.871)	2.122 (1.335)	1.572 (0.948)	−0.558 (1.601)	−1.503 (1.345)	0.945 (0.847)
Barren share	−0.006 (0.035)	0.012 (0.053)	−0.018 (0.046)	0.138 (0.187)	0.199 (0.468)	−0.061 (0.404)	−1.144 (0.938)	−0.720 (0.545)	−0.424 (0.478)
<i>D. Water and Other</i>									
Water & ice share	0.208 (0.266)	0.139 (0.089)	0.069 (0.239)	0.114 (0.148)	−0.008 (0.098)	0.122 (0.122)	0.007 (0.097)	0.070 (0.065)	−0.063 (0.060)

Notes: Entries report region-specific Callaway-Sant’Anna (2021) ATTs using a 5-mile buffer. The sample is restricted to the three high-value crop regions: Northern Plains, Pacific Northwest, and SW + Southern Plains/OK. Int. DiD reports the CS-DiD on the inside outcome Y_{it}^{in} ; Ext. DiD on the outside outcome Y_{it}^{out} ; Gap reports the triple-difference estimate from applying the CS estimator directly to $Z_{it} = Y_{it}^{in} - Y_{it}^{out}$. All outcomes are measured as shares of total reservation area (percentage points). Standard errors in parentheses are clustered at the reservation level. *** $p < 0.001$, * $p < 0.05$, · $p < 0.10$.

Interpretation of Extensive Margin Results

The regional extensive-margin estimates in Table 6 provide no statistically reliable evidence of heterogeneous treatment effects across regions. In the Northern Plains, the cropland-weighted estimate of the effect on the interior-exterior gap in high-value crop share is small and positive (0.093 percentage points; $p = 0.671$). In the Pacific Northwest, the point estimate is positive (2.913 percentage points), but it is very imprecisely estimated and statistically indistinguishable from zero ($p = 0.387$). In SW + Southern Plains/Oklahoma, the estimate is negative (-0.917 percentage points; $p = 0.175$), though likewise not statistically significant. Across all three regions, the confidence intervals are wide and include zero, indicating that the data do not support a clear regional pattern in the intensive-margin response of high-value crop share.

The extensive-margin estimates in Table 6 similarly show little evidence of systematic re-allocation of land across major cover categories within any region. Estimated effects on total cropland share are essentially zero in the Northern Plains (0.007 percentage points) and negative in the Pacific Northwest (-0.293 percentage points), while the SW + Southern Plains/Oklahoma estimate is positive (0.408 percentage points; $p = 0.103$); however, none of these effects are statistically distinguishable from zero at conventional levels. Estimates for fallow, natural vegetation, barren land, and water/ice shares are also small and imprecisely estimated across all regions.

A few outcomes display larger point estimates in magnitude. A negative development-gap estimate in the Pacific Northwest (-1.110 percentage points; $p = 0.095$) and a positive rangeland/pasture-gap estimate in the same region (1.572 percentage points; $p = 0.097$) are each marginally significant at the 10% level, as is a negative interior development estimate in SW + Southern Plains/Oklahoma (-0.698 percentage points; $p = 0.027$) that is statistically significant at the 5% level. However, the corresponding gap estimates for development and rangeland in SW + Southern Plains/Oklahoma remain statistically indistinguishable from zero, suggesting that similar trends may be occurring on both sides of the reservation boundary in that region. These patterns should be interpreted as suggestive rather than as robust evidence of regional heterogeneity.

Of note in the Northern Plains, the exterior cropland share estimate is large and highly

significant (0.755 percentage points; $p < 0.001$), and the interior estimate is also significant (0.762 percentage points; $p = 0.041$). The near-identical magnitude of these two estimates produces a gap estimate indistinguishable from zero (0.007 percentage points; $p = 0.987$), consistent with parallel trends in cropland expansion on both sides of the reservation boundary in the Northern Plains during the treatment period rather than any differential program effect.

Overall, the regional results reinforce the pooled findings. Across both intensive and extensive margins, the estimates provide limited evidence that the Land Buy-Back Program systematically altered crop composition within cropland or reallocated land across broad land cover categories inside reservations relative to nearby border areas.

CHAPTER 9

CONCLUSION

Land tenure institutions are a central mechanism through which persistent economic outcomes are shaped on Native American reservations. One aspect of these land tenure institutions is fractionated ownership, which raises the transaction costs of coordinating land use decisions, suppresses investment incentives, and can thus limit the productive potential of reservation land. The Land Buy-Back Program for Tribal Nations represented the most significant federal effort to address this problem directly, spending \$1.9 billion over a decade to consolidate fractional interests into tribal ownership. Whether this consolidation translated into measurable changes in how land is actually used is an open empirical question. This paper provides the first econometric evaluation of the LBBP and finds no statistically significant effect of the program on land use outcomes.

These null results are consistent with the theoretical framework developed in this paper. In this model, fractionated ownership can generate underinvestment through a coordination failure: individual interest holders internalize only a fraction of the marginal returns to land improvement, and the transaction costs of collective action prevent efficient bargaining. Consolidation into tribal ownership eliminates this anticommons problem, but it does not resolve the underlying incentive misalignment. When land-use authority is transferred to a tribal government whose compensation is only partially tied to land management outcomes, a principal-agent problem may replace the coordination failure. The Tribal government's effective marginal benefit from investment may be discounted relative to that of a unified residual claimant, and underinvestment can persist. Compounding this, the federal trust framework remains in place after consolidation: administrative approval requirements, restrictions on collateralization, and layered bureaucratic oversight continue to raise the marginal cost of investment on reservation land regardless of who holds the consolidated interest. The LBBP addressed the ownership structure without altering the institutional environment in which land-use decisions are made.

These findings carry direct implications for future consolidation policy. Scholars and ad-

vocates have begun calling for a successor program or extension of federal buy-back authority to continue addressing fractionation across Indian Country. (Conrad 2023) The results here suggest that renewed consolidation efforts modeled on the LBBP, including centralized purchase programs that transfer fractional interests to tribal governments, are unlikely, on their own, to generate measurable changes in land use. The bottleneck is not fractionation alone but the broader set of institutional constraints that govern reservation land after consolidation occurs. Reforms that enhance the alignment between decision-making authority and residual claimancy, such as by facilitating voluntary exchanges that allow owners to consolidate, may be better positioned to translate ownership consolidation into productive land use.

Ultimately, this paper underscores a recurring theme in the institutional economics of Federal Indian policy: the difficulty of improving economic outcomes through ownership reforms that leave the surrounding institutional environment unchanged. Fractionation is a genuine constraint on reservation land productivity, and addressing it is an important policy objective. However, the evidence presented here suggests that centralized consolidation alone absent complementary reforms to the trust framework, the governance of tribal land management, and the institutional options available to individual Native American landowners is insufficient to generate measurable improvements in how land is used. Future policy in this area will be most effective if it is designed not only to simplify ownership, but to strengthen the incentives and expand the autonomy of those most directly dependent on the land's productivity. In other words, future policy that seeks to address the fractionation problem is more likely to succeed if it ultimately reconciles the individual Native American with management of reservation land as opposed to pushing them further apart.

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APPENDICES

APPENDIX A

ROBUSTNESS TO BUFFER SIZE

Table A.1. Triple-Difference Estimates by Border Buffer Size

Outcome	1 mi	3 mi	5 mi	7 mi	10 mi
High-value crop share	−2.205 (2.291)	−0.080 (2.052)	0.350 (1.984)	0.018 (2.056)	0.212 (2.054)
Cropland share (total)	0.260 (0.324)	0.066 (0.357)	0.056 (0.380)	0.030 (0.425)	−0.030 (0.466)
Fallow share	0.089 (0.293)	−0.082 (0.316)	−0.127 (0.345)	−0.160 (0.402)	−0.164 (0.466)
Development share	−0.526* (0.264)	−0.520 (0.283)	−0.514 (0.293)	−0.493 (0.296)	−0.465 (0.302)
Natural vegetation share	−0.026 (0.591)	0.029 (0.646)	0.115 (0.679)	0.154 (0.682)	0.132 (0.695)
Rangeland share	0.597 (0.464)	0.771 (0.495)	0.746 (0.481)	0.702 (0.466)	0.764 (0.479)
Barren share	−0.201 (0.250)	−0.204 (0.202)	−0.242 (0.207)	−0.243 (0.208)	−0.230 (0.202)
Water and ice share	0.064 (0.068)	0.047 (0.055)	0.020 (0.059)	0.011 (0.064)	−0.003 (0.066)

Notes: Entries report Callaway-Sant’Anna average treatment effects on the treated from applying the estimator to the interior-exterior gap $Z_{it} = Y_{it}^{in} - Y_{it}^{out}$. Standard errors are in parentheses. Buffer sizes indicate the width of the exterior border ring used to construct the outside comparison outcome. The 5-mile estimates correspond to the preferred specification reported in the main text. * $p < 0.05$, $p < 0.10$.

Note on Numerical Differences Between Reported Estimates

The 5-mile estimates in Table A.1 differ negligibly from those in the main results tables. ATT point estimates are identical across both sets of tables; the small discrepancies in standard errors reflect simulation noise from the multiplier bootstrap used by the Callaway-Sant’Anna estimator. Because the bootstrap draws a fresh set of random weights at each call, standard errors vary slightly across independent script executions even when the data and specification are identical. These differences are confined to the third decimal place and have no effect on inference.

Table A.2. Sample Composition by Border Buffer Size

	1 mile	3 mile	7 mile	10 mile
Total observations	2431	2431	2431	2431
Reservations	143	143	143	143
Never treated reservations	1547	1547	1547	1547
Reservations treated in 2016	272	272	272	272
Reservations treated in 2017	612	612	612	612
Observations with finite HVC gap	2176	2188	2196	2198
Observations with 0 total cropland (inside)	231	231	231	231
Observations with 0 total cropland (outside)	99	58	29	20
Observations without finite gap outcome	255	243	235	233

Notes: The table reports sample composition across alternative border buffer sizes used to construct the exterior comparison outcome. The number of reservations and total observations remain constant across specifications. Larger buffers reduce the number of observations with zero total cropland in the exterior comparison ring, thereby increasing the number of observations with a finite interior-exterior gap outcome.

Table A.3. Triple-Difference Estimates by Region and Buffer Size (Intensive Margin)

	Northern Plains		Pacific Northwest		SW + S. Plains/OK	
Buffer	ATT	SE	ATT	SE	ATT	SE
1 mile	0.192	(0.249)	−5.831	(6.752)	−1.591*	(0.678)
3 mile	0.059	(0.136)	0.755	(5.175)	−1.419	(2.058)
5 mile	0.117	(0.113)	1.371	(5.376)	−1.063	(1.160)
7 mile	0.136	(0.103)	0.616	(5.420)	−1.133	(1.062)
10 mile	0.183	(0.113)	1.016	(5.563)	−0.953	(0.959)

Notes: Entries report unweighted Callaway-Sant’Anna triple-difference ATTs for the high-value crop share outcome across buffer sizes and regions. Standard errors in parentheses are clustered at the reservation level. * $p < 0.05$.

Table A.4. Triple-Difference Estimates by Region (Extensive Margin) - 1 Mile Buffer

Outcome	Northern Plains			Pacific Northwest			SW + S. Plains/OK		
	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap
<i>A. Agricultural Land</i>									
Cropland share	0.762*	0.742***	0.020	-0.833	-1.048	0.215	0.808	0.546	0.261
	(0.366)	(0.178)	(0.325)	(1.319)	(0.746)	(0.683)	(0.764)	(0.696)	(0.267)
Fallow share	-0.613	-0.553	-0.060	-0.618	-0.492	-0.125	-0.051	-0.212	0.161
	(0.344)	(0.379)	(0.211)	(1.234)	(0.927)	(0.469)	(0.302)	(0.351)	(0.174)
<i>B. Developed and Built-Up Land</i>									
Development share	0.342	0.054	0.288	-1.328	-0.147	-1.181*	-0.698*	-0.086	-0.612
	(0.304)	(0.115)	(0.255)	(0.695)	(0.322)	(0.567)	(0.308)	(0.278)	(0.574)
<i>C. Natural and Semi-Natural Land</i>									
Natural veg. share	0.594	1.010	-0.416	-1.852	-1.939	0.088	1.584	1.625	-0.041
	(1.073)	(1.184)	(0.437)	(2.249)	(1.572)	(1.313)	(1.325)	(1.168)	(0.823)
Rangeland share	-1.900	-1.857	-0.043	3.693	2.574*	1.119	-0.558	-1.633	1.076
	(1.090)	(1.156)	(0.360)	(2.004)	(1.289)	(1.068)	(1.568)	(1.205)	(0.839)
Barren share	-0.006	-0.024	0.018	0.138	0.026	0.113	-1.144	-0.649	-0.495
	(0.036)	(0.053)	(0.031)	(0.192)	(0.163)	(0.167)	(0.948)	(0.428)	(0.589)
<i>D. Water and Other</i>									
Water & ice share	0.208	0.076	0.133	0.114	0.040	0.074	0.007	0.183	-0.176
	(0.271)	(0.193)	(0.162)	(0.146)	(0.107)	(0.107)	(0.088)	(0.206)	(0.124)

Notes: Entries report region-specific Callaway-Sant'Anna (2021) ATTs using a 1-mile buffer. All outcomes are measured as shares of total reservation area (percentage points). All specifications are unweighted. Standard errors in parentheses are clustered at the reservation level. *** $p < 0.001$, * $p < 0.05$, $p < 0.10$.

Table A.5. Triple-Difference Estimates by Region (Extensive Margin) - 3 Mile Buffer

Outcome	Northern Plains			Pacific Northwest			SW + S. Plains/OK		
	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap
<i>A. Agricultural Land</i>									
Cropland share	0.762*	0.793***	-0.030	-0.833	-0.598	-0.235	0.808	0.427	0.381
	(0.366)	(0.193)	(0.383)	(1.319)	(0.615)	(0.865)	(0.764)	(0.689)	(0.240)
Fallow share	-0.613	-0.507	-0.107	-0.618	-0.109	-0.509	-0.051	-0.113	0.061
	(0.344)	(0.352)	(0.183)	(1.234)	(0.608)	(0.651)	(0.302)	(0.268)	(0.216)
<i>B. Developed and Built-Up Land</i>									
Development share	0.342	0.019	0.323	-1.328	-0.208	-1.119	-0.698*	0.023	-0.721
	(0.304)	(0.097)	(0.303)	(0.695)	(0.266)	(0.636)	(0.308)	(0.324)	(0.617)
<i>C. Natural and Semi-Natural Land</i>									
Natural veg. share	0.594	0.931	-0.337	-1.852	-1.940	0.088	1.584	1.740	-0.155
	(1.073)	(1.147)	(0.441)	(2.249)	(1.488)	(1.375)	(1.325)	(1.252)	(0.725)
Rangeland share	-1.900	-1.851	-0.049	3.693	2.125	1.569	-0.558	-1.576	1.018
	(1.090)	(1.182)	(0.360)	(2.004)	(1.385)	(1.045)	(1.568)	(1.284)	(0.819)
Barren share	-0.006	-0.013	0.007	0.138	0.099	0.039	-1.144	-0.711	-0.433
	(0.036)	(0.051)	(0.030)	(0.192)	(0.300)	(0.247)	(0.948)	(0.484)	(0.528)
<i>D. Water and Other</i>									
Water & ice share	0.208	0.122	0.086	0.114	-0.026	0.140	0.007	0.089	-0.082
	(0.271)	(0.112)	(0.209)	(0.146)	(0.112)	(0.111)	(0.088)	(0.089)	(0.050)

Notes: Entries report region-specific Callaway-Sant'Anna (2021) ATTs using a 3-mile buffer. All outcomes are measured as shares of total reservation area (percentage points). All specifications are unweighted. Standard errors in parentheses are clustered at the reservation level. *** $p < 0.001$, * $p < 0.05$, $\cdot$ $p < 0.10$.

Table A.6. Triple-Difference Estimates by Region (Extensive Margin) - 7 Mile Buffer

Outcome	Northern Plains			Pacific Northwest			SW + S. Plains/OK		
	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap
<i>A. Agricultural Land</i>									
Cropland share	0.762*	0.778***	-0.016	-0.833	-0.481	-0.352	0.808	0.362	0.445
	(0.366)	(0.197)	(0.419)	(1.319)	(0.405)	(1.028)	(0.764)	(0.758)	(0.265)
Fallow share	-0.613	-0.402	-0.211	-0.618	-0.123	-0.495	-0.051	-0.014	-0.037
	(0.344)	(0.306)	(0.126)	(1.234)	(0.388)	(0.873)	(0.302)	(0.247)	(0.232)
<i>B. Developed and Built-Up Land</i>									
Development share	0.342	-0.025	0.367	-1.328	-0.241	-1.086	-0.698*	0.034	-0.732
	(0.304)	(0.088)	(0.301)	(0.695)	(0.200)	(0.652)	(0.308)	(0.303)	(0.593)
<i>C. Natural and Semi-Natural Land</i>									
Natural veg. share	0.594	0.972	-0.378	-1.852	-2.071	0.220	1.584	1.533	0.051
	(1.073)	(1.074)	(0.482)	(2.249)	(1.283)	(1.516)	(1.325)	(1.140)	(0.636)
Rangeland share	-1.900	-1.887	-0.013	3.693	2.125	1.568	-0.558	-1.290	0.732
	(1.090)	(1.160)	(0.386)	(2.004)	(1.287)	(1.061)	(1.568)	(1.266)	(0.719)
Barren share	-0.006	0.025	-0.031	0.138	0.196	-0.058	-1.144	-0.715	-0.429
	(0.036)	(0.051)	(0.044)	(0.192)	(0.425)	(0.377)	(0.948)	(0.539)	(0.484)
<i>D. Water and Other</i>									
Water & ice share	0.208	0.137	0.071	0.114	-0.008	0.122	0.007	0.071	-0.064
	(0.271)	(0.090)	(0.257)	(0.146)	(0.088)	(0.122)	(0.088)	(0.065)	(0.062)

Notes: Entries report region-specific Callaway-Sant'Anna (2021) ATTs using a 7-mile buffer. All outcomes are measured as shares of total reservation area (percentage points). All specifications are unweighted. Standard errors in parentheses are clustered at the reservation level. *** $p < 0.001$, * $p < 0.05$, $\cdot$ $p < 0.10$.

Table A.7. Triple-Difference Estimates by Region (Extensive Margin) - 10 Mile Buffer

Outcome	Northern Plains			Pacific Northwest			SW + S. Plains/OK		
	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap	Int. DiD	Ext. DiD	Gap
<i>A. Agricultural Land</i>									
Cropland share	0.762*	0.830***	−0.068	−0.833	−0.351	−0.482	0.808	0.297	0.510
	(0.366)	(0.217)	(0.453)	(1.319)	(0.301)	(1.123)	(0.764)	(0.683)	(0.300)
Fallow share	−0.613	−0.409	−0.204	−0.618	−0.112	−0.505	−0.051	−0.018	−0.034
	(0.344)	(0.316)	(0.141)	(1.234)	(0.262)	(1.020)	(0.302)	(0.243)	(0.239)
<i>B. Developed and Built-Up Land</i>									
Development share	0.342	−0.019	0.361	−1.328	−0.303	−1.024	−0.698*	−0.026	−0.672
	(0.304)	(0.087)	(0.304)	(0.695)	(0.166)	(0.678)	(0.308)	(0.265)	(0.552)
<i>C. Natural and Semi-Natural Land</i>									
Natural veg. share	0.594	0.950	−0.356	−1.852	−1.861	0.010	1.584	1.308	0.276
	(1.073)	(1.034)	(0.472)	(2.249)	(1.256)	(1.609)	(1.325)	(1.182)	(0.608)
Rangeland share	−1.900	−1.924	0.023	3.693	1.853	1.841	−0.558	−0.985	0.428
	(1.090)	(1.128)	(0.387)	(2.004)	(1.267)	(1.118)	(1.568)	(1.274)	(0.706)
Barren share	−0.006	0.031	−0.038	0.138	0.144	−0.005	−1.144	−0.658	−0.486
	(0.036)	(0.049)	(0.042)	(0.192)	(0.378)	(0.340)	(0.948)	(0.532)	(0.468)
<i>D. Water and Other</i>									
Water & ice share	0.208	0.132	0.076	0.114	0.019	0.095	0.007	0.060	−0.053
	(0.271)	(0.086)	(0.270)	(0.146)	(0.066)	(0.123)	(0.088)	(0.051)	(0.065)

Notes: Entries report region-specific Callaway-Sant’Anna (2021) ATTs using a 10-mile buffer. All outcomes are measured as shares of total reservation area (percentage points). All specifications are unweighted. Standard errors in parentheses are clustered at the reservation level. *** $p < 0.001$, * $p < 0.05$, $\cdot$ $p < 0.10$.

APPENDIX B

ROBUSTNESS TO CROP BASKETS

Table B.1. Land Cover Classifications

Outcome	Land Cover Classes Included
High-Value Crop Share (Intensive margin; share of cropland)	<i>High-value crops (numerator):</i> Apples, Almonds, Pistachios, Pecans, Walnuts, Peaches, Plums, Apricots, Cherries, Pomegranates, Oranges, Citrus, Blueberries, Cranberries, Caneberries, Pears, Tomatoes, Potatoes, Sweet Potatoes, Onions, Garlic, Lettuce, Greens, Herbs, Peppers, Eggplants, Radishes, Broccoli, Cauliflower, Carrots, Cabbage, Spinach, Celery, Watermelons, Cantaloupes, Honeydew Melons, Squash, Cucumbers, Pumpkins, Hops, Mint. <i>Cropland (denominator):</i> All land classified as cultivated agriculture, including Fallow / Idle Cropland , and excluding Development, Natural Vegetation, Rangeland / Pasture, Barren, Water and Ice, and No Data / Missing.
Three Sisters Crop Share (Intensive margin; share of cropland)	<i>Three Sisters crops (numerator):</i> Sweet Corn, Popcorn / Ornamental Corn, Dry Beans, Squash. Field corn is excluded; the basket is restricted to crop classes more consistent with traditional Indigenous cultivation practices. <i>Cropland (denominator):</i> Same as High-Value Crop Share above.
Cropland Share (Total) (Extensive margin; share of total area)	All cultivated agriculture, including Fallow / Idle Cropland. (This category is an agricultural land-base measure; it includes the fallow category below as a subset.)
Fallow Share (Extensive margin; share of total area)	Fallow / Idle Cropland.
Development Share	Developed (High Intensity), Developed (Medium Intensity), Developed (Low Intensity), Developed (Open Space).
Natural Vegetation Share	Deciduous Forest, Evergreen Forest, Mixed Forest, Forest (generic), Shrubland, Herbaceous Wetlands, Woody Wetlands, Wetlands.
Rangeland / Pasture Share	Grassland / Pasture (rangeland and improved pasture).
Water and Ice Share	Open Water, Aquaculture, Perennial Ice / Snow.

Table B.2. Triple Difference Estimates for Three Sisters Share of Cropland (Intensive Margin)

Sample	Specification	ATT	SE	z	p -value	95% CI
Overall	DDD: Gap (In – Out)	0.013	0.156	0.083	0.934	[–0.293, 0.319]
Overall	Inside (In)	–0.254	0.281	–0.904	0.366	[–0.803, 0.296]
Overall	Outside (Out)	–0.201	0.307	–0.655	0.513	[–0.802, 0.400]
Northern Plains	DDD: Gap (In – Out)	–0.203	0.180	–1.130	0.258	[–0.556, 0.149]
Northern Plains	Inside (In)	0.393	0.575	0.684	0.494	[–0.733, 1.520]
Northern Plains	Outside (Out)	0.153	0.294	0.518	0.604	[–0.424, 0.730]
Pacific Northwest	DDD: Gap (In – Out)	0.160	0.673	0.237	0.813	[–1.159, 1.478]
Pacific Northwest	Inside (In)	–1.358	0.847	–1.604	0.109	[–3.017, 0.301]
Pacific Northwest	Outside (Out)	–1.027	1.347	–0.763	0.446	[–3.667, 1.613]
SW + Southern Plains/OK	DDD: Gap (In – Out)	0.015	0.033	0.454	0.650	[–0.050, 0.080]
SW + Southern Plains/OK	Inside (In)	0.074	0.089	0.833	0.405	[–0.100, 0.248]
SW + Southern Plains/OK	Outside (Out)	0.088	0.097	0.902	0.367	[–0.103, 0.278]

Notes: Entries report cropland-weighted Callaway-Sant’Anna difference-in-differences estimates for the intensive-margin outcome defined as the share of cropland planted in the Three Sisters crop basket. The DDD estimate is the CS-DiD estimate on the inside-minus-outside gap.

APPENDIX C

ROBUSTNESS TO MINIMUM CROP THRESHOLD

Table C.1. Sensitivity to Minimum Total Cropland Threshold on Intensive Margin

Cropland Threshold (Minimum %)	Interior DiD	Exterior DiD	Triple Difference (Z_{it})
0.01	1.203 (2.477)	0.379 (2.475)	0.824 (2.008)
0.1	1.414 (2.410)	-0.013 (2.872)	1.427 (1.815)
1	-0.595 (1.436)	-2.975 (1.583)	2.381 (1.225)
5	-0.685 (1.030)	-0.943 (0.813)	0.257 (0.931)

Notes: Entries report Callaway-Sant’Anna (2021) difference-in-differences estimates using a 5-mile buffer specification. Rows vary the minimum cropland share threshold used to define observations included in the high-value crop share calculation. The final column reports the preferred triple-difference estimate obtained by applying the estimator to the interior-exterior gap $Z_{it} = Y_{it}^{in} - Y_{it}^{out}$. Standard errors (in parentheses) are clustered at the reservation level.

Table C.2. Sample Sizes by Minimum Cropland Threshold

Cropland Threshold (Minimum %)	Reservations	Observations	Finite Gap Observations
0.01	138	2346	2159
0.1	119	2023	1940
1	84	1428	1419
5	60	1020	1018

Notes: Entries report the number of reservations and observations included in the estimation sample for each minimum cropland threshold used in the robustness analysis. “Finite Gap Observations” denotes the number of observations with non-missing values for the interior-exterior gap outcome $Z_{it} = Y_{it}^{in} - Y_{it}^{out}$.

APPENDIX D

ROBUSTNESS TO ALTERNATIVE CLUSTERING

Table D.1. DDD Estimates with Region-Level Clustering

Outcome	ATT	SE	<i>t</i>	<i>p</i>	95% CI
HVC share of cropland (weighted)	0.021	0.207	0.103	0.924	[-0.385, 0.428]
Cropland share (total)	0.023	0.146	0.154	0.887	[-0.264, 0.309]
Fallow share	-0.021	0.065	-0.331	0.762	[-0.148, 0.106]
Development share	-0.765	0.580	-1.318	0.279	[-1.902, 0.373]
Natural vegetation share	-0.427	0.282	-1.515	0.227	[-0.979, 0.125]
Rangeland share	1.458	0.911	1.600	0.208	[-0.328, 3.244]
Barren share	-0.277	0.231	-1.200	0.316	[-0.729, 0.175]
Water and ice share	-0.010	0.074	-0.137	0.899	[-0.156, 0.136]

Notes: Entries report overall triple-difference estimates using the inside-outside land-use gap as the outcome. The high-value crop specification is weighted by cropland area. Standard errors are clustered at the broad regional level.