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A STUDY OF INDIAN LAND ALLOTMENT

Christian Dippel
Dustin Frye
Bryan Leonard

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ABSTRACT

Governments often place restrictions on the transferability of property rights to protect property owners from making "mistakes" such as selling their property under value. However, these restrictions entail costs: they reduce the property's value as collateral in credit markets, limit owners' ability and incentives to invest in the land, and create various transaction costs that constrain optimal land use. We investigate these costs over the long run, using a natural experiment whereby millions of acres of reservation lands were allotted to Native American households under differing land-titles between 1887–1934. We compare non-transferable land plots to neighboring plots held with full property rights, using fine-grained satellite imagery to study differences in land development and agricultural activity from 1974–today.

Christian Dippel
UCLA Anderson School of Management
110 Westwood Plaza, C-521
Los Angeles, CA 90095
and NBER
christian.dippel@anderson.ucla.edu

Dustin Frye
Vassar College
124 Raymond Ave, Box 76
Department of Economics
Poughkeepsie, NY 12604
dufrye@vassar.edu

Bryan Leonard
School of Sustainability
Arizona State University
bryan.leonard@asu.edu

1 Introduction

Government programs that formalize the property rights of the poor often include provisions that limit the ability to transfer or alienate property for fear that property owners may sell their property under value or against their own long-term interest. Legally speaking, owners enjoy *usufruct* rights, i.e. they can use their property and enjoy its "fruits," but they cannot transfer or alienate their property (Rose-Ackerman 1985, Ellickson 1993, Alston, Alston, Mueller, and Nonnenmacher 2018, ch2-3). Such transfer restrictions may have been well-justified at the time they were instituted. Many government programs that granted or organized property rights to poor communities were passed by political coalitions of Yandle's proverbial "bootleggers and baptists," and the "baptists" may have correctly identified a need to protect newly created property owners from the "bootleggers" (who in the setting we study were land-hungry white settlers).[1] In the long run, however, transfer restrictions may come at a heavy price: they can undermine a property's collateralizability, reduce the incentive to invest in improvements, prevent assembly of multiple plots to achieve scale economies, and constrain inheritance practices, leading to fractionated ownership claims that can create transactions costs and free-riding or hold-up problems (see e.g. Place and Swallow 2000 and Fenske 2011).

To investigate the long-run consequences of limits on transfer rights, we leverage a natural experiment that resulted from the policy of "Indian allotment" on American Indian reservations in the early 20th century. This policy generated a patchwork of land titles on reservations, with some Native households owning their land in non-transferable "allotted trust" and other immediately adjacent Native households owning land under full fee-simple property rights. To compare economic activity on plots with different land titles, we map the universe of historic land allotments from the *Bureau of Land Management* (BLM) to the *Public Land Survey System* (PLSS) grid, and to high-resolution satellite data from the *National Wall-to-Wall Land Use Trends Database* (NWALT).

The allotment period began in 1887 and ended with the *Indian Reorganization Act* (IRA) of 1934 (Taylor, 1980; Carlson, 1981). In the intervening half-century, the federal government allotted millions of acres of previously tribe-owned land to individual Native American households, starting with the Dawes Act, and accelerating after the 1906 Burke Act. All land rights were first issued

[1] India's prohibition of letting its citizens enter indentured servitude contracts in the British colonies constitutes an application of the same idea to property rights over one's own labor (Sen, 2016)

in non-transferable "allotted trust," and could then—after a period of trusteeship—be selectively converted into fee simple by a reservation's local *Bureau of Indian Affairs* (BIA) agent. Had this policy run its full course, all reservations would have eventually been allotted, and all allottees would have eventually seen their land rights converted to fee simple. However, the 1934 IRA put an abrupt stop to the process, ending all allotment for good and freezing all allotted-trust plots into trusteeship in perpetuity.[2] This created a checkerboard of land tenures on reservations that has persisted to the present day.

Endogeneity problems in the comparison of non-transferable allotted-trust and fee-simple lands on reservations arise from the fact that allotments may have been selectively converted into fee simple. The primary concern is selection on land characteristics: plots with certain characteristics may have gotten converted at a higher rate. We address this with a spatial fixed effect strategy that compares plots only inside neighborhoods that are small enough to eliminate observable differences in land characteristics. In our preferred specification, non-transferable allotted-trust status reduces overall land utilization by 0.2 standard deviations, which translates into a 4 percentage point lower share of land in agricultural cultivation, and a 0.2 percentage point lower share of land in development.[3]

Another potential concern is that *allottees* with certain characteristics (such as a higher proclivity for farming) may have had their plots converted at a higher rate before the policy ended in 1934, and that such characteristics continue to matter today. One approach to addressing this concern is to include (reservation-specific) family-name fixed effects in our baseline estimation. Family-name fixed effects add considerable explanatory power to the regressions, but their effect on our core estimates is marginal. As a second approach, we pursue an instrumental variable (IV) strategy that generates exogenous variation in whether an allotted plot was converted to fee-simple title before the process ended in 1934. The IV leverages the original allottees' birth year, with later birth cohorts receiving allotments later and thus being less likely to convert to fee simple by 1934. The IV's exclusion restriction is that the birth year of the original allottee has no direct

[2] Subsequent to 1934, moving land out of trust status remains a theoretical possibility but requires special approval from the Secretary of the Interior (Shoemaker, 2003; C.F.R.150.1-150.11, 1981).

[3] Our findings are robust to various forms of spatial correlation, including clustering by PLSS township, reservation, or spatial HAC standard errors proposed by Conley (1999, 2008). We obtain very similar estimates when we measure outcomes in the *National Land Cover Database* (NLCD), which is available only after 2001 but at a slightly higher resolution than NWALT.

effects on *long-run* land use of their heirs eighty to one hundred years later. We also construct a second instrument based on the identity of the exogenously rotating BIA agents who decided on conversion to fee simple on each reservation. This second instrument confirms the results of the main IV, and allows for over-identification tests that supports the validity of the exclusion restriction.

We leverage the fact that the NWALT satellite data exist in five decadal waves (1974, 1982, 1992, 2002, and 2012) for a panel analysis, and find that the land-utilization gap between allotted-trust and fee-simple land grew monotonically over 1974—2012. This is true even when including plot fixed effects that absorb all unobserved differences in time-invariant characteristics (of both the land and the original allottees). There was no difference at all in land development in 1974, implying that the entire difference in 2012 is driven by subsequent divergence. By contrast, over eighty percent of the 2012 difference in agricultural cultivation was already present in 1974. These patterns are congruent with the process of structural transformation away from agriculture and into manufacturing, tourism, and services that has occurred on reservations since 1974 (Cornell and Kalt 1992, Jorgensen 2007, Treuer 2012, ch6).

Turning to mechanisms, the literature on land tenure shows that more complete rights over land encourage investment and economic activity by strengthening claims to output, by increasing access to capital, and by allowing owners to gain from selling their land or liquidating their sunk investments in response to adverse income shocks (see, e.g. Fenske 2011). These channels are referred to respectively as "assurance," "collateralizability," and "realizability" in Brasselle, Gaspart, and Platteau (2002).[4] A fourth channel of potential importance on reservations is that transferability creates "assembly problems" by preventing farms from being aggregated to more efficient scale. In addition to these *direct* channels, transfer-restrictions may also stifle economic activity *indirectly* by creating fractionated competing ownership claims to the same property over generations through a process we describe in Section 2. This fifth potential problem, "fractionation," can stifle land utilization on allotted-trust land for several reasons. One is transaction costs: because all claimants have equal undivided claims on an allotted-trust plot, each claimant can undermine whatever productive activity another claimant may want to engage in. Another problem is free-riding because each claimant is entitled to a share of whatever fruits emerge from the

[4] They are referred to as security, collateral, and gains-from-trade in Besley (1995).

productive activities of the other claimants.

The assurance channel can be ruled out on allotted-trust land because title is fully secure, and we cannot test for the importance of the realizability effect without data on individual-level income shocks. However, the data do allow us to provide direct evidence for the other three channels. Using FDIC banking data, we show that an expansion of banking around a reservation amplifies the difference between allotted-trust and fee-simple plots and causes a substitution of agricultural cultivation towards more capital-intensive land development, providing direct evidence for the collateralizability mechanism. We also construct a measure of farm assembly across plots, and find that there is significantly more assembly across fee-simple than across allotted-trust plots. Finally, we find evidence that allotted trust plots with greater exposure to fractionation exhibit less land utilization than other plots.[5] In summary, we provide evidence that transfer restrictions affect land use through *at least* three channels: reducing access to credit, impeding land assembly, and creating problems associated with competing ownership claims.

Our paper complements a large literature on land tenure and economic development (Alston, Libecap, and Mueller, 2000; Banerjee, Gertler, and Ghatak, 2002; Besley and Ghatak, 2010; Hornbeck, 2010). This literature has tended to focus more on property rights *security* than on *transferability* as the primary source of assurance, collateralizability and realizability problems (De Soto, 2000; Goldstein and Udry, 2008; Besley, Burchardi, and Ghatak, 2012). Non-transferability has been shown to affect investment mostly insofar as title in some settings is conditioned on occupancy or gets returned to the community (village or lineage group) after an owner's passing (Migot-Adholla, Hazell, Blarel, and Place, 1991; Fenske, 2011).[6] In contrast, our results show that transfer-restrictions can be of first-order importance even when title is perfectly secure and not conditional on occupancy. This is particularly true in settings where collateralizability and assembly to larger scale are of primary concern, making our findings relevant for developing nations as they continue to formalize their land titling systems and transition to more capital-intensive forms of development and agriculture.

Our paper also speaks to a literature on indigenous economic development. Non-transferable property rights are particularly common among indigenous peoples, who historically had less

[5] We use historical data to construct a measure of a plot's *latent* fractionation because the actual fractionation of claims is private information.

[6] Besley (1995) uses the language of transfer rights but is really focused on the security of rights.

bargaining power in shaping their property rights, and were often viewed by the government as needing protections from making "mistakes" with their property. Examples include indigenous land rights in Mexico until recent *Procede* land reforms (De Janvry, Emerick, Gonzalez-Navarro, and Sadoulet, 2015), historical restrictions of Alaska Natives' transfer rights over their reindeer herds (Massey and Carlos, 2019), and many Native American households and tribes who historically did not, and today often still do not have transfer rights over their land. A number of studies suggest that more complete property rights could improve economic outcomes in indigenous communities (Trosper, 1978; Johnson and Libecap, 1980; Libecap and Johnson, 1980; Anderson, 1995; Alcantara, 2007; Dippel, 2014; Leonard, Parker, and Anderson, 2020). Our study contributes to these by providing plausibly causal estimates of the cost of non-transferable land rights, using highly disaggregated spatial units of analysis. By including the near-universe of allotted reservations, we provide the average treatment effect to complement a number of case studies comparing trust-land and fee-simple land on specific reservations, including Agua Caliente in California (Akee, 2009; Akee and Jorgensen, 2014), Fort Berthold in North Dakota (Leonard and Parker, 2021), and Uintah and Ouray in Utah (Ge, Edwards, and Akhundjanov, 2019). Our paper is also similar to Aragón and Kessler (2020), who find that Canada's "certificates of possession," which are similar to allotted-trust rights, fall short of generating the benefits of full property rights.

Because our paper is of first-order relevance to reservations, we extend the analysis in several ways. First, we add tribal land to the analysis (without a claim to causal identification) as it still constitutes the majority of reservation land today. We find that land utilization on tribally owned land is higher than on allotted-trust plots, although significantly lower than on fee-simple plots. In the panel, tribally owned plots appear to be on a more positive dynamic trajectory than allotted-trust plots. In short, transfer restrictions render land use on private land less efficient than even on communally owned land. We discuss tradeoffs between either returning allotted-trust land to tribal control or converting it to fee-simple. Lastly, we develop a back-of-the-envelope estimate of the negative impact of transfer restrictions on land values. To do so, we combine the estimated effect of fee-simple title on land utilization with an estimate of the effect of land utilization on land values using county assessor data. This exercise suggests that fee-simple title would add between \$973 and \$4,765 in value to an acre of allotted-trust land, or between \$156,000 and \$762,000 to a 160-acre plot, with the wide range determined by surrounding land values.

2 Background

Historical Backdrop: Following the establishment of the reservation system, *"Friends of the Indian"* reformers became concerned with the question of assimilation (Carlson, 1981, p80).[7] Private property was viewed as the path towards assimilation, and reformers viewed land allotment as the best way to introduce real property to Indians (Otis 2014).[8] The government concurred, and in 1886 Henry Dawes introduced an allotment bill to the Senate. On February 8, 1887, President Grover Cleveland signed the Dawes General Allotment Act into law. The Dawes Act authorized the president, through the *Office of Indian Affairs* (the BIA's precursor), to survey and allot reservation lands (Banner, 2009). Heads of household received 160 acres, and single persons over the age of 18, as well as orphans, received 80 acres. Part of the government's favorable view of allotment could be explained by the fact that after allotting a reservation, and selling the surplus land, the reservation itself would constitute no more than a spatial cluster of Native American individuals. As such, the tribes themselves would lose their raison d'être as polities. This view was reflected in Theodore Roosevelt's first annual message to Congress in December 1901, when he stated that "*the time has arrived when we should definitely make up our minds to recognize the Indian as an individual and not as a member of a tribe. The General Allotment Act is a mighty pulverizing engine to break up the tribal mass. It acts directly upon the family and the individual*."

Indian land allotment was supported by a political coalition of Yandle's proverbial "bootleggers and baptists." The "baptists" were the reformers, while the "bootleggers" were an alliance of state and local politicians and land speculators who wanted to free up Native American-owned land for white settlement.[9] To protect allottees from the "bootleggers," the "baptists" designed allotment with some safeguards against land loss; in particular the policy prohibited the transfer of property rights until such a time that the allottees could acquire sufficient experience ("competence" was the word used) with private property. In practice, this was achieved by putting the land into an "allotted trust" with a reservation's local *BIA agent* for 25 years, or until allottees were

[7] The two main reformist groups were the *Indian Rights Association* and the *National Indian Defense Association*, respectively formed in 1882 and 1885.

[8] Most tribes had norms of private property, and the majority of tribes viewed their land as their tribal property, but no tribe had traditionally had private property rights over land (Demsetz, 1967).

[9] Unallotted reservation land was designated as surplus and could be made available for outside settlement (see Appendix-Figure A1). Proceeds from the sales of the surplus land were held in trust and appropriated at the discretion of Congress for "education and civilization" (Banner, 2009). We exclude surplus land inside modern reservation boundaries from our analysis.

declared competent by their agent and granted full (i.e. fee simple) rights. Critically, land held in allotted trust could not be transferred or alienated.

Selection of Land into Allotment: On an allotted reservation, allotments were mandatory. There was no explicit policy about selecting land for allotment. Allottees could select a plot, but often did not, in which case the *allotting agents* determined the assignment of allotments (Banner, 2009; Otis, 2014; Carlson, 1981). *Allotting agents* often did not know much about the quality of the land because they were typically distinct from the reservation's permanent BIA agent, and as such they only visited the reservations for the specific task of allotment (Bureau of Indian Affairs , 1887–1926). The 1928 Meriam report, which came out after the vast majority of allotments had been issued (see Appendix-Figure A2), characterized the process as follows: "*The original allotments of land to the Indians were generally made more or less mechanically. Some Indians exercise their privilege of making their own selections [...]; others failing to exercise this right where assigned land. Often Indians who exercise the privilege made selections on the basis of the utility of the land as a means of continuing their primitive mode of existence. Nearness to the customary domestic water supply, availability of firewood, or the presence of some native wild food were common motives*" (Meriam, 1928, p470).[10] When we compare never-allotted tribal land to allotted (trust or fee-simple) land in the data, we do find some evidence for positive selection of land into allotment, with lower elevation, less ruggedness, and better soil quality on allotted land compared to never-allotted land. Small differences remain on these dimension even within small geographic neighborhoods; suggesting some positive selection of the land by either Native allottees, the allotting agents, or both.[11]

Selection into Fee Simple: The more important question for our study, which compares two different types of initially-allotted plots, is whether those plots that local BIA agents ended up converting to fee simple were different from the plots they did not convert. It is, for example, plausible that allotted plots that were more suitable for farming could have been either more or less likely to be be converted to fee simple by the BIA agent. One may expect the former, i.e. positive selection. However, the latter is equally possible, given the Meriam report's alleged racism and corruption of the process, and given McChesney's (1990) characterization of the process of allotment as one where the BIA acted as a Peltzman-style self-serving bureaucracy that was pri-

[10] Meriam's report was written for the Institute of Governmental Research, a precursor of Brookings Institution. The report was concerned with the socio-economic conditions on reservations, with special attention to allotment.

[11] See Panel A in Appendix-Table A6.

marily trying to maximize the budget it controlled (Peltzman, 1976). Either way, differences in observable land characteristics between allotted-trust and fee-simple plots disappear within the finer spatial fixed effects (2×2-miles) that we will use as our empirical baseline specification.

There may nonetheless be other sources of potential selection, especially on the characteristics of the allottees themselves. If BIA agents only had the Native American allottees' interests at heart, then better farmers may have been more likely to see their land converted into fee simple. However, the opposite could again have been the case if the BIA wanted to maximize its control over rents, in line with McChesney's account of allotment. Lastly, selection could have also occurred on personal characteristics that may only spuriously correlate with later land utilization. For example, Dippel and Frye (2020) argue that allottees responded to the incentives of the allotment policy by *signaling* their cultural assimilation to the BIA agents through acts like going to church and wearing "civilized dress." In our estimation exercises, we will address these selection concerns with an IV strategy that generates exogenous variation for whether allotted land was converted to fee simple.

The 1934 IRA: By the 1930s, sentiment within the BIA had turned against allotment. One reason may have been the failures of allotment reported in the Meriam report. Another reason may have been that the BIA tried to protect its own relevance as a trustee of the land (McChesney, 1990). Either way, in 1934 the Commissioner of Indian Affairs, John Collier, introduced the Indian Reorganization Act (IRA), which ended allotment: reservations that the BIA had not yet managed to survey by 1934 were never allotted (unallotted reservations play no role in our empirics); the IRA froze allotted-trust land in its trusteeship status indefinitely; already-converted fee-simple land remained fee simple; and unallotted lands remained under tribal ownership. Because much of the allotted land had not yet passed through its trust period by 1934, the IRA's legacy was to create a patchwork land tenure pattern on reservations of (*i*) individually owned allotted-trust plots, (*ii*) individually owned fee-simple plots, and (*iii*) tribally owned plots. This patchwork persists to the present day.

Transfer Restrictions and the Fractionation of Interests: The original allottees' heirs that own allotted-trust plots today hold usufruct rights (*beneficial title*) to their land, but the federal government retains the *legal title* to it. This means the owners cannot transfer or alienate their rights. This is as true today as it was 100 years ago. As noted in the introduction, these transfer-restrictions shape economic choices and options on reservations *directly* (e.g. through the collateralizability problem) as well as *indirectly* by creating fractionated ownership claims. To understand how this fractionation-effect occurs, start with the observation that when property in the U.S. is bequeathed without a will, all heirs have an equal undivided interest in it (as "tenants in common").[12] With transfer rights, this issue is easily resolved: heirs either sell the inherited property and divide the proceeds, or one heir takes out a mortgage on the property to buy out the others. In this way, American farms have historically been able to remain at their efficient size and ownership structure, thanks in large part to well-developed rural financial markets (Alston and Ferrie, 2012). On allotted-trust land, however, where the property is non-transferable, both of these paths are closed and when there is no will explicitly bequeathing the property to one heir, all heirs are stuck sharing the property in equal undivided interest. This issue was particularly pronounced for allotments whose original allottees passed away earlier, because will-writing was uncommon among Native Americans in the early parts of the twentieth century; in fact it was prohibited until 1913 (Stainbrook 2016, p2, Shumway 2017, p648).

Once started, interest-fractionation has the tendency to snowball over time as each heir may have multiple heirs themselves, and the owners of already-fractionated interests may themselves have lower incentives to write a will to prevent further fractionation. Today, the average allotted-trust plot has 13 claimants, but there are many instances of trust plots with hundreds of claimants on them (Department of Interior, 2013). Shoemaker (2003, p746) cites a 1987 report prepared for the Supreme Court according to which "*Tract 1305 (on the Sisseton-Wahpeton Lake Traverse Sioux reservation) is 40 acres. [...] It has 439 owners, one-third of whom receive less than $0.05 in annual rent and two-thirds of whom receive less than $1. The largest interest holder receives $82.85 annually.*" This problem did not get better after 1987; for instance, Russ and Stratmann (2014) show that fractionation doubled from 1992 to 2010. Post-dating our 2012 satellite data, there have since been some improvements due to the Cobell settlement of 2014, which we discuss in the conclusion.

[12] An important piece to this is that the *court presumption* in U.S. states is common heirship into equal *undivided* claims (i.e. tenancy in common) on a property. An alternative court presumption, which holds in India today, and held in most of continental Europe in the 19th century, is common heirship into *divided* interests. This results not in ownership fractionation, but instead in a fracturing of the property itself, giving rise to farm sizes that are too small to operate at efficient scale (Libecap and Alter, 1982; Foster and Rosenzweig, 2011, 2017).

3 Data Sources

Allotment data: Following approval from the President, each patent issued on a reservation was filed with the General Land Office (GLO). These patents—subsequently digitized by the Bureau of Land Management (BLM)—record the transfer of land titles from the federal government to individuals. Each patent contains information regarding the patentee's name, the specific location of the parcel(s), the official signature date, total acreage, and the type of patent issued. These patents include cash sales, all homestead entries, and Indian allotments. An important feature of the GLO data is that we can see the date on which each allotment was issued and the date on which it was converted into fee simple, if ever. This ability to follow the individual allotments and when they were converted to fee simple allows us to identify them as either allotted-trust or fee-simple lands today. Appendix-Figure A2 depicts the aggregate annual flow of allotments issued and converted into fee simple from 1887–1934.

The Public Land Survey System: The GLO allotment data also describe the location of each land allotment within the Public Land Survey System (PLSS), a rectilinear grid that divides (most of) the United States into 36-square mile townships, each with a unique identifier.[13] Each township is composed of 36 square-mile sections numbered 1 to 36. Hence, any individual square mile of land within the PLSS can be referenced using the township identifier and section number. These numbered sections, which are 640 acres, were often divided into smaller "aliquot parts" when transferred to private ownership. The most common division is the quarter section, which is a 160-acre, $\frac{1}{2} \times \frac{1}{2}$-mile square referenced by a direction within a section (e.g., NE refers to the northeast corner of the section). Land could be further subdivided smaller than a quarter section, but the relevant quarter section can still be extracted from the aliquot part listed in the BLM allotment. For example, an allotment with an aliquot part of SW$\frac{1}{4}$NW is the southwest quarter of the north-west quarter-section.

We focus on 160-acre quarter sections, which we refer to as *plots*, as the basic unit of analysis because quarter sections were the size of a standard Indian allotment and because quarter-sections are a standard unit of analysis that has been used previously in the literature to analyze land use decisions with satellite data (see, e.g., Holmes and Lee 2012). Of the universe of allotments with

[13] Each township is referenced by a township number and direction that indicate its North-South position and a range number and direction that identifies its East-West position relative a prime meridian.

a potentially matchable aliquot part variable in our data, we successfully matched over 95% to quarter sections in the PLSS using a shapefile from the BLM.[14] Figure A3 depicts the location of all allotted plots across the Western United States. In most cases, these clusters of allotments trace out the boundaries of present-day reservations. In some rare cases, clusters of allotments trace out the boundaries of a former reservation that was later terminated. This is true, for example, of the more dispersed looking clouds of allotments in Central and Northern California. Oklahoma, which is in fact densely covered by allotments, is the only gap in our spatial allotment data.[15] Eastern Oklahoma was covered by reservations for the 'Five Civilized Tribes' (the Cherokee, Chickasaw, Choctaw, Creek, and Seminole) who had been relocated there in the 1830s. These tribes were fully allotted and we have their individual allotment records, but for some reason their allotments were either not filed with the General Land Office or not digitized by the BLM.

Once allotments are geo-located, we track the history of BIA transactions associated with each allotment to code whether it was converted from allotted trust to fee simple. Figure 1 depicts an example of our data on the Pine Ridge Reservation in South Dakota.[16] Dark/orange plots are still in allotted-trust status, whereas light/grey plots have been converted to fee simple. The larger square outlines are the boundaries of 6×6-mile PLSS townships (nearly 150 can be seen on Pine Ridge). Unshaded areas correspond to quarter sections that are not associated with an allotment and therefore do not play a role in our analysis. There are three types of quarter sections for which this is true: (*i*) land was never allotted and is thus tribally owned; (*ii*) surplus land that was made available to white settlers (Appendix-Figure A4 shows a version of Figure 1 that separately identifies such surplus land on Pine Ridge);[17] (*iii*) quarter sections which we are unable to match to the BLM data.[18] In our empirical analysis, we will focus on progressively finer spatial variation and compare only nearby plots of different tenure regimes. It is therefore important to note that

[14] In some cases the aliquot part is either missing, corrupted, or not not formatted in a way that allows matching to quarter-sections. Some quarter sections in our data are associated with more than one allotment, but we only use quarter sections that are mapped to a unique land tenure type.

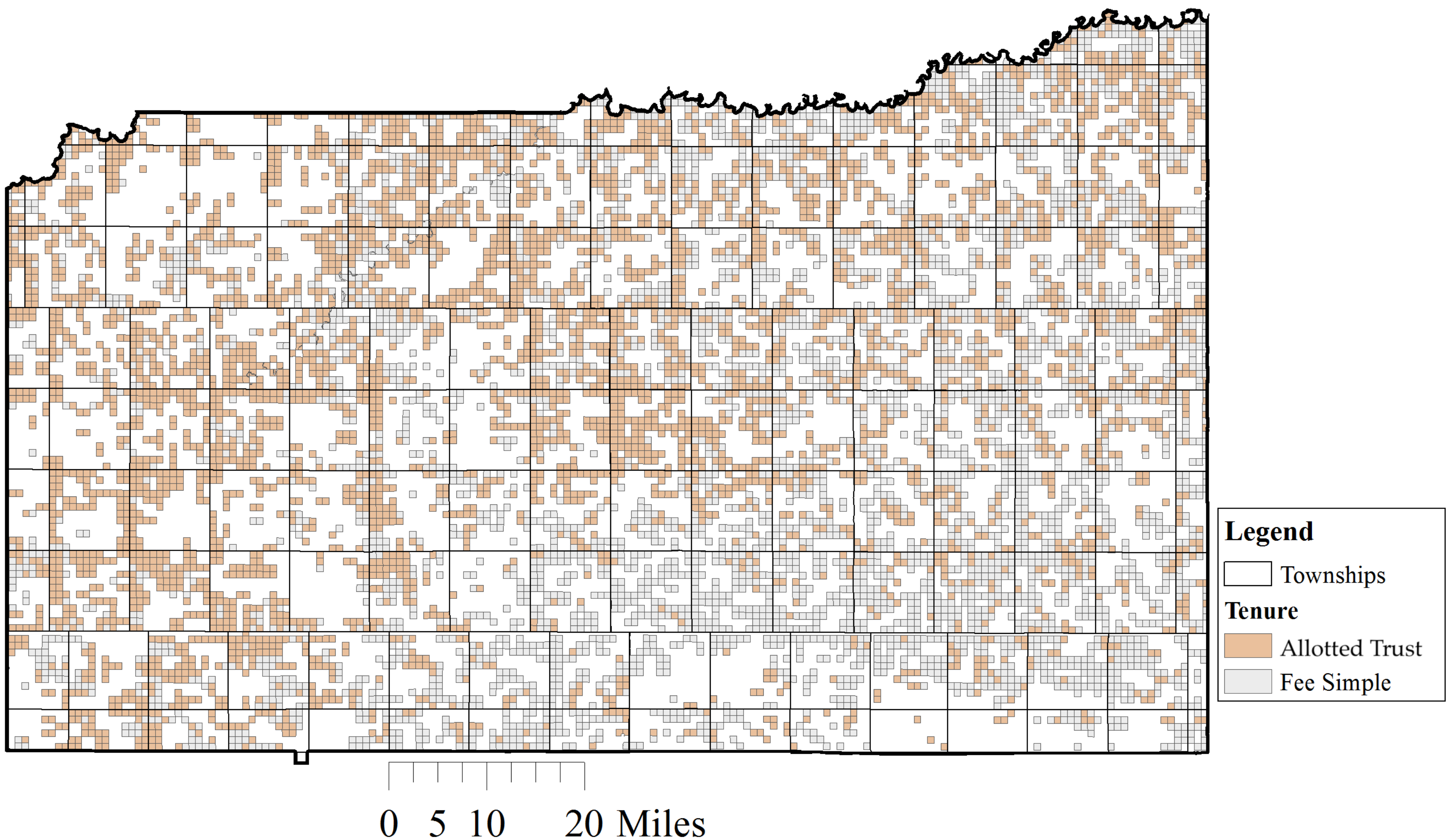
[15] Our match rate is above 99% for most states, with notably lower match rates for New Mexico (where the PLSS grid is less cleanly defined) and Wisconsin.

[16] To simplify the analysis, we focus on plots which are matched to either all fee simple or all allotted trust, but not a mix. We also omit observations that converted from allotted-trust to fee-simple title after 1934, a rare occurrence that required special approval from the Secretary of the Interior. (See footnote 2).

[17] We always omit surplus land from our analysis. The vast majority of surplus lands is outside of reservations, because it was ceded from reservations as large tracts. See discussion in footnote 9 and reference to Appendix-Figure A1.

[18]Reservation-level data obtained from Anderson and Parker (2008) indicates that 32% of the land on Pine Ridge is held in tribal trust and therefore falls into cateogry (*i*).

Figure 1: Checkerboard Pattern of Land Tenure on the Pine Ridge Reservation

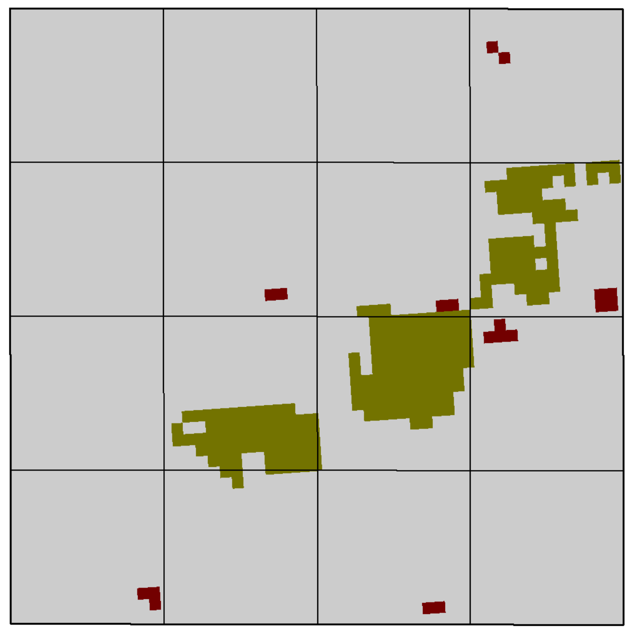


Notes: Distribution of Land tenure on the Pine Ridge reservation by allotment parcel (quarter-section) in the GLO data. Overlaying the reservation is a township grid. Each township is 36 square miles and contained in each are 144 (= 36 × 4) quarter sections, each of which is 160 acres (one-quarter of a square mile) large. The figure depicts only the allotted quarter sections.

land tenure regimes vary within close proximity of one another in Figure 1; i.e. most allotted-trust plots have at least one fee-simple direct neighbor and vice versa. This pattern is representative of most reservations.

Land use satellite imagery data: Our main outcome data on land use come from the *National Wall-to-Wall Land Use Trends* Database (NWALT). A collection of federal agencies known as the *Multi-Resolution Land Characteristics Consortium* produces the NWALT by combining satellite images from the Land-Sat database with remote processing techniques. The resulting database provides estimates of land cover at a 60×60-meter resolution for 1974, 1982, 1992, 2002, and 2012. We focus our attention on two main land cover classes in the NWALT: development and cultivated crops.[19] These two measures—development and cultivation—comprise the majority of "productive" uses of land that may be affected by restrictions on transferability.[20] Developed pixels in NWALT reflect capital investments in the construction of durable structures that may be associated with manufacturing, commercial activity, or private residences, and other scholars have used similar measures to study economic activity and growth at a fine spatial scale (Burchfield, Overman, Puga, and Turner, 2006; Saiz, 2010).

Figure 2: NWALT Land Use Data



Notes: This figure depicts our outcome measure of cultivated and developed land in the NWALT data. The figure depicts 16 quarter-sections of 160 acres each. A one quarter-section plot is our unit of analysis (compare figure-notes in Figure 1). The 16-plot, 2 × 2-mile neighborhood depicted here is our favored fixed effect, and corresponds to panel (c) of Figure 3.

Figure 2 depicts our coding of land use from the NWALT data on a subset of the Fort Berthold reservation in North Dakota. The figure depicts four PLSS sections comprised of sixteen individ-

[19] Pixels coded as cultivated by the NWALT include annual crop production, orchard crops, and any land that is being tilled. The NWALT also codes a variety of other land cover types including pasture, scrub/brush, forests, wetlands, perennial snow/ice, water, and "barren" land comprised of bedrock, talus, or sand dunes. For our land use measures, we exclude water from a plot's area: the denominator of each parcel's share-variable is land only.

[20] Another productive land use is extraction of natural resources such as coal or oil, but this is highly dependent on the location of valuable deposits.

ual 160-acre plots, which are our unit of analysis. We express land use as a share of total usable parcel area, and define this denominator as the total number of pixels in a parcel excluding water and perennial snow/ice. We recognize that the NWALT data only allow us to capture changes in land use at the *extensive* margin; i.e, bringing new land into agricultural production or development. *Intensive*-margin improvements such as intensifying irrigation and agricultural use, or buildings constructed over an empty parking lot are not measured. As a result, our estimates will likely understate the full effect of non-transferability. As an alternative outcome measure, we also use the *National Land Cover Database* (NLCD). The NLCD data have slightly higher resolution than NWALT, but are only available from 2001, whereas NWALT is available from 1974. Below, we show that our main results are robust to the use of the NLCD data rather than the NWALT data.

Constructing a land utilization index: Investigating development and agricultural cultivation separately is interesting, but is econometrically harder to interpret because the two land uses are obvious substitutes. In our core specification, we will therefore focus on a single unified land utilization index, although we also separately investigate the different uses later in the paper. We construct a single land utilization index $Z(Use)$ that aggregates information over both measures following Kling, Liebman, and Katz (2007). The index is the weighted average of standardized z-scores from both components. We calculate each z-score separately by reservation and year by subtracting the reservation-year-specific mean and dividing by the reservation-year-specific standard deviation. Following the approach in Kling et al. (2007) and Hoynes, Schanzenbach, and Almond (2016) of calculating standardized indices relative to the control group, we calculate the mean and standard deviation from allotted-trust land in each reservation-year. The allotted-trust quarter sections therefore have a mean index value of 0 and a standard deviation of 1 by construction (see the top-left cell in Table 1).

Geographic covariates: As controls, we construct terrain characteristics and soil quality for each plot. We use 30×30-meter elevation data from the *National Elevation Dataset* (NED) to measure the mean and standard deviation of elevation in each plot. We define the variable ruggedness as the standard deviation of elevation, a commonly-used measure of terrain ruggedness (Ascione, Cinque, Miccadei, Villani, and Berti, 2008). We use the soil productivity index developed by Schaetzl, Krist Jr, and Miller (2012) and estimate the average of the soil index within each plot. The soil productivity index ranges from 0 to 21, with soil index values greater than 10 representing highly productive soils (Schaetzl et al., 2012).

4 The Effect of Transferable Property Rights

Section 4.1 presents our baseline identification strategy and results, where we use fine spatial fixed effects to address concerns about geographic selection in the historical conversion of allotments from allotted trust to fee simple. While we view geographic selection as the primary identication threat, we are also concerned about selection on allottees' characteristics. Section 4.2 addresses this concern in two ways. First, we condition our results on (reservation-specific) allottee last names to absorb potential confouding variation from unobservable family-traits on a reservation. Second, we pursue an IV strategy that addresses remaining selection concerns arising primarily from unobserved allottees' actions and characteristics which may have played a role in the BIA agents' historical decision to covert trust land into fee simple.

4.1 Baseline Identification Strategy

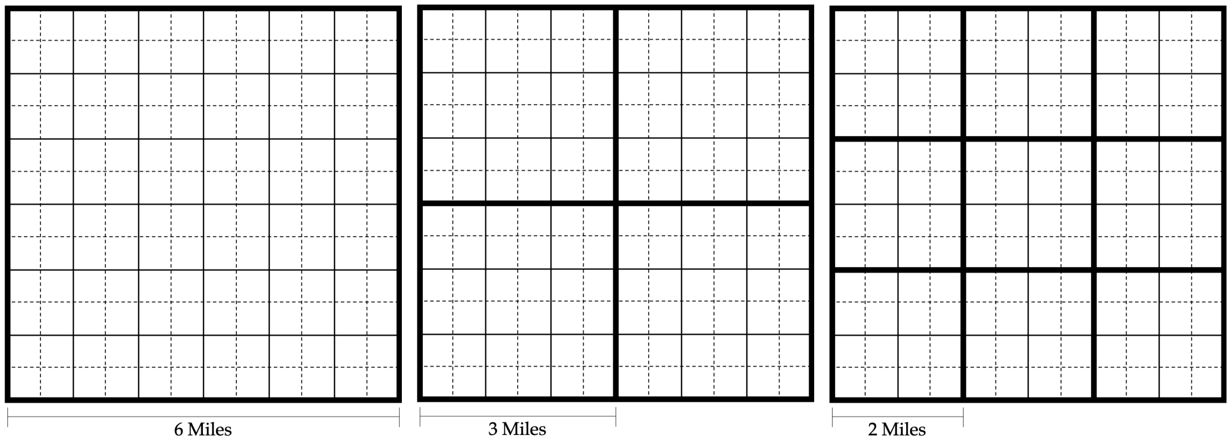
We estimate the effect of tenure on land utilization, using the following linear regression model

$$y_{ij} = \theta \times \text{FeeSimple}_i + \kappa_j + \lambda' X_i + \varepsilon_{ij}, \tag{1}$$

where y_{ij} is the outcome of interest on plot i in spatial region j. As detailed in section 3, we focus on a standardized land utilization index $y_{ij} = Z(Use)$ that aggregates the share of land classified as developed and the share of land in cultivation. FeeSimple_i is an indicator equal to 1 if a plot is under fee-simple ownership. The coefficient of interest is θ, which represents the average difference in land use for fee simple versus nearby allotted-trust plots within the same spatial neighborhood κ_j. The vector of controls X_{it} includes the three land quality characteristics elevation, ruggedness, and soil quality.

One concern with the comparison in equation (1), which we discuss in Section 2, is that the geographic characteristics of a plot could have played a role in BIA agents' historical decision to convert it from allotted-trust to fee simple, and could have at the same time influenced contemporary land utilization directly. Our approach to address this is to choose the spatial neighborhood

Figure 3: Visualization of Spatial Fixed Effects



(a) Township FE (b) 1/4 Township FE (c) 1/9 Township FE

Notes: This figure depicts three spatial fixed effects used in the paper. All three panels depict one township of 36 square miles. (As a point of reference, the Pine Ridge reservation in Figure 1 contains around 150 townships.) Each township contains 144 (= 36×4) individual plots, our unit of analysis. Panel (a) depicts one full-township fixed effects. Panel (b) depicts four $1/4$-township fixed effects. Panel (c) depicts nine $1/9$-township fixed effects. The spatial extent of one fixed effect in Panel (c) corresponds to the 16 plots depicted in Figure 2.

κ_j within which land characteristics X_{it} are balanced across allotted-trust and fee-simple plots. Figure 3 illustrates this approach. From left to right, it depicts increasingly more fine-grained spatial fixed effects κ_j. Each panel depicts a single township comprising $36 \times 4 = 144$ plots. In panel (a), κ_j is a whole township of 144 plots. In panel (b), κ_j is a "1/4-township" fixed effect that divides each township into four sub-areas and leverage comparisons of 36 plots in a 3×3-mile neighborhood. In panel (c), κ_j is a "1/9-township" fixed effect that compares 16 plots in 2×2-mile neighborhoods. (Figure 2 is one such neighborhood.) In panel (c), even plots in opposite corners of a neighborhood κ_j are only 1.4 miles apart.

Table 1 presents means and standard deviations (in brackets) for the estimation sample, reported separately for allotted-trust (column 1) and fee-simple plots (column 2). Columns 3–6 report the difference between fee-simple and allotted-trust plots, beginning with an unconditional difference in column 3 and progressing to within-1/9-township in column 6; with standard errors reported in parentheses.[21] The unconditional differences reported in column 3 of Table 1

[21] There were 119,000 allotments made in Oklahoma. which is home to the Cherokee, Chickasaw, Choctaw, Creek, and Seminole. As we discuss in Section 3, Oklahoma is not included in the data because its allotments were administered separately (through the so-called *Dawes Rolls*), and–as a result of the separate process–*every single allotment* was converted to fee simple, so that Oklahoma allotments would not contribute to the allotted trust vs fee simple compari-

suggest that when all data are pooled, higher-quality lands were more likely to transition out of allotted-trust status: fee simple lands are at lower elevation, are less rugged (by about a standard deviation), and have higher soil quality (by half a standard deviation).[22] This is consistent with previous findings by Leonard et al. (2020). Importantly, these differences are much less pronounced in column 4 within townships: the difference in ruggedness falls by roughly 30% and the difference in soil quality falls by an order of magnitude. This pattern continues with progressively finer fixed effects, and the within-1/9-township differences are all statistically indistinguishable from zero. Moreover, these differences are *at least* an order of magnitude smaller than the unconditional differences. The 1/9-township fixed effect in column 6 is our preferred specification throughout the paper because it delivers balance across all three observable land characteristics, elevation, ruggedness, and soil quality.

Table 1: Summary Statistics

	Trust	Fee	Difference: Fee - Trust			
	(1)	(2)	(3)	(4)	(5)	(6)
Elevation	938.100	734.241	-203.859*	-8.973	-4.347	-0.694
	[459.61]	[357.32]	(83.906)	(5.054)	(2.363)	(0.918)
Ruggedness	14.010	12.575	-1.435	-1.179	-0.675**	0.058
	[21.26]	[38.84]	(2.598)	(0.627)	(0.230)	(0.275)
Soil Quality	9.704	11.603	1.899***	0.444***	0.225***	0.026
	[4.43]	[3.88]	(0.389)	(0.119)	(0.064)	(0.032)
Observations	42,164	26,393	68,557	68,557	68,557	68,557
Township Fixed Effects				Yes		
1/4 Twnshp Fixed Effects					Yes	
1/9 Twnshp Fixed Effects						Yes

Notes: Baselines differences in land utilization, development and cultivation are from the 2012 NWALT. Columns 1–2 present mean and standard deviations by land tenure. The index *Z(Use)* is normalized to have a mean of zero and standard deviation of one for allotted-trust land. Column 3 reports unconditional differences of fee-simple vs allotted-trust land, and columns 4–6 report differences conditional on fixed effects. Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In summary, adding progressively finer spatial fixed effects helps to compress differences in land quality that could confound comparisons of land use across ownership regimes. With the 1/9-township fixed effect in column 6, there are no significant differences left in observed land quality across allotted-trust and fee-simple plots.

son (Office of Indian Affairs, 1935).

[22] Elevation and ruggedness are expressed in 1,000s of meters in our regression models.

Table 2: **Outcome:** Land Utilization Index

	(1)	(2)	(3)	(4)	(5)	(6)
Fee Simple	0.385***	0.335***	0.291***	0.269***	0.216***	0.214***
	(0.052)	(0.045)	(0.050)	(0.048)	(0.049)	(0.050)
Ruggedness		-6.670**		-8.289**		-8.192***
		(2.848)		(3.264)		(2.677)
Elevation		-1.687***		-1.111**		-0.939*
		(0.331)		(0.422)		(0.505)
Soil Quality		57.895***		49.393***		43.178***
		(8.455)		(7.812)		(7.448)
Adj. R^2	0.2844	0.2949	0.4280	0.4335	0.4696	0.4729
Observations	67,049	67,049	66,195	66,195	65,408	65,408
#Fixed Effects	2,445	2,445	6,705	6,705	10,702	10,702
Geographic Controls	.	Yes	.	Yes	.	Yes
Township Fixed Effects	Yes	Yes				
1/4 Twnshp Fixed Effects			Yes	Yes		
1/9 Twnshp Fixed Effects					Yes	Yes
Spatial HAC SEs (10 mi)	0.033	0.031	0.031	0.031	0.031	0.031
Spatial HAC SEs (25 mi)	0.041	0.037	0.037	0.036	0.036	0.037
Spatial HAC SEs (100 mi)	0.050	0.043	0.044	0.044	0.044	0.043

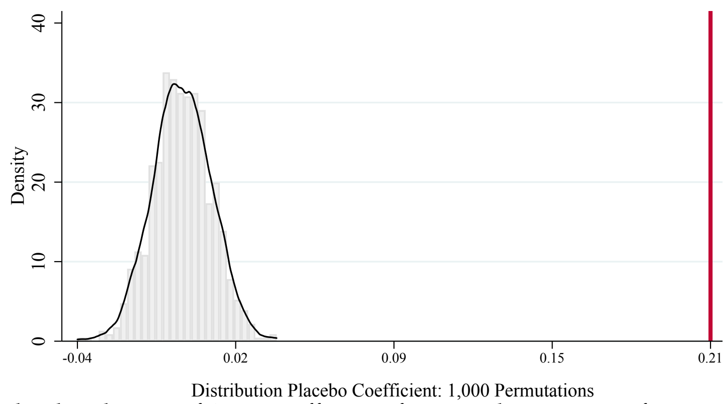
Notes: This table introduces increasingly finer spatial fixed affects across columns: Columns 1–2 use township fixed effects (panel a of Figure 3), columns 3–4 use 1/4-township fixed effects (panel b of Figure 3), columns 5–6 use 1/9-township fixed effects (panel c of Figure 3). Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2 presents our baseline results. Columns 1–2 use the township fixed effects (column 4 of Table 1), columns 3–4 use the 1/4-township fixed effects (column 5 of Table 1), columns 5–6 use the 1/9-township fixed effects (column 6 of Table 1). The even-numbered columns 2, 4 and 6 add geographic controls to the odd-numbered columns 1, 3 and 5. As we add more fine-grained spatial fixed effects, our coefficient of interest $\widehat{\theta}$ decreases from a 0.385 standard deviation increase in land utilization in column 1 to a 0.214 standard deviation increase in column 6.

Considering that the balance of geographic characteristics increases with finer-grained spatial fixed effects in Table 1, we expect the effect of adding geographic controls on the estimated $\widehat{\theta}$ to decline as we go left to right towards finer-grained spatial fixed effects. This is exactly what we find: with township fixed effects, adding geographic controls reduces $\widehat{\theta}$ by twelve percent ($\frac{0.385-0.335}{0.385}$) going from column 1 to 2, with 1/4-township fixed effects, adding geographic controls reduces $\widehat{\theta}$ by around eight percent ($\frac{0.291-0.269}{0.291}$) going from column 3 to 4, and with 1/9-township fixed effects, adding geographic controls does not reduce $\widehat{\theta}$ at all in going from column 5 to 6.

For large reservations, clustering by reservation allows all plots within a reservation to be arbitrarily correlated. However, some reservations are quite small, meaning that spatial clustering may insufficiently address spatial correlation (Kelly, 2019, 2020). At the bottom of the table, we therefore also report spatial HAC standard errors following Conley (2008) and Hsiang (2010). In areas such as Washington State and the Southwest, Conley standard errors effectively allow the error terms to be correlated across nearby but distinct reservations.

Figure 4: Randomization Inference



Notes: The figure shows the distribution of 1,000 coefficients from randomization inference estimations where we replace the actual fee-simple plots with an equal number of randomly drawn plots. In contrast to the distribution, the vertical line shows the magnitude of the actual estimated coefficient.

As a further robustness check, we use randomization inference to rule out spuriously correlated effects through a permutation test. For this purpose, we replace the actual over $26,000$ fee-simple plots with an equal number of randomly drawn plots (from all plots), and then re-estimate our preferred specification with geographic controls and 1/9-township fixed effects from column 6 of Table 1. We repeat this experiment 1,000 times, comparing the distribution of the estimated placebo effects to the fee-simple effect. Figure 4 shows the result of this permutation exercise: the permuted distribution is centered around a mean of zero, and even the 99-th percentile of the distribution is far to the left of the actual estimate in column 6 of Table 1.[23]

Lastly, as discussed in Section 3, the *National Land Cover Database* NLCD offers an alternative data-source to the NWALT. Appendix-Table A2 shows that we obtain practically identical results when we measure land utilization in the NLCD rather than NWALT.

[23] If we randomly assign fee-simple status to $26,000$ of the allotted-trust plots, the distribution of estimated placebo effects naturally shifts more towards the negative.

4.2 Selection on Allottees instead of Geography

A remaining challenge that is not addressed by our identification strategy so far is that allottees' characteristics (or actions) could have played a role in the BIA agents' historical decision to convert trust land into fee simple, and that these same characteristics or actions could have had some independent long-run effects on the allottees' heirs' future land utilization. Our first approach to addressing this concern is to condition equation (1) on (reservation-specific) fixed effects for allottees' last names. This is becoming a common way of addressing unobservable producitivity differences in the literature on land tenure and productivty; see e.g. Deininger and Ali (2008). The results are presented in Table 3. The Adjusted R^2 suggesst that family-name fixed effects add considerable explanatory power to the regressions, but their effect on our core estimates is marginal.[24]

Table 3: Adding (Reservation-Specific) Fixed Effects for Allottees' Family Names

	(1)	(2)	(3)	(4)	(5)	(6)
Fee Simple	0.361***	0.309***	0.259***	0.235***	0.187***	0.184***
	(0.048)	(0.036)	(0.053)	(0.051)	(0.061)	(0.061)
Ruggedness		-11.640***		-12.146***		-9.397***
		(2.699)		(2.561)		(2.319)
Elevation		-1.281***		-0.851*		-0.453
		(0.426)		(0.430)		(0.527)
Soil Quality		57.993***		48.463***		43.306***
		(7.671)		(7.132)		(6.657)
Adj. R^2	0.3746	0.3866	0.4984	0.5050	0.5349	0.5386
Observations	54,167	54,167	53,096	53,096	51,994	51,994
#Fixed Effects	12,877	12,877	16,471	16,471	19,733	19,733

Notes: This table has the same structure as Table 2, with the addition of (reservation-specific) fixed effects for allottees' last names. Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Our second approach is to predict conversion into fee simple with an instrumental variable (IV) that plasuibly has no direct effect on land utilization today. This IV is a transformation of the original allottees' birthyear, motivated by three facts: *(i)* earlier allotments were mechanically more likely to convert to fee simple (because of the 25-year trust window), *(ii)* all allottees who were of age on a given reservation received their allotments at essentially the same time, and *(iii)* birth-cohorts that were not of age when a reservation was originally allotted received their allotments considerably later. We document the latter two facts in Appendix D.1, using a data

[24] The number of observations drops because of singletons.

source called the *Indian Census Rolls* (ICR), which we can record-link to the BLM data by allotment-number, and which allows us to assign an allottees' birthyear to an allotment. Because a portion of the original allottees had already died at the time the ICR was collected in the mid-1930s, we find only about two-thirds of our allotments in the ICR, i.e. around 40,000 allotments. For this reason, we use an allotment's issuance year as our IV, and use the ICR only to show that within a reservation, variation in allottments' issuance year is explained by allottees' birthyears. The instrument's exclusion restriction is that the birth year of the original allottee has no direct effects on the *long-run* land utilization of their heirs eighty to one hundred years later. We estimate the first-stage relationship

$$\text{FeeSimple}_{i(j)} = \alpha_1 \times \text{issue-year}_i + \kappa_j + \lambda' X_i + \varepsilon_{ij}. \tag{2}$$

The results are reported in Table 4. Column 1 includes only 1/9-township fixed effects, column 2 includes linear geographic controls, and column 3 uses a flexible binned specification with separate fixed effects for each decile of each geographic control. In all three specifications, allotment year is a strong predictor of fee-simple property rights—the coefficient estimate implies that receiving an allotment one year later reduces the probability of conversation to fee simple by 1.8 percentage points.

A natural concern is that issuance year may be correlated with land characteristics because earlier allotments may have occurred on better land. Table A3 indeed shows that later allotments are more rugged, at higher elevations, and have worse soil. The differences are small, and the fact that the first-stage coefficient in Table 4 is very stable across columns 1–3 suggests this is not a major concern. Nonetheless, because differences are statistically significant, we introduce a second instrument that is uncorrelated with land characteristics. This second instrument will lacks sufficient power to be used as a stand-alone instrument, but adds enough predictive power to perform over-identification tests to confirm the validity of our main instrument. The second instrument is based on the exogenous rotation of BIA allotting agents across reservations and their varying propensity to convert land from allotted-trust into fee-simple title. To construct it, we coded up the universe of BIA allotting agents on reservations from 1897–1934.[25] We construct

[25] For a description of sources, see Appendix D.2.

a duration panel that tracks each allotment from its issuance year until it is either converted to fee simple, or up to the 1934 IRA. An allotment's outcome in year t is an indicator $D_{i(r)t}$ that takes value 1 if allotment i in reservation r was converted into fee simple in year t, and 0 otherwise. Consider the following duration-style regression

$$D_{i(r)t} = \mu_{j(rt)} + \mu_r + \mu_t + \beta_\tau \cdot (t - \text{issue-year}_i) + \epsilon_{i(r)t}, \tag{3}$$

where $t - \text{issue-year}_i$ is the time that had passed since allotment i's initial issuance, μ_r is a reservation fixed effect, and a year fixed effect μ_t controls for the possibility that the process of land conversion may also have been faster at certain times than others. With the estimated coefficient β_τ and fixed effects $\{\widehat{\mu_{j(rt)}}, \widehat{\mu_r}, \widehat{\mu_t}\}$, we compute an estimated probability of conversion into fee simple $\mathbb{P}(\widehat{D_{i(r)t} = 1})$ for each allotment i in each year t.[26] To turn the estimation of equation (3) into a cross-sectional instrument Z_i we calculate the cumulative probability that an allotment was converted into fee simple, by summing over the probability tree from i's issue-year through to 1934:

$$\begin{aligned} Z_i \;&= \mathbb{P}(\widehat{D_{i(r),t=\tau} = 1}) \\ &+[1 - \mathbb{P}(\widehat{D_{i(r),t=\tau} = 1})] \cdot \mathbb{P}(\widehat{D_{i(r),t=\tau+1} = 1}) \\ &+[1 - \mathbb{P}(\widehat{D_{i(r),t=\tau+1} = 1})] \cdot \mathbb{P}(\widehat{D_{i(r),t=\tau+2} = 1}) + ... \\ &+[1 - \mathbb{P}(\widehat{D_{i(r),t=1933} = 1})] \cdot \mathbb{P}(\widehat{D_{i(r),t=1934} = 1}). \end{aligned} \tag{4}$$

Columns 4 through 6 of Table 4 (Panel A) add "$\alpha_2 \times \text{Z}_i$" into the estimation of the first-stage equation (2).[27] The estimated Z_i is indeed highly predictive of conversion to fee-simple ownership. Furthermore, Table A3 shows that the second instrument Z_i is uncorrelated with land characteristics within 1/9-township fixed effects.

[26] We estimate one $\widehat{\mu_{j(\cdot)}}$ per agent j; notation $j(rt)$ only clarifies that agents rotate across r over time.

[27] When estimating 2SLS using a generated regressor like Z_i, under very weak assumptions the point estimates are consistent and the standard errors and test statistics asymptotically valid. See Pagan (1984) and Wooldridge (2010, pp116–117).

Table 4: Instrumental Variables Estimates

Panel A:	First Stage					
	(1)	(2)	(3)	(4)	(5)	(6)
Allotment Year	-0.018***	-0.018***	-0.018***	-0.018***	-0.018***	-0.017***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Z_i				0.318**	0.318**	0.317**
				(0.128)	(0.128)	(0.127)
Ruggedness		0.536*			0.528*	
		(0.277)			(0.275)	
Elevation		0.068			0.071	
		(0.064)			(0.063)	
Soil Quality		-0.338			-0.347	
		(0.842)			(0.820)	
Adj. R^2	0.6118	0.6119	0.6124	0.6126	0.6127	0.6131
Geographic Controls		Linear	Binned		Linear	Binned
1/9 Twnshp Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Panel B:	Second Stage IV Results					
	(1)	(2)	(3)	(4)	(5)	(6)
Fee Simple	0.596***	0.542***	0.512**	0.565***	0.512***	0.481**
	(0.204)	(0.202)	(0.207)	(0.185)	(0.184)	(0.188)
Observations	65,408	65,408	65,408	65,334	65,334	65,334
1/9 Twnshp Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls		Linear	Binned		Linear	Binned
p-value Hausman Test	.03607	.05629	.06638	.08604	.1476	.1758
p-value Hansen J stat				.2667	.2735	.2759
Kleibergen-Paap F stat	86.42	87.33	86.79	43.28	43.73	43.46

Note: Columns 1–3 investigate the correlation of each instrument with an allotment's geographic characteristics; the main instrument is the year of an allotment's issuance in Panel A; in Panel B we add Z_i from equation (4). Columns 4–6 report on the first stage results of regressing an allotment's fee-simple status on the instruments Significance levels denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

As Table 4 reports, the *Kleibergen-Paap F statistic* for weak instruments is above 40 when both instruments are included. However, before proceeding to the second stage, we discuss two more questions surrounding Z_i. The first is whether the key component in equation (3), and hence in expression (4), is indeed the agent fixed effects $\widehat{\mu_{j(rt)}}$, as we have so far assumed. In other words, we assumed that the identifying variation of Z_i in columns 4–6 of Table 4 (Panel A) is driven by $\widehat{\mu_{j(rt)}}$ and not by, say, simply a non-linear transformation of issue-year. Implicit in this assumption is that the BIA agents had sufficiently dispersed idiosyncratic propensities to convert land to fee simple, as well as enough discretion to make these propensities matter.[28] In Appendix

[28] One can think of this as the usual conditions in the 'judge fixed effect' literature. See, for example, Kling (2006);

D.3, we document the observed dispersion of these propensities to convert, and discuss a case study of Indian agents with differing propensities to convert land to fee simple. To validate our assumption more directly, we re-estimate equation (3) without agent fixed effects, and re-construct the resulting expression (4) as a "Placebo-Z_i". Appendix-Table A4 is the equivalent of Panel B in Table 4, and shows that this "Placebo-Z_i" has no predictive power whatsoever for a plot's conversion into fee simple, thus confirming that the identifying variation of Z_i is driven by $\widehat{\mu_{j(rt)}}$.

The second question concerns the *validity* of Z_i as an instrument, which requires that the assignment of BIA agents to reservations was not endogenous, e.g., to reservations' characteristics. In Appendix D.3, we document and show that the timing of BIA agents' rotation was largely explained by the pattern of turnover inside the general federal administration (Appendix-Figure A8). Furthermore, we document that the land converted by high-$\widehat{\mu_{j(rt)}}$ BIA agents was not different from the land converted by low-$\widehat{\mu_{j(rt)}}$ agents, even within the same reservation (Appendix-Table A5).

Panel B of Table 4 reports on the two-stage least squares estimation of the second-stage equation (1). Columns 1–3 use issuance year as the only instrument, columns 4–6 use both instruments. Columns 1 and 4 omit land quality controls, columns 2 and 5 use linear controls, and columns 3 and 6 use binned controls. The instruments are strong across specifications, as indicated by the *Kleibergen-Paap F statistic*. The *p-value* on Hansen's over-identification *J-statistic* in columns 4–6 provides a critical test of the validity of our IV strategy. It suggests that the local average treatment effects of the two instruments are closely aligned. Therefore, while our primary instrument is not uncorrelated with geographic characteristics of the allotment, the data suggest that this correlation does not invalidate the exclusion restriction on the instrument.

The IV estimate of the effect of fee-simple title is stable across specifications. It is roughly double the OLS estimate (consistent with McChesney's account of allotment in Section 2), although in our preferred setup using both instruments the *Hausman test* for the equality of the OLS estimate and the IV estimate is not rejected in columns 5 and 6. As a consequence, we view 0.481 as our preferred point estimate of the paper's core coefficient of interest.

Di Tella and Schargrodsky (2013); Galasso and Schankerman (2014); Aizer and Doyle Jr (2015); Melero, Palomeras, and Wehrheim (2017); Dobbie, Goldin, and Yang (2018); Frandsen, Lefgren, and Leslie (2019). Our setup departs from the standard 'judge fixed effect' setup in that our setup is naturally estimated as a duration analysis because the decision to convert land from allotted-trust to fee-simple status was taken *repeatedly*.

5 Mechanisms

In this section, we explore the mechanisms underlying the difference in land utilization between fee-simple and allotted-trust land. In Section 5.1, we break land utilization down into development versus agricultural cultivation, and use panel variation to show that the advantages of fee-simple title for development are a recent phenomenon, while the effects on agricultural cultivation were largely already present forty years ago. In Section 5.2, we provide evidence that transfer restrictions affect land use through *at least* three channels: reducing access to credit, impeding land assembly, and creating problems associated with competing ownership claims.

5.1 Decomposition of Land Uses and Evolution over Time

As we discuss in Appendix E, agriculture was the dominant form of economic activity on reservations prior to the 1980s, but non-agricultural forms of development have subsequently taken off in a pattern that mirrors the standard path of structural transformation that is well-known from other contexts. Hence, it is useful in this section to break the index measure $Z(Use)$ into its components (agricultural land use vs. economic development) so that we can separately consider the evolution of these two forms of productive land use on allotted trust vs. fee simple plots. Given that structural transformation did not start on reservations until at least the 1970s, we expect the dynamics to be especially important for economic development.

We utilize the five waves of NWALT data from 1974–2012 to examine the dynamic evolution of land use on allotted-trust vs. fee-simple land by estimating the following equation

$$y_{ijt} = \gamma \times FeeSimple_i + \sum_{t=1982}^{2012} \gamma_t (FeeSimple_i \times \tau_t) + \kappa_j + \lambda' X_{it} + \tau_t + \varepsilon_{ijt}, \tag{5}$$

where τ_t are year fixed effects, and $\sum_{t=1982}^{2012} \gamma_t (FeeSimple_i \times \tau_t)$ is a series of interactions between these and the fee-simple indicator. γ captures the difference between allotted-trust and fee-simple plots in 1974, while over-time divergence in this difference is captured by the γ_t coefficients. An advantage of the panel data is that they also allow us to let κ_j be *plot* fixed effects, and thus absorb all unobserved differences in invariant characteristics (of both the land and the original allottees).

Table 5 presents the results of examining the coefficients from equation (5). In columns 1 and

2, the dependent variable is the land utilization index $Z(Use)$. To conserve space, Table 5 presents only two spatial fixed effects: the 1/9-township fixed effect that was our preferred specification in the cross-section (in columns 1, 3, and 5), and a *plot* fixed effect (in columns 2, 4, and 6). Plot fixed effects absorb all unobserved differences in fixed characteristics, i.e. there are as many spatial fixed effects as there are units of observation in the cross-sectional analysis.

Column 1 shows a significant difference in overall land use $Z(Use)$ in 1974, as well as a monotonic increase in this difference over time (i.e. $\hat{\gamma}_t > \hat{\gamma}_{t-1} > 0$), even relative to an overall monotonic increase in land use across all tenure regimes (i.e. $\hat{\tau}_t > \hat{\tau}_{t-1}$). As points of reference, column 1's $\hat{\gamma} + \hat{\gamma}_{2012} + \hat{\tau}_{2012} = 0.116 + 0.102 + 0.07 = 0.288$ is a comparison of 2012 fee-simple land to 1974 trust land, while $\hat{\gamma} + \hat{\gamma}_{2012} = 0.116 + 0.102 = 0.218$ is a comparison of 2012 fee-simple land to 2012 trust land, which approximates the cross-sectional OLS estimate in column 5 of Table 2. This pattern remains robust to the plot fixed effect specification in column 2.

In column 3–6, we break the index measure $Z(Use)$ into its components to explore whether fee-simple rights have differentially affected agricultural land use vs. development over time. The dependent variable in columns 3 and 4 is a plot's share of land under development in year t. This can measure a manufacturing plant, barn, casino, or any other permanent structure or paved road. The dependent variable in columns 5 and 6 is the share of a plot used for agriculture in year t. Column 3 shows no difference in development in 1974 ($-0.098 \not> 0$), but column 5 shows a significantly higher share of agricultural land on fee-simple parcels in 1974 ($3.593 > 0$). Column 3 shows that land development has monotonically increased since then, even on trust land, (i.e. $\hat{\tau}_t > \hat{\tau}_{t-1} > 0$). However, land development increased differentially more on fee-simple land, (i.e. $\hat{\gamma}_t > \hat{\gamma}_{t-1} > 0$). Importantly, the coefficients are practically unchanged from column 3 to 4.

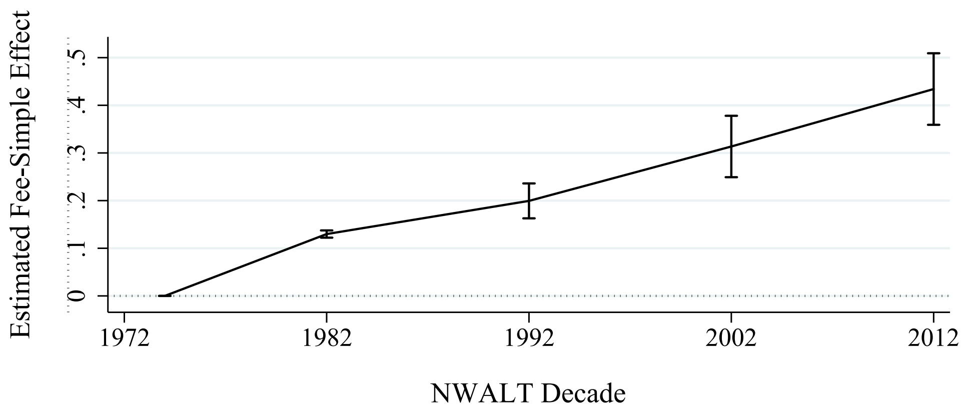
Table 5: Effect of Tenure on Development Over Time

	Z(Use)		Development		Cultivation	
	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{\gamma}$: Fee Simple	0.116***		-0.098		3.593***	
	(0.016)		(0.076)		(0.224)	
$\hat{\gamma}_{1982}(FeeSimple_i \times \tau_{1982})$	0.039***	0.038***	0.132***	0.130***	0.179***	0.151***
	(0.002)	(0.002)	(0.007)	(0.003)	(0.030)	(0.005)
$\hat{\gamma}_{1992}(FeeSimple_i \times \tau_{1992})$	0.052***	0.049***	0.209***	0.199***	-0.037	-0.101***
	(0.003)	(0.008)	(0.007)	(0.013)	(0.029)	(0.017)
$\hat{\gamma}_{2002}(FeeSimple_i \times \tau_{2002})$	0.089***	0.086***	0.322***	0.314***	0.137**	0.051
	(0.003)	(0.010)	(0.007)	(0.023)	(0.030)	(0.034)
$\hat{\gamma}_{2012}(FeeSimple_i \times \tau_{2012})$	0.102***	0.099***	0.436***	0.434***	0.369***	0.262***
	(0.003)	(0.010)	(0.006)	(0.027)	(0.029)	(0.039)
ShareDeveloped$_{it}$					-0.332***	-0.122***
					(0.018)	(0.025)
ShareCultivated$_{it}$			-0.021***	-0.039***		
			(0.002)	(0.008)		
$\hat{\tau}_{1982}$	0.024***	0.024***	0.083***	0.087***	0.202***	0.185***
	(0.001)	(0.001)	(0.004)	(0.003)	(0.013)	(0.005)
$\hat{\tau}_{1992}$	0.036***	0.036***	0.125***	0.133***	0.456***	0.432***
	(0.001)	(0.002)	(0.004)	(0.006)	(0.013)	(0.012)
$\hat{\tau}_{2002}$	0.057***	0.057***	0.177***	0.192***	0.838***	0.804***
	(0.001)	(0.002)	(0.005)	(0.011)	(0.014)	(0.022)
$\hat{\tau}_{2012}$	0.070***	0.070***	0.229***	0.245***	0.919***	0.875***
	(0.001)	(0.002)	(0.005)	(0.013)	(0.013)	(0.023)
Adj. R^2	0.5630	0.8935	0.6277	0.9135	0.7478	0.9887
Observations	326,063	325,873	344,368	344,183	344,368	344,183
#Fixed Effects	12,367	65,348	13,069	69,010	13,069	69,010
1/9 Twnshp Fixed Effects	Yes		Yes		Yes	
Allotment Fixed Effects		Yes		Yes		Yes
p-value($\hat{\gamma_{1982}} = \hat{\gamma_{1992}}$)	0.00002	0.11020	0.00000	0.00336	0.00000	0.00028
p-value($\hat{\gamma_{1992}} = \hat{\gamma_{2002}}$)	0.00000	0.00034	0.00000	0.00036	0.00000	0.00110
p-value($\hat{\gamma_{2002}} = \hat{\gamma_{2012}}$)	0.00000	0.00001	0.00000	0.00001	0.00000	0.00000
Trust Land's 1974 Share Developed			0.61794	0.61792		
Fee Land's 1974 Share Developed			1.32954	1.32988		
Trust Land's 1974 Share Agricultural					10.32865	10.32841
Fee Land's 1974 Share Agricultural					27.12638	27.12391

Notes: This table shows how the effect of fee simple on land use has changed since 1974. Columns 1–2 consider the land utilization index as the outcome, columns 3–4 consider land development as the outcome, columns 5–6 consider agricultural cultivation. In columns 1, 3, and 5, this table uses the more fine-grained spatial fixed effects in Table 2. In columns 2, 4, and 6, it adds plot fixed effects, focusing solely on within-plot variation. The coefficient-estimates on year fixed effects are the $\hat{\tau}_t$ in equation (5). Further, the 'Fee-Simple × year' coefficients report on the $\hat{\gamma}_t$ in equation (5). s.e. are clustered at the township level, significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 5 plots the coefficient estimates from column 4 of Table 5 to depict the decade-on-decade changes in development on fee-simple land. Interestingly, this figure highlights that the divergence between fee-simple and allotted-trust land was *least* pronounced during the 1980s, which is consistent with the generally depressed economic opportunities on reservations during that period, discussed in Appendix E.

Figure 5: Decade-Specific Fee-Simple Coefficients Relative to 1974



Notes: This figure plots the coefficient estimates and confidence bands on $\hat{\gamma}_t$ in column 4 of Table 5

The dependent variable in columns 5 and 6 is a plot's share of land under agricultural cultivation in year t. While the share of land in agricultural use has also increased monotonically over time (i.e. $\hat{\tau}_t > \hat{\tau}_{t-1} > 0$ in columns 5–6), there is no pattern of monotonic divergence on fee-simple land (i.e. $\hat{\gamma}_t \not> \hat{\gamma}_{t-1} \not> 0$ in columns 5–6). Even in years when $\hat{\gamma}_t > 0$, this fee-simple growth-rate difference was small in agriculture relative to development, e.g. comparing $\hat{\gamma}_{2012}/\hat{\tau}_{2012} = 0.262/0.875 \approx 0.3$ in column 6 to $0.434/0.245 \approx 1.8$ in column 4.

5.2 Mechanisms: Collateralizability, Assembly, & Fractionation

Transfer restrictions on allotted-trust land may reduce investment and economic activity *directly* because they reduce access to capital (collateralizability), because of the inability to liquidate any sunk investments (realizability), and because they prevent farms from being aggregated to optimal scale (assembly). While it is difficult to gauge the importance of the realizability effect in our setting, collateralizability has long been viewed as a significant impediment to investment on reservations (Community Development Financial Institutions Fund, 2001).[29] Similarly, the assembly problem is viewed as important on reservations, which are often located in arid areas where optimal farm sizes can be large (Anderson and Lueck 1992; Leonard and Parker 2021). In addition, transfer-restrictions may also impact investment and economic activity *indirectly* by creating fractionated and competing ownership claims on the same plot (see Section 2). Fractionation increases *transaction costs* because each claimant can undermine whatever production other claimants want to engage in, and it creates *free-riding problems* because each claimant has a claim on rents earned from the productive activities of the other claimants.

Collateralizability Channel: To study the collateralizability, we investigate access to two kinds of financial institutions: in the first instance, we consider specialized *Native American financial institutions* (NAFI), whose business is specifically geared towards helping Native-owned businesses on reservations. We obtain data on all NAFIs from the Federal Reserve's Center for Indian Country Development (CICD), and assign each NAFI an opening date as well as the reservation in which it operated. These institutions are likely to have the most direct impact, but their opening on a reservation is unlikely to be fully exogenous to underlying local conditions and trends. In the second instance, we therefore alternatively consider the stock of all off-reservation, regular commercial banks within a 10-mile radius around each reservation. While off-reservation commercial banks are likely to be less impactful on the reservation, their opening and closing is more likely to be exogenous to the reservation itself. We obtain data on the opening dates and precise locations of all commercial banks from the *Federal Deposit Insurance Corporation* (FDIC), to determine which banks opened within 10 miles of a reservation, and when.

For each of the two data-sets, we construct two reservation-year measures of banking: Banked_{rt} is the number of banks associated with reservation r (and plot i in it) in decade t,[30] $\text{FeeSimple}_i \times \text{Banked-Rez}_{rt}$ is a plot's fee-simple indicator interacted with the same. Figure A10 shows the expansion of these banks in our data over time. Given the dynamic time-path of development in Table 5, we utilize our preferred panel specification of equation (5) with individual plot fixed effects to study the effect of banking access over time. We add a reservation-year specific baseline mea-

[29] It also creates distortions. For example, Native Americans have by far the highest rate of mobile-home ownership in the U.S. because mobile homes can be repossessed whereas permanent structures built on trust land cannot be repossessed any more than the land itself (Treuer, 2012; Feir and Cattaneo, 2020).

[30] For NAFI-Banked_{rt} this is banks on the reservation, for FDIC-Banked_{rt} this is banks around the reservation.

sure of banking to absorb any overall changes in land utilization that may coincide with changes in banking, and the plot-year-specific measure that tests whether land utilization on fee-simple plots relative to allotted-trust plots diverged because of banking.

We hypothesize that the collateralizability and credit-access channel should primarily curtail development because building structures is much more capital-intensive than agricultural cultivation (De Soto, 2000). Given the findings in Table 5, this also suggests that the collateralizability-effect is more likely to be dynamic in nature. Columns 1–4 of Table 6 present the results of our tests for the credit access mechanism—columns 1–2 for agricultural cultivation, and columns 3–4 for development. In columns 1 and 3, we consider the NAFI measure of banking that is likely to be more directly impactful on reservations, but is less plausibly exogenous to conditions on a reservation. In columns 2 and 4, we consider the FDIC measure of banking that is likely to be less directly impactful on reservations, but is more plausibly exogenous to conditions on a reservation.

Table 6: The Collateralizability Channel

	Share Crop$_t$		Share Dev$_t$	
	(1)	(2)	(3)	(4)
FeeSimple$_i$	-1.347**		1.989**	
$\times$NAFI-Banked$_{rt}$	(0.431)		(0.618)	
NAFI-Banked$_{rt}$	-0.372***		0.280	
	(0.071)		(0.150)	
FeeSimple$_i$		-0.009		0.043***
$\times$FDIC-Banked$_{rt}$		(0.009)		(0.009)
FDIC-Banked$_{rt}$		-0.008*		0.009**
		(0.003)		(0.003)
$\hat{\gamma}_{1982}(\text{FeeSimple}_i \times \tau_{1982})$	0.136***	0.154***	0.125***	0.093***
	(0.004)	(0.008)	(0.002)	(0.006)
$\hat{\gamma}_{1992}(\text{FeeSimple}_i \times \tau_{1992})$	-0.127***	-0.097**	0.205***	0.139***
	(0.017)	(0.023)	(0.014)	(0.016)
$\hat{\gamma}_{2002}(\text{FeeSimple}_i \times \tau_{2002})$	0.030	0.064	0.290***	0.154**
	(0.033)	(0.056)	(0.023)	(0.035)
$\hat{\gamma}_{2012}(\text{FeeSimple}_i \times \tau_{2012})$	0.282***	0.265**	0.323***	0.200**
	(0.043)	(0.089)	(0.038)	(0.053)
$\hat{\tau}_{1982}$	0.175***	0.199***	0.080***	0.069***
	(0.005)	(0.006)	(0.002)	(0.005)
$\hat{\tau}_{1992}$	0.417***	0.455***	0.117***	0.103***
	(0.012)	(0.016)	(0.005)	(0.010)
$\hat{\tau}_{2002}$	0.784***	0.865***	0.161***	0.115***
	(0.021)	(0.033)	(0.009)	(0.023)
$\hat{\tau}_{2012}$	0.862***	0.991***	0.202***	0.100*
	(0.023)	(0.051)	(0.011)	(0.041)
Adj. R^2	0.9886	0.9887	0.9136	0.9142
Observations	344,183	344,183	344,183	344,183
Average(Outcome)	17.3	.	1.093	.
1/9 Twnshp Fixed Effects				
Allotment Fixed Effects	Yes	Yes	Yes	Yes

Notes: This table reports on the results of estimating an expanded version of equation (5), with measures of banking access added. Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Comparing columns 1–2 versus 3–4, the difference across outcomes is striking and suggestive of strong substitution patterns: increasing financial access (NAFI-Banked$_{rt}$ or FDIC-Banked$_{rt}$) is associated with across-the-board increases in a plot's share of land in development and decreases in a plot's share of land in agricultural cultivation. Consistent with our predictions, these patterns are much larger on fee-simple plots, where access to banks causes agriculture to decrease more and development to increases more by a factor of five. On the overall changes, the positive development effects and negative cultivation effects roughly offset each other ($|-0.372| \approx 0.280$; $|-0.008| \approx 0.009$). On the fee-simple interactions, the positive development effects dominate the negative cultivation effects ($|-1.347| < 1.989$; $|-0.009| < 0.043$).

Comparing the two banking measures, the NAFI-coefficients are about fifty times larger than FDIC-coefficients. There are three reasons for this: first, the NAFI banks are specifically designed to help Native-owned businesses and can thus be expected to have a larger effect; second, the NAFI banks may be endogenously placed where they are likely to succeed whilst the FDIC banks primarily serve an off-reservation clientele; third, and most important, there is a large difference in the overall prevalence of each type of bank. As Figure A10 shows, the total number of NAFI banks increased from 12 to 45 from 1974–2012, while the total number of FDIC banks around reservations increased from 3,416 to 11,552 in the same time.

Land Assembly Channel: Transfer restrictions may also prevent landowners from aggregating land ownership to an efficient size for agricultural production.[31] For example, Hansen and Libecap (2004) find that small, 160-acre land allocations contributed to farm failures in arid regions of the United States before land was subsequently assembled into much larger, more efficient farms. In principle assembly problems could also arise due to the capital constraints discussed above. However, the transfer restrictions on allotted-trust land would prevent assembly even if ample capital was present, so that we think of assembly as a distinct problem.

Figure A11 depicts the distribution of adjacent-county average farm size—a proxy for optimal farm size—in 2012 for the parcels in our main sample.[32] Average farm size exceeds 160 acres (the size of most allotments) for over 98% of our sample, suggesting that the assembly problem is a plausible mechanism for the effect of non-transferability on agriculture. To test for the presence of a land assembly mechanism, we create a plot-level measure of land aggregation from the NWALT data. First, we dissolve each contiguous cluster of NWALT crop pixels into a unique polygon that we call a "synthetic farm." We then create a plot-level indicator variable "D(Crop Spillover$_i$)" that

[31] By contrast, assembly is not a plausible constraint for development because very few (if any) building projects would require assembling contiguous plots of land exceeding 160 acres, which would allow a developer to construct a building that is $\frac{1}{2}$-mile$\times\frac{1}{2}$-miles.

[32] Data on average farm size come from the 2012 Census of Agriculture.

is equal to one if plot i is connected to other plots through overlap with a shared synthetic farm. To avoid coding spurious spillovers that are due to measurement error, we only associated a plot with a synthetic farm if $\text{CropsShare}_i > 10\%$ for that plot.[33] In Figure 2, for example, this criterion ensures that none of the plots are connected because the synthetic farm spillovers account for less than 10% of a neighboring plot. Figure A12 provides an example for which "D(Spillover$_i$)" = 1 because a large contiguous block of agricultural pixels spills across several plots.

Table 7 presents the results of our tests for the land assembly mechanism. Column 1 mimics our preferred specification of equation (1) but uses "D(Crop Spillover$_i$)" as the dependent variable. Column 2 interacts the fee-simple coefficient with adjacent-county average farm size (measured in thousands of acres) to test whether the effect of fee simple on assembly is greater on reservations where optimal farm size is larger.

The results in column 1 of Table 7 indicate that fee-simple plots are 4.8 percentage points more likely than allotted-trust plots to be part of a synthetic farm spanning multiple plots. Despite the fact that optimal farm size exceeds 160 acres for 98% of the sample, just 30.9% of plots are associated with a farm that includes multiple plots. Hence, the fee-simple effect in column 1 represents a 15% increase in land assembly relative to the mean. The column 2 results suggest that differences in land assembly are more pronounced on reservations with a larger optimal farm size: a 1,000-acre increase in adjacent-county average farm size increases the effect of fee-simple on assembly by 1.1 percentage points. The relative magnitudes of the baseline fee-simple coefficient and the interaction term imply that the probability of spillovers is not different for fee-simple plots unless optimal farm size exceeds about 1,600 acres ($1000 \times 0.018/0.011$). This may suggest that agricultural leases can solve the land assembly problem when a small number of plots are involved, but that assembling larger numbers of plots becomes infeasible without transferability.

Table 7: The Land Assembly Channel

	D(Crop Spillover$_i$)	
	(1)	(2)
Fee Simple	0.048***	0.018
	(0.007)	(0.013)
Fee Simple $\times$ $\overline{\text{Farm Size}}$		0.011**
		(0.004)
Adj. R^2	0.7312	0.7313
Observations	63,672	63,672
Average(Outcome)	.309	.309
1/9 Twnshp Fixed Effects	Yes	Yes

Notes: This table reports the results of estimating equation (1) with D(Crop Spillover$_i$) as the dependent variable. The adjacent-county farm size interaction in column 2 is measured in thousands of acres. Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[33] Our results are not sensitive to the choice of cutoff.

Fractionation Channel: While the credit-access channel should affect all allotted-trust plots equally (because they are all equally non-transferrable), fractionation should affect allotted-trust plots differentially depending on the number of competing interests on a plot. Hence, we test for the fractionation channel at the *intensive margin*, i.e. by comparing allotted-trust plots of differing degrees of fractionation to one another. Russ and Stratmann (2014) show that the extent of fractionation on an allotment negatively impacts agricultural *income*, and we hypothesize that a similar effect might be observable for land utilization. We expect any effect of fractionation to be concentrated in agriculture because all allotted-trust plots lack access to the credit needed to finance development, regardless of how fractionated they are. In agriculture, by comparison, fractionation increases the transaction costs of reaching leasing agreements as well as agreement on the various recurring decisions involved in agricultural land use (e.g., crop choice, irrigation strategies, and fallowing rotations).

Records of interests associated with each allotted-trust plot are confidential,[34] so we instead construct a measure of a plot's *latent* potential for fractionation. Specifically, we assume that allotments that we cannot find in the mid-1930s *Indian Census Rolls* (ICR) belonged to allottees that had already passed away by then, implying that those allotments were more likely to become highly fractionated over time because the process of fractionation started earlier and because earlier deaths were more likely to occur without a will, as discussed in Section 2. We validate this assumption in Appendix E.4, where we show that *(i)* sequential allotment numbers are highly correlated with age within a reservation and *(ii)* it is systematically the early allotment numbers that we cannot find in the ICR (Figure A13).

Let the indicator "D(not in ICR)$_i$" denote whether plot i's allotment number can be found in the mid-1930s ICR. This indicator is almost evenly distributed across fee-simple and allotted-trust lands: we match 47 percent of all fee-simple plots and 53 percent of all allotted-trust plots to the ICR. Given the evidence in Figure A13, we interpret this indicator as a measure of latent or potential fractionation, which we use in the absence of observable plot-level measures of fractionation. We gain confidence in this interpretation from relating the indictor to reported reservation-aggregate measures of fractionation today. Specifically, we obtain from a 2013 BIA report a reservation's share of trust plots that are classified as highly fractionated, i.e. with more than 50 inter-

[34] These records are managed by the BIA through the so-called *Trust Asset Accounting Management System*.

ests per plot (Department of Interior, 2013). Figure A14 shows that this share correlates well with a reservation's average number of plots not linked to the mid-1930s ICR.

To determine whether fractionation contributes to the effect of non-transferability, we estimate a modified version of our preferred specification of equation (1) with 1/9-township fixed effects:

$$y_{ij} = \theta \times \text{FeeSimple}_i + \theta^A_{\text{frac}} \times \text{Allotted}_i \times \text{D(not in ICR)}_i + \theta^F_{\text{frac}} \times \text{FeeSimple}_i \times \text{D(not in ICR)}_i + \kappa_j + \lambda' X_i + \varepsilon_{ij}, \tag{6}$$

where our hypothesis is that $\theta^A_{\text{frac}} < 0$, and $\theta^F_{\text{frac}} = 0$, because latent fractionation is much more likely to cause actual fractionation on allotted-trust plots than on fee-simple plots for the reasons discussed at the end of Section 2.

Table 8 shows the results of estimating equation (6). Our hypotheses are borne out: when y_{ij} is a plot's share of land under agricultural cultivation; $\widehat{\theta^A_{\text{frac}}} < 0$, and $\widehat{\theta^F_{\text{frac}}} = 0$, implying that allotted-trust parcels with higher latent fractionation see less agricultural cultivation than allotted-trust parcels with lower latent fractionation (the omitted category). Moreover, the difference in latent fractionation is not important for fee-simple plots (as predicted). When y_{ij} is a plot's share of land in development, both interactions are near zero and statistically insignificant, consistent with the fractionation problem being secondary to the collateralization problem for development.

Table 8: The Fractionation Channel

	Share Crop$_i$	Share Dev$_i$	D(Spillover$_i$)
	(1)	(2)	(3)
Fee Simple	4.315***	0.179	0.049***
	(0.802)	(0.178)	(0.007)
θ^A_{frac}	-0.644**	-0.023	-0.005
	(0.319)	(0.060)	(0.003)
θ^F_{frac}	-0.277	-0.022	-0.009
	(0.542)	(0.160)	(0.006)
Adj. R^2	0.6833	0.6123	0.7364
Observations	67,103	67,103	67,103
Average(Outcome)	17.92	1.24	1
1/9 Twnshp F.E.	Yes	Yes	Yes

Notes: This table reports on the results of estimating equation (6). Significance denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

One interesting question is whether fractionation amplifies the assembly problem on reservations. This stands to reason: the only way to assemble allotted-trust lands into larger units is through agricultural leases, and Anderson and Lueck (1992, 434) make it clear that fractionation can create substantial roadblocks to leasing: "*since leasing and other land use decisions require unanimous agreement by all shareholders, costs of negotiating leases can be prohibitive*." In column 3, were therefore add D(Crop Spillover$_i$) as an outcome. Indeed, we see that $\widehat{\theta^A_{\text{frac}}} < 0$ here as well, although the effect is imprecise, with a t-statistic of 1.5 ($\approx 0.005/0.003$). This suggests that the effect of fractionation on agricultural cultivation is likely to be in part mediated by its preventing optimal assembly.

6 Extensions

In this section, we explore two extensions to our core estimation. First, we investigate land use on tribally owned (i.e. unallotted) lands. Second, we develop a back-of-the-envelope estimate of the effect of transfer-restrictions on land values.

6.1 Tribally Owned Land

The majority of all reservation land remains tribally owned today. While an investigation of land use on tribal lands is somewhat outside of the scope of our focus on transfer restrictions on private land, it is certainly of intrinsic interest for understanding Native American economic development. We therefore report the tables from this investigation in Appendix E, while discussing the key results here. As discussed in Section 2, Panel A in Appendix-Table A6 shows little evidence for selection of land into initial allotment, or stated conversely, little evidence for selection of land into remaining under tribal control. Appendix-Table A7 reports results of estimating equation (1), with tribal land-plots added to the data, and an indicator for tribal land added to the regression. Adding spatial fixed effects across columns in the same way as in the baseline, we find that tribal land is utilized more than allotted-trust land, but this difference is only about 15 percent of the difference between allotted-trust land and fee-simple land, and teeters on the edge of statistical significance, with an average *p-value* of 0.12 across columns.

In the panel, Appendix-Table A8 shows that in 1974, tribal lands had about the same (low) level of development as allotted-trust lands and fee-simple lands. In column 5 of that table, tribal plots and fee-simple plots have about the same positive agricultural land-use difference relative to allotted-trust lands. Over time, agricultural land utilization on tribal lands actually falls behind relative to allotted trust. This is compensated, however, by tribal land increasing in land development in each decade from 1974–2012 at the same relative rate as fee-simple plots (column 3–4). In combination, these patterns indicate that, even when considered relative to *tribal* land, allotted-trust plots appear to be largely *locked out* of structural transformation towards manufacturing or services, instead remaining *locked into* relatively low value-added farming and ranching activities.

6.2 Estimating the Effect of Property Rights on Land Values

As a second extension, we develop a back-of-the-envelope estimate of the impact of trusteeship on land values. Because county assessors rarely assess allotted-trust land and do not assess even fee-simple land on reservations in a consistent manner, we are forced to use assessors' data just off the reservation for this analysis.[35] To construct an estimate of how much fee-simple title would increase the (inherently unobserved) value of allotted-trust land, we estimate the relationship between land utilization Z(Use) and assessed land values per acre for parcels *immediately adjacent to reservations*, and multiply this relationship, call it $\hat{\sigma}$, with the previously estimated effect of ownership on land utilization $\widehat{\theta}$ *on reservations*. This gives us $\hat{\sigma} \times \widehat{\theta}$ as a back-of-the envelope estimate of the effect of ownership on land values.

We estimate $\hat{\sigma}$ using a linear regression model—described in Appendix Appendix F.2—where we include our preferred 1/9-township fixed effects and determine the relationship between $Z(Use)$ and the natural log of the land value per acre for property i. Because land values and land utilization are clearly jointly determined, we view the resulting $\hat{\sigma}$ as a transformation factor rather than a causal effect; i.e. higher land use Z(Use) reflects more economic activity, and we use the corresponding higher land values to approximate the net present value of this increased activity. Following this logic, because increases in land utilization Z(Use) obviously require costly investments, the back-of-the envelope measure we construct should be interpreted as a measure of the counterfactual *value*-creation from moving allotted-trust plots into fee simple, and not of counterfactual increase in *net wealth* for land owners.

[35] Even where we do observe assessor data on reservations, many trust parcels are simply treated as "exempt" by county assessors because they are legally owned by the federal government. Estimated values for trust parcels (when they exist) are systematically different because trust parcels can never have actual transactions from which to estimate market value. By design, there are *zero* transactions of trust parcels on which to base value estimates. The upshot is that trust parcels are likely to be valued systematically differently than fee simple parcels for reasons other than land utilization. Moreover, the treatment and valuation of reservation lands varies from one county to the next, even within reservations.

Table 9: Estimated Effects on Land Value Per Acre

	Montana		Washington		Utah	
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{\sigma}$	0.173*	0.182**	0.021	0.025***	0.039	0.054**
	(0.096)	(0.072)	(0.012)	(0.008)	(0.030)	(0.021)
$\widehat{\theta}$	0.481	0.481	0.481	0.481	0.481	0.481
$\widehat{\theta} \times \widehat{\sigma}$	0.0832	0.0875	0.0101	0.0120	0.0188	0.0260
Median LVPA ($)	35,021	25,077	96,321	121,138	108,224	183,448
∂LPVA/∂Fee Simple ($)	2,914	2,195	973	1,457	2,030	4,765
Adj. R^2	.8784	.877	.8016	.8134	.7868	.8086
Observations	70,477	199,767	522,043	1,361,192	50,932	208,992
Distance Cutoff (mi)	10 Miles	25 Miles	10 Miles	25 Miles	10 Miles	25 Miles

Note: Columns 1,3,5 use all properties within 10 miles of a reservation, columns 2,4,6 use all properties within 25 miles of a reservation After estimating $\hat{\theta}$, it is multiplied by $\hat{\sigma}$, and the Median(LVPA) in the 10- or 25-mile radius of a reservation.

Table 9 presents our estimates of $\hat{\sigma}$ across three states that make statewide assessor data available and are home to 49 reservations in our sample. We also using two different criteria for defining parcels "near" a reservation (10 vs. 25 miles). Across nearly all samples, there is a statistically significant increase in land values associated with an increase in the land utilization measure. There is considerable variability in the magnitude of $\hat{\sigma}$. This is largely explained by $\hat{\sigma}$ being a semi-elasticity, i.e. there is a mechanically higher percentage-effect on lands of lower base-value; $\hat{\sigma}$ is highest in Montana where the reported median LVPA is the lowest. To obtain our back-of-the-envelope calculation we combine $\hat{\sigma}$ with $\hat{\theta}$ with a state's median LVPA: this product ranges from a low of $973 per acre in Washington to a high of $4,765 per acre in Utah. By multiplying this number by 160, we obtain the value of converting a plot from allotted trust into fee simple. This estimate ranges from $156,000 to $762,000.

7 Conclusion

This paper estimates the long-run cost of non-transferable property rights, comparing land without transfer rights to land with full property rights on Native American reservations from 1974 to today. We leverage a natural experiment in the allocation of property rights to individual households in the early part of the 20th century that left a patchwork of different land tenures on reservations which persists to the present day. We find that land utilization on fee-simple land is about

0.5 standard deviations higher than on non-transferable trust land. When we break this down by land-use, fee simple increases both the share of land under development and the share of land under agricultural cultivation. A panel analysis reveals that the development effect is entirely driven by dynamic structural transformation over the last four decades, whereas the agricultural cultivation effect was mostly already present present in 1974.

We provide evidence that transfer restrictions affect land use through *at least* three channels: reducing access to credit, impeding land assembly, and creating problems associated with competing ownership claims. External credit conditions accentuate the difference between allotted-trust and fee-simple plots, and this difference primarily affects development. In agriculture, allotted-trust plots are less likely than fee-simple plots to be part of a satellite-measured "synthetic farm" that spans multiple plots, especially on reservations in arid areas with larger average farm sizes. We also find that an exogenous predictor of ownership-fractionation inhibits agricultural land use on allotted-trust plots (where it cannot be resolved) but not on fee-simple plots (where it can).

Finally, we develop a back-of-the-envelope estimate of the negative impact of trusteeship on land values; this estimate indicates that fee-simple title adds between $973 and $4,765 in value to an acre of land, or between $156,000 and $762,000 (160 times as much) to the typical allotted plot.

While our core focus is on comparing different forms of private property rights we also extend the analysis to include tribally owned land. In the cross-section, tribally-owned land is closer to allotted-trust than to fee-simple land in land development and agricultural production. However, the panel reveals that this is a mix of tribally owned land being worse than allotted-trust land in 1974, but being on a dynamic trajectory that is as positive as that of fee simple in recent decades.

In summary, land with non-transferable private property rights fares worse than either fully private land or communally held land, and it is on a significantly worse dynamic trajectory than both. It is important to be careful when considering the implications of these findings. Our results indicate that converting allotted-trust land to full fee-simple individual property rights would generate the biggest economic efficiency gains. However, the alternative—returning allotted trust to tribal control—would also deliver some efficiency gains *and* it may better safeguard the territorial integrity of tribes' land base. This creates tradeoffs. Our view is that (*a*) both the conversion to fee simple or the return to tribal control would be preferable to keeping land in allotted trust, and that (*b*) the choice of which (if either) path to pursue must be that of individual tribes.

From a practical standpoint, there is a workable precedent for conversion to tribal control because it is already happening on some reservations: under the 2014 'Cobell settlement', the Department of Interior (DOI) has been allocated 1.9 billion dollars to buy fractionated allotted-trust claims and return them to tribal control, in close consultation with tribes.

In contrast, conversion to fee simple is currently legally impossible under the 1934 IRA. Even if an act of congress paved the way for conversion to fee simple in principle, there would remain the practical difficulty of untangling the potentially hundreds of claims on some plots. Fortunately, there is a related legal precedent that is paving the way for changing this: so-called 'heir's property' is a pervasive problem for Black-owned land in the U.S. South where it makes up thirty-five to fifty percent of all parcels (Emergency Land Fund, 1980). Like allotted-trust land, heir's property is hampered by high transaction costs from fractionated ownership claims, and by an inability to collateralize; it is viewed as a major contributor to rural poverty (Graber, 1978; Mitchell, 2000; Shoemaker, 2003; Chandler, 2005; Rivers, 2006; Gaither and Zarnoch, 2017). The *Uniform Law Commission*'s *Uniform Partition of Heirs Property Act* (UPHPA) has recently been enacted into law in 14 states for the purpose of untangling fractionated claims on heir's property (Mitchell, 2019). Given the similarities between heir's property and allotted-trust land, legal statutes modeled on the UPHPA could be applied to untangling claims on reservations, and the ULC is actively working on a uniform Indian probate code to apply to reservations.

Lastly, it is worth noting that any movement away from allotted-trust land need not be a binary choice. One can imagine giving owners of trust land fully transferable property rights (thus maximizing the value from these lands) but leaving it to tribes to decide whether this transferability should extend only within the tribe or beyond. Mexico's second land reform (*Procede*) offers a useful template in this regard: from 1993–2006, indigenous farmers were given full title to the land that they had long held usufruct rights to, but it was the communities *ejidos* who then decided whether these rights would be transferable only within the ejido or whether land could also be transferred to non-ejidatarios (De Janvry et al., 2015). We see such a solution as eminently workable on American Indian reservations.

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Figure A1: 1910 Advertisement for Reservation Lands Left from Allotment

Appendix A Appendix to Section 2

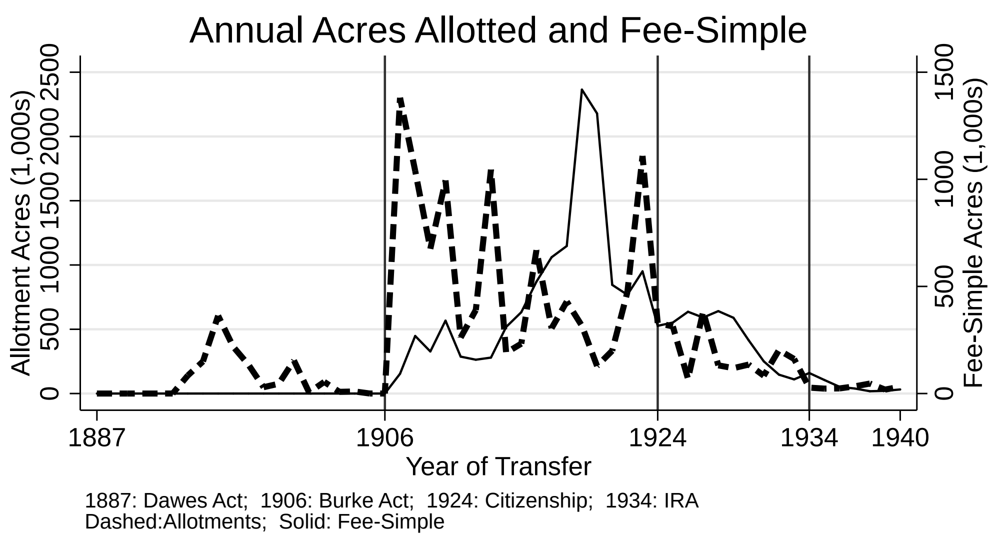
Figure A1 shows an advertisement for the sale of surplus land, discussed in Section 2.

Figure A2 tracks the flow of total acres that were allotted and the flow of acres subsequently converted into fee simple in the BLM data; discussed in Section 2.

Below Figure A2, we discuss the relationship between inheritance laws and land fractionation.

Intestacy Laws and Fractionation In this section, we discuss the relationship between inheritance laws and land fractionation. In the classic treatment by Habakkuk (1955), impartible ('unigeniture') single-heir practices intend to keep the family property intact, while partible ('common heirship') practices intend to keep the extended family intact. Land fractionation is always caused by *partible* inheritance (i.e. 'common heirship') practices and laws. The *practice* of partible inheritance refers to parents (the testator) writing common heirship into their will. *laws* of partible inheritance refers to a *court presumption* of common heirship that applies under intestacy, i.e. in

Figure A2: Flow of Allotments and Transfers into Fee Simple



Notes: This figure tracks the flow of total acres that were allotted and the flow of acres subsequently transferred into fee simple in the BLM data.

the absence of a will. The practices or the legal presumption of partible inheritance can cause land fractionation in two forms: when either the testator's preference or the court's presumption under intestacy is common heirship into *divided* interests, the result is farm sizes that are potentially too small to operate at efficient scale, causing under-development and agricultural poverty. Such is the case in India today, and most of continental Europe in the 19th century (Libecap and Alter, 1982; Foster and Rosenzweig, 2011, 2017). When the testator's preference or the court presumption under intestacy is common heirship into *undivided* claims on the same property, the result is ownership fractionation over the same asset under *tenancy in common*. In the U.S., the court presumption is partible inheritance but land fractionation has nonetheless historically been mostly avoided because (a) many landowners wrote wills to keep the farm intact, and because (b) well-developed financial markets would allow one heir to mortgage the farm to pay out the other heirs and thus maintain the farm at its efficient scale (Alston and Ferrie, 2012). Heir's property is the exception to this general rule and it was the result of a lack of will-writing ('intestacy'), a reluctance to go through the courts' probate systems, and historically limited access to credit.

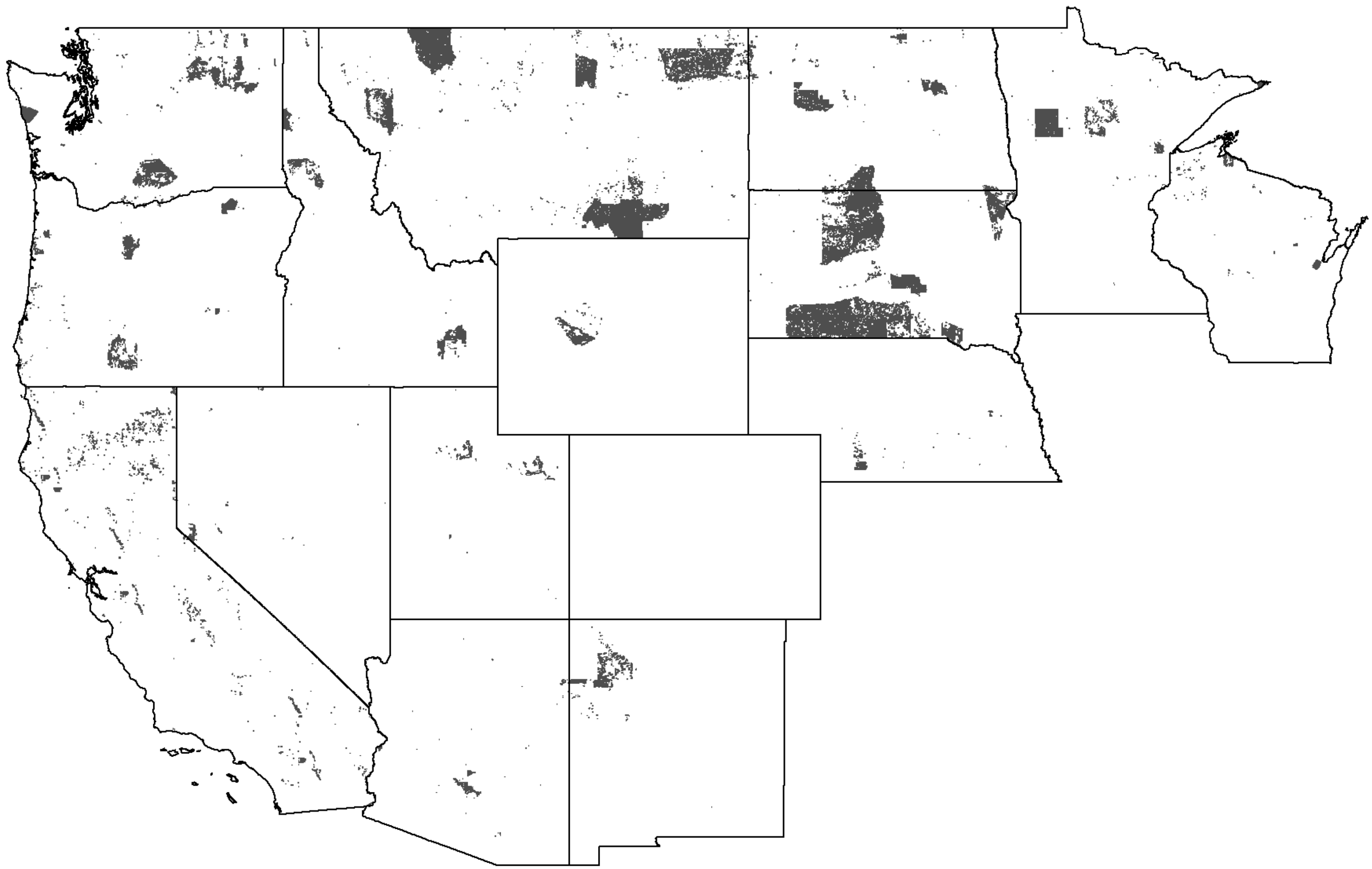
Appendix B Appendix to Section 3

Figure A3 depicts the location of allotments matched to quarter sections. In most cases, these clusters of allotments trace out the boundaries of present-day reservations (with the gaps filled in mostly by tribal lands). In some rare cases, clusters of allotments trace out the boundaries of a former reservation that was later terminated. This is true, for example, of the more dispersed looking 'clouds' of allotments in Central and Northern California. Oklahoma, which is in fact densely covered by allotments, is the only gap in our spatial allotment data.[36] Eastern Oklahoma was covered by reservations for the 'Five Civilized Tribes' (the Cherokee, Chickasaw, Choctaw, Creek, and Seminole) who had been relocated there in the 1830s. These tribes were fully allotted and we have their individual allotment records, but for some reason their allotments were either not filed with the Government Land Office or not digitized by the BLM.

Figure A4 shows a version of Figure 1 where we separately identify surplus land in the reservation. The vast majority of surplus lands is outside of reservations, because it was ceded from reservations as large tracts. See discussion in footnote 9 and reference to Appendix-Figure A1. The larger black outlines are the boundaries of 6×6-mile PLSS townships.

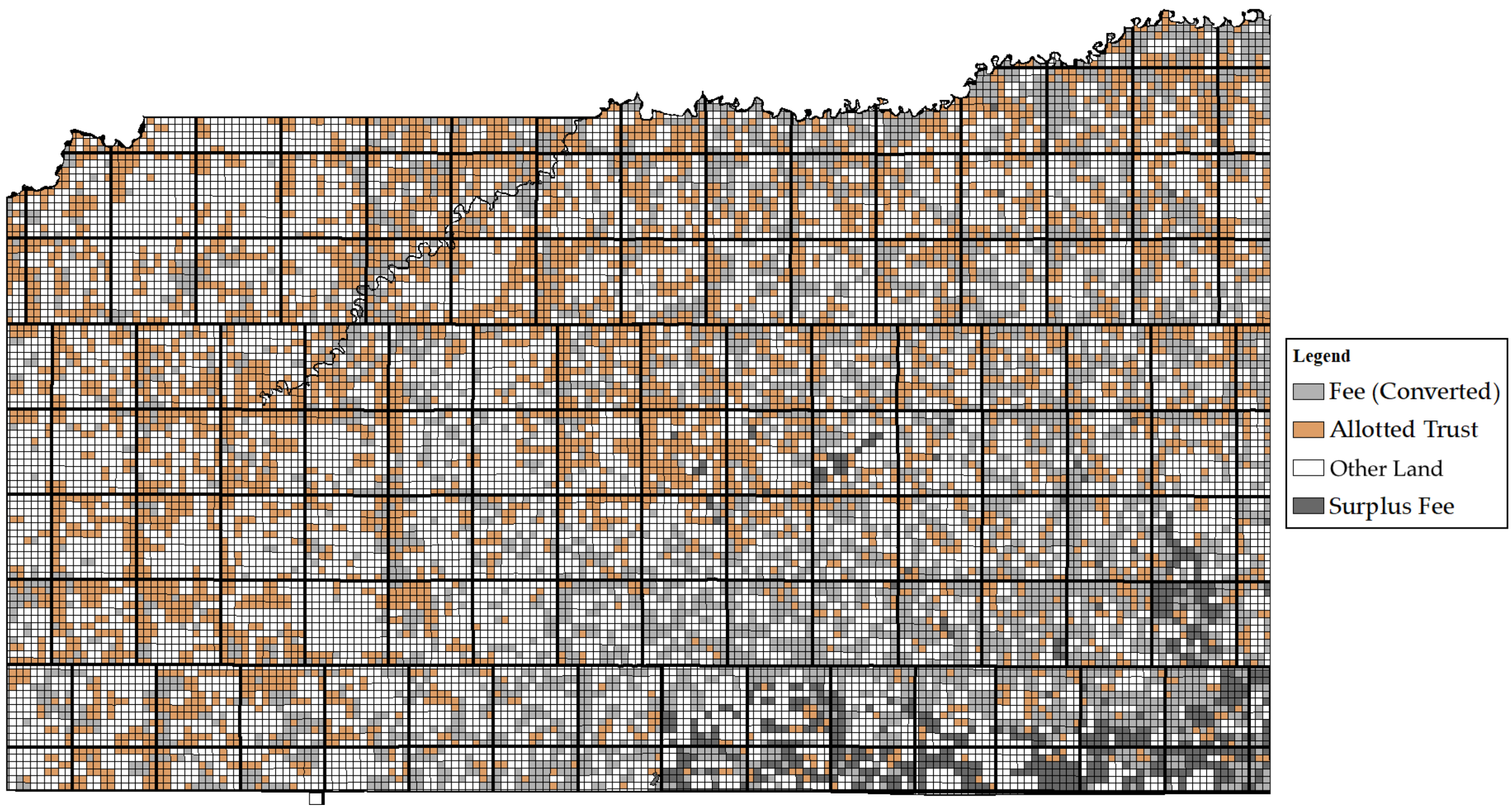
[36] Our match rate is above 99% for most states, with notably lower match rates for New Mexico (where the PLSS grid is less cleanly defined) and Wisconsin.

Figure A3: Allotted Quarter Sections and Reservations



Notes: This figure depicts the location of allotments across the U.S. The main omission is Oklahoma, where the Five Civilized Tribes (and the Osage) were allotted, but their allotments where not included in the GLO data. The parcels depicted include land in allotted-trust as well as fee-simple lands.

Figure A4: Checkerboard Pattern of Land Tenure on the Pine Ridge Reservation



Notes: This is a version of Figure 1 that includes 'Surplus Fee' land.

Appendix C Robustness Checks to Section 4

Table A1 re-estimates columns 2, 4, 6 of Table 2 with deciles of each land characteristics (i.e. 30 fixed effects) instead of linearly adding the geographic controls. Table A2 re-estimates Table 2 with the NLCD outcome data discussed in footnote 3.

Table A1: **Outcome:** Land Utilization Index

	(1)	(2)	(3)
Fee Simple	0.292***	0.242***	0.194***
	(0.047)	(0.050)	(0.050)
Adj. R^2	0.3087	0.4420	0.4783
Observations	67,049	66,195	65,408
#Fixed Effects	2,475	6,735	10,732
Geographic Controls	Deciles	Deciles	Deciles
Township Fixed Effects	Yes		
1/4 Twnshp Fixed Effects		Yes	
1/9 Twnshp Fixed Effects			Yes
Spatial HAC SEs (10 mi)	0.031	0.031	0.031
Spatial HAC SEs (25 mi)	0.037	0.036	0.037
Spatial HAC SEs (100 mi)	0.044	0.044	0.043

Notes: This table introduces increasingly finer spatial fixed affects across columns: Columns 1–3 use township fixed effects (panel a of Figure 3), columns 4 and 5 correspond to the fixed effects depicted in panels b and c of Figure 3. Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A2: **Outcome:** Land Utilization Index (NLCD)

	(1)	(2)	(3)	(4)	(5)	(6)
Fee Simple	0.410***	0.351***	0.290***	0.264***	0.174***	0.198***
	(0.058)	(0.047)	(0.045)	(0.043)	(0.035)	(0.035)
Ruggedness		-7.434**		-9.761**		-10.505***
		(3.280)		(3.838)		(3.219)
Elevation		-1.857***		-1.124***		-0.871**
		(0.339)		(0.406)		(0.427)
Soil Quality		73.266***		61.028***		48.780***
		(9.630)		(8.318)		(7.376)
Adj. R^2	0.2870	0.2977	0.2951	0.3005	0.3212	0.3172
Observations	65,409	65,408	64,580	64,579	63,824	63,824
#Fixed Effects	2,337	2,337	6,473	6,473	10,396	10,366
Geographic Controls	.	Linear	Binned	Binned	Binned	Binned
Township Fixed Effects	Yes	Yes				
1/4 Twnshp Fixed Effects			Yes	Yes		
1/9 Twnshp Fixed Effects					Yes	Yes

Notes: This table introduces increasingly finer spatial fixed affects across columns: Columns 1–3 use township fixed effects (panel a of Figure 3), columns 4 and 5 correspond to the fixed effects depicted in panels b and c of Figure 3. Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix D Additional Materials Related to Section 4.2

Appendix D.1 The Indian Census Rolls

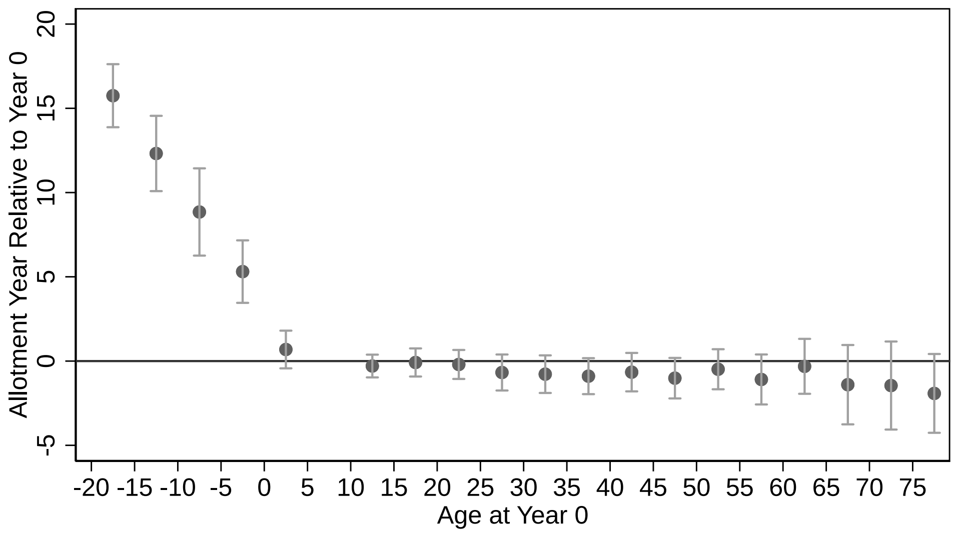
This section verifies our claim that within a reservation issuance year is explained by birth year. To be able to attach an allottee's characteristics like birth year to an allotted plot, we digitized an additional data source called the *Indian Census Rolls* (ICR). The ICR were censuses collected by the BIA on reservations; they contained basic demographic information such as age, and critically also included allotment numbers, which allows us to link allottee birth years to allotment issuance-years recorded in the BLM data. We digitized a single mid-1930s ICR volume for each reservation, which amounted to digitizing about 18,000 pages like the one in Appendix-Figure A6.

The *Indian Census Rolls* (ICR) contained individuals' allotment numbers, which we can then match to our allotment data. Figure A6 shows a snapshot of one page of the ICR. In any year, The records are organized by reservation, reported on the top of the page. (The top of the page also reports on the identity of the local BIA agents, which we peruse in Appendix D.2.) On the left, individuals are grouped by households, and sex, age and family relations are reported. In the far right column, the ICR report the allotment number, which—coupled with a reservation identifier—can be linked to the BLM allotment records we discuss in Section 3.

Because a portion of the original allottees had already died by the mid-1930s, we find only about three-quarters of our allotments in the ICR, i.e. around 45,000 allotments. (This affects the number of observations used to generate Figure A5, but does not affect our IV estimates based on issuance year, because issuance year is observed directly in the BLM patent data.)

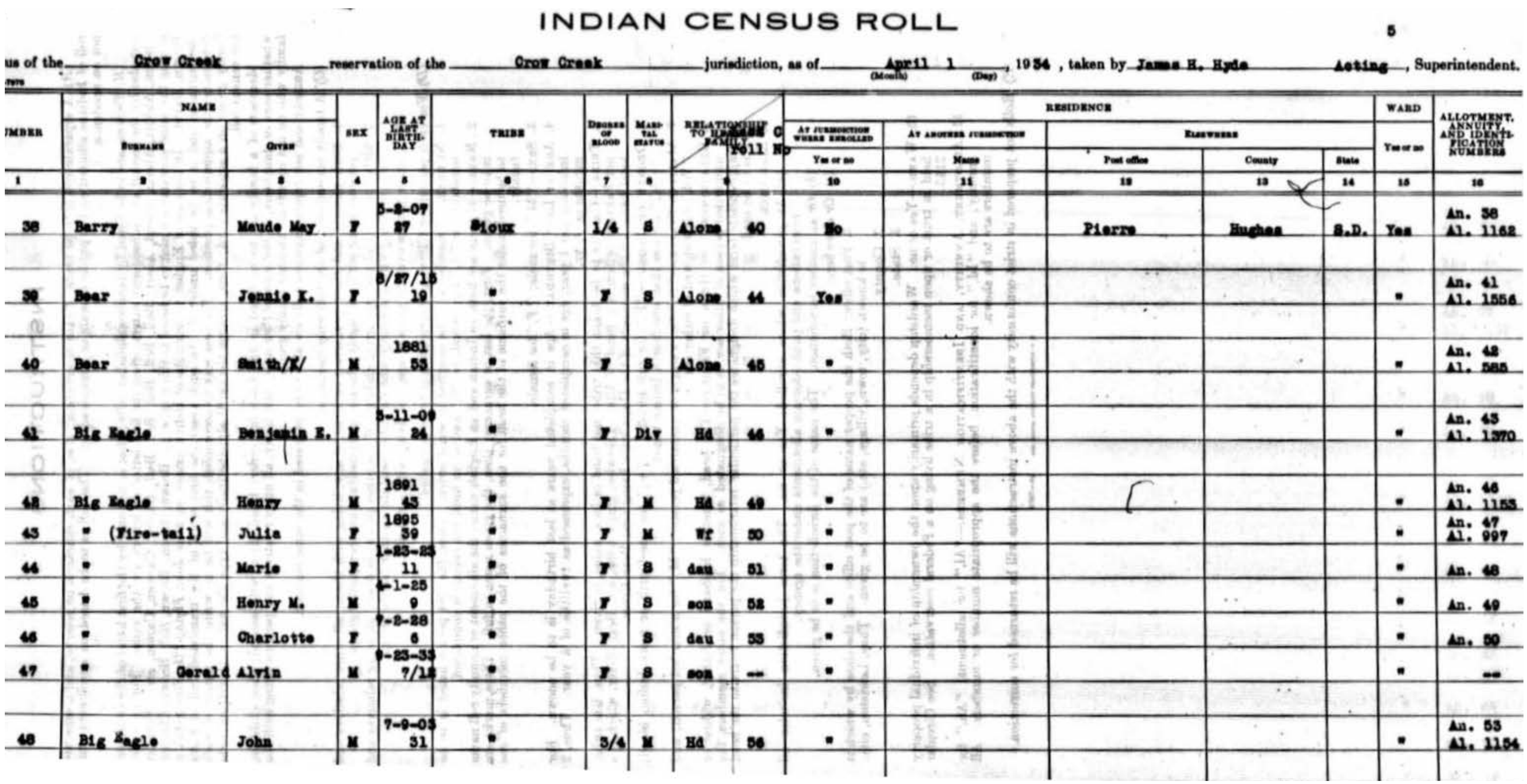
To verify our claim, we define for each reservation a year $t = 0$ as the year of the first major wave of allotments. On average, over seventy percent of a reservation's allotments were issued in that year, consistent with the narrative above. Figure A5 shows the coefficients that result from regressing allotments' issuance year (normalized relative to year $t = 0$) on reservation fixed effects and on allottees' age in year $t = 0$ (with negative ages for the later born), in 5-year bins. The figure shows that all allottees who were alive in year 0 received their allotment in year 0; i.e. the average allotment year is not statistically different from year $t = 0$ for *any* cohort born before year 0. Allottees that were not yet alive in year $t = 0$ received their allotment some years later ($t > 0$ on the vertical axis). In summary, this figure verifies that issuance-year variation is explained fully by birthyear, so that the exclusion restriction is that the birthyear of an original allottee has no direct effects on their heirs' land utilization eighty or a hundred years later.

Figure A5: Allotments' Issuance Year Explained by Allottees' Birthyear



Notes: This figure depicts the coefficients from a regression of allotments' issue-year on reservation fixed effects and allottees' ages, both normalized to year $t = 0$ in which the majority of a reservation's allotments were issued. The pattern shows that all allottees who were alive in year 0 indeed received an allotment in year 0, and later allotments were made as new cohorts were born. The omitted category is allottees aged 5-9 at year 0. Confidence bands are for s.e. clustered at the reservation-level.

Figure A6: Sample Page of the Indian Census Rolls



INDIAN CENSUS ROLL

5

us of the Crow Creek reservation of the Crow Creek jurisdiction, as of April (Month) 1 (Day), 1934, taken by James H. Hyde Acting, Superintendent.

Number	Name: Surname	Name: Given	Sex	Age at last birthday	Tribe	Degree of blood	Marital status	Relationship to head of family	Roll No	Residence: At jurisdiction where enrolled, Yes or no	At another jurisdiction: Name	Elsewhere: Post office	County	State	Ward: Yes or no	Allotment, annuity, and identification numbers
1	2	3	4	5	6	7	8	9		10	11	12	13	14	15	16
38	Barry	Maude May	F	5-2-07 27	Sioux	1/4	S	Alone	40	No		Pierre	Hughes	S.D.	Yes	An. 38 Al. 1162
39	Bear	Jennie K.	F	8/27/15 19	"	F	S	Alone	44	Yes					"	An. 41 Al. 1556
40	Bear	Smith/K/	M	1881 53	"	F	S	Alone	45	"					"	An. 42 Al. 585
41	Big Eagle	Benjamin E.	M	5-11-09 24	"	F	Div	Hd	46	"					"	An. 43 Al. 1370
42	Big Eagle	Henry	M	1891 43	"	F	M	Hd	49	"					"	An. 46 Al. 1153
43	" (Fire-tail)	Julia	F	1895 39	"	F	M	Wf	50	"					"	An. 47 Al. 997
44	"	Marie	F	1-23-23 11	"	F	S	dau	51	"					"	An. 48
45	"	Henry M.	M	4-1-25 9	"	F	S	son	52	"					"	An. 49
46	"	Charlotte	F	7-2-28 6	"	F	S	dau	53	"					"	An. 50
47	"	Gerald Alvin	M	9-23-33 7/12	"	F	S	son	--	"					"	--
48	Big Eagle	John	M	7-9-03 31	"	3/4	M	Hd	56	"					"	An. 53 Al. 1154

Notes: This page shows 7 allottees with allotment numbers (as well as some 'annuity numbers' which related to other treaty obligations like ration payments). We collected about 18,000 pages like this to get one complete cross-section. A large chunk of the full data we collected was on un-allotted reservation so that we have a total of almost 45,000 allotment numbers across 18,000 pages.

Columns 1–3 of Table A3 show that the IV discussed in Appendix D.1 displays some correlation with land characteristics; columns 4–6 show that the IV discussed in Appendix D.2 does not.

Table A3: Correlation of Geographic Controls with Instruments

	Ruggedn.	Elev.	Soil Q.	Ruggedn.	Elev.	Soil Q.
	(1)	(2)	(3)	(4)	(5)	(6)
Allotment Year	0.000***	0.000**	-0.000*			
	(0.000)	(0.000)	(0.000)			
Z_i				0.001	-0.004	-0.000
				(0.001)	(0.003)	(0.000)
Adj. R^2	0.9204	0.9953	0.8421	0.9203	0.9952	0.8423
Observations	67,103	67,103	67,102	67,019	67,019	67,018
1/9 Twnshp Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Across columns, this table shows the second stage results of instrumenting fee-simple status with the year of an allotment's issuance (column 1–3) and additionally with Z_i from expression (4) (in columns 4–6). Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix D.2 The Indian Agents

To gain identification we construct an instrument based on the exogenous rotation of Indian Agents across reservations, and their varying propensity to transfer land into fee simple. To operationalize this strategy, we construct a complete reservation-year panel of Indian Agents from 1879–1940. Our primary source of agent information is from the Department of Interior employment rosters recorded in the Official Register of the United States (1932).[37] The records provide agent name, birthplace, position title, and annual pay. Each agent is listed by agency and city, which we link to reservations. We supplement these records with agent narratives included in the Bureau of Indian Affairs Reports published annually from 1879 to 1907. Each agent was required to produce an annual summary of agency events. We recorded each agents name from the end of the summary. As well, we compare these records with the agent names listed on the ICR discussed in Appendix D.1 above.

Appendix D.3 The Identifying Assumption of the Instrument

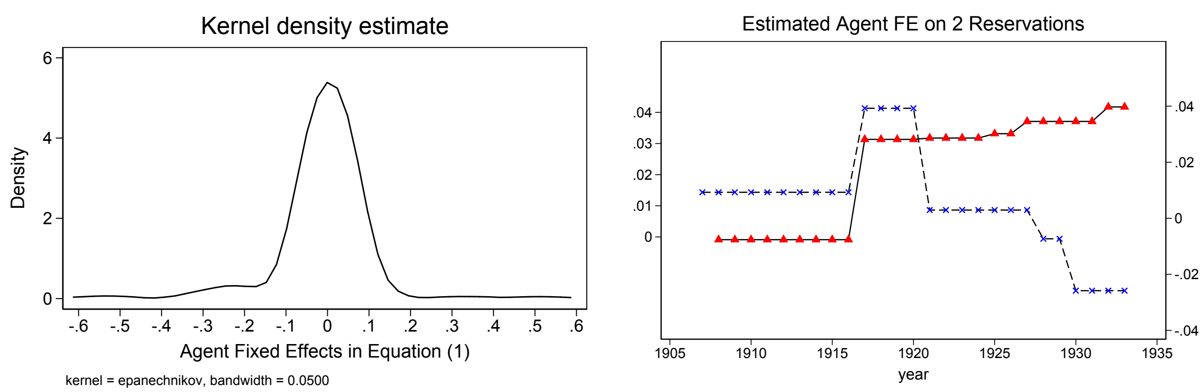
Two elements need to be in place for judge fixed effect type strategies: For precision and statistical power, (*i*) the BIA agents needed to have sufficient discretion for their idiosyncratic preferences matter, as well as enough discretion to make these propensities matter. For exogeneity, (*ii*) the assignment of BIA agents to reservations should not have been endogenous to reservations' characteristics.

For (*i*), the historical and institutional narrative surrounding allotment makes it clear that the BIA agents possessed considerable discretionary room over the assignment of allotments (Banner, 2009; Otis, 2014; Carlson, 1981). For illustration, the left panel of Figure A7 shows the distribution of the roughly 450 agent fixed effects $\widehat{\mu_{j(\cdot)}}$ estimated in equation (3). The right panel of Figure A7 shows how the rotation of agents over time induces different time-paths in the propensity to convert land into fee simple on two different reservations. In the initial years after the Burke Act, Salt River had an Indian Agent whose propensity to convert land was about average, with a $\widehat{\mu_{j(\cdot)}} \approx 0$ (Charles E. Coe From 1906–1917); but from 1917 until the end of the allotment era in 1934, Spirit Lake, had a series of agents who all had higher than average propensities to transfer land into

[37] The Official Registers were published biennially from 1879–1940.

fee simple (Byron A. Sharp, 1917–1921, Frank A. Virtue, 1921–1925, Charles S. Young 1925–1927, John B. Brown 1927–1932, Arthur J. Wheeler, from 1932). Salt River, by contrast, had agents with a higher propensity to convert land to fee simple in the early years (Charles M. Ziebach 1906–1917, Samuel A. M. Young, 1917–1921), but then had a succession of three agents with a lower propensity towards the end of the allotment process (William R. Beyer 1921–1928, John S. R. Hammitt 1928–1930, and Orrin C. Gray 1930–1934).

Figure A7: Distribution of Estimated $\widehat{\mu_{j(\cdot)}}$



Notes: The left panel of this figure shows the distribution of roughly 450 agent fixed effects $\widehat{\mu_{j(\cdot)}}$ estimated in equation (3). The right panel shows how the rotation of agents over time induces different time-paths in $\widehat{\mu_{j(rt)}}$, i.e. the propensity to convert land into fee simple, on Spirit Lake (red triangles, solid line) and on Salt River (blue crosses, dashed line).

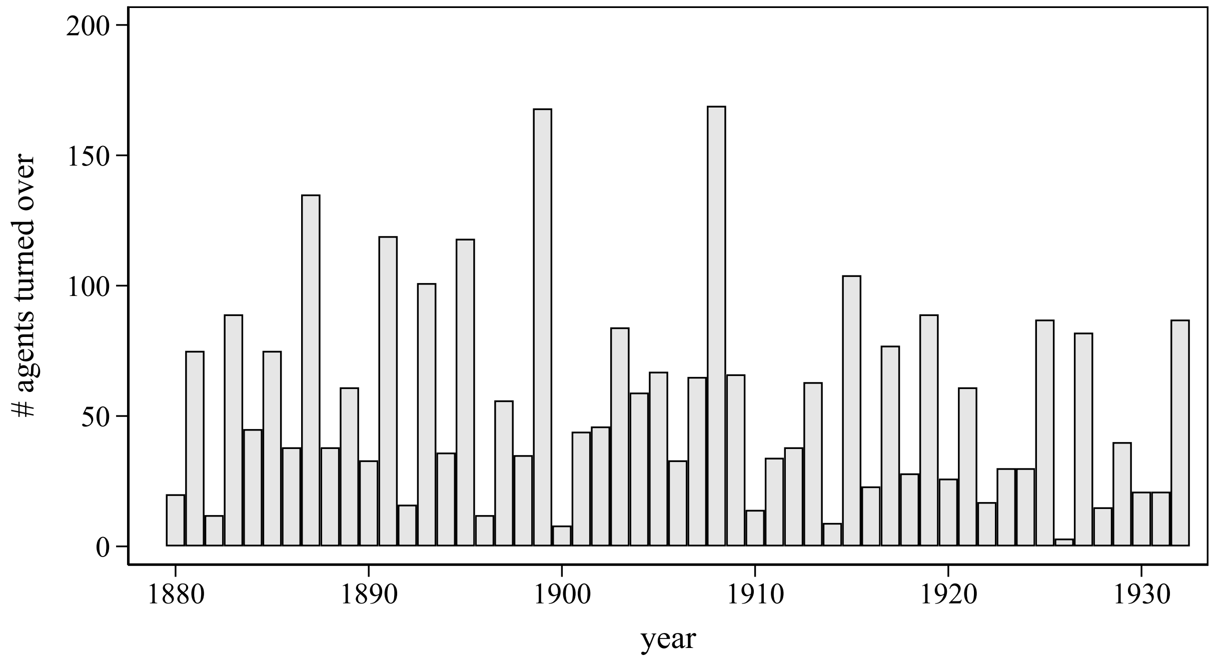
To ensure that whatever variation in expression (4) will contribute to identification is in fact driven by $\widehat{\mu_{j(rt)}}$ rather than, say, by a non-linear transformation of issue-year, we re-estimate equation (3) and re-construct expression (4) without agent fixed effects, and compare the resulting "Placebo-Z_i" to the Z_i we use in our estimation. We show the results in Table A4, which is the equivalent of Panel B in Table 4 with the "Placebo-Z_i" replacing Z_i. Table A4 shows that when expression (4) is constructed without agent fixed effects, it has no predictive power whatsoever for a plot's conversion into fee simple.

Table A4: **Instruments:** Correlation of "Placebo-Z_i" with Land Characteristics, and First Stage

	Ruggedn.	Elev.	Soil Q.	Fee Simple		
	(1)	(2)	(3)	(4)	(5)	(6)
Allotment Year				-0.018***	-0.018***	-0.017***
				(0.002)	(0.002)	(0.002)
Placebo-Z_i	-0.001	-0.008	0.000	0.187	0.188	0.186
	(0.001)	(0.008)	(0.000)	(0.230)	(0.230)	(0.230)
Adj. R^2	0.9203	0.9952	0.8423	0.6118	0.6119	0.6124
Observations	67,019	67,019	67,018	67,019	67,018	67,018
Geographic Controls					Linear	Binned
1/9 Twnshp Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports on a version of Table 4, Panel B where we construct a "Placebo-Z_i" (defined in equation (4)) without using agent fixed effects in the estimation of equation (3). The purpose is to validate assumption (*i*) by showing that without $\widehat{\mu_{j(\cdot)}}$, Z_i does not add predictive power to the first stage.

Figure A8: Turnover of BIA Agents over Time



Notes: This figure shows the count of agent-turnover (agents switching reservations) over time.

For (*ii*), we require that the assignment of a BIA agent to a reservation was conducted in a manner that was exogenous to the allotments that were considered for transfer into fee simple on that reservation. In terms of timing, the historical record shows that the timing of rotation was anchored on the federal administration cycle: the majority of BIA agents were rotated with the federal electoral cycle, i.e. after two, four, six or eight years. This is documented in Figure A8, which shows aggregate turnover in the agent panel and displays a clear pattern of turnover spiking every two years with each new congressional term

Of course, exogenous timing is not enough for exogeneity because it does not preclude the possibility of selection. The particular worry is that BIA agents with a higher propensity for converting land into fee simple were transferred to reservations with certain characteristics, particularly over land. The historical record does not suggest that this was the case because the primary job of BIA agents was to foster education and public health on the reservations, and there is no reason to expect these characteristics to have been correlated with the propensity to convert allotments. To approach this question more formally, we test whether the agent fixed effects $\widehat{\mu_{j(rt)}}$ that we estimated in equation (3) correlate with the characteristics of the land that the agents converted. We also investigate the relation between agent fixed effects and land characteristics in a panel setting. To do so, we aggregate the plot-year duration-panel up to a reservation-year (r, t)-panel where we average over the plots that were converted to fee-simple in year t. In

$$\text{geo-characteristics}_{rt} = \beta \cdot \widehat{\mu_{j(rt)}} + \beta_\tau \cdot (t - \text{issue-year}_{rt}) + \gamma' \mathbf{X}_r + \mu_r + \delta_t + \epsilon_{jrt} \tag{7}$$

we regress the average of each observable geo-characteristics$_{rt}$ of plots converted in year t on the fixed effect $\widehat{\mu_{j(rt)}}$ of the agents in charge in t, conditional on reservation and year fixed effects, as well as the average years since issuance (t − issue-year$_{rt}$) of these plots. $\mathbf{X}_r$ controls for the average of the land characteristic under investigation for allotted plots that had not yet converted into fee simple. If higher propensity-to-convert agents were selectively converting better land, we should see a negative correlation between $\widehat{\mu_{j(rt)}}$ and ruggedness, a negative correlation between $\widehat{\mu_{j(rt)}}$ and elevation, and a positive correlation with soil quality. The coefficients in Table A5 are sign-consistent with this hypothesis, but the correlations are nowhere near statistically significant. In the even columns, we add $\mathbf{X}_r$ controls, which adds explanatory power but does not change the overall pattern.

Table A5: Correlation of $\widehat{\mu_{j(rt)}}$ with Land Characteristics

	Ruggedness		Elevation		Soil Quality	
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{\mu_{j(rt)}}$	-2.564	-0.367	-58.553	-33.062	0.887	0.824
	(12.248)	(12.649)	(47.620)	(48.159)	(1.243)	(1.253)
avg t - issue-year	0.060	0.103	-0.765	0.770	-0.032	-0.021
	(0.228)	(0.235)	(0.888)	(0.906)	(0.023)	(0.023)
Ruggedness on trust-plots in rez-year		0.405***				
		(0.115)				
Elevation on trust-plots in rez-year				0.493***		
				(0.059)		
Soil-Quality on trust-plots in rez-year						-0.084
						(0.067)
Adj. R^2	0.8561	0.8584	0.9783	0.9791	0.6878	0.7001
Observations	1,342	1,313	1,342	1,313	1,342	1,313
Reservation Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table shows the results of estimating equation (7), which tests whether agent fixed effects $\widehat{\mu_{j(rt)}}$ correlate with the land characteristics of the plots converted.

Appendix E Appendix Materials for Section 5 (Mechanisms)

Appendix E.1 Evolution over Reservation Economies over Time

Here, we provide a background narrative on how economic activity on reservations evolved over time. Land allotment was the cornerstone of the *Assimilation Era*, which lasted from the Dawes Act in 1887 until the IRA in 1934. A spurt of economic growth followed the IRA, under John Collier's leadership of the BIA from 1934 to 1945. What followed was the first period since the establishment of reservations that many consider to have been one of positive changes, as Collier's tenure at the helm of the BIA empowered tribes, and many young Native Americans received training and found employment in the the Civilian Conservation Corps and in the Army.

Unfortunately, the Truman and the Eisenhower administrations' attitudes towards reservations (1945–1961) were markedly different from those of the previous Roosevelt administration, and there was a period of stagnation into the late 1960s. This period was defined by the passing of two concurrent federal acts in 1953—the *Termination Act*, and *Public Law 280*— which Treuer (2019, p255) describes as "a dry pair of names for two exceptionally bloody acts." These acts put control of federal funds back with the BIA. A tribal member who lived through this period recounts how "in the 1950s, you couldn't get anything done without [the BIA's] approval. They controlled everything. They controlled the land and collected rents. All fees were paid to them. They paid out the money. All leases, all business deals, all disputes, it went through them" (Treuer, 2012, p128).

The late 1960s brought significant change, in part on the tails of the Civil Rights Movement and the Johnson administration's War on Poverty. The Office of Economic Opportunity (OEO) funded wide-ranging Community Action Programs (CAP) on reservations including investments in litigation capabilities; the Indian Education Act of 1972 dramatically improved Indian educational resources; the Indian Financing Act of 1974 improved access to finance on reservations; the Indian Self-Determination and Education Assistance Act of 1975 authorized federal agencies other than the BIA to directly contract with, and make grants to, individual tribes; and in 1976 the Supreme Court curtailed the sway of Public Law 280 over taxation and other civil law matters on reservation (Cornell and Kalt 2007, ch1, Treuer 2012, p136, p384, p330, p220, p369).[38] By the early

[38] This period also brought non-economic change that empowered Native Americans: The late Sixties saw the rise of the American Indian Movement, and in 1978 Congress passed the American Indian Religious Freedom Act.

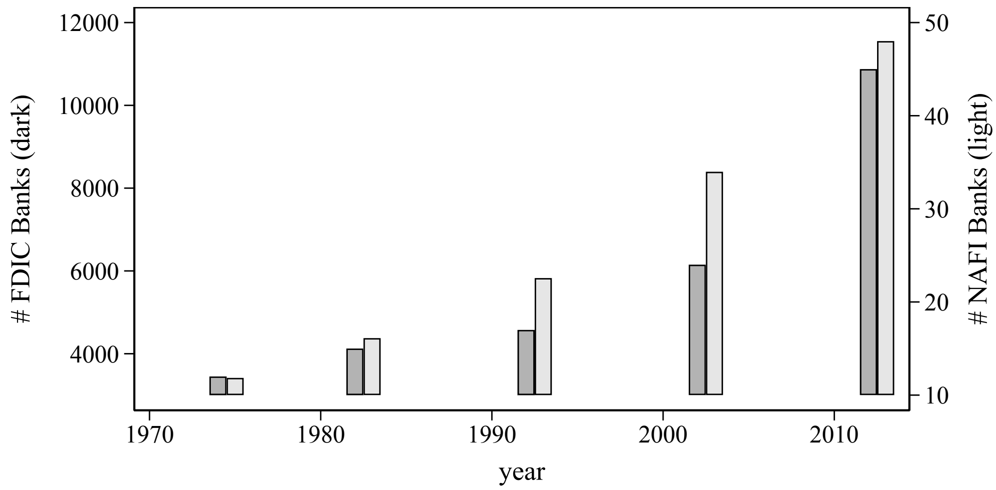
1970s, tribes had begun to gain more independence from the BIA, and the 1970s were — at least economically — a good decade for American Indians. The economic expansion of the 1970s was followed by a period of relative stagnation in the early to mid 1980s, primarily because the Reagan administration (1981–1989) dismantled the OEO and various other sources of federal grants and funding in 1981. This stagnation was temporary, however. By the late 1980s, the sovereignty that tribes had secured in the early 1970s began to bear fruit in the establishment of tribal businesses. Tribes had developed the infrastructure to do well economically even without federal grants and funding. And economic growth on reservations mirrored the usual pattern of structural transformation, transitioning from primarily agricultural production towards manufacturing and services (Herrendorf, Rogerson, and Valentinyi, 2014). While until early 1970s, practically *all* economic activity on reservations was agricultural (Carlson, 1981; Trosper, 1978; Anderson and Lueck, 1992), the *Harvard Project on American Indian Economic Development* has carefully documented the subsequent emergence of wide-ranging manufacturing activities in electronics, cement, fish canneries, saw mills, and auto parts, as well services, particularly a variety of tourism activities (two Apache reservations each run their own ski resorts) (Cornell and Kalt, 1987, 1992). In 1988, Congress passed the Indian Gaming and Regulatory Act. While only a handful of reservations have grown rich from gambling, many have used the modest but steady casino revenues to finance and encourage the development of other businesses (Jorgensen 2007, Treuer 2012, ch6). The time-path of development discussed here is depicted in Figure A9.

Figure A9: Economic Development on U.S. Reservations over time

Notes: Reservation-level per capita income was collected from BIA reports held at the National Archives for 1915, 1938, and 1945. From 1970–2010, on-reservation per-capita income aggregates are reported as part of the decennial census.

Appendix E.2 Banking Access

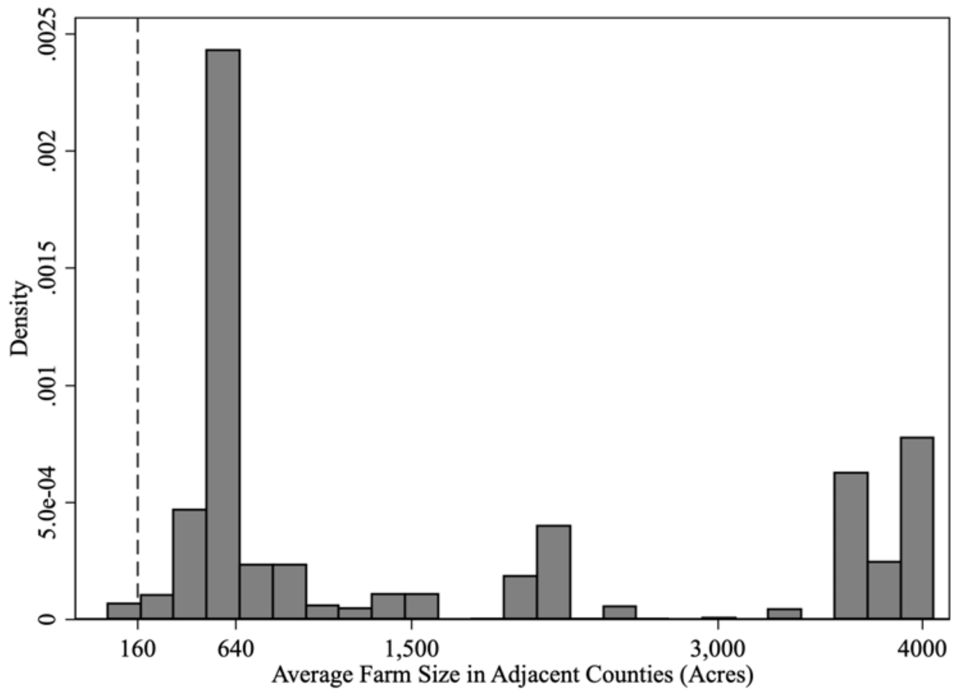
Figure A10: Specialized Banks on Reservations over time



Notes: This graph plots the number of specialized banks we see in the reservations in our data over time, increasing from 12 in 1974 to 45 in 2012.

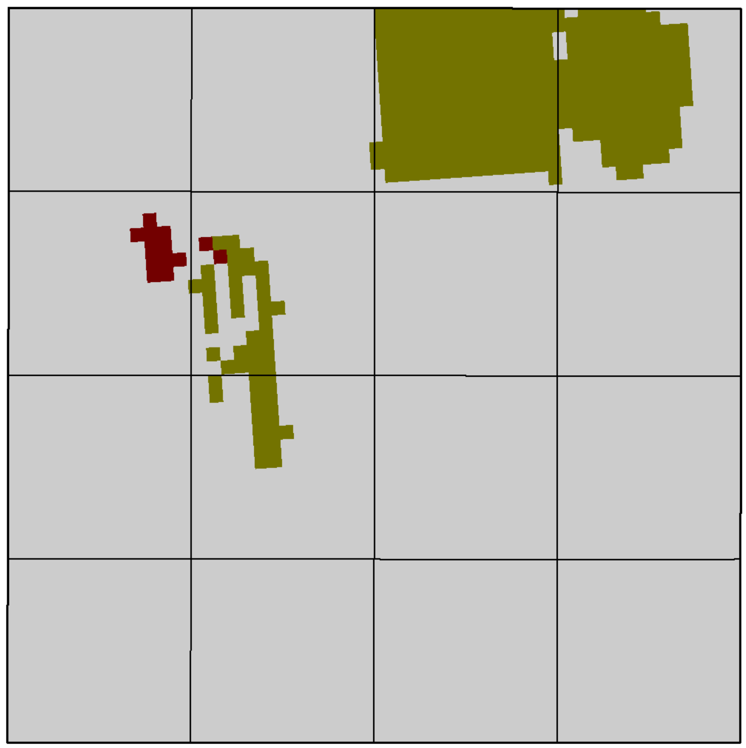
Appendix E.3 Measuring Agricultural Spillovers

Figure A11: Distribution of Average Farm Size in Adjacent Counties



Notes: This graph plots the distribution of adjacent-county average farm size for the parcels in our main estimating sample. The vertical dashed line corresponds to 160 acres, which is the size of a single quarter-section and the size of most allotments.

Figure A12: Measuring Agricultural Spillovers

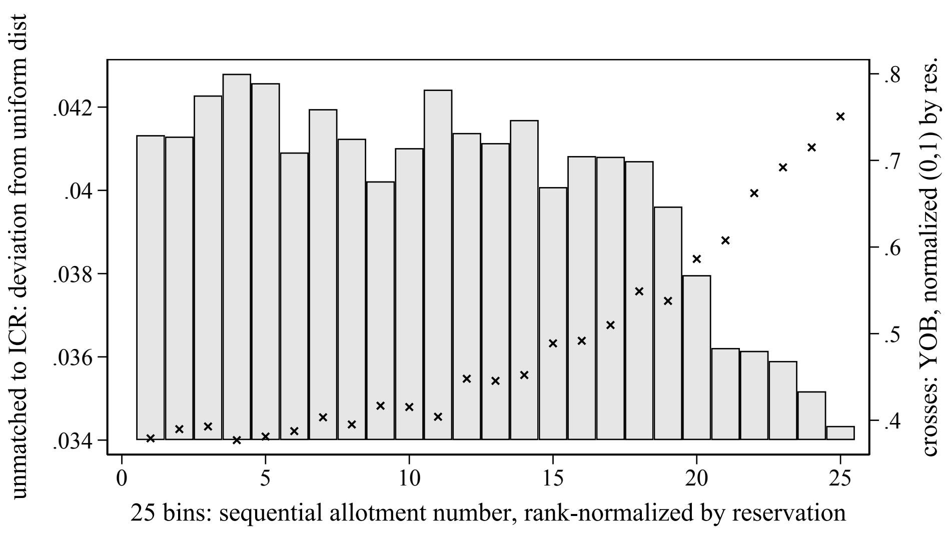


Notes: This figure depicts an example of how we identify agricultural spillovers—contiguous polygons of crops that intersect multiple quarter sections—from the NWALT data. The two plots in the upper right corner are considered to be part of one ”synthetic farm,” as described in Section 5.2. This synthetic farm can be seen to spill over marginally onto the second plot from the left in the top row, but this second plot from the left is *excluded* based on our cutoff rule, also described in Section 5.2. The two plots in the middle of the figure also form a ”synthetic farm” in our coding.

Appendix E.4 Measuring Latent Fractionation

Our measure of latent fractionation rests on the assumption that allotments *not* matched to the ICR correspond to individuals who are decreased by 1930. We can validate this assumption by leveraging the fact that allotment numbers were issued *sequentially*, which allows us to show that, *within* a reservation, smaller allotment numbers belonged to older allottees and were associated with a higher likelihood of not being recorded in the mid-1930s ICR. Figure A13 bins each reservation's rank-normalized allotment numbers into 25 bins on the horizontal axis and plots normalized birth-year by bin to show that smaller allotment numbers were associated with earlier birth-years for the allotments that we *do* match to the ICR.[39] The figure also plots the distribution of unmatched allotments to illustrate that it is skewed towards low allotment numbers, relative to a distribution of *all* allotments that is uniform by definition (because it splits the data into equal-sized bins). This is evidence that allotments that we do not find in the ICR disproportionately belonged to older individuals who where more likely to be deceased by the mid-1930s.

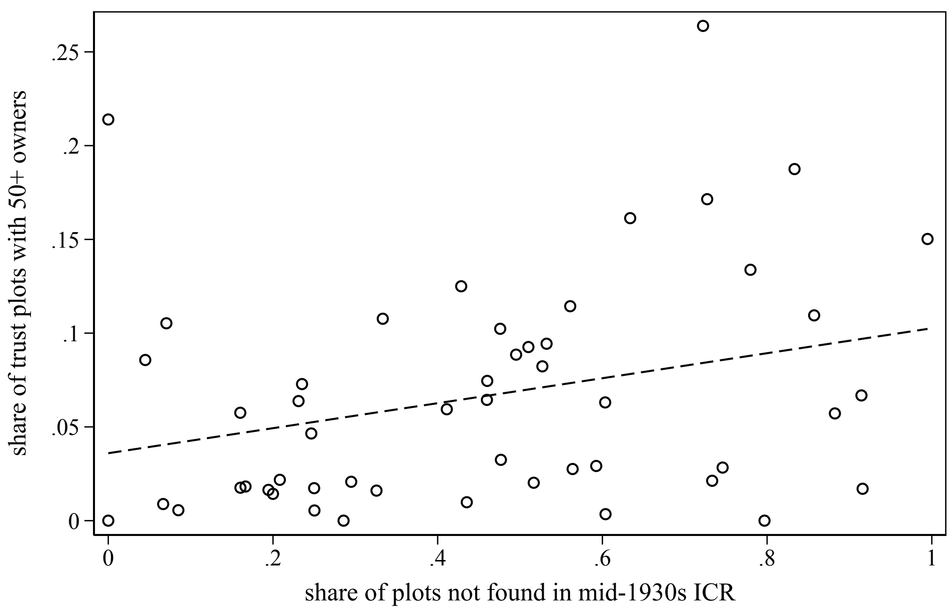
Figure A13: Original Allottees' Age and Sequential Allotment Number



Notes: This figure shows that, *within* each reservation, smaller allotment numbers belonged to older allottees (see scatter plot) and were associated with a higher likelihood of not being recorded in the mid-1930s ICR.

[39] Normalization (0–1) by reservation is needed because some reservations were allotted decades before others.

Figure A14: Relating Today's Measured Fractionation to Finding Allotments in the ICR



Notes: This graph plots each reservation's average number of trust parcels that are classified as highly fractionated in Department of Interior (2013) against the reservation's average number of plots not found in the ICR

Appendix F Extensions to Section 6

Appendix F.1 Tribal Lands

Table A6 reports on an expanded version of Table 1 that includes tribal plots (in 160-acre quarter-sections). Tribal quarter sections include the one-half of reservations that were never allotted. (These reservations are included for completeness, but they play no role in our results because all of our spatial fixed effects are considerably finer-grained than the reservation.)

Table A7 re-estimates Table 2 with tribal plots included.

Table A8 re-estimates Table 5 with tribal lands included. Similar to Table 5, development is estimated to have grown at a rate of two and a half times as fast on fee-simple land as on allotted-trust land; $(\gamma^{\hat{Fee}}{}_{2012} + \hat{\tau}_{2012})/\hat{\tau}_{2012} = (0.45 + 0.29)/0.29$. Development on tribal land also grew faster than on allotted-trust land, at about twice the rate; $(\gamma^{\hat{Tribe}}{}_{2012} + \hat{\tau}_{2012})/\hat{\tau}_{2012} = (0.34 + 0.29)/0.29$.

Table A6: Summary Statistics (Table 1) with Tribal Lands Added

Panel A:	Unallotted	Allotted	Alloted vs. Unallotted			
	(1)	(2)	(3)	(4)	(5)	(6)
Elevation	1446.696	858.445	-588.251***	-19.349*	-10.914*	-6.605*
	[661.03]	[434.15]	(121.037)	(8.188)	(5.274)	(3.344)
Ruggedness	19.462	13.450	-6.013**	-1.451	-0.661	-0.178
	[25.09]	[29.41]	(2.223)	(1.348)	(1.134)	(1.040)
Soil Quality	7.406	10.446	3.041***	0.263*	0.192*	0.143*
	[5.22]	[4.33]	(0.814)	(0.117)	(0.087)	(0.070)
Observations	295,139	68,557				
Panel B:	Trust	Tribal	Tribal vs. Trust			
	(1)	(2)	(3)	(4)	(5)	(6)
Elevation	938.100	1446.696	508.595***	18.977*	11.610*	7.283
	[459.61]	[661.03]	(112.819)	(8.008)	(5.907)	(3.942)
Ruggedness	14.010	19.462	5.452**	2.447**	1.678*	1.171
	[21.26]	[25.09]	(2.074)	(0.947)	(0.770)	(0.615)
Soil Quality	9.704	7.406	-2.299**	-0.151	-0.127	-0.114
	[4.43]	[5.22]	(0.798)	(0.132)	(0.099)	(0.080)
Observations	42,164	295,139				
Township Fixed Effects				Yes		
1/4 Twnshp Fixed Effects					Yes	
1/9 Twnshp Fixed Effects						Yes

Note: Panel A repeats Table 1. Panel B adds tribal quarter sections. Tribal quarter sections include the one-half of reservations that were never allotted. (These reservations are included for completeness, but they play no role in our results because all of our spatial fixed effects are considerably finer-grained than the reservation.) *(b)* Columns 1–2 present mean and standard deviations by land tenure. Column 3 reports unconditional differences of fee-simple vs trust land, and columns 4–7 report differences conditional on fixed effects. Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A7: Table 2 with Tribal Lands Added

	(1)	(2)	(3)	(4)	(5)	(6)
Fee Simple	0.377***	0.360***	0.273***	0.268***	0.229***	0.232***
	(0.055)	(0.055)	(0.039)	(0.040)	(0.031)	(0.032)
Tribal Land	0.018	0.046	0.023	0.040	0.025	0.036*
	(0.028)	(0.028)	(0.025)	(0.026)	(0.020)	(0.021)
Ruggedness		-4.153**		-3.661**		-3.265**
		(1.587)		(1.486)		(1.469)
Elevation		-0.620***		-0.463***		-0.480***
		(0.126)		(0.118)		(0.120)
Soil Quality		54.058***		53.141***		35.863***
		(17.597)		(19.967)		(11.965)
Adj. R^2	0.4986	0.4989	0.5764	0.5765	0.6657	0.6657
Observations	267,340	267,340	266,420	266,420	265,819	265,819
#Fixed Effects	4,339	4,339	14,255	14,255	23,807	23,807
Geographic Controls	.	Linear	Binned	Binned	Binned	Binned
Township Fixed Effects	Yes	Yes				
1/4 Twnshp Fixed Effects			Yes	Yes		
1/9 Twnshp Fixed Effects					Yes	Yes

Notes: This table has the exact identical structure to Table 2. This table introduces increasingly finer spatial fixed affects across columns: Columns 1–3 use township fixed effects (panel a of Figure 3), columns 4 and 5 correspond to the fixed effects depicted in panels b and c of Figure 3. Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A8: Adding Tribal Lands to Panel Results in Table 5

	Z(Use)		Development		Cultivation	
	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{\gamma^F}$: Fee Simple Land	0.149***		-0.046		4.206***	
	(0.018)		(0.064)		(0.189)	
$\hat{\gamma^F}_{1982}(FeeSimple_i \times \tau_{1982})$	0.038***	0.038***	0.132***	0.137***	0.151***	0.142***
	(0.002)	(0.002)	(0.007)	(0.003)	(0.029)	(0.004)
$\hat{\gamma^F}_{1992}(FeeSimple_i \times \tau_{1992})$	0.051***	0.049***	0.207***	0.193***	-0.084**	-0.116***
	(0.003)	(0.008)	(0.008)	(0.013)	(0.029)	(0.017)
$\hat{\gamma^F}_{2002}(FeeSimple_i \times \tau_{2002})$	0.088***	0.086***	0.321***	0.314***	0.069*	0.028
	(0.003)	(0.010)	(0.008)	(0.023)	(0.029)	(0.033)
$\hat{\gamma^F}_{2012}(FeeSimple_i \times \tau_{2012})$	0.099***	0.099***	0.431***	0.445***	0.285***	0.231***
	(0.003)	(0.010)	(0.007)	(0.027)	(0.028)	(0.038)
$\hat{\gamma^T}$: Tribal Land	0.031**		-0.135		0.499**	
	(0.008)		(0.074)		(0.174)	
$\hat{\gamma^T}_{2012}(Tribal_i \times \tau_{1982})$	-0.002	-0.002***	0.133***	0.123***	-0.135***	-0.146***
	(0.001)	(0.000)	(0.004)	(0.003)	(0.017)	(0.004)
$\hat{\gamma^T}_{2012}(Tribal_i \times \tau_{1992})$	-0.006***	-0.006**	0.207***	0.185***	-0.313***	-0.329***
	(0.001)	(0.002)	(0.004)	(0.008)	(0.018)	(0.012)
$\hat{\gamma^T}_{2012}(Tribal_i \times \tau_{2002})$	-0.007***	-0.007	0.334***	0.293***	-0.580***	-0.607***
	(0.001)	(0.004)	(0.005)	(0.015)	(0.018)	(0.022)
$\hat{\gamma^T}_{2012}(Tribal_i \times \tau_{2012})$	-0.002	-0.002	0.386***	0.344***	-0.595***	-0.626***
	(0.001)	(0.006)	(0.005)	(0.017)	(0.018)	(0.023)
ShareDeveloped$_{it}$					-0.127***	-0.050***
					(0.007)	(0.007)
ShareCultivated$_{it}$			-0.025***	-0.089***		
			(0.003)	(0.015)		
$\hat{\tau}_{1982}$	0.024***	0.024***	0.084***	0.095***	0.186***	0.179***
	(0.001)	(0.001)	(0.004)	(0.003)	(0.016)	(0.004)
$\hat{\tau}_{1992}$	0.036***	0.036***	0.127***	0.154***	0.432***	0.423***
	(0.001)	(0.002)	(0.004)	(0.008)	(0.016)	(0.012)
$\hat{\tau}_{2002}$	0.057***	0.057***	0.181***	0.231***	0.805***	0.792***
	(0.001)	(0.002)	(0.005)	(0.015)	(0.016)	(0.021)
$\hat{\tau}_{2012}$	0.070***	0.070***	0.233***	0.288***	0.876***	0.860***
	(0.001)	(0.002)	(0.005)	(0.017)	(0.016)	(0.022)
Adj. R^2	0.4925	0.8521	0.5851	0.8320	0.7521	0.9890
Observations	907,167	906,973	1,820,067	1,819,878	1,820,067	1,819,878
#Fixed Effects	19,321	181,568	33,745	364,149	33,745	364,149
1/9 Twnshp Fixed Effects	Yes		Yes		Yes	
Allotment Fixed Effects		Yes		Yes		Yes
Trust Land's 1974 Share Developed			.6179	.6179		
Fee Land's 1974 Share Developed			1.33	1.33		
Tribal Land's 1974 Share Developed			.5797	.5797		
Trust Land's 1974 Share Agricultural					10.33	10.33
Fee Land's 1974 Share Agricultural					27.13	27.12
Tribal Land's 1974 Share Agricultural					3.806	3.806

Notes: This table shows how the effect on land utilization of being held under fee simple or being held by a tribe has changed since 1974. Columns 1–2 consider the land utilization index as the outcome, columns 3–4 consider land development as the outcome, columns 5–6 consider agricultural cultivation. In columns 1, 3, and 5, this table uses the more fine-grained spatial fixed effects in Table 2. In columns 2, 4, and 6, it adds plot fixed effects, focusing solely on within-plot variation. The coefficient-estimates on year fixed effects are the $\hat{\tau}_t$ in equation (5). Further, the 'Fee-Simple × year' coefficients report on the $\hat{\gamma}_t$ in equation (5). Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

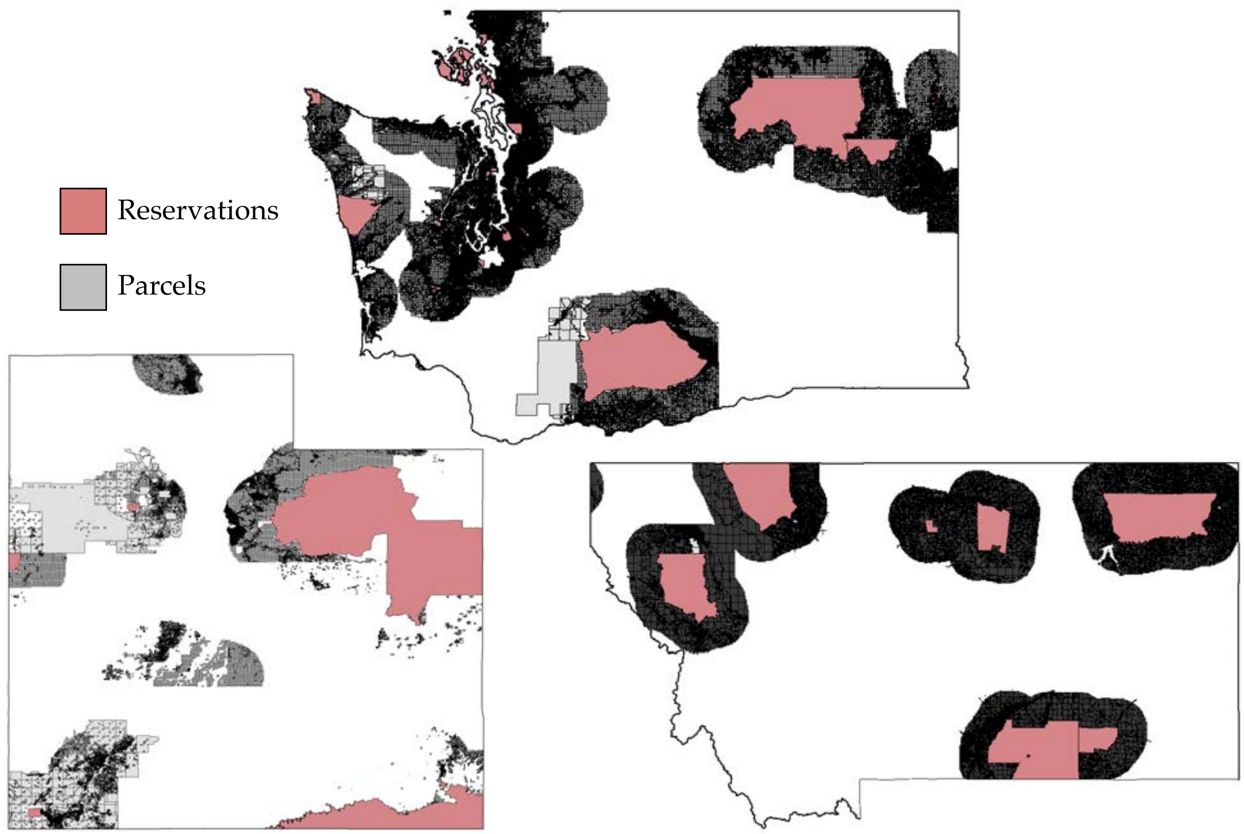
Appendix F.2 Land Values

County assessor data are normally published at the county-level, and tend not to be available in counties that are close to, or overlap with, reservations. Fortunately, Montana, Utah and Washington are the exception to this rule in that of each makes the state-universe of assessed properties available.[40] What is more, these three states are home to a combined total of 55 reservations (representing nearly half our main sample of reservations that were ever allotted), and they represent a broad spectrum of distinct land markets with varying degrees of development and agriculture. To make the comparison as relevant as possible, we restrict our attention to parcels within 10 or 25 miles of reservations. The choice of 10 or 25 miles presents a trade-off: lands closest to the reservation likely form the best comparison group in terms of unobservables, but land values in the most restrictive samples are likely dominated by the effect of the reservation itself.[41] Figure A15 depicts the set of parcels used for this analysis. After excluding tax-exempt land we are left with roughly 1.7 million individual properties for which we know both land utilization Z(Use) and *land values per acre* (LVPA). We estimate the following linear regression model: $ln(\text{LVPA}_{ij}) = \sigma \times Z(Use)_i + \kappa_j + \lambda' X_i + \varepsilon_{ij}$, where the outcome is the natural log of the land value per acre for property i, κ_j is our preferred 1/9-township fixed effects, and $Z(Use)_i$ is the same standardized land utilization index as before.

[40] These data include individual property boundaries with valuations for the most recent tax year.

[41] Somewhat surprisingly, in Montana land just outside reservations is more valuable than land a little further away from reservation boundaries. This is explained by Montana reservations' proximity to amenities like Glacier National Park, Flathead Lake, and several ski resorts. Washington and Utah exhibit the more expected pattern of lower land values closer to reservations. In Washington, expanding to a larger distance can mean including highly valuable properties within the Seattle metropolitan area.

Figure A15: Assessor Data Properties



Notes: This figure depicts assessed properties (grey) and reservations (pink) in Montana, Utah, and Washington State; 3 states that together have 55 reservations. We include parcels that satisfy two criteria: i) they are in reservation-adjacent counties, and ii) they are within 25 miles of a reservation. Large, un-subdivided grey areas are government-owned property that we exclude from the estimation sample.