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PROPERTY RIGHTS WITHOUT TRANSFER RIGHTS:
A STUDY OF INDIAN LAND ALLOTMENT

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ABSTRACT

Governments sometimes place restrictions on the transferability of property rights to prevent the property's owners from making "mistakes" such as selling their property under value. Such restrictions have often been applied to poor and indigenous communities around the world. The potentially high cost of such transfer-restrictions is that they limit or even eliminate the property's value as collateral in credit markets. We investigate this cost 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 plots to neighboring plots held without transfer restrictions using fine-grained satellite imagery to study differences in land development and agricultural activity from 1974–today.

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1 Introduction

Government programs that formalize the property rights of the poor often include paternalistic 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, such property rights are called *usufruct*, i.e. owners can use their property and enjoy its "fruits", and their title may well be perfectly secure, but they cannot transfer or alienate their property (Rose-Ackerman 1985, Ellickson 1993, Alston, Alston, Mueller, and Nonnenmacher 2018, ch2-3). Usufruct property rights are particularly common among indigenous peoples, who have historically been viewed as needing protections from making "mistakes" with their property.[1] 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.[2]

Such transfer restrictions may have been well-justified at one point in time. Many government programs that granted property rights to poor indigenous communities were passed by political coalitions of Yandle's proverbial "bootleggers and baptists," and the "baptists," may correctly identify a need to protect newly created property owners from the "bootleggers," in our case land-hungry white settlers. In the long run, however, such transfer restrictions come at a heavy price: non-transferable property is non-collateralizable property, and a lack of collateralizability may well be the single biggest impediment to wealth creation for the global poor (De Soto, 2000; Besley, Burchardi, and Ghatak, 2012).

To investigate the long-run consequences of limits on transfer rights, we leverage a natural experiment that resulted from the policy of land 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," while neighboring households own land under full fee-simple property rights. We map the universe of historic land allotments from the *Bureau of Land Management* (BLM) to the *Public Land Survey System* (PLSS)

[1] Mistakes are in apostrophes because it is rarely clear exactly when a voluntary transaction is a mistake.

[2] 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)

grid, and from there to high-resolution satellite data from the *National Wall-to-Wall Land Use Trends Database* (NWALT) to compare land use on plots with different land titles.

Indian allotment 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 1887 Dawes Act, and accelerating after the 1906 Burke Act. All land rights were first issued 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 the policy run its course, all reservations would have eventually been allotted, and all allottees would have eventually obtained their land rights in fee simple. However, the 1934 IRA put an abrupt stop to this, ending all allotment for good, and freezing all allotted-trust plots into trusteeship in perpetuity.[3] This created a patchwork of land tenures on reservations that persists today.

Endogeneity problems in the comparison of "allotted-trust" lands and fee-simple lands on reservations arise from the fact that allotments were selectively converted into fee simple. There was the potential for both selection on land characteristics (plots with certain characteristics getting converted at a higher rate), and selection on the unobserved characteristics of the original allottees (allottees with certain characteristics having their plots converted to fee simple at a higher rate). To address selection, we compare plots only inside neighborhoods that are small enough to make all observable differences in land characteristics disappear.

We also 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. Our first instrument is an allotment's issuance year, which—within a reservation—is fully explained by the original allottees' birth-year because all men and older children received their allotments simultaneously when a reservation was first allotted. Young children and the unborn received their allotments in later waves, and were less likely to ever see their allotments converted to fee simple because of the program's abrupt end in 1934. The instrument's exclusion restriction is that the birth-year of the original allottee has no direct effects on *long-run* land use of their heirs eighty to one hundred years later. We construct a second instrument based on the identity of the

[3] 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).

exogenously rotating BIA allotting agents on each reservation at different times. To this end, we coded up a complete reservation-year panel of the BIA agents who decided on conversion to fee simple on individual reservations. Our core finding is that fee-simple property rights increase land use by around 0.5 standard deviations.[4]

The NWALT satellite data exist in five decadal waves (1974, 1982, 1992, 2002, and 2012), allowing us to pursue another approach to statistical identification where we include individual plot fixed effects which absorb all unobserved differences in invariant characteristics (of both the land and the original allottees). Using the panel fixed effects model, we find that the gap between fee-simple and allotted-trust land grew monotonically over 1974—2012. We also use the panel to separately explore land development and agricultural cultivation. Land development is of special interest because it is (*i*) much less likely than agricultural cultivation to be endogenous to any 1887–1934 differences in land and allottee characteristics; and it (*ii*) best captures the process of structural transformation away from agriculture and into manufacturing, tourism, and services that occurred on reservations since 1974 (Cornell and Kalt 1992, Jorgensen 2007, Treuer 2012, ch6). We find that there was no difference at all in land development in 1974, implying that the entire difference in 2012 is driven by subsequent divergence. This contrasts sharply with agricultural use, for which over eighty percent of the 2012 difference was already present in 1974.

While our focus is on comparing allotted-trust land to fee-simple land, we also extend the analysis to include tribally owned land, which still constitutes the majority of all reservation lands today. In the cross-section, land utilization on tribally owned plots is a lot more similar to allotted-trust plots than to fee-simple plots. In the panel, however, development on tribally owned land increased over time relative to allotted-trust land at the same rate of divergence as fee-simple land, suggesting a considerably more positive dynamic land utilization trajectory on tribally owned land than on allotted-trust land.[5]

There are two primary channels through which transfer-limitations affect land use on reservations, one is obvious and direct, the second is a less obvious indirect and longer-run channel. The direct channel is the well-known "de Soto effect" that non-collateralizable property does not

[4] Our findings are robust to various forms of spatial correlation, including clustering by PLSS township, reservation, or those 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.

[5] This is consistent with Aragón and Kessler (2020), who find that tribal land on Canadian reserves is only slightly less efficiently used than land under private 'certificates of possessions'.

give its owner the access to credit needed to make investments. This is a major problem on reservation trust-land (Community Development Financial Institutions Fund, 2001). The indirect and less obvious channel is that in the long run, transfer-limitations create highly fractionated interests over the same plot, which create large transaction costs as we explain in Section 2. We find evidence that both channels are driving the negative effect of allotted-trust property rights on land utilization.

Finally, 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 estimated correlation between land utilization using county assessor data for reservation-adjacent parcels. This exercise suggests that fee-simple title adds between $973 and $4,765 in value to an acre of land, or between $156,000 and $762,000 to a 160-acre plot.

Our paper is of first-order relevance to Native American economic development and to indigenous development. Our results are in line with a range of studies suggesting that more complete property rights would improve economic outcomes for indigenous communities (Trosper, 1978; Johnson and Libecap, 1980; Libecap and Johnson, 1980; Anderson and Lueck, 1992; Anderson, 1995; Alcantara, 2007; Dippel, 2014; Leonard, Parker, and Anderson, 2020). Our study contributes to this literature 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, 2020), and Uintah and Ouray in Utah (Ge, Edwards, and Akhundjanov, 2019).

Our results indicate that conversion to fee simple would generate the biggest economic efficiency gains on allotted-trust plots. The alternative of returning allotted trust to tribal control may, however, 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 ownership would would be preferable to keeping land in allotted trust, but that (*b*) the choice of which (if either) path to pursue must be the individual tribes'. In the conclusion, we discuss the trade-offs and legal obstacles involved in these two choices.

Our paper complements a large literature on land tenure and economic development. The focus of this literature has been on property rights *security*, (Alston, Libecap, and Mueller, 2000; Banerjee, Gertler, and Ghatak, 2002; Goldstein and Udry, 2008; Besley and Ghatak, 2010; Hornbeck, 2010), and the nexus of security of title and collateralizability plays an important role in it (De Soto, 2000; Besley et al., 2012). Non-transferable usufruct land rights have also been studied in this literature in the context of West Africa, and have been found to lead to under-investment in land. However, the mechanism there is not credit-access; instead, investments in land are under-incentivized because land can be seized by tribal chiefs or is by default returned to them after an owner's passing (Migot-Adholla, Hazell, Blarel, and Place, 1991; Besley, 1995; Goldstein and Udry, 2008). Our results imply that secure title may not be sufficient to avoid the "de Soto effect" if rights are not transferrable.

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).[6] 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).[7] 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 deemed appropriate (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 concurrence 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 was reflected in Teddy 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*

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

[7] 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).

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.[8] 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 before allottees could eventually be granted full (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 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:[9] "*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). 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 unallotted land. Small differences remain on

[8] 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.

[9] 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.

these dimension even within small geographic neighborhoods; suggesting some positive selection of the land by either allottees or allotting agents or both.[10]

Selection into Fee Simple: The more important question for our study, which principally compares different types of initially-allotted plots, is whether those plots that local BIA agents ended up converting to fee simple were different from 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, given the alleged racism and corruption in the process, the latter is equally possible because BIA agents may have wanted to retain the more valuable plots in trust so that they could control and administer their proceeds. 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 Native Americans' 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 fact, this is exactly what McChesney's 1990 account of the BIA's handling of allotment argues. 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. McChesney (1990) suggests a different reason: he explains allotment through the lens of a Peltzman-style model in which the BIA acted as a self-serving bureaucracy that ended the process of allotment to maintain its own budget and relevance as a trustee of the land (Peltzman, 1976). Either way, in 1934 the Commissioner of Indian Affairs, John Collier, introduced the Indian Reorganization Act (IRA),

[10] See Panel A in Appendix-Table A4.

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 Non-Collateralizability: 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 a consequence, they cannot collateralize or mortgage their lands to obtain capital. This gives rise to the well-known "de Soto effect," the difference being that on reservations it is caused by *non-transferable* rather than *insecure* property rights (Community Development Financial Institutions Fund, 2001). Aside from dramatically decreasing access to capital, this also creates distortions; e.g. 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 any more than the land itself (Treuer, 2012; Feir and Cattaneo, 2020).

Transfer Restrictions and Interest-Fractionation: The second, and less obvious cost created by the non-transferability of property rights is the fractionation of ownership. To understand how this occurs, one starts with the observation that most property everywhere in the U.S. was historically bequeathed without a will, meaning that it was common for multiple heirs to have a claim on it. On property with full transfer rights, this issue is easily resolved: heirs either simply 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 the heirs are stuck sharing the property in "equal undivided interest." 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 is common heirship into *divided* interests, which would not result 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. Such is the case in India today, and was in most of continental Europe in the 19th century (Libecap and Alter, 1982; Foster and Rosenzweig, 2011, 2017).

This interest-fractionation tends to proliferate over time as each heir may have multiple heirs themselves. 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 $.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 any better after 1987; for instance, Russ and Stratmann (2014) show that fractionation doubled from 1992 to 2010. There have since been some improvements due to the Cobell settlement of 2014, which we discuss in the conclusion.

3 Data Sources

Allotment data: Following approval from the President, each patent issued on the 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 exact 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.[11] 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).[12] Of the universe of allotments with a potentially matchable aliquot part variable in our data, we successfully matched 97.7% to quarter sections in the PLSS using a shapefile from the BLM.[13]

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.[14] Eastern Oklahoma was covered by reservations for the 'Five Civilized Tribes' (the Cherokee, Chickasaw, Choctaw, Creek, and Seminole) who had been relo-

[11] 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.

[12] If land was aggregated over time, it is possible that multiple plots in our data comprise a single farm or ranch. However, Holmes and Lee (2012) demonstrate that agricultural land use decisions are most often made at the level of a 40-acre "field" and can vary substantially within a farm. This implies such aggregation would be largely irrelevant to outcomes. Moreover, common ownership of comparison fee-simple and allotted-trust plots should bias estimates toward zero because single owners could conceivably pool their resources across both types of land, suppressing the potential drag of non-transferability.

[13] 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.

[14] 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.

cated 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.[15] 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 (over 120 can be seen on Pine Ridge). Unshaded areas mostly represent tribally owned land, but there is also a small amount of surplus land that was made available to white settlers. We are able to identify all surplus land and always omit it from our analysis.[16] 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 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 LandSat 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.[17] These two measures — development and cultivation — comprise the majority of "productive" uses of land that may be affected by restrictions on transferability.[18] Developed pixels in NWALT reflect capital investments in the construction of durable structures that may be as-

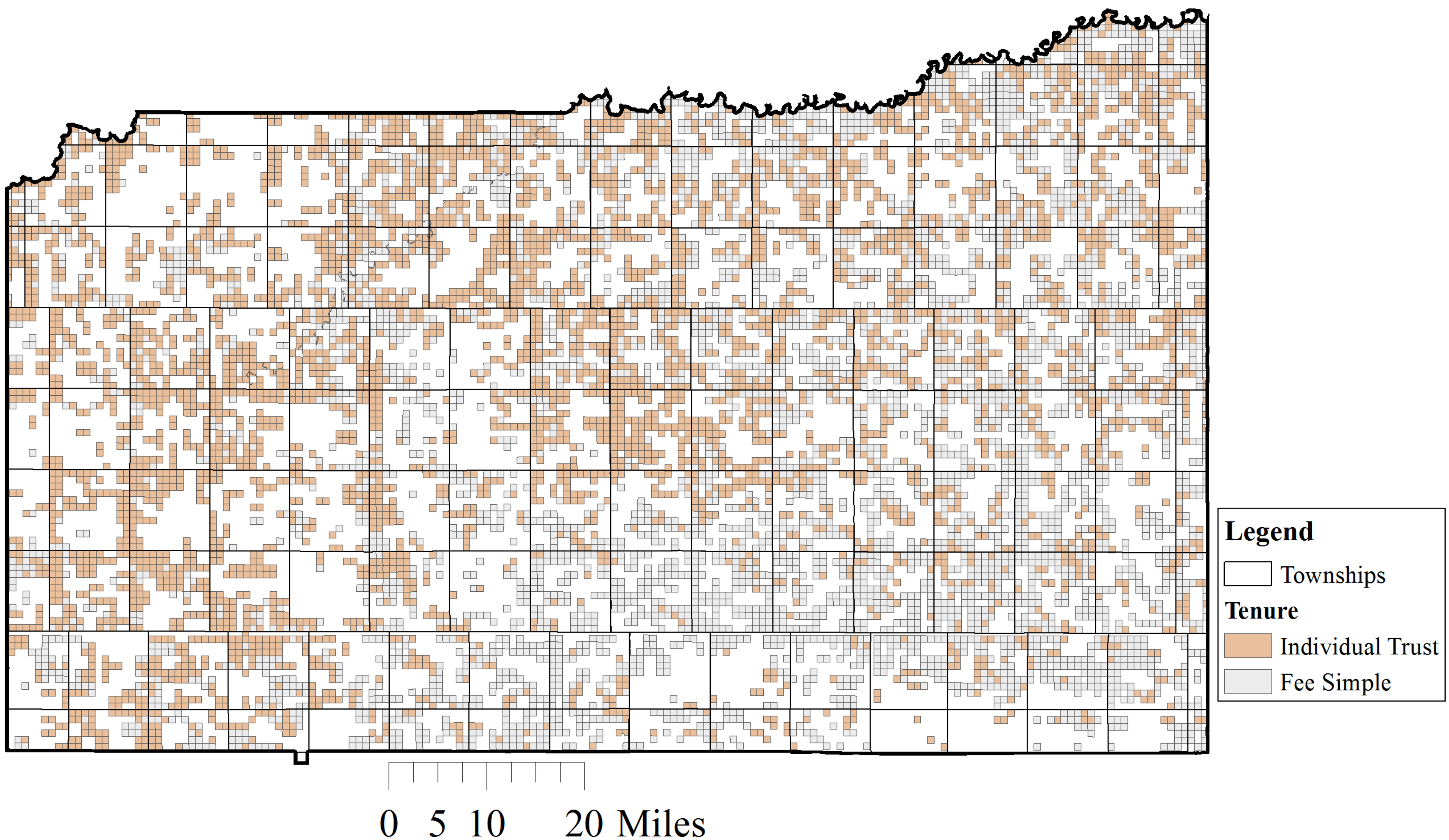
[15] To simplify the analysis, we focus on plots which are matched to either all fee simple or all allotted trust, but not a mix. We also omit observations that converted from allotted-trust to fee-simple title after 1934, a rare occurrence that required special approval from the Secretary of the Interior. (See footnote 3).

[16] Appendix-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 8 and reference to Appendix-Figure A1.

[17] 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.

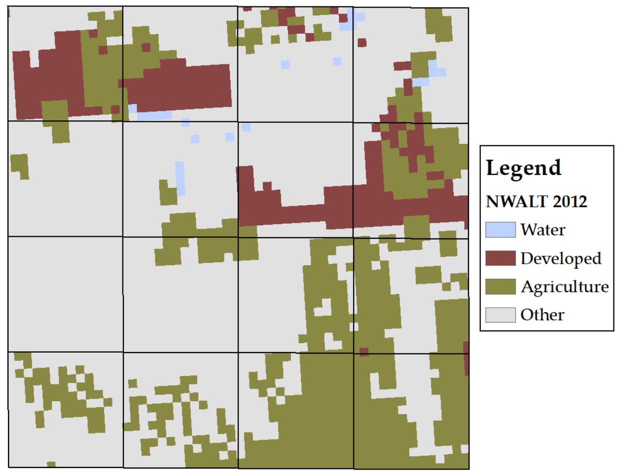
[18] Another productive land use is extraction of natural resources such as coal or oil, but this is highly dependent on the location of valuable deposits.

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 it 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.

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-plots 2×2-mile neighborhood depicted here is our favored fixed effect, and corresponds to panel (c) of Figure 3. Light blue color shading indicates water, which plays no role in our empirics: the denominator of each parcel's share-variable is land only. (In black & white print, water is indistinguishable from 'other'.)

sociated 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 depicts our coding of land use from the NWALT data on a subset of the Pine Ridge reservation. The figure depicts four PLSS sections comprised of sixteen individual 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. The top panel of Appendix-Figure A5 shows the most fine-grained version of the NWALT data, which breaks the 'other' category into its sub-categories. The bottom panel of the same figure depicts the *National Land Cover Database* (NLCD) data for the same four sections. The NLCD data have slightly higher resolution than NWALT, but are only available from 2001, whereas NWALT is available from 1974. We use the NLCD data for robustness checks on the main results.

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 do 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 presents our core cross-sectional results. Section 4.1 discusses how we use fine spatial fixed effects to address concerns about spatial selection that could have affected the historical conversion of allotments from trusteeship to fee simple. Section 4.2 presents the baseline results. Section 4.3 presents an IV strategy that addresses remaining selection concerns arising primarily from unobserved allottees' actions and characteristics which have played a role in the BIA agents' historical decision to covert trust land into fee simple.

4.1 Baseline Identification Strategy

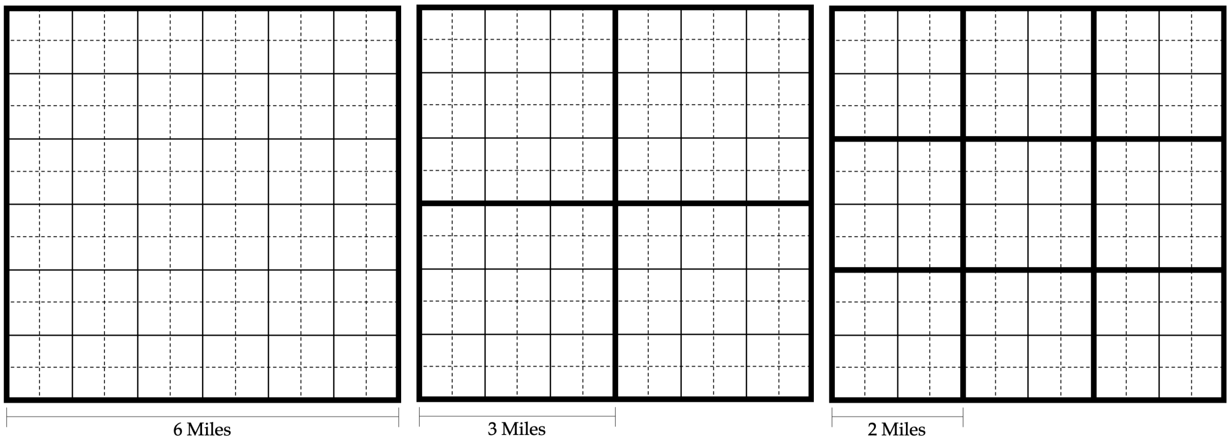
We estimate the effect of tenure on land utilization, using the following linear regression model

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

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 this is to choose the spatial neighborhood κ_j within which we observe land characteristics X_{it} becoming 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.

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 the fixed effect in Panel (c) corresponds to the 16 plots depicted in Figure 2.

Table 1: Summary Statistics

	(1)	(2)	(3)	(4)	(5)	(6)
Z(Use)	0.000	0.733	0.733***	0.385***	0.291***	0.216***
	[1.00]	[3.11]	(0.114)	(0.052)	(0.050)	(0.049)
Share Developed	0.830	1.971	1.141**	0.419***	0.255*	0.088
	[5.40]	[9.55]	(0.364)	(0.157)	(0.120)	(0.131)
Share Cultivated	11.177	28.188	17.011***	7.649***	5.721***	4.455***
	[26.67]	[36.44]	(2.304)	(1.117)	(0.959)	(0.806)
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				
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 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1 presents means and standard deviations 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 brackets.[19] The unconditional differences reported in column 3 of Table 1 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).[20] 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. Even finer 1×1-mile spatial fixed effects also deliver balance across observable land characteristics, but we lose almost 10,000 observations to singletons due to having only one allotted plot within a 1×1-mile neighborhood.

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.

4.2 Baseline Results

Table 2 presents our baseline results. Columns 1–2 use the township fixed effects from column 4 of Table 1, columns 3–4 use the 1/4-township fixed effects from column 5 of Table 1, columns 5–6

[19] 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 comparison (Office of Indian Affairs, 1935).

[20] Both elevation and ruggedness are expressed in 1,000s of meters in our regression models for notational convenience.

use the 1/9-township fixed effects from 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 ($\frac{0.385-0.335}{0.385}$), with 1/4-township fixed effects, adding geographic controls reduces $\widehat{\theta}$ by around eight percent ($\frac{0.291-0.269}{0.291}$), and with 1/9-township fixed effects, adding geographic controls does not reduce $\widehat{\theta}$ at all.

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

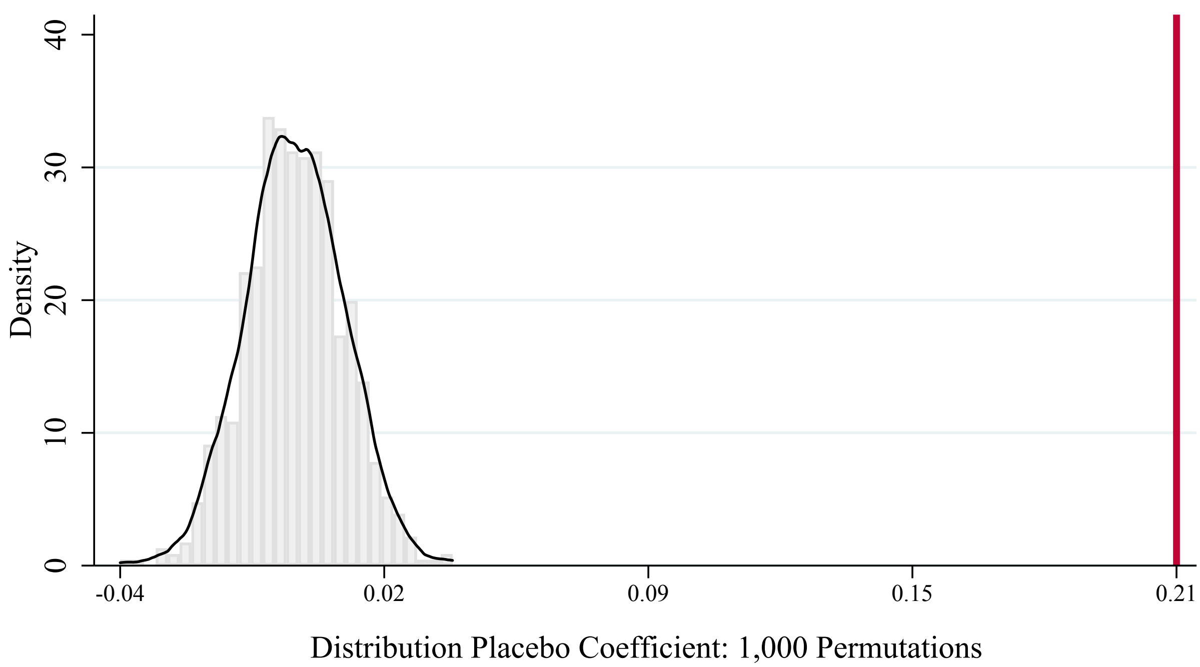
	(1)	(2)	(3)	(4)	(5)	(6)
Fee Simple	0.385***	0.335***	0.291***	0.269***	0.216***	0.214***
	(0.052)	(0.045)	(0.050)	(0.048)	(0.049)	(0.050)
Ruggedness		-6.670**		-8.289**		-8.192***
		(2.848)		(3.264)		(2.677)
Elevation		-1.687***		-1.111**		-0.939*
		(0.331)		(0.422)		(0.505)
Soil Quality		57.895***		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
Oster's Delta		0.1075		0.1213		0.8938
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 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

To get a more formal sense for potential selection on unobservables in the full and matched sample, we report Oster's δ in the bottom of the table. This parameter measures how large the bias from unobservables would have to be relative to bias from observable land characteristics to imply a true value of $\theta = 0$ (Oster, 2019). Reassuringly, δ increases considerably from column 2 to 4 to 6. As a further robustness check, Appendix-Table A1 replaces linear controls for geographic characteristics with flexible non-parametric ones; this slightly reduces $\widehat{\theta}$.

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: Permutation Tests



Notes: The figure shows the distribution of 1,000 coefficients from placebo 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 rule out spuriously correlated effects through a permutation test, replacing the actual over $26,000$ fee-simple plots with an equal number of randomly drawn plots, and then re-estimating 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.

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.

4.3 IV Strategy

A remaining challenge that is not addressed by spatial fixed effects 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. We address this concern with an IV strategy that uses allotments' issuance year as an instrument, based on the logic that all allotments had to be held in trust for a certain period, so that earlier allotments were more likely to have been converted into fee simple when the program ended in 1934. The date of initial issuance is not itself endogenous because, within a reservation, *all* allotments to adults and orphans above a minimum age were issued at the same time. Variation in issuance dates within a reservation therefore comes solely from the fact that additional allotments were later issued to cohorts that were not yet alive during the initial wave (Meriam, 1928). The instrument's exclusion restriction is that the birth year of the original allottee has no direct effects on *long-run* land use of their heirs eighty to one hundred years later.

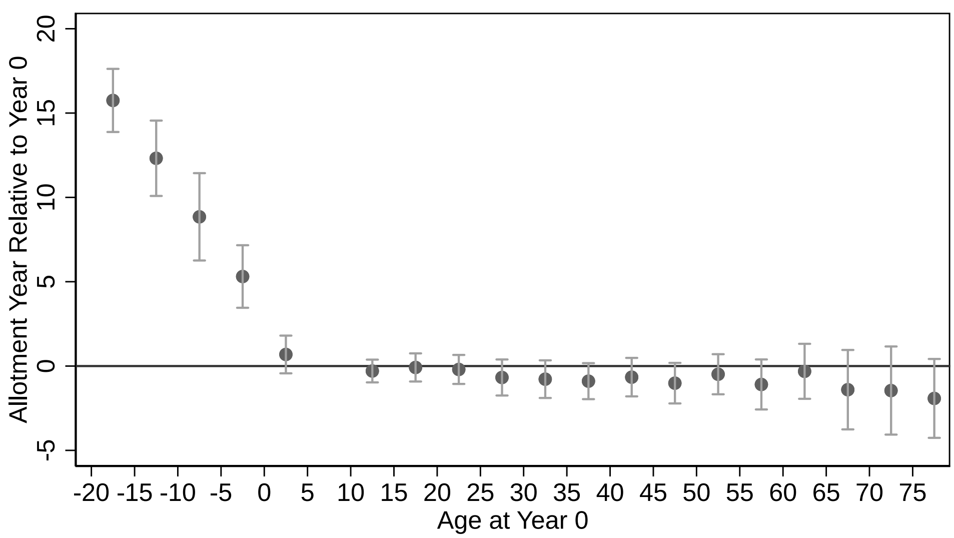
We first verify our claim that within a reservation issuance year is explained by birth year. To be able to attach an allottee's characteristics like birth year to an allotted plot, we digitized an additional data source called the *Indian Census Rolls* (ICR). The ICR were censuses collected by the BIA 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.[21] 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.

[21] We discuss the ICR in more detail in Appendix D.1.

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.[22]

For each reservation, we define 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 5 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 birth-year, so that the exclusion restriction is that the birth-year of an original allottee has no direct effects on their heirs' land utilization eighty or a hundred years later.

Figure 5: Allotments' Issuance year is Explained by Allottees' Birth-Year



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.

A natural concern is that issuance year may be correlated with land characteristics, particularly

[22] This effects the number of observations used to generate Figure 5, but does not affect our IV estimates based on issuance year, which we observe directly from the patent data.

that earlier allotments may have occurred on better land. Columns 1 through 3 in Panel A of Table 3 report the correlation between allotment year and each of the three geographic controls within 1/9-township fixed effects. Consistent with our concern, later allotments are more rugged, at higher elevations, and have worse soil. Although the differences are small, they are statistically significant within our preferred 1/9-township fixed effects.

It follows that our identification strategy therefore relies on a *conditional on controls* exogeneity argument: we assume that all differences in land characteristics correlated with allotment year will be absorbed by the inclusion of geographic controls within 1/9-township fixed effects. We will validate this assumption in what follows, but before doing so, we estimate the first-stage relationship

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

whose results are reported in columns 4 through 6 of Table 3. Column 4 includes only 1/9-township fixed effects, column 5 includes linear geographic controls, and column 6 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. Importantly, the first-stage coefficient on issuance year is very stable across columns 4–6. This suggests that the observed weak correlation between allotments' land characteristics and issuance year is not likely to invalidate issuance year as an instrument.

To further confirm the validity of our IV approach, we introduce a second instrument. This second instrument lacks sufficient power to be used as a stand-alone instrument, but it is uncorrelated with land characteristics, and it adds enough predictive power to perform over-identification tests to confirm the validity of our main instrument. This 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.[23] We construct a duration panel that tracks each allotment from its issuance year until it is either converted to fee simple, or up to 1934 IRA. An

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

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.

Table 3: **Instruments:** Correlation with Land Characteristics, and First Stage

Panel A:	Ruggedn.	Elev.	Soil Q.	Fee Simple		
	(1)	(2)	(3)	(4)	(5)	(6)
Allotment Year	0.000***	0.000**	-0.000*	-0.018***	-0.018***	-0.018***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)
Ruggedness					0.536*	
					(0.277)	
Elevation					0.068	
					(0.064)	
Soil Quality					-0.338	
					(0.842)	
Adj. R^2	0.9204	0.9953	0.8421	0.6118	0.6119	0.6124
Panel B:	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)
Z_i	0.001	-0.004	-0.000	0.318**	0.318**	0.317**
	(0.001)	(0.003)	(0.000)	(0.128)	(0.128)	(0.127)
Adj. R^2	0.9203	0.9952	0.8423	0.6126	0.6127	0.6131
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: 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 expression (4). Columns 4–6 report on the first stage results of regressing an allotment's fee-simple status on the instruments Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Consider the following duration-style regression

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

where $t - \tau_i$ 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.[24] The key exogenous component in equation (3)

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

are the agent fixed effects $\widehat{\mu_{j(rt)}}$. Our identification strategy is thus akin to the strategies used in the 'judge fixed effect' literature.[25] For this strategy's validity, the BIA agents needed to have sufficient discretion for their idiosyncratic preferences matter, and the assignment of BIA agents to reservations should not have been endogenous to reservations' characteristics. These assumptions are discussed and validated in Appendix D.3, where we also provide some case studies of Indian agents with differing propensities to convert land to fee simple. 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 between its issuance in year τ and the year 1934:

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

Columns 1 through 3 in Panel B of Table 3 show that the second instrument Z_i is uncorrelated with land characteristics within 1/9-township fixed effects. Columns 4 through 6 add "$\alpha_2 \times Z_i$" into the estimation of the first-stage equation (2).[26] The estimated Z_i is indeed highly predictive of conversion to fee-simple ownership. We recognize that the first instrument, issuance year, also plays a role in the construction of the second instrument, but there nothing econometrically wrong with this so long as the *Kleibergen-Paap F statistic* for weak instruments is high enough, which it

[25] See, for example, Kling (2006); 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*.

[26] 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).

comfortably is.

Table 4: 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
Geographic Controls		Linear	Binned		Linear	Binned
p-value Hansen J stat				.2667	.2735	.2759
Kleibergen-Paap F stat	86.42	87.33	86.79	43.28	43.73	43.46

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 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4 reports on the two-stage least squares estiamtion 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. We view the IV estimate in column 6 of Table 4 as our preferred causal estimate, which suggests that full fee-simple property rights causally lead to about 0.48 standard deviations higher land utilization.

5 Extensions and Mechanisms

In this section, we pursue several extensions to the comparison of fee-simple and allotted-trust land: (*i*) we investigate the evolution of the effect of property rights on land use over time (1974–2012), for the land utilization index and also broken down by land development versus agricultural cultivation separately; (*ii*) we present evidence that non-transferable property rights indeed affect land utilization via the underlying mechanisms of credit access and ownership fractionation; (*iii*) we investigate land use on tribally owned (i.e. unallotted) lands; (*iv*) we develop a back-of-the-envelope estimate of the effect of trusteeship on land *values*.

Evolution of land uses over time (*i*): The waves of NWALT data from 1974–2012 allow us to examine the dynamic evolution of development on allotted-trust vs. fee-simple land. We begin by estimating the following equation

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

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.

A major 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 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. $\hat{\tau}_t > \hat{\tau}_{t-1}$). This pattern remains robust to the plot fixed effect specification in column 2. As points of reference, $\hat{\gamma} + \hat{\tau}_{2012} + \hat{\gamma}_{2012} = 0.116 + 0.07 + 0.102 = 0.288$ 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 is approximately the OLS estimate in column 5 of Table 2.

Table 5: Effect of Tenure on Development Over Time

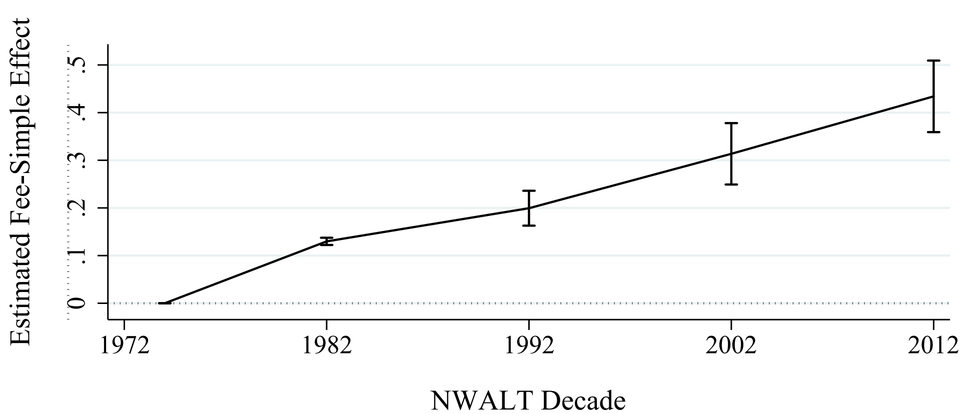
	Z(Use)		Development		Cultivation	
	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{\gamma}$: Fee Simple	0.116***		-0.098		3.593***	
	(0.016)		(0.076)		(0.224)	
$\hat{\gamma}_{1982}(FeeSimple_i \times \tau_{1982})$	0.039***	0.038***	0.132***	0.130***	0.179***	0.151***
	(0.002)	(0.002)	(0.007)	(0.003)	(0.030)	(0.005)
$\hat{\gamma}_{1992}(FeeSimple_i \times \tau_{1992})$	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: $\hat{\gamma_{1982}} = \hat{\gamma_{1992}}$	.0000239	.1102	1.560e-08	.003362	2.373e-10	.0002775
p-value: $\hat{\gamma_{1992}} = \hat{\gamma_{2002}}$	1.820e-09	.0003392	1.330e-08	.0003595	2.843e-10	.001095
p-value: $\hat{\gamma_{2002}} = \hat{\gamma_{2012}}$	1.352e-12	.00001322	2.366e-09	7.563e-06	4.681e-09	3.477e-06
Trust Land's 1974 Share Developed			.6179	.6179		
Fee Land's 1974 Share Developed			1.33	1.33		
Trust Land's 1974 Share Agricultural					10.33	10.33
Fee Land's 1974 Share Agricultural					27.13	27.12

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). Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In column 3–6, we explore the extent to which fee-simple rights have differentially affected development vs. agricultural land use over time. As we discuss in Appendix E.1, 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 pattern of structural transformation well-known from other contexts.

The dependent variable in columns 3 and 4 is the share of a plot with developed land in year t. This can measure a manufacturing plant, a ranching stable, a 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, but column 5 shows a significantly higher share of agricultural land on fee-simple parcels in 1974. 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. 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 $\hat{\tau}_t > 0$, 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.

Figure 6: 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

Figure 6 plots the coefficient estimates from column 4 of Table 5 to depict the decade-on-decade changes in development on fee-simple land. The figure highlights that the divergence between fee-simple and allotted-trust land was least pronounced in the 1980s, consistent with the generally lower economic opportunities during that period, which we discuss in Appendix E.1 around Appendix-Figure A8.

The two proposed mechanisms (*ii*): Throughout the paper, we posit that allotted-trust land suffers from two related but distinct problems: the first is the well-known "de Soto effect" that non-collateralizable property undermines credit access; the second, indirect and longer-run, channel is that non-transferable property cannot go through probate which, over generations, creates severe land fractionation. To provide at least some evidence for both, we turn to additional data sources that allow us to measure credit access and fractionation at the reservation level. All evidence we provide in this section is suggestive and not causal.

Credit access is an issue on all reservations, and even the owners of fee-simple land still face significant practical hurdles in obtaining loans because most commercial banks simply do not provide loans to reservation residents and businesses (Anderson and Parker, 2008). However, this credit gap is increasingly being filled by more specialized banks and credit unions that are either headquartered on reservations or designed to primarily serve American Indians (Feir and Cattaneo, 2020). We hypothesize that the ability to use land as collateral only leads to differences between allotted-trust and fee-simple landowners when there are *any* institutions willing to make loans to reservation residents and businesses. To test this, we obtain data on these specialized financial institutions and their geo-location from the Federal Reserve's Center for Indian Economic Development (CIDC).[27] We overlay this location information with current reservation boundary maps to match financial institutions to specific reservations.

For the second mechanism, we conjecture that the relative benefits of fee-simple ownership will be larger on reservations with the more severe fractionation on allotted-trust plots. To test this hypothesis, we utilize a 2013 BIA report that provides information on various dimensions of fractionation (Department of Interior, 2013). For each reservation, we know the total number of fractionated interests and the number of parcels held in trust.[28] From this we calculate the average number of interests per parcel and construct an indicator variable D(Highly Fractionated) that is equal to one for reservations that have greater than the median number ($= 15$) of interests/claims per parcel.

[27] https://www.minneapolisfed.org/indiancountry/resources/mapping-native-banks

[28] In some cases, there are multiple parcels per quarter section because some land was given out in 40- and 80-acre allotments. See Section 2.

Table 6: **Mechanisms:** Credit Access and Land Ownership Fractionation

	(1)	(2)	(3)	(4)	(5)
Fee Simple	0.112***	0.113***	0.135***	0.074*	0.096***
	(0.017)	(0.023)	(0.025)	(0.041)	(0.030)
Fee Simple × D(Bank in Rez)	0.160**			0.136**	
	(0.079)			(0.067)	
Fee Simple × D(Bank within 10 Miles)		0.134*			0.086*
		(0.072)			(0.051)
Fee Simple × D(Highly Fractionated)			0.131	0.098	0.093
			(0.086)	(0.073)	(0.080)
Adj. R^2	0.5057	0.5056	0.5056	0.5057	0.5056
Observations	61,286	61,286	61,286	61,286	61,286
#Fixed Effects	9,757	9,757	9,757	9,757	9,757
Geographic Controls	Binned	Binned	Binned	Binned	Binned
1/9 Twnshp Fixed Effects	Yes	Yes	Yes	Yes	Yes

Note: This table interacts the core regressor or interest with measures of a reservation's access to credit and the measured degree of its ownership fractionation problem. Standard errors are clustered at the reservation level. Significance levels are denoted by * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6 reports the results of regressions where we interact the fee-simple indicator with measures of bank access and with D(Highly Fractionated). We recognize that both interactions are only reservation-aggregates and are furthermore potentially endogenous. The following regression results should therefore be seen as suggestive evidence for our proposed channels rather than as causal estimates. Columns 1 and 2 use two different measures of banking access, i.e. wether there is a bank on or near the reservation. Column 3 focuses on fractionation, and columns 4 and 5 include both banking and fractionation together. All results are consistent with our hypotheses: columns 1 and 2 indicate that the effect of fee-simple property rights is more than twice as large on reservations that have access to American Indian banking institutions, based on either measure (having a bank on or within 10 miles of a reservation); column 3 indicates that the fee-simple effect is substantially larger on reservations where trust land is highly fractionated, although the effect is marginally statistically insignificant.

Tribally owned land (*iii*): 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 to 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 headline results here. As discussed in Section 2, Panel A in Appendix-Table A4 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 A5 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.

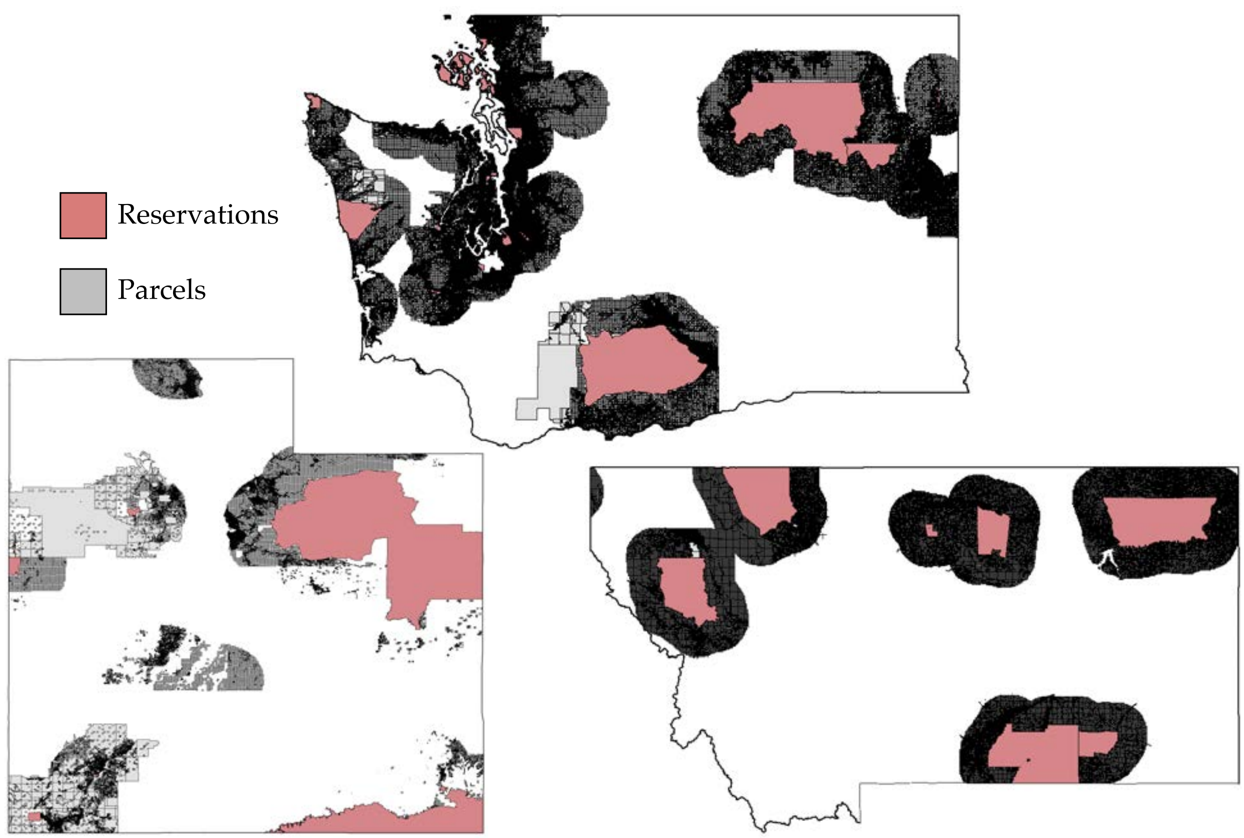
In the panel, Appendix-Table A6 shows that in 1974, tribal lands had about the same (low) level of development as allotted-trust lands and fee-simple lands. In column 5 of that table, tribal plots and fee-simple plots have about the same positive agricultural land-use difference relative to allotted-trust 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.

Estimating the effect of property rights on land values (*iv*): In this section, we develop a back-of-the-envelope estimate of the impact of trusteeship on land values, using county assessor data of property valuations. County assessors often do not value allotted-trust land because it is not transferable and not taxed; even fee-simple land on reservations is rarely assessed in a consistent way.[29] Any hypothesized negative effect of allotted-trust status on land values can therefore only be constructed *out of sample* as a counter-factual. To construct this counter-factual, we combine the NWALT satellite imagery on land utilization Z(Use) with county-assessed data on land values per acre (LVPA) to estimate the correlation between the former and the latter *immediately adjacent to* reservations. We then multiply these off-reservation estimates $\frac{\partial \text{LVPA}}{\partial Z(Use)}$ with the estimated effect $\widehat{\theta}$ of fee simple on land utilization to construct our object of interest $\frac{\partial \text{LVPA}}{\partial \text{FeeSimple}}$.

County assessor data are normally published at the county-level, and tend not to be available

[29] 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.

Figure 7: 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.

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.[30] 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.[31] Figure 7 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 effect of land utilization on 2019 land values at the property level using the following linear regression model

$$ln(\text{LVPA}_{ij}) = \sigma \times Z(Use)_i + \kappa_j + \lambda' X_i + \varepsilon_{ij}, \tag{6}$$

where $ln(\text{LVPA}_{ij})$ 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 standardized land utilization measure discussed in Section 4.[32] The coefficient of interest is σ, which reflects the percentage increase in land value per acre for a one-standard-deviation increase in the land utilization measure for property i. For the purposes of our back-of-the-envelope calculation, the estimated $\hat{\sigma}$ should be viewed as a transformation-factor rather than a causal effect, because land values and land utilization in equation (6) are largely jointly determined: higher land use Z(Use) generates more economic activity, and the corresponding higher land values largely approximate the net present value of this increased activity.

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

[31] 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.

[32] We calculate NWALT land use as well as land characteristics for each property in the same way that we do for quarter-section plots on reservations.

Table 7: 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 $\hat{\sigma}$ obtained from estimating equation (6), and the Median(LVPA) in the 10- or 25-mile radius of a reservation.

Table 7 presents our estimates of $\hat{\sigma}$ across three states and two samples (10 vs. 25 miles). Across nearly all samples, there is a statistically significant increase in land values associated with an increased 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 $\frac{\partial \text{LVPA}}{\partial \text{FeeSimple}}$, we combine $\hat{\sigma}$ with $\hat{\theta}$ from Table 4 and with a state's median LVPA, to calculate $\hat{\theta} \times \hat{\sigma} \times$ median(LVPA). This estimate ranges from a low of $973 per acre in Washington to a high of $4,765 per acre in Utah. By multiplying $\frac{\partial \text{LVPA}}{\partial \text{FeeSimple}} \times 160$, we obtain the value of converting a plot from allotted trust into fee simple. This estimate ranges from $156,000 to $762,000.

It is worth noting that the estimated $\frac{\partial \text{LVPA}}{\partial \text{FeeSimple}} \times 160$ is a measure of the potential counterfactual *value*-creation, and not a measure of land owners' counterfactual *net wealth* creation, from moving allotted-trust plots to fee simple. This is because embedded in this calculation is an increase in land utilization Z(Use) that obviously requires costly investments into the land.

6 Conclusion

This paper estimates the long-run cost of non-transferable property rights, comparing land under such 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 land use effect is entirely driven by dynamic structural transformation towards more intensive development, whereas the agricultural cultivation effect was mostly already present present in 1974. 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. As we state in the introduction, 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 in 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

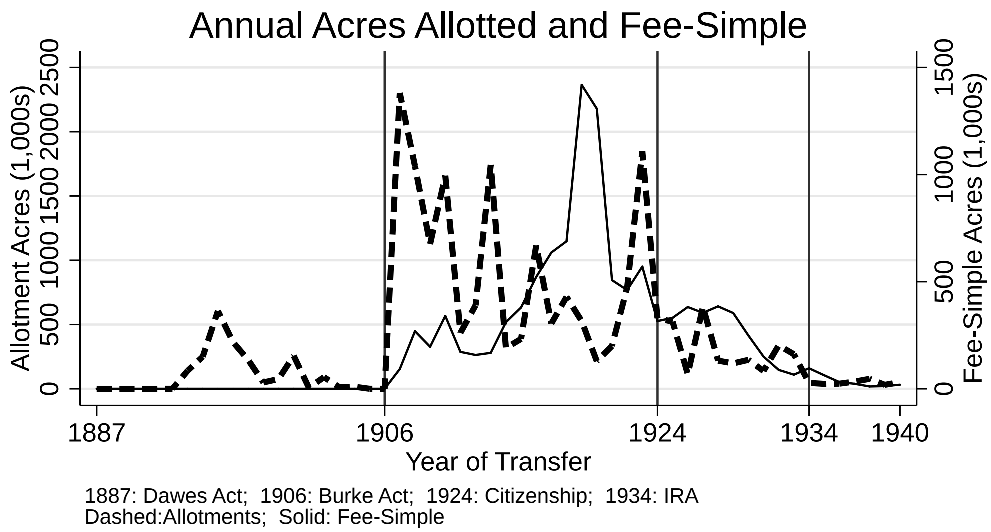
Figure A1 shows an advertisement for the sale of surplus land, discussed in Section 2.

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

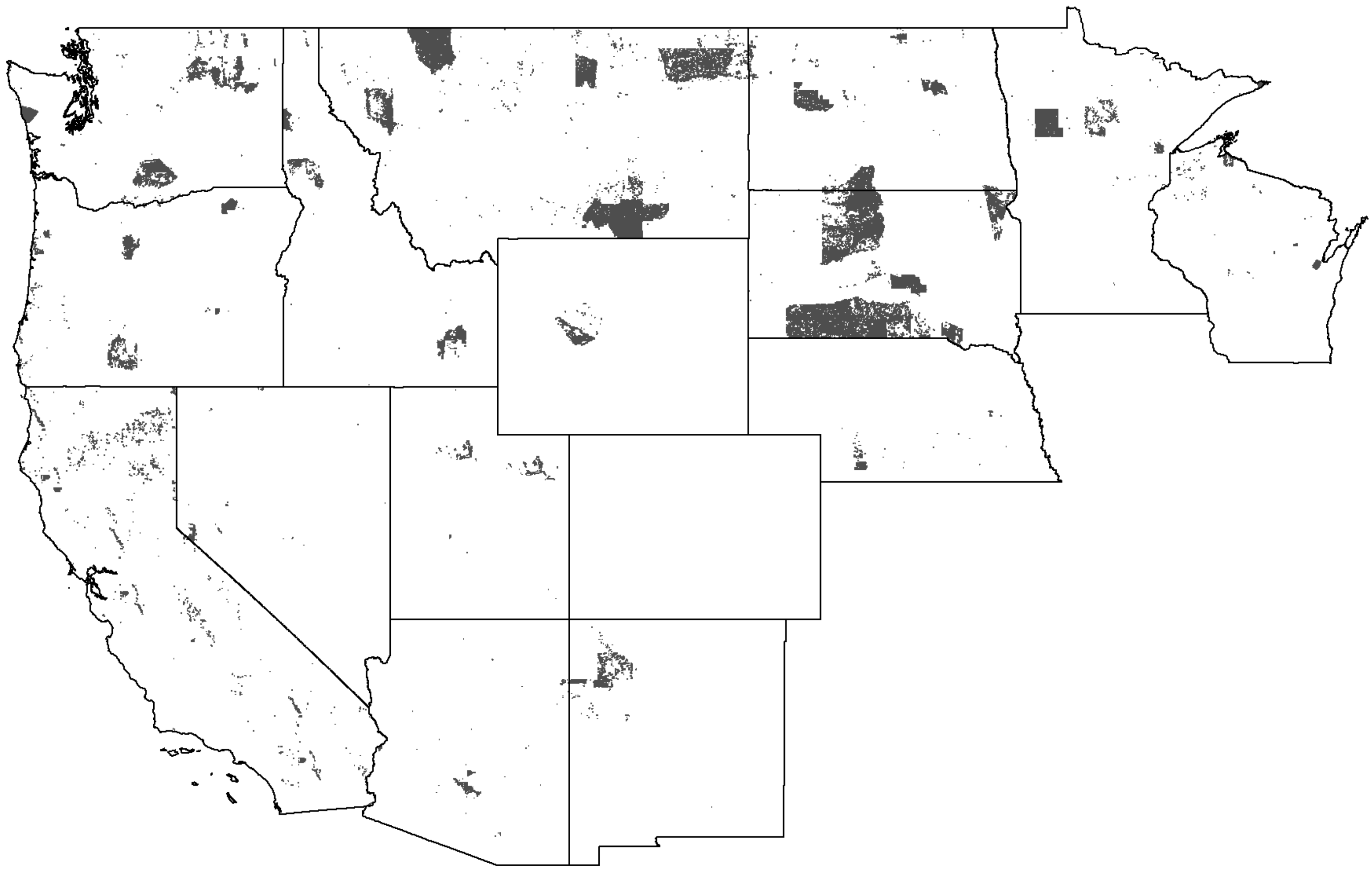
Figure A3 depicts the location of allotments matched to quarter sections. In most cases, these clusters of allotments trace out the boundaries of present-day reservations (with the gaps filled in mostly by tribal lands). In some rare cases, clusters of allotments trace out the boundaries of a former 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.[33] 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 8 and reference to Appendix-Figure A1. The larger black outlines are the boundaries of 6×6-mile PLSS townships.

The left panel of Figure A5 shows the most fine-grained version of the NWALT data, which breaks the 'other' category in Figure 2 into finer sub-categories. The right panel of Figure A5 depicts the *National Land Cover Database* NLCD version of this, which is available only after 2001 but at a slightly higher resolution than NWALT. The NLCD data is used in Table A2.

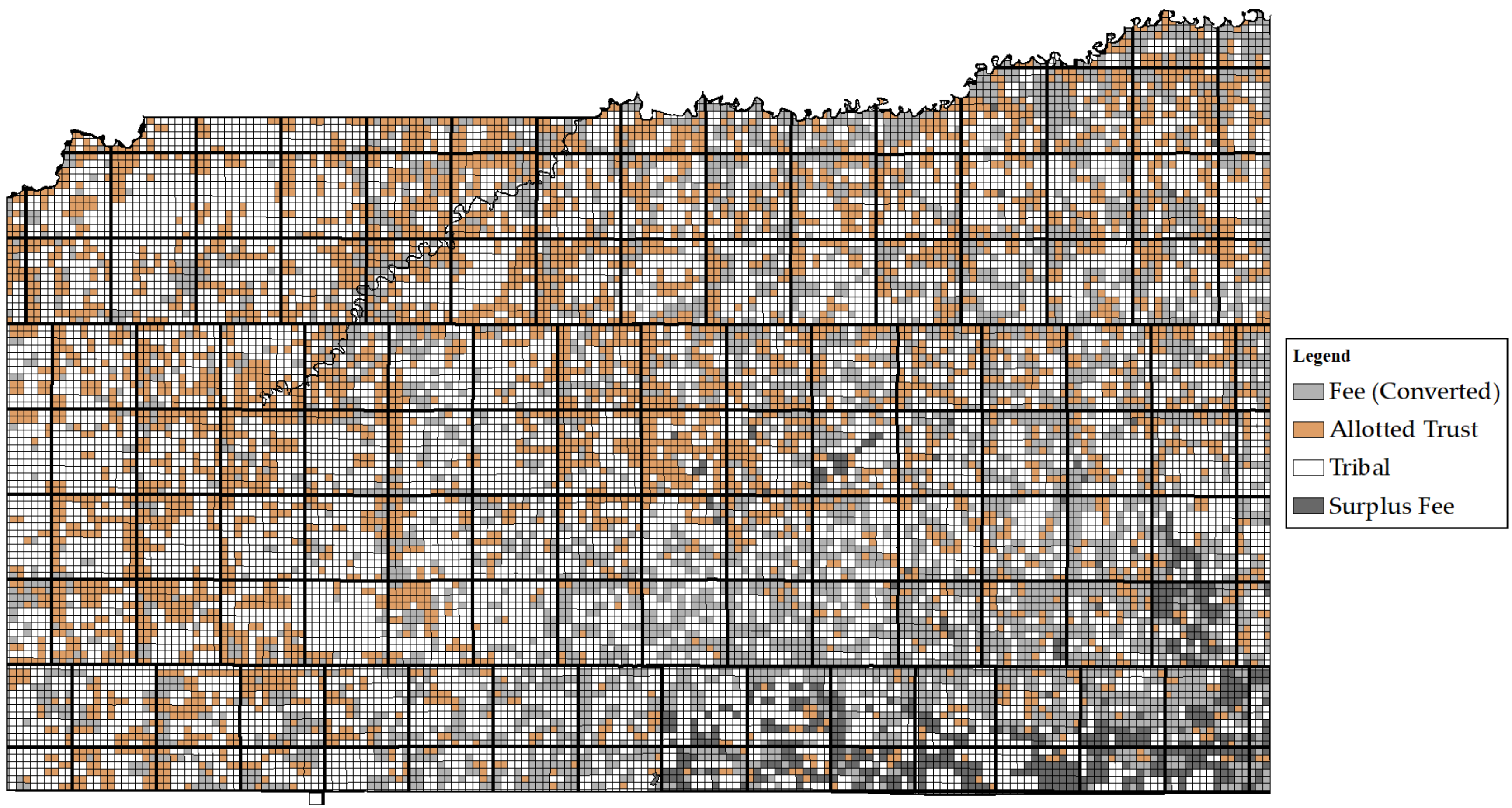
[33] Our match rate is above 99% for most states, with notably lower match rates for New Mexico (where the PLSS grid is less cleanly defined) and Wisconsin.

Figure A3: Allotted Quarter Sections and Reservations



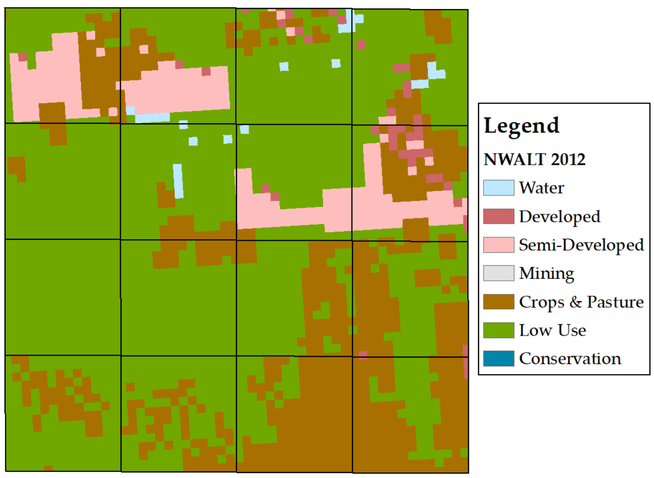
Notes: This figure depicts the location of allotments across the U.S. The main omission is Oklahoma, where the Five Civilized Tribes (and the Osage) were allotted, but their allotments where not included in the GLO data. The parcels depicted include land in allotted-trust as well as fee-simple lands.

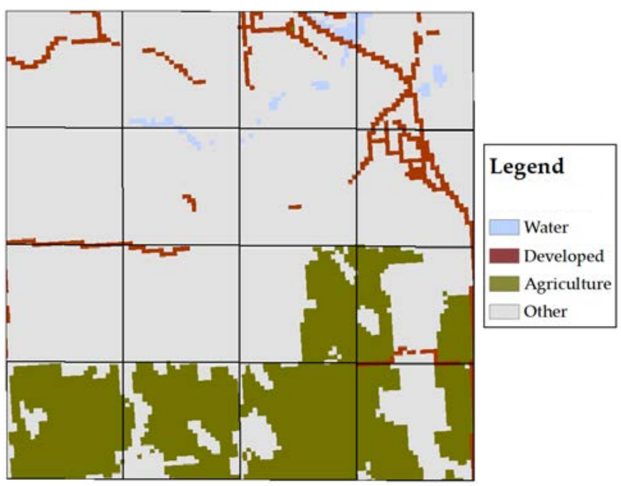
Figure A4: Checkerboard Pattern of Land Tenure on the Pine Ridge Reservation



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

Figure A5: NWALT Finest Breakdown and NLCD Data





Notes: The left panel of this figure shows the most fine-grained version of the NWALT data, which breaks the 'other' category in Figure 2 into finer sub-categories.
The right panel of this figure shows the Land Cover Data (NLCD) version of Figure 2.

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 4, and depicted in the second panel of Appendix-Figure A5.

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 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

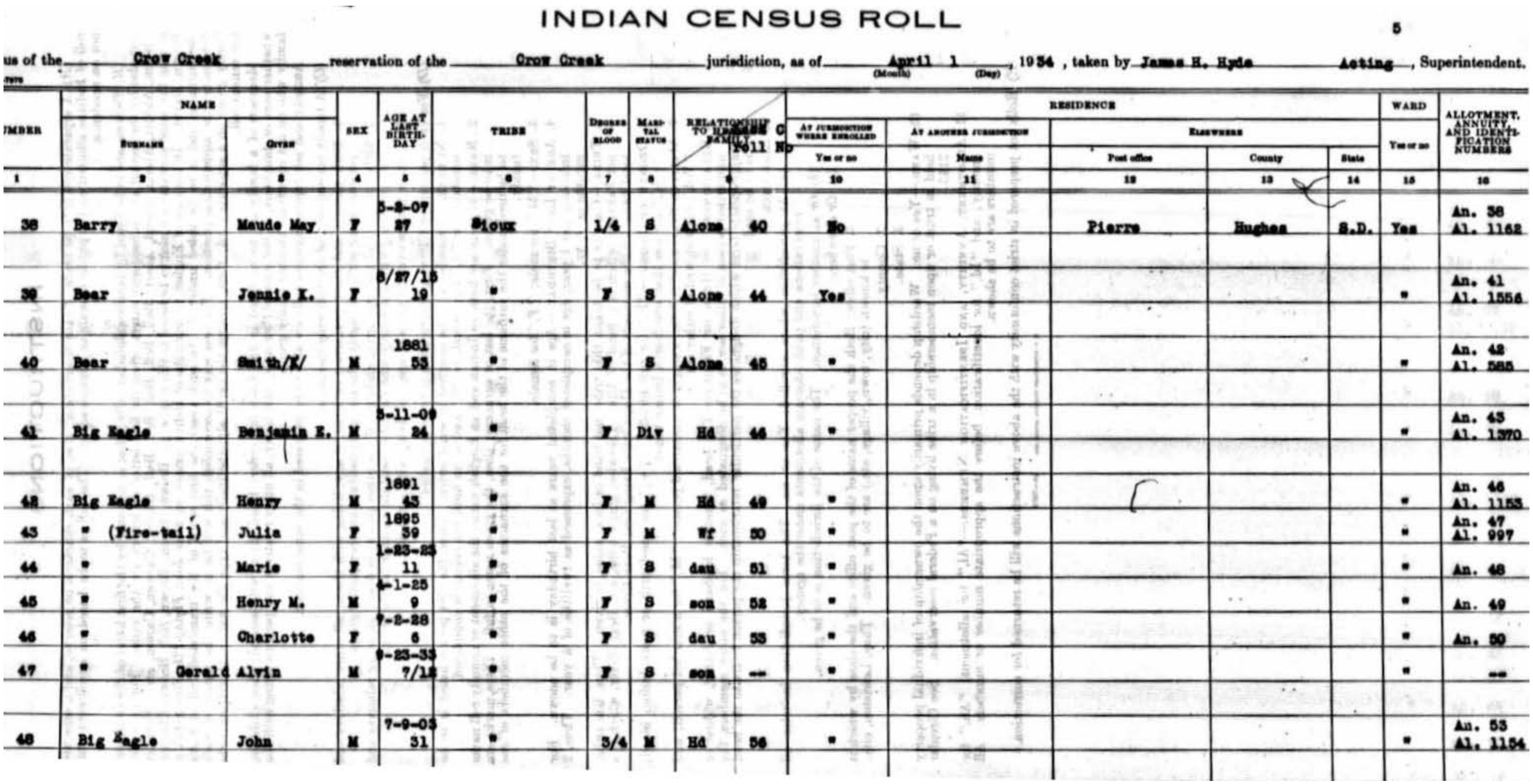
Appendix D Additional Materials Related to Section 4.3

Appendix D.1 The Indian Census Rolls

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.

The ICR linked to the BLM data are used in Section 4.3 to validate that allotment year is explained by allottee birth-year.

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 1, 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	C Roll No	RESIDENCE: At jurisdiction where enrolled (Yes or no)	RESIDENCE: At another jurisdiction (Name)	RESIDENCE: Elsewhere (Post office)	RESIDENCE: Elsewhere (County)	RESIDENCE: Elsewhere (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.

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).[34] 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

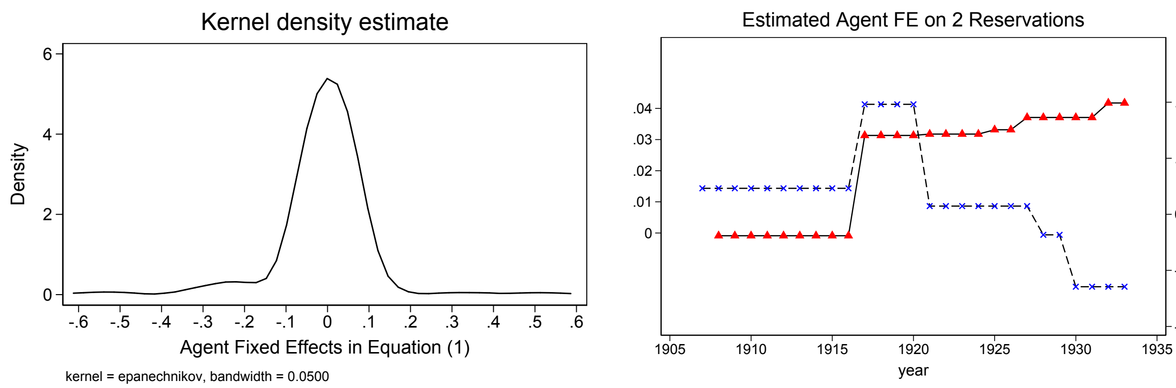
Two elements need to be in place for judge fixed effect type strategies: For precision and statistical power, (*i*) the BIA agents needed to have sufficient discretion for their idiosyncratic preferences matter, and for exogeneity, (*ii*) the the assignment of BIA agents to reservations should not have 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 fee simple (Byron A. Sharp, 1917–1921, Frank A. Virtue, 1921–1925, Charles S. Young 1925–1927,

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

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).

For (*ii*), the assignment of judges to cases should not be endogenous to the outcome under study. In our setting, a BIA agent was in charge of all allotments during the time they were in charge on a reservation. We thus 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.[35] From the perspective of selection, the ideal institutional setting would be one where BIA agents were rotated across reservations via a lottery. Unfortunately, the BIA did not assign agents to reservations via a lottery. One may therefore worry that the BIA allocated agents with a higher proclivity for transferring land into fee simple to reservations with certain characteristics, particularly over land. However, the historical record again suggests that this was not the case. The primary job of BIA agents was to foster education and public health

[35] The historical record shows that the timing of rotation was anchored on the federal administration cycle: the majority of BIA agents were rotated with every when a new administration came in at the federal level every four or every eight years.On average, BIA agents managed a single reservation for approximately eight years, with the average career length lasting twelve years.

on the reservations, and we argue that any selection on these characteristics would have been orthogonal to the process of allotments. We can statistically test this argument to an extent, based on the idea that if agents were chosen for the purpose of land transfer, then one might expect agent pay to correlate with $\widehat{\mu_{j(\cdot)}}$. We collected agent salary information from the Official Registers for every agent and year from 1879 to 1940. Average agent salaries were approximately $44,000 in 2018 dollars.[36] To quantify the relationship between agents' pay and the agents' estimated fixed effects, we estimate regression.

$$AgentPay_{jrt} = \mu_r + \delta_t + \beta \cdot \widehat{\mu_{j(\cdot)}} + \epsilon_{jrt}, \tag{7}$$

where $AgentPay_{jrt}$, was collected for each agent, j, located at reservation, r, in year t. Our main coefficient of interest, β, indicates whether or not agents with a higher propensity to transfer land were compensated more. We condition this specification on reservation and year fixed effects and cluster our standard errors at the reservation level. Column (1) of Table A3 reports the results of estimating equation (7). The results indicate that the agent fixed-effect is not significantly correlated with the agent salaries, which we view as evidence against selection of agents on their allotting propensity.

Table A3: Relating Estimated BIA Agent Fixed Effects to Salaries and Land Suitability

	(1) Ln(Agent Salary)	(2) Ln(Trust Land Quality)
Agent Fixed Effect	0.094	0.061
	[0.244]	[0.700]
Ln(Total Land Quality)		1.200***
		[0.000]
reservation fixed effect	Yes	
year fixed effects	Yes	
Observations	8,255	426
R-squared	0.576	0.762

Notes: In this table, we relate the estimated BIA agent fixed effects to agent salaries as well as to the quality of trust land the agent faced during their career. Column (1) reports the results of estimating equation (7). Column (2) reports the results of estimating equation (8). In square brackets are the p-values for the standard errors clustered on the reservation in column (1), and for robust standard errors in column (2); *** p<0.01, ** p<0.05, * p<0.1

[36] This is similar to a current federal employee paid at the General Schedule 8 grade.

We are also interested in whether agents with a higher propensity to transfer land transferred lower quality land on average. To ask this, we constructed a weighted average of the land quality of reservations that agent j was ever on (weighted by number of years they were on), i.e. $TotalLandQuality_j$. We also construct the average quality of land allotted out of this pool under agent j, i.e. $TrustLandQuality_j$.[37] We then ask whether $\widehat{\mu_{j(\cdot)}}$ correlated with $TrustLandQuality_j$, conditional on the land quality of the available land pool:

$$TrustLandQuality_j = \beta \cdot \widehat{\mu_{j(\cdot)}} + \gamma \cdot TotalLandQuality_j + \epsilon_j \tag{8}$$

Column (2) of Table A3 reports the results of estimating equation (8). There is no evidence that higher land transfer propensity correlates with the quality of allotted land, relative to what land was available.

[37] We quantify land quality we use the FAO land suitability measure for rain fed wheat. We measure the land quality an agent faced by calculating the weighted average suitability index they faced over their career living at reservations r during years t.

Appendix E Extensions to Section 5

Appendix E.1 Extensions to "Evolution of land uses over time (*i*)"

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).

Figure A8: 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 Extensions to "Tribally owned land (*iv*)"

Table A4 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 A5 re-estimates Table 2 with tribal plots included.

Table A6 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; $(\hat{\gamma^{Fee}}_{2012}+\hat{\tau}_{2012})/\hat{\tau}_{2012} = (0.45+0.29)/0.29$. Development on tribal land also grew faster than on allotted-trust land, at about twice the rate; $(\hat{\gamma^{Tribe}}_{2012} + \hat{\tau}_{2012})/\hat{\tau}_{2012} = (0.34 + 0.29)/0.29$.

Table A4: Summary Statistics (Table 1) with Tribal Lands Added

Panel A:	Unallotted	Allotted	Alloted vs. Unallotted			
	(1)	(2)	(3)	(4)	(5)	(6)
Z(Use)	0.319	0.287	-0.032	0.106***	0.067**	0.051*
	[10.93]	[2.13]	(0.285)	(0.032)	(0.025)	(0.022)
Share Developed	1.194	1.276	0.082	0.084	0.016	0.012
	[8.91]	[7.33]	(0.344)	(0.103)	(0.088)	(0.093)
Share Cultivated	4.009	17.824	13.815***	2.495**	1.688**	1.407**
	[17.29]	[31.96]	(2.130)	(0.791)	(0.596)	(0.429)
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)
Z(Use)	-0.000	0.319	0.319	0.029	0.026	0.030
	[1.00]	[10.93]	(.)	(0.029)	(0.025)	(0.018)
Share Developed	0.830	1.194	0.364	0.076	0.038	0.018
	[5.40]	[8.91]	(0.317)	(0.064)	(0.052)	(0.043)
Share Cultivated	11.177	4.009	-7.168***	-0.134	0.166	0.228
	[26.67]	[17.29]	(1.875)	(1.126)	(0.847)	(0.679)
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 A5: 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 A6: 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 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.