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

Christian Dippel
Dustin Frye
Bryan Leonard

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Property Rights without Transfer Rights: A Study of Indian Land Allotment
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ABSTRACT

In the early 20th century, the U.S. government allotted millions of acres of tribe-owned reservation lands to individual Native American households. Allotments were initially held in trusteeship, to be later converted to fee-simple with full transfer rights. In 1934, this program was shut down, locking more than half of all allotments into trusteeship indefinitely. We investigate the long-run consequences of non-transferability on land development and agricultural activity, using fine-grained satellite imagery from 1974–today.

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

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

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

1 Introduction

Property rights to land are a cornerstone of economic development. Yet, they are often incomplete in practice. For many landowners, especially in already disadvantaged groups, their land rights frequently entail only usufruct ("use and enjoy") and exclusion rights, but not the ability to sell or transfer these rights (Rose-Ackerman 1985, Ellickson 1993, Alston, Alston, Mueller, and Nonnenmacher 2018, ch2-3): indigenous land rights in Latin America and sub-Saharan Africa are often non-transferable usufruct (Migot-Adholla, Hazell, Blarel, and Place, 1991; Goldstein and Udry, 2008; De Janvry, Emerick, Gonzalez-Navarro, and Sadoulet, 2015); one-half of all Black-owned land in the rural South is tied up in so-called *heir's property* (Emergency Land Fund, 1980); and the property rights of many Native American land owners remain usufruct to the present day.[1] Native American owners of non-transferable "allotted trust" land cannot collateralize it with a bank, and lack of control over testation to their heirs creates highly fractionated ownership claims over time, which in turn cause high transaction costs (Anderson and Parker, 2008; Parker, 2012; Brown, Cookson, and Heimer, 2017; Feir and Cattaneo, 2020; Russ and Stratmann, 2014).

To investigate the long-run consequences of these limits on transfer rights, we leverage a natural experiment that resulted from the policy of Indian allotment on American Indian reservations in the early part of the 20th century, and generated a patchwork of lands, some with full fee-simple rights and some (i.e. allotted trust) with only non-transferable property rights. We map the universe of historic land allotments from the *Bureau of Land Management* (BLM) to the *Public Land Survey System* (PLSS) grid and compare land use across ownership regimes using high-resolution satellite data from the *National Wall-to-Wall Land Use Trends Database* (NWALT). Within increasingly smaller neighborhoods ranging from six square miles to one square mile, we find that fee-simple property rights increase land use by between 0.2 and 0.4 standard deviations. This decomposes into a twenty-percent higher share of land under development and a thirty-five percent higher share of land under cultivation. To establish that these differences are causal, we pursue an instrumental variable (IV) strategy that uses an allotment's issuance year and the identity of exogenously rotating *Bureau of Indian Affairs* (BIA) agents on reservations a century ago to predict whether an allotment was converted to fee-simple title.

[1] Another historically important manifestation of transfer limits pertained to property rights over one's own labor; using e.g. 'Black Codes' and anti-vagrancy laws in the Jim Crow South (Wright, 1986; Alston and Ferrie, 1993).

The natural experiment underlying our data was a result of the policy of Indian allotment: between 1906 and 1924, the U.S. government allotted millions of acres of previously tribe-owned land to individual Native American households under the authority of the Dawes and Burke Acts.[2] Indian allotments were first placed into the trusteeship of local BIA agents. Following a stipulated period of trusteeship, allottees could have their land converted into fee simple, with full property rights. Had the policy run its course, all reservations would have eventually been allotted, all allottees would have eventually obtained their lands in fee simple, and remaining "surplus" reservation lands would have been opened for non-Native settlement, with the potential end-result of altogether terminating reservations as polities.[3] In the late 1920s, concerns grew that allotment undermined the social cohesion of tribes as well as the integrity of their land base. These concerns led John Collier, then head of the BIA, to introduce the *Indian Reorganization Act* (IRA) to Congress in 1934 (Meriam, 1928; Taylor, 1980; Carlson, 1981). The IRA is the data-generating process underlying our empirical investigation: it put a sudden stop to the policy of Indian allotment; it froze all allotted-trust land into trusteeship indefinitely, thus creating a patchwork of land tenures that persists on Native American reservations to the present day. (Detailed discussion in Sections 2 and 3.)

Our analysis begins with a cross-sectional comparison of land use on fee-simple vs. allotted-trust lands in 2012 (the most recent iteration of NWALT) controlling for soil quality, elevation, and ruggedness. Our ability to match each allotment exactly to a 160-acre 'quarter-section' in the PLSS grid allows us to use fine spatial fixed effects down to the one-mile square 'section', and thus to address the concern that unobserved spatial characteristics (e.g. historical proximity to BIA buildings) could have played a role in BIA agents' decision to convert allotted trust land to fee simple.[4] A remaining concern that is that allottees' actions and characteristics could have also played a role in the BIA agents' historical decisions, and that these same actions or characteristics could have had some independent long-run effects on development. We address this concern with an IV strategy that uses allotments' issuance year and the identity of the BIA allotting agents that were exogenously rotated across reservations from 1897–1934 to predict an allotment's land tenure: earlier allotments were

[2] Allotment nominally started with the 1887 Dawes Act, but the big push occurred only after the 1906 Burke Act.

[3] The drivers of the policy of Indian allotment in Washington were primarily concerned with assimilation, but the sale of surplus lands was a powerful motive for local politicians and land speculators to support it. See Appendix-Figure A1.

[4] Our findings are robust to various forms of spatial correlation, including clustering by PLSS township, reservation, or those proposed by Conley (1999, 2010). We also analyze land use with data from the *National Land Cover Database* (NLCD), which is available only after 2001 but at a slightly higher resolution than NWALT.

more likely to be converted into fee simple before the program ended in 1934 because all allotments had to be held in trust for a certain period; but the date of initial issuance is not itself endogenous because *all* adult household heads on a reservation obtained their allotments at the same time. Within a reservation, variation in issuance dates comes only from the fact that not all potential allottees were of age at the time of the first round of allotments, which necessitated later additional rounds of allotments for younger allottees. Thus, the exclusion restriction is that the age of an allottee at the time of the first allotments on a reservation had no direct effects on *long-run* use of their land eighty years later. To gain additional first-stage predictive power, we interact an allotment's issuance year with the exogenously rotating BIA agents' measured propensity to convert land of differing issuance dates into fee simple. To this end, we coded up a complete reservation-year panel of the BIA agents who managed allotments on individual reservations. The resulting IV results are precisely estimated and confirm the OLS results: fee-simple property rights increase land use by between 0.2 and 0.4 standard deviations.

Because the NWALT data exist in six decadal waves (1974, 1982, 1992, 2002, and 2012) we can get at the timing of our core effect. We find that the gap between fee-simple and allotted-trust land grew monotonically over 1974—2012. This pattern is robust to the inclusion of individual quarter-section fixed effects, which completely rule out *all* fixed, unobserved differences in land characteristics and landowners. Importantly, we find a higher rate of divergence in decades when more favorable legal provisions, federal funding, and judicial presumptions (in relation to state and federal government) allowed reservations to fare better overall. This suggests that transferable property rights matter most when opportunities for economic development are better overall. For development, there was no difference at all in 1974, so that the entire difference in 2012 is driven by subsequent divergence. In contrast, over eighty percent of the 2012 difference in cultivation already existed in 1974, i.e. mid-way between the IRA and the most recent outcome measures. This is consistent with the well-known history of structural transformation on reservations: until the mid-1970s, the *only* economic production on reservations was farming and grazing, while reservations have since then successfully diversified into a range of manufacturing and tourism industries (Cornell and Kalt 1992, Jorgensen 2007, Treuer 2012, ch6).

We are also able to unbundle our core effect into its underlying mechanisms of (non-) collateralizability and fractionation. We posit that the first mechanism should only be at work on 'banked' reservations where there is any access to credit, since otherwise the ability to collateralize is inconsequential even for fee-simple land owners. For the second mechanism, we can measure ownership fractionation directly from a *Department of Interior* (DOI) report. We confirm that our core effect is mediated by both credit access and the measured degree of fractionation.

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, tribally owned land falls in between allotted-trust and fee-simple land in both land development and agricultural production. In the panel, development on tribally owned land increased over time relative to allotted-trust land at about half the rate of divergence of fee-simple land. In summary, land with non-transferable private property rights not only fared worse than land with complete private property rights, but it also fared worse than land with communal property rights.[5]

Finally, we develop a back-of-the-envelope estimate of the negative impact of trusteeship on land values by combining the NWALT data on land use with county assessor data on land values for over 1.6 million reservation-adjacent parcels with the estimated effect of trusteeship on land utilization on reservations. This exercise suggests that fee simple title adds between \$4,000 and \$15,000 in value to an acre of land, or between \$500,000 and \$1.8 million to a quarter section.

Our paper is of first-order relevance to Native American economic development and to indigenous development in other settings with paternalistically limited property rights similar to those on U.S. reservations. Studies from a range of settings suggest that more private property rights would help indigenous communities (Trosper, 1978; Johnson and Libecap, 1980; Libecap and Johnson, 1980; Anderson and Lueck, 1992; Anderson, 1995; Flanagan and Alcantara, 2003; Alcantara, 2007; Akee, 2009; Flanagan, Alcantara, and Le Dressay, 2010; Leonard and Parker, 2020; Leonard, Parker, and Anderson, 2020; Ge, Edwards, and Akhundjanov, 2019). What our study shows is that allotted-trust land is the worst of three land tenures, and that full fee-simple property rights clearly lead to the most efficient use of land. However, an important caveat to this statement is that reservation land is more than just an asset of individual Native Americans; it is also the land base of Native American tribes and communities. This creates tradeoffs in the choice between converting allotted-trust lands to

[5] This is consistent Aragón and Kessler (2020) compare tribal land with land under 'certificates of possessions' on Canadian reserves, and estimate relatively small inefficiencies from communal ownership, consistent with, e.g., the seminal work in Ostrom (1990).

more complete private fee-simple rights, or converting it to more tribal control. Our view is that either would be preferable to the status quo, but that the choice has to ultimately be that of individual tribes. The choice need not be binary. Mexico's second land reform (*Procede*) provides a valuable template in this regard: From 1993–2006, indigenous farmers were given full title to the land that they had had usufruct rights to since the 1930s. Communities (*ejido*) then separately decided collectively 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).

Our paper also contributes to a literature on the consequences of fractionated land ownership.[6] Black-owned land is also plagued by fractionation in the U.S. South, where a lack of will-writing ('intestacy'), a reluctance to go through the courts' probate systems, and historically limited access to credit have conspired to make fractionated land ownership a serious problem.[7] The outcome is 'heir's property', which makes up thirty-five to fifty percent of all Black-owned land in the rural South (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 in the South (Graber, 1978; Mitchell, 2000; Shoemaker, 2003a; Chandler, 2005; Rivers, 2006; Gaither and Zarnoch, 2017). Yet, there are no causally identified studies of its impact. We view our results as the best available estimate for the cost of heir's property.[8]

Lastly, our paper complements a large literature on land tenure and economic development. The focus of this literature has been on the security of property rights, (Alston, Libecap, and Mueller, 2000; De Soto, 2000; Banerjee, Gertler, and Ghatak, 2002; Goldstein and Udry, 2008; Besley and Ghatak, 2010; Hornbeck, 2010), whereas we study the transferability of property rights.

[6] Fractionated and competing claims are at the heart of hold-up problems in agriculture that are sometimes called the "anti-commons"; see e.g. Rosenthal 1990; Bogart and Richardson 2009; Lamoreaux 2011.

[7] On the credit issues, see Collins and Margo (2011); Aaronson, Hartley, and Mazumder (2017).

[8] From a legal stand-point, the practical challenge of solving fractionated ownership problems is also similar on the two land types: Fortunately, the *Uniform Law Commission*'s *Uniform Partition of Heirs Property Act* (UPHPA) is now in place for the purpose of untangling fractionated claims on heir's property (Mitchell, 2019). UPHPA has been enacted into law in 14 states already, and the ULC is now working on a uniform Indian probate code to replace the BIA's default of following state laws of intestate succession.

2 Background

Following the establishment of the reservation system in the 1860s to 1880s, *Friends of the Indian* reformers became concerned with the question of assimilation.[9] Private property was viewed as the path towards assimilation, and reformers viewed land allotment as the best way to introduce real property to Indians (Carlson 1981, p80, Otis 2014).[10] The government concurred; as BIA Commissioner Thomas Morgan stated in his 1891 Annual Report: "*if there were no other reason [for allotment], the fact that individual ownership of property is the universal custom among civilized people of this country would be a sufficient reason for urging the handful of Indians to adopt it.*" The reformers' attitudes towards Native Americans were paternalistic, and they were concerned about speculators cheating Indians out of their allotments. Allotment was therefore designed with safeguards against land loss that granted allottees usufruct rights to their land, while prohibiting the transfer of these 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 a period of trusteeship before allottees could be granted full (fee-simple) rights.

The history of allotment: After several general allotment acts failed to pass through Congress, Henry Dawes introduced an allotment bill to the Senate in 1886. 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, single persons over the age of 18 received 80 acres.[11] If the land was only suitable for grazing the allotment amounts doubled. If a prior treaty specified larger allotments, the prior treaty acreages were applied. Allotments were mandatory and anyone not selecting an allotment would be assigned a parcel by the Indian Agent. Once selected, allotments were approved by the Secretary of Interior and each Indian was issued a trust patent.[12] Land held in trust could not be alienated and was not subject to state

[9] The *Indian Rights Association* and the *National Indian Defense Association* were formed in 1882 and 1885.

[10] Both private property and communal land rights were common among tribes, but private property over land was not (Demsetz, 1967).

[11] 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.

[12] Unallotted reservation land was designated as surplus and made available for outside settlement. We know the extent of surplus land inside modern reservation boundaries and exclude it from our analysis. The law required tribal approval of ceded surplus land, but tribes were rarely in a position to negotiate (Carlson, 1981). After 1903, tribal approval was no longer necessary. Proceeds from the sales of the surplus land were held in trust and appropriated at the discretion of

or local taxes. At the end of the trust period, the allotment would be converted into fee simple, thus giving the allottee (or their heirs) full transfer rights. Under the Dawes Act, the trust period was originally 25 years, but the 1906 Burke Act granted the BIA agents the authority to shorten or lengthen the trust period as they saw fit. The vast majority of allotments were issued between 1906 and 1924; see Appendix-Figure A2. Allottees could select a parcel, but most did not. When they did not, the local BIA agents determined the assignment of allotments (Banner, 2009; Otis, 2014; Carlson, 1981). In 1928, Lewis Meriam of the Institute of Governmental Research (precursor of the Brookings Institution) published a report on the social and economic conditions on reservations that paid special attention to allotment, and characterized the process as follows: "*The original allotments of land to the Indians were generally made more or less mechanically. Some Indians exercise their privilege of making their own selections; others failing to exercise this right where assigned land. Often Indians who exercise the privilege made selections on the basis of the utility of the land as a means of continuing their primitive mode of existence. Nearness to the customary domestic water supply, availability of firewood, or the presence of some native wild food were common motives. Few were sufficiently far sighted to select land on the basis of its productivity when used as the white man used it.*" (Meriam, 1928, p470).

The Meriam report was highly critical of the social and economic conditions on reservations, and concluded that allotment had not been helpful in this regard. The report was very influential at the time and led to a shift in policy makers' opinion regarding allotment. In 1934, Roosevelt's new Commissioner of Indian Affairs, John Collier, introduced the Indian Reorganization Act (IRA), which ended allotment of Indian reservations. 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, today called "tribal trust". Because much of the allotted land had not yet passed through its trust period by 1934, one of the IRA's legacies was to create a patchwork land tenure pattern of (*i*) fee-simple land, (*ii*) allotted-trust land, and (*iii*) tribal land on reservations that has persisted to the present day (Minneapolis Fed 2018, p1, Montana 2009, p2).[13]

Restrictions on the transfer of trusteeship land: While owners of allotted-trust land (the original allottees' heirs) hold usufruct rights (*beneficial title*) to their land, the U.S. government retains

Congress for "education and civilization" (Banner, 2009).

[13] Subsequent to 1934, moving land out of trust status requires special approval from the secretary of the interior (Shoemaker, 2003a; C.F.R.150.1-150.11, 1981). Some re-titling across the three land types has occurred in this way, but observe later re-titling of allotments in the BLM data and exclude re-titled parcels from all analysis. See reference back to this footnote in Section 3.

the *legal title*. This means the owners cannot transfer 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, which creates major economic constraints (Stainbrook, 2016, p5). A second implication of the non-transferability of property rights arises from the fact that owners of allotted-trust land often cannot control the transfer of rights to their own heirs. Native Americans were not allowed to write wills until 1913 (Stainbrook, 2016, p5). This meant that until that year, every deceased allottee's land passed to all heirs in equal and undivided claims because under U.S. laws of intestate succession, the court presumption is *tenancy in common* (Stainbrook 2016, p2, Shumway 2017, p648).[14] Even after 1913, estate planning remained alien to the vast majority of Native Americans, and the BIA provided neither information nor resources in this respect (Shoemaker, 2003b). This quickly led to a proliferation in the number of claimants on allotted-trust land and today the average allotted-trust parcel has 13 claimants, with many instances of trust parcels with several hundred claimants on them (Department of Interior, 2013). Russ and Stratmann (2014) show that fractionation has doubled over 1992–2010, despite this being a period when the BIA was finally actively trying to address the problem. It is worth noting that the court presumption of tenancy in common does not lead to fractination for most Americans because there are three obvious ways to circumvent it: (*i*) write a will, (*ii*) the inheritance can be sold and then divided between the heirs, (*iii*) one heir can take out a mortgage on the inheritance to buy out the other heirs (Alston and Ferrie, 2012). For owners of allotted-trust land, the second and third avenues are still closed today, while the first was opened too late to prevent the proliferation of claimants that had already occurred.

Economic development on reservations from allotment to today: 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. This was followed by a period of stagnation into the late 1960s. By the early 1970s, tribes had begun to gain more independence from the BIA, and the 1970s were — at least economically — a good decade for American Indians. This was followed by stagnation in the 1980s, driven in large part by the dismantling of many federal funding sources. By the 1980s, the sovereignty that tribes had secured in the early 1970s began to bear fruit in the establishment of tribal businesses. Economic growth on reservations since the 1990s has mirrored the usual pattern of structural transformation,

[14] Appendix F.1 provides historical background on the evolution of intestacy laws.

Figure 1: 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.

transitioning from primarily agricultural production towards manufacturing and services. We provide a much more detailed discussion of these patterns in Appendix A. Figure 1 shows the ebb and flow discussed here, reflected in per capita incomes. The land use satellite data that we describe in the next section covers the years 1974, 1982, 1992, 2002, and 2012, allowing us to assess the impact of property rights on land use during critical phases of economic development on reservations.

3 Data Sources

Allotment data: Following approval from the President, each patent issued on the reservation was filed with the Government 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 process of the issuance of allotted-trust land and its conversion into fee simple.

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.[15] 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$\frac{1}{2}$NW is the southwest half of the north-west quarter-section. To simplify the analysis and improve the quality of our matches, we focus on 160-acre quarter sections as the basic unit of analysis, which matches the size of a standard Indian allotment. Of the 412,900 allotment-transactions with a potentially matchable aliquot part variable in our data, we successfully matched 403,197, or 97.7% to quarter sections in the PLSS using a shapefile from the BLM.[16]

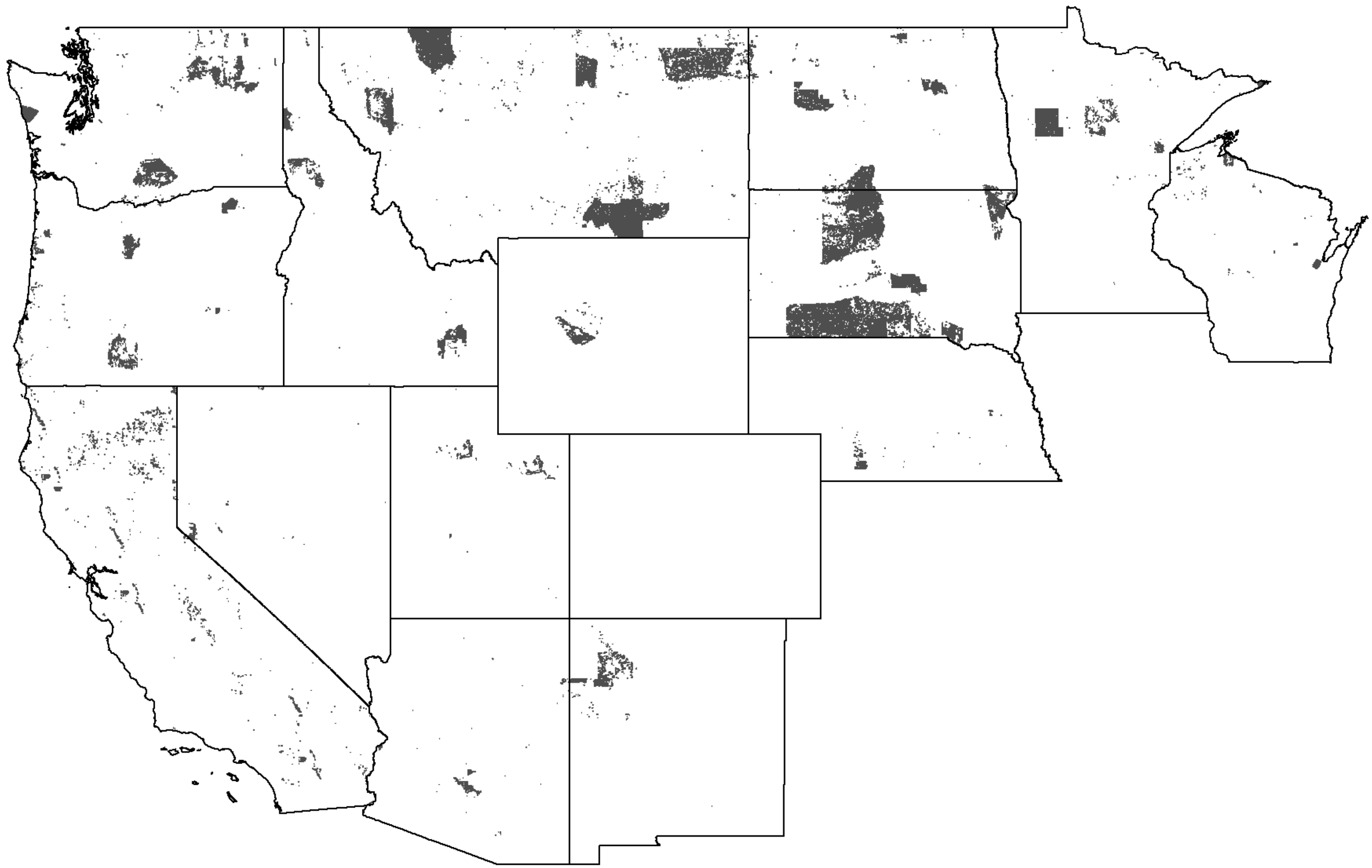
Figure 2 depicts the location of allotments matched to quarter sections. In most cases, these clusters of allotments trace out the boundaries of present-day reservations (with the gaps filled in mostly by tribal lands). In some rare cases, clusters of allotments trace out the boundaries of a former reservation 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.[17] Eastern Oklahoma was covered by reservations for the 'Five Civilized Tribes' (the Cherokee, Chickasaw, Choctaw, Creek, and Seminole) who

[15] 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.

[16] In some cases the aliquot part is either missing, corrupted, or not not formatted in a way that allows matching to quarter-sections.

[17] 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 2: 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.

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.

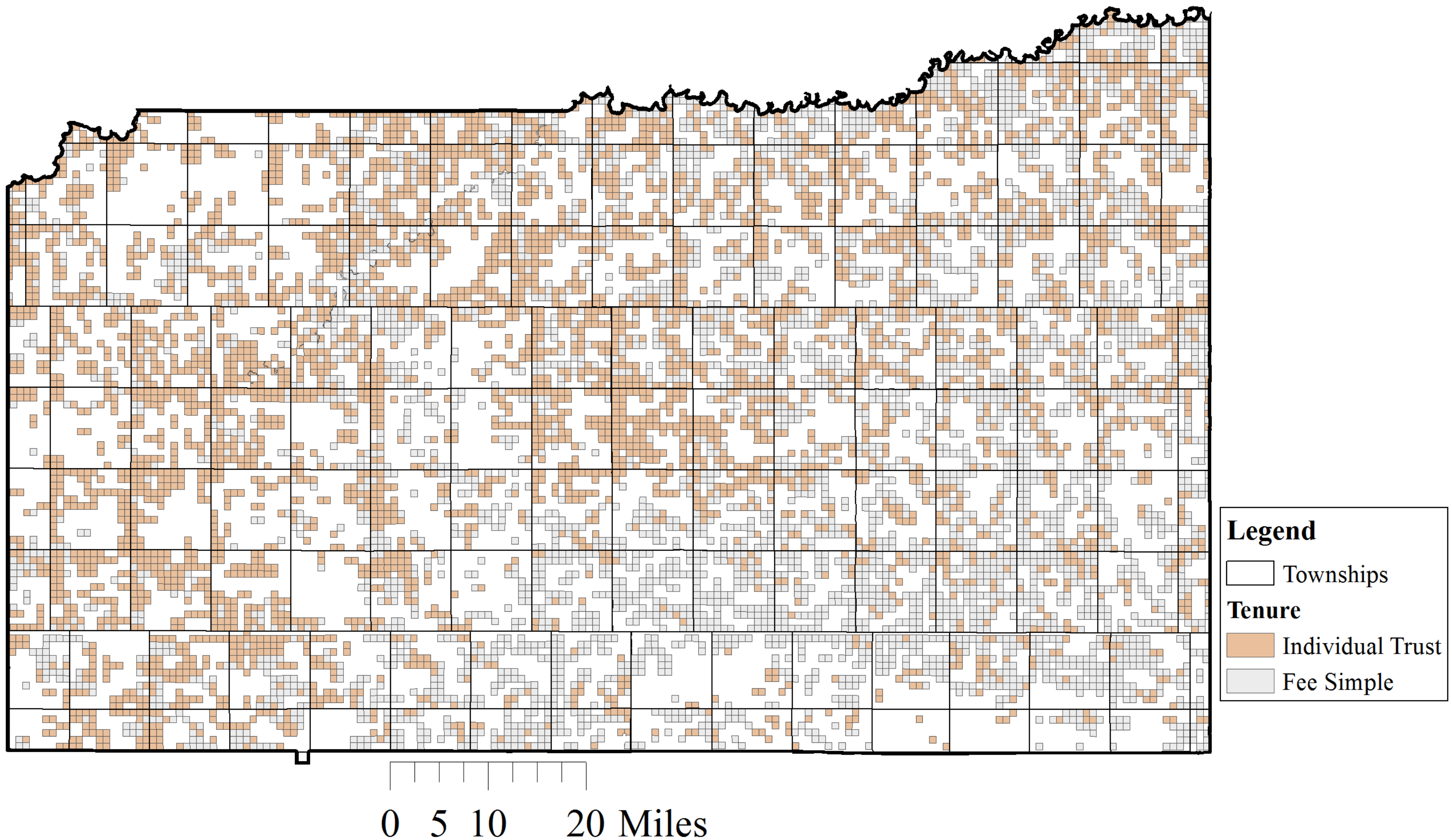
After matching allotments to quarter sections, we track the history of transactions associated with each allotment to determine when it was converted from allotted-trust to fee-simple, if ever. Every allotment in our main sample begins in trust status, but only some convert to fee-simple by 1934. We impose two additional restrictions on the sample to simplify the analysis. First, we focus on quarter sections which are matched to either all fee simple or all allotted trust, but not a mix. Second, we 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 13).

Figure 3 depicts an example of our matched, cleaned data on the Pine Ridge Reservation in South Dakota. Orange parcels are still in allotted trust status, whereas grey parcels have been converted to fee-simple. Unshaded areas represent tribally owned or surplus fee land, which we omit from our main analysis but discuss in the appendix. The larger black outlines are the boundaries of 6×6-mile PLSS townships. Tenure regimes are notably in close proximity to one another, often in a checkerboard fashion. Although there some concentrations of allotted-trust vs fee-simple land in certain areas, in most cases each allotted trust parcel has at least several fee neighbors. This pattern is representative of many reservations. In our empirical analysis, we will focus on progressively finer spatial variation and compare only nearby parcels of different tenure regimes.

Land use satellite imagery data: Our main outcome data on land use come from 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. The NWALT codes ten different levels of development including commercial, urban, and residential land uses as well as transportation infrastructure. Pixels coded as cultivated by the NWALT include annual crop production, orchard crops, and any land that is being tilled.[18]

[18] 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.

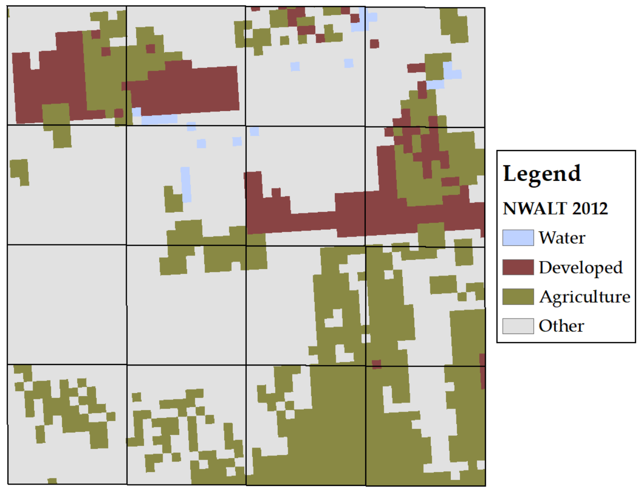
Figure 3: Checkerboard Pattern of Land Tenure on the Pine Ridge Reservation



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 ($= 36 \times 4$) quarter sections, each of which is 160 acres (one-quarter of a square mile) large. The figure depicts only the allotted quarter sections.

Figure 4: 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. The quarter section is our unit of analysis. (Compare figure-notes in Figure 3.) The 16 quarter sections depicted here correspond to the spatial extent of the one-ninth township fixed effect in panel (b) of Figure 5. Light blue color shading indicates water. In black & white print, water is indistinguishable from 'other', but this is by design because water plays no role in our empirics: the denominator of each parcel's share-variable is land only.

These two measures — development and cultivation — comprise the majority of "productive" uses of land that may be affected by restrictions on transferability.[19] Other scholars have used similar measures to study the effect of terrain, climate, policy, and public infrastructure on economic activity and urban growth at a fine spatial scale (Burchfield, Overman, Puga, and Turner, 2006; Saiz, 2010). "Developed" pixels in NWALT reflect capital investments in the construction of durable structures that may be utilized for manufacturing, commercial, and private structures. Restrictions on transfer may impair development by restricting access to credit, by suppressing investment incentives of co-owners, or by making it difficult for many co-owners to agree on land use planning. On the other hand, the impact of non-transferability on cultivation may be less severe due to the availability of long-term leases and the more reversible nature of land use decisions.

Figure 4 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 quarter sections, which are our unit of analysis. We focus on development and cultivation for our measures of productive land uses. We call a pixel "Developed" if it falls into any of the ten development classes

[19] 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.

and simply adopt NWALT's definition of cultivation. We express land use as a share of total usable parcel area, which we calculate as the total number of pixels in a parcel excluding water and perennial snow/ice. Appendix-Figure A3 shows the most fine-grained version of the NWALT data, which breaks the 'other' category into finer sub-categories. Appendix-Figure A4 depicts the NLCD version of this.

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 substitutes: land under productive agricultural cultivation is less likely to be developed for non-agricultural purposes and vice versa. Our core focus will therefore be on a single unified land utilization index, before we separately investigate the different uses in a mechanisms section. 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 are calculated 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.

Geographic covariates: We also estimate terrain characteristics and soil quality for each quarter-section. We use 30×30-meter elevation data from the National Elevation Dataset (NED) to measure the mean and standard deviation of elevation in each section. 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).[20] We use the soil productivity index developed by Schaetzl, Krist Jr, and Miller (2012) and estimate the average of the soil index within each quarter section. The soil productivity index ranges from 0 to 21, with soil index values greater than 10 representing highly productive soils (Schaetzl et al., 2012).

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

4 The Effect of Transferable Property Rights

Section 4.1 discusses how we can 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 our 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 Spatial Control Identification Strategy

We estimate the effect of tenure on land use in 2012 at the quarter section-level using the following linear regression model

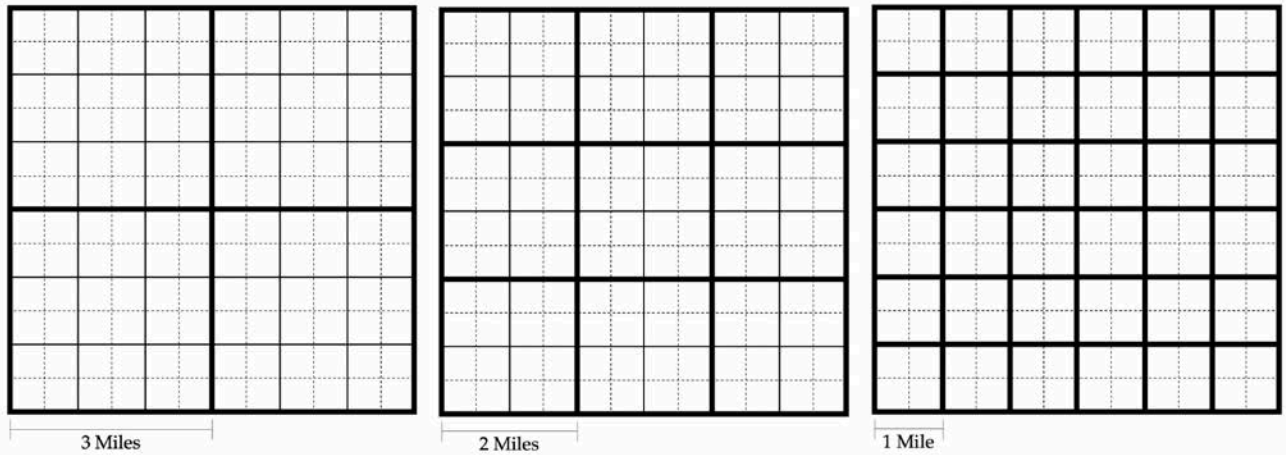
$$y_{ij} = \theta \times \text{FeeSimple}_i + \kappa_j + \lambda' X_i + \varepsilon_{ij}, \tag{1}$$

where y_{ij} is the outcome of interest in quarter section i in spatial region j. As detailed in section 3, we focus on a standardized land utilization index that aggregates share of land classified as developed and the share of land in cultivation. $FeeSimple_i$ is an indicator equal to 1 if a quarter section was entirely converted into fee-simple ownership prior to our study period. The coefficient of interest is θ, which represents the average difference in land use for fee-simple versus nearby allotted-trust parcels in 2012. We include spatial fixed-effects, κ_j, which are derived from the parcels placement within the PLSS grid. The vector X_{it} includes the three land quality characteristics: elevation, ruggedness, and soil quality. We cluster our standard errors at the PLSS township-level, but report the results of reservation-level clustering as well.[21]

One concern with the comparison in equation (1) is that unobserved spatial characteristics (e.g. proximity to a pre-existing infrastructure or planned development) could have played a role in the BIA agents' historical decision to convert trust land to fee land. The description of the process in Section 2 does not suggest that spatial selection was a major concern in regards to how allotments were initially selected. However, spatial characteristics may still have influenced the later conversion of allotments from trusteeship to fee-simple title. We can address this concern thanks to our ability to match each allotment exactly to a quarter-section and to locate each quarter-section exactly inside the PLSS grid. This allows us to use progressively finer spatial fixed effects, and thus to compare tenure

[21] Appendix-Table A2 presents spatially adjusted standard errors following Conley (1999, 2010).

Figure 5: Visualization of Spatial Fixed Effects



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

Notes: This figure depicts three spatial fixed effects used in the paper. All three panels depict one township of 36 square miles. (For reference, the Pine Ridge reservation in Figure 3 shows areound 150 townships.) Each township contains 144 (= 36 × 4) quarter-sections, our unit of analysis. (See also Figure 3.) Panel (a) depicts four 1/4-township fixed effects. Panel (b) depicts nine 1/9-township fixed effects. Panel (c) depicts thirty six section fixed effects. The spatial extent of the fixed effect in Panel (b) is equal the 16 quarter-sections depicted in Figure 4.

types inside an increasingly smaller neighborhood.

Figure 5 depicts the spatial fixed effects we use to identify θ in equation (1). All three panels depict 144 quarter sections (outlined with dashed lines) comprising a single PLSS township, which is our least restrictive spatial fixed effect. Panel (a) depicts "1/4-township" fixed effects that divide each township into four sub-areas and leverage comparisons of 36 quarter-sections in a 3×3-mile neighborhood. Panel (b) depicts "1/9-township" fixed effects that compare 16 quarter sections in 2×2-mile neighborhoods (Figure 4 provides an example of one such neighborhood). In this case, even parcels in opposite corners of a neighborhood are just 1.4 miles apart. Finally, Panel (c) depicts PLSS section fixed effects, which are equivalent to one square mile and compare only directly adjacent quarter sections.

Table 1 presents summary statistics for the estimation sample, reported separately for allotted-trust and fee-simple quarter sections in Columns 1 and 2, respectively. Variable definitions and descriptions are provided in the table note. Columns 4–7 report the difference between fee simple an allotted quarter sections, beginning with an unconditional difference in Column 3 and progressing to within-section differences in Column 7; *p-values* for these differences are reported in square brackets.

Table 1: Summary Statistics

	(1) Trust	(2) Fee-Simple	(3) Unconditional Difference	(4) Conditional: Township-FE	(5) Conditional: 1/4 Township	(6) Conditional: 1/9 Township	(7) Conditional: 1/36 Township
Z(Use)	3.1e-09	.7187	.7187	0.3630	0.2536	0.1685	0.1354
	(1.007)	(2.474)	[<1.0e-40]	[<1.0e-40]	[<1.0e-40]	[<1.0e-40]	[7.4e-09]
Share Developed	.6179	1.331	.7135	0.3008	0.1609	0.0443	0.0538
	(4.164)	(6.945)	[3.9e-09]	[5.6e-04]	[.0117]	[.4518]	[.3923]
Share Cultivated	10.33	27.15	16.82	7.3619	5.3877	4.0865	2.8644
	(25.74)	(35.98)	[<1.0e-40]	[<1.0e-40]	[<1.0e-40]	[<1.0e-40]	[1.6e-15]
Elevation	938.1	728.4	-209.7	-8.5616	-4.2150	-0.5593	-0.1606
	(459.6)	(354.4)	[1.7e-33]	[7.6e-09]	[1.9e-09]	[.1815]	[.6445]
Ruggedness	14.01	12.68	-1.334	-1.1509	-0.6702	0.0830	-0.0456
	(21.26)	(39.26)	[.1252]	[1.1e-05]	[5.8e-09]	[.537]	[.619]
Soil Quality	9.704	11.6	1.898	0.4543	0.2283	0.0251	0.0028
	(4.434)	(3.882)	[<1.0e-40]	[<1.0e-40]	[5.8e-11]	[.3206]	[.901]
Observations	42,164	26,393	68,557	68,557	68,557	68,557	68,557

Notes: Baselines differences in development and cultivation from NWALT in 1974. Columns 1–2 present mean and standard deviations by land tenure. Column 3 reports unconditional differences of fee-simple vs allotted-trust land, and columns 4–7 report differences conditional on fixed effects.

We discuss in Section 3 that Oklahoma is not included in the PLSS GLO data. In terms of the number of observations, this is a big omission.[22] However, Oklahoma allotments were administered separately (through the so-called *Dawes Rolls*), and *every single allotment* was converted to fee-simple, so that Oklahoma allotments would not contribute to the allotted-trust vs fee-simple comparison even if they were in the data (Office of Indian Affairs, 1935).

The unconditional differences reported in column 3 of Table 1 suggest that 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).[23] Importantly, these differences are much less pronounced 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 upshot is that adding progressively finer

[22] There were 119,000 allotments made in Oklahoma. which is home to the Cherokee, Chickasaw, Choctaw, Creek, and Seminole, all of whom were full allotted.

[23] This is consistent with previous findings by Leonard et al. (2020).

spatial fixed effects helps to compress differences in land quality that could confound comparisons of land use across ownership regimes. However, we continue to control for land characteristics within small neighborhoods. While the 1/36 fixed effect specification in column 7 shows even more balance on covariates, we will treat the 1/9-township fixed effect specification in column 6 as our preferred specification throughout the paper because we lose about 8,000 observations to singletons (i.e. only one observation inside a fixed effect) in the 1/36 version of the fixed effects.

4.2 Baseline Results

Table 2: Cross-Sectional Results for Land Utilization Index

	(1)	(2)	(3)	(4)	(5)	(6)
Fee-Simple	0.3846	0.3354	0.2922	0.2423	0.1938	0.1372
	[3.3e-37]	[3.1e-32]	[4.1e-26]	[2.0e-15]	[6.0e-10]	[1.6e-08]
	{4.31e-10}	{2.28e-10}	{4.09e-08}	{9.3e-06}	{0.00027}	{0.00091}
Adjusted R-squared	0.284	0.295	0.309	0.442	0.478	0.664
Observations	67,462	67,462	67,462	66,595	65,809	57,996
# Fixed Effects	2,465	2,465	2,465	6,742	10,760	20,892
Land Quality Controls		*linear*	*binned*	*binned*	*binned*	*binned*
Township FE	✓	✓	✓			
4 FE per Townshp				✓		
9 FE per Townshp					✓	
36 FE per Townshp						✓

Notes: This table introduces increasingly finer spatial fixed affects across columns: Columns 1–3 use township fixed effects, while columns 4, 5, 6 correspond to the fixed effects depicted in panels a, b, c of Figure 5. In square brackets, we report *p-values* for standard errors clustered at the township level; In braces, we report *p-values* for standard errors clustered at the township level.

Table 2 presents our baseline results for the land utilization index developed in Section 3 (”Constructing a Land Utilization Index”). The first column reports uses PLSS townships as the spatial fixed-effect and does not include land quality controls. The model in column 2 adds the three linear land quality controls; *p-values* with standard errors clustered by township are reported in brackets and the alternative (clustering by reservation) are reported in braces for the main coefficient of interest. Column 3 switches from linear controls to a flexible binned approach that includes dummy variables indicating whether a parcel is in a given decile of the elevation, ruggedness, and soil quality distributions. Fee-simple land has significantly more land under development. The coefficient estimate in column 3 indicates a fee-simple plot has around 0.29 standard deviations higher land use overall.

The estimates in columns 1 through 3 include township fixed-effects that restrict the quarter section comparison to within a 6×6 mile PLSS township. At this scale, one could still be concerned about unobserved land characteristics that influenced BIA agents' historical decision to convert land to fee-simple that continue to be correlated with contemporary land use. Columns 4 through 6 report results with increasingly finer spatial fixed-effects. The magnitude of the fee-simple coefficients decreases slightly but remains statistically significant while clustering at either the township or reservation-level. Our preferred estimate in columns 5 indicate that land utilization is 0.2 standard deviations higher on fee-simple land relative to allotted-trust land within a 2×2-mile or 1×1-mile neighborhood. Column 6 has the highest *R-squared*, but we lose around 8,000 observations to singletons, so that we view column 5 as our preferred estimate. Panel A of Appendix-Table A3 shows very similar results when we measure land use with the NLCD rather than NWALT.

4.3 IV Strategy

A remaining challenge that is not addressed by spatial fixed effects is that allottees' actions and characteristics could have played a role in the BIA agents' historical decision to convert trust land into fee simple, and that these same actions or characteristics could have had some independent long-run effects on development. We address this concern with an IV strategy that uses allotments' issuance year as an instrument: earlier allotments were more likely to be converted into fee simple before the program ended in 1934 because all allotments had to be held in trust for a certain period; but the date of initial issuance is not itself endogenous because *all* adult household heads obtained their allotments at the same time. Within a reservation, variation in issuance dates comes only from the fact that not all potential allottees were of age at the time of the first round of allotments, which necessitated later additional rounds of allotments for younger allottees. Thus, the exclusion restriction is that the age of an allottee at the time of the first allotments on a reservation had no direct effects on *long-run* use of their land eighty years later. We discuss this exclusion restriction in Appendix D.1, where we introduce a newly digitized additional data-source called the *Indian Census Rolls*, from which we can link a sub-set of allottees' ages to the BLM land data to verify our assertion.

To gain additional first-stage predictive power, we construct a second instrument that 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 this end, we coded up a complete reservation-year panel of the universe of BIA allotting agents on reservations from 1897–1934, from the sources described in Appendix D.2. Our identification strategy is anchored on the exogenous rotation of Indian Agents across reservations over time, and their varying propensity to convert land from trust status into fee simple. To operationalize this idea we constructed a duration panel that tracks each allotment from its issuance year until it is either converted to fee simple, or up to 1934 IRA. The duration-setup captures the fact that if an allotment i was not converted into fee simple in year t, then it may be converted in $t+1$. An allotment's outcome in year t is an indicator $D_{i(r)t}$ that takes value 1 if allotment i tied to reservation r was converted into fee simple in year t, and 0. The key identifying variation in our framework comes from the fixed effect $\mu_{j(rt)}$ of agent j in charge of reservation r in year t.[24] Consider the following duration-style regression

$$D_{i(r)t} = \mu_{j(rt)} + \mu_r + \mu_t + \beta_\tau \cdot (t - \tau_i) + \epsilon_{i(r)t}, \tag{2}$$

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. We expect $\beta_\tau > 0$, and $\beta_b > 0$. With the estimated coefficients $\{\widehat{\beta_\tau}, \widehat{\beta_b}\}$ and vectors of fixed effects $\{\widehat{\mu_{j(\cdot)}}, \widehat{\mu_r}, \widehat{\mu_t}\}$, 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. The key exogenous component in equation (2) 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]

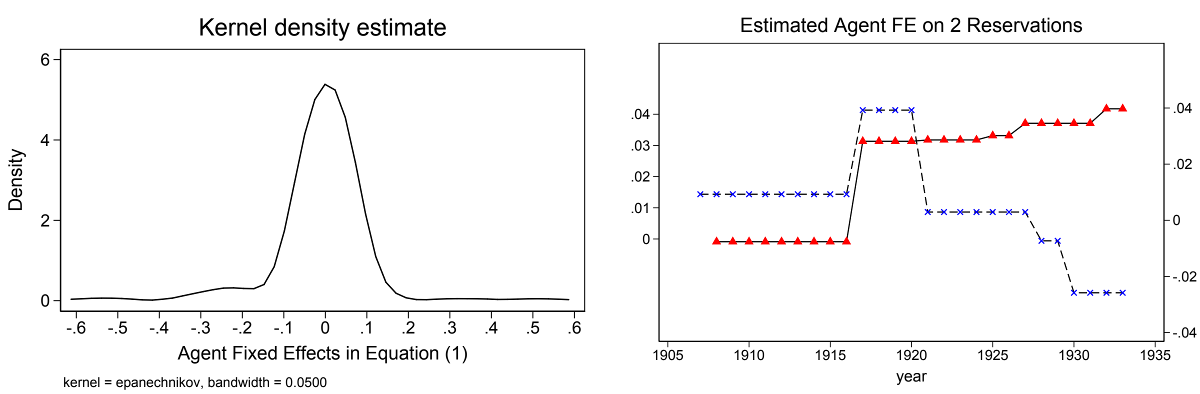
There are three elements that need to be in place for these strategies. For precision and statistical power, (*i*) the BIA agents needed to have sufficient discretion for their idiosyncratic preferences to matter, (*ii*) there needed to have been enough rotation of agents. For exogeneity, (*iii*) the the assignment of BIA agents to reservations should not have been endogenous to reservations' characteristics. In Appendix D.2, we discuss and provide evidence for each of these elements in turn. For illustration,

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

[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*.

the left panel of Figure 6 shows the distribution of the roughly 450 agent fixed effects $\widehat{\mu_{j(\cdot)}}$ estimated in equation (2). The right panel of Figure 6 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, 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 6: 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 (2). The right panel shows how the rotation of agents over time induces different time-paths in $\widehat{\mu_{j(rt)}}$, i.e. the propensity to convert land into fee simple, on Spirit Lake (red triangles, solid line) and on Salt River (blue crosses, dashed line).

To turn the results of the estimation of the duration setup into a cross-sectional instrument Z_i for the second-stage analysis, we calculate the cumulative probability that an allotment was converted into fee simple between its issuance in year τ and the year 1934 (when the process was terminated):

$$
\begin{aligned}
Z_i \quad &= \mathbb{P}(\widehat{D_{i(r),t=\tau}} = 1) \\
&+[1 - \mathbb{P}(\widehat{D_{i(r),t=\tau}} = 1)] \cdot \mathbb{P}(\widehat{D_{i(r),t=\tau+1}} = 1) \\
&+[1 - \mathbb{P}(\widehat{D_{i(r),t=\tau+1}} = 1)] \cdot \mathbb{P}(\widehat{D_{i(r),t=\tau+2}} = 1) + ... \\
&+[1 - \mathbb{P}(\widehat{D_{i(r),t=1933}} = 1)] \cdot \mathbb{P}(\widehat{D_{i(r),t=1934}} = 1).
\end{aligned} \tag{3}
$$

Equations (2) and (3) describe how we construct the instrument Z_i. 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 .[26] We therefore proceed with 2SLS estimation, where

$$
\text{FeeSimple}_{i(j)} = \alpha_1 \times \text{Issue-Year}_i + \alpha_2 \times \text{Z}_i + \kappa_j + \lambda' X_i + \varepsilon_{ij} \tag{4}
$$

forms the first-stage equation and equation (1) is the second stage.

We expect that the later an allotment was issued, the less likely it was to be converted to fee simple before 1934, i.e. $\widehat{\alpha_1} < 0$; and the constructed likelihood of conversion should predict the actual likelihood, i.e. $\widehat{\alpha_2} > 0$. We recognize that the first instrument, Issue-Year$_i$, also plays an important role in the construction of the second instrument. There is nothing econometrically wrong with this as long as one instrument is not linearly dependent on the other. The instrument Z_i should be thought of as a way of aggregating into a single measure the rotation of agents with varying propensities for conversion of land into fee simple. Panel B in Table 3 reports on the results of estimating the first-stage equation (4). The table follows the same structure as previous tables of incrementally more conservative geographic controls and more fine-grained spatial fixed effects. In the most conservative specification in column 6, we find that an allotment that was issued 25 years earlier than a neighboring allotment in the same one-mile square was 37 percent (0.0149×25) more likely to have been converted into fee simple. Similarly, we find that an allotment that had a predicted likelihood $Z_i = 1$ of being converted to fee simple was in fact 43 percent more likely to have been converted into fee simple than a neighboring allotment $Z_i = 0$.

Panel A in Table 3 reports on the results of estimating the associated second-stage equation (1). The instruments are strong across specifications, as indicated by the *Wald F statistic*. The *p-value* on

[26] See Pagan (1984) and Wooldridge (2010, pp116–117).

Table 3: IV Results

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:	*Second Stage*					
FeeSimple	.6666	.5193	.4307	.3374	.4633	.2917
	[5.398e-19]	[6.765e-13]	[1.481e-09]	[1.172e-04]	[2.053e-05]	[3.239e-02]
	{1.680e-07}	{3.581e-06}	{4.861e-05}	{2.502e-04}	{1.279e-02}	{2.513e-02}
Observations	66,975	66,975	66,975	66,123	65,334	57,570
Kleibergen-Paap Wald rk F statistic	79.99	80.92	80.63	63.60	48.10	22.07
Hausman-p	0.00190	0.00611	0.0222	0.0542	0.215	0.193
Hansen p-value	0.0211	0.0451	0.0814	0.177	0.211	0.385
Panel B:	*First Stage*					
Allotment Year	-.02088	-.02058	-.02029	-.019	-.01765	-.01495
	[0.000e+00]	[0.000e+00]	[0.000e+00]	[3.109e-270]	[1.105e-229]	[3.130e-140]
	{8.070e-22}	{6.699e-22}	{7.280e-22}	{2.119e-18}	{5.643e-15}	{3.343e-09}
Z_i	.5866	.5942	.5996	.5667	.5397	.4264
	[6.744e-37]	[2.254e-37]	[6.177e-37]	[4.177e-35]	[5.139e-35]	[1.645e-21]
	{2.258e-04}	{2.147e-04}	{2.115e-04}	{3.033e-04}	{7.235e-04}	{6.765e-03}
R-squared	0.5515	0.5528	0.5550	0.6184	0.6785	0.8005
Land Quality Controls		*linear*	*binned*	*binned*	*binned*	*binned*
Township FE	✓	✓	✓			
4 FE per Townshp				✓		
9 FE per Townshp					✓	
36 FE per Townshp						✓

Notes: Across columns, this table has the same structure as Table 2, including the same number of observations and fixed effects, which are not re-reported. Panel A shows the second stage results of instrumenting fee-simple status with the year of an allotment's issuance and with Z_i from expression (3). In square brackets, we report *p-values* for standard errors clustered at the township level; In braces, we report *p-values* for standard errors clustered at the township level.

Hansen's over-identification *J-statistic* suggests that the local average treatment effects of the two instruments become more in line with each other in columns 4–6. Finally, the *Hausman test* for endogeneity indicates no significant difference between OLS and IV in the last two columns. In summary, the key test statistics in Table 3 all appear to validate our instrumental variable strategy, so that we view these results as our best causal estimate of the effect of fee simple property rights on land use. Our preferred estimate in column 5 suggests that land utilization on fee simple land is about 0.46 standard deviations higher than on trust land.

5 Heterogeneity, Dynamics, and Mechanisms

Our core comparison is between allotted lands of two types: fee simple and trust. In Sections 4.2 and 4.3, we make this comparison by investigating a single land utilization index in the most recent available NWALT cross-section. In this section, we explore three subtleties underlying this comparison: (*i*) we explore the effects on each land use (agricultural cultivation and land development) separately; (*ii*) we explore the evolution of the effect of property rights on the two different land uses over time (1974–2012); (*iii*) we investigate the extent to which our fee-simple effect is mediated by its proposed underlying mechanisms of ownership fractionation and of access to credit; (*iv*) we investigate land use on tribally-owned unallotted lands relative to the baseline comparison.

Development and cultivation (*i*): Table 4 investigates the effect of fee-simple on one land use, while controlling for the other. Panel A of Table 4 presents our baseline results for land development. The first column reports results while controlling for the alternative land use share and using PLSS townships as the spatial fixed-effect. We always control for the share of land under cultivation because the prevalence of long-term agricultural leases is an important economic constraint on reservations that cannot quickly adjust (Trosper, 1978; Cornell and Kalt, 1992). The model in column 2 adds the three linear land-quality controls; *p-values* with standard errors clustered by township are reported in brackets and the alternative clustering by reservation are reported in braces for the main coefficient of interest. Column 3 switches from linear controls to a flexible binned approach that includes dummy variables indicating whether a parcel is in a given decile of the elevation, ruggedness, and soil quality distributions. Fee-simple land has significantly more development. The coefficient estimate in column 3 indicates a fee-simple plot has around fifty-five percent more development than

Table 4: Baseline Cross-Sectional Results for Land Development

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Development						
Fee-Simple	0.557	0.461	0.447	0.312	0.167	0.140
	[3.6e-07]	[6.7e-06]	[7.4e-06]	[3.8e-04]	[.0502]	[.0638]
	{.0019}	{.0011}	{.0018}	{.0145}	{.191}	{.1591}
Share Cultivated	-0.0182	-0.0204	-0.0244	-0.0236	-0.0231	-0.0227
	[2.6e-08]	[2.5e-09]	[1.3e-10]	[9.2e-09]	[3.2e-09]	[9.2e-08]
Adjusted R-squared	0.416	0.422	0.423	0.538	0.614	0.740
Panel B: Cultivation						
Fee-Simple	7.767	6.811	5.647	4.682	3.929	2.870
	[5.6e-66]	[1.1e-60]	[9.7e-49]	[2.4e-39]	[6.4e-29]	[1.9e-15]
	{4.2e-10}	{1.7e-08}	{1.2e-07}	{6.8e-07}	{1.4e-06}	{.00103}
Share Developed	-0.281	-0.305	-0.339	-0.353	-0.355	-0.372
	[2.0e-15]	[2.5e-18]	[3.3e-22]	[4.0e-17]	[2.7e-20]	[2.6e-15]
Adjusted R-squared	0.537	0.557	0.589	0.657	0.703	0.797
Observations	68,792	68,791	68,791	67,906	67,102	59,175
# Fixed Effects	2,516	2,516	2,546	6,889	10,972	21,321
Land Quality Controls		*linear*	*binned*	*binned*	*binned*	*binned*
Township FE	✓	✓	✓			
4 FE per Townshp				✓		
9 FE per Townshp					✓	
36 FE per Townshp						✓
Trust Share Dev (2012)	.80943	.80945	.80945	.7918	.80086	.77725
Fee Share Dev (2012)	1.952	1.952	1.952	1.9404	1.9304	1.9385
Trust Share Cultiv (2012)	11.193	11.194	11.194	11.205	11.208	11.24
Fee Share Cultiv (2012)	28.225	28.225	28.225	28.333	28.481	29.574

Notes: This table has the exact identical structure to Table 2, including the same number of observations and fixed effects. In square brackets, we report *p-values* for standard errors clustered at the township level; In braces, we report *p-values* for standard errors clustered at the township level.

trust land ($0.447/0.809$). This is reduced down to about twenty percent in our preferred specification in column 5 ($0.167/0.8$).

Panel B indicates a similar relationship for the share of land in cultivation. The coefficient estimate from column 3 indicates the share of cultivation is fifty percent larger relative to the mean on trust land ($5.647/11.194$), and about thirty-five percent in our preferred specification in column 5 ($3.93/11.2$).[27] Much of the agricultural cultivation on reservations happens through leases, where the inability to collateralize may not be very important. However, Anderson and Lueck (1992, 434) make it clear that fractionated ownership can still create substantial frictions even in the ability to lease out trust-land: "*since leasing and other land use decisions require unanimous agreement by all shareholders, costs of negotiating leases can be prohibitive*."

Evolution over time (*ii*) : The results in the previous sections reveal striking differences in the pattern of land use in 2012 across allotted trust vs. fee-simple land *within* small geographic areas on reservations, conditional on land quality. The repeat waves of NWALT data allow us to examine the time-path of development on allotted trust vs. fee simple land. To do so, we begin by estimating the following equation:

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

where $\sum_{t=1982}^{2012} \gamma_t (FeeSimple_i \times \tau_t)$ is a series of interactions between the fee-simple indicator and the year fixed effects. All other variables are defined as before. This specification allows the effect of fee-simple tenure on land use to be different in each year, and these effects are captured by the γ_t coefficients; γ captures the difference between fee-simple and allotted trust in 1974 while γ_t measures the change in the fee simple effect from 1974 to year t. Hence, $\gamma > 0$ would capture a base-line persistent difference between trust and fee-simple, and $\gamma_t > 0$ would capture divergence between fee simple a trust land from 1974 to year t.

Table 5 presents the results of examining the coefficients from equation (5), with development as the outcome in columns 1–3. To conserve space, Table 5 presents only the three most conservative spatial fixed effects: columns 1–2 correspond to columns 5–6 of Table 2. Both columns condition

[27] Panels B and C of Appendix-Table A3 shows very similar results to Table 4 when the land use outcome is measured in the NLCD.

Table 5: The Effect of Tenure on Development Over Time

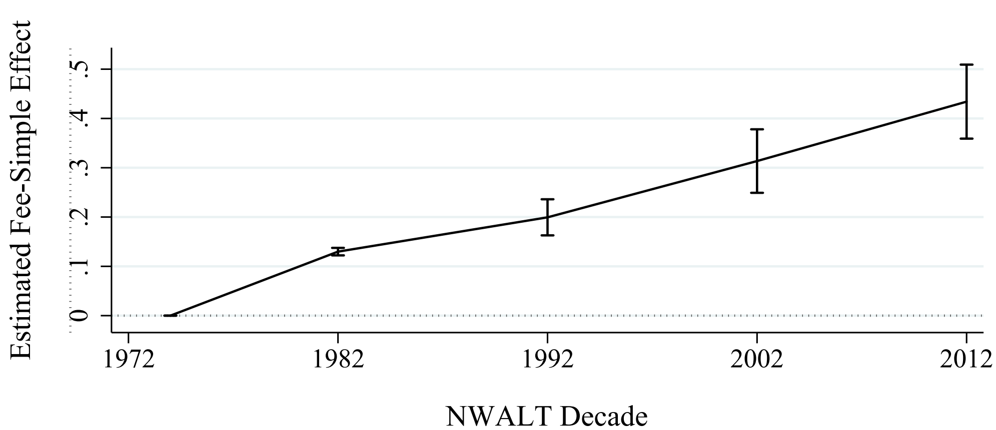
	(1) Developed	(2) Developed	(3) Developed	(4) Cultivated	(5) Cultivated	(6) Cultivated
Fee-Simple	-0.0977	-0.110		3.593	2.602	
	[.2681]	[.2643]		[7.5e-05]	[5.0e-04]	
Fee-Simple x 1982	0.132	0.128	0.130	0.179	0.177	0.151
	[2.1e-04]	[1.1e-04]	[2.4e-06]	[.0321]	[.0058]	[1.1e-05]
Fee-Simple x 1992	0.209	0.203	0.199	-0.0373	-0.0602	-0.101
	[3.4e-05]	[2.2e-06]	[1.1e-04]	[.53]	[.1277]	[.0044]
Fee-Simple x 2002	0.322	0.316	0.314	0.137	0.109	0.0506
	[5.0e-06]	[4.0e-06]	[1.7e-04]	[.0669]	[.0261]	[.2078]
Fee-Simple x 2012	0.436	0.430	0.434	0.369	0.341	0.262
	[1.1e-06]	[2.1e-06]	[9.2e-05]	[.0022]	[3.7e-04]	[.0026]
Share Cultivated	-0.0207	-0.0206	-0.0394			
	[3.2e-04]	[7.6e-04]	[.0095]			
Share Developed				-0.332	-0.292	-0.122
				[4.9e-05]	[4.2e-04]	[.008]
year=1982	0.0834	0.0834	0.0867	0.202	0.199	0.185
	[1.4e-04]	[2.8e-05]	[5.4e-06]	[.0036]	[5.9e-04]	[6.8e-06]
year=1992	0.125	0.125	0.133	0.456	0.451	0.432
	[3.0e-05]	[4.8e-06]	[3.4e-05]	[1.5e-04]	[2.1e-05]	[3.8e-06]
year=2002	0.177	0.177	0.192	0.838	0.831	0.804
	[8.2e-06]	[1.6e-06]	[6.7e-05]	[1.4e-05]	[1.8e-06]	[3.4e-06]
year=2012	0.229	0.229	0.245	0.919	0.911	0.875
	[2.4e-06]	[5.1e-07]	[4.9e-05]	[9.2e-06]	[1.2e-06]	[3.1e-06]
Land Quality Controls	*binned*	*binned*	*binned*	*binned*	*binned*	*binned*
Township FE						
4 FE per Townshp						
9 FE per Townshp	✓			✓		
36 FE per Townshp		✓			✓	
Parcel			✓			✓
Observations	344,368	344,331	344,183	344,368	344,331	344,183
# Fixed Effects	13,069	31,308	69,010	13,069	31,308	69,010
Allot. Shr Devel. (1974)	.61794	.61794	.61792			
Fee Shr Devel. (1974)	1.3295	1.3296	1.3299			
Allot. Shr Cultiv. (1974)				10.329	10.329	10.328
Fee Shr Cultiv. (1974)				27.126	27.126	27.124
Adjusted R-squared	0.628	0.783	0.913	0.748	0.870	0.989

Notes: This table shows how the effect of fee simple on land use has changed since 1974. Columns 1–3 consider land development as the outcome, columns 4–6 consider cultivation. In columns 1–2 and 4–5, this table uses the more fine-grained spatial fixed effects in Table 2. In columns 3 and 6, it adds quarter-section fixed effects, the most fine-grained possible. The coefficient-estimates on year fixed effects are the $\hat{\tau}_t$ in equation (5). Further, the 'Fee-Simple $\times$ year' coefficients report on the $\hat{\gamma}_t$ in equation (5). These display a monotonic divergence between fee-simple and trust land over time.

on pre-existing differences in land use through 1974. In addition, column 3 introduces individual quarter-section fixed effects, which cannot be included in the cross-section. We report the specifications with coarser-grained spatial fixed effects in Appendix-Table A5. Across specifications, we detect a negative but only marginally significant difference in the share of developed land on fee simple parcels in 1974 ($\hat{\theta}_{1974} = 0$).[28] This is consistent with the narrative that non-agricultural economic development only came to reservations in the early 1970s. The table shows that land development has monotonically increased since then even on trust land, i.e. $\hat{\tau}_t > 0$ and growing in 1982, 1992, 20002, and 2012. The difference in the rate of development across tenure regimes is striking: there is a monotonic increase in the difference between fee simple and trust land over time ($\hat{\gamma}_t > 0$) that is nearly unchanged across columns. Whether one focuses on broader within-township or narrow within-quarter-section comparisons, the change in development from 1974 to 2012 is almost three times greater on fee simple land, i.e. $(\hat{\gamma}_{2012} + \hat{\tau}_{2012})/\hat{\tau}_{2012} = (0.43 + 0.23)/0.23$. As a point of reference, $\hat{\gamma} + \hat{\gamma}_{2012} = -0.11 + 0.43 = 0.32$ approximates a comparison of 2012 fee-simple land to 1974 trust land.

Figure 7 plots the coefficient estimates from column 3 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 the context of Figure 1 .

Figure 7: Decade-Specific Fee-Simple Coefficients Relative to 1974



Notes: This figure plots the coefficient estimates and confidence bands on $\hat{\gamma}_t$ in column 3 of Table 5

[28] By construction, the quarter-section fixed effect specification normalizes this difference to zero.

Columns 4–6 of Table 5 present the panel results for cultivation. In contrast to development, we find evidence that fee simple lands had significantly higher rates of cultivation than trust lands in 1974 ($\hat{\gamma} > 0$). There is also less evidence that the gap in cultivation is widening in a dramatic fashion. Although there are some indication of slight changes in cultivation decade-on-decade, these changes are small relative to the level difference in 1974 and they are sensitive to the choice of clustering and fixed effects. In summary, around eighty percent in the difference between fee-simple and trust in agricultural production in 2012 is a function of differences that already existed in 1974.

Unbundling the benefits of fee-simple (*iii*): Throughout the paper, we posit that allotted-trust land suffers from the twin problems of getting fractionated into a multitude of ownership claims and of not being collateralizable. In this part, we unbundle these two underlying mechanisms. To do so, we take advantage of two additional data sources that allow us to measure access to credit and fractionation at the reservation level. Credit access is an issue on many reservations, where even the owners of fee simple land still face significant practical hurdles in obtaining loans because commercial banks — not wanting to deal with the jurisdictional hassles (Anderson and Parker, 2008) — simply do not provide credit to reservation residents and businesses. When this is the case, neither fee-simple nor allotted trust landowners have access to credit, rendering the inability to collateralize trust land less important. In some cases, this credit gap is 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). The Federal Reserve's Center for Indian Economic Development (CIDC) provides a database of 96 such financial institutions and their geo-location.[29] We overlay this location information with current reservation boundary maps to match institutions to specific reservations. We posit that a reservation has access to a bank if at least one bank is located within it. In the appendix, we also consider specifications where banks are located just off a reservation and can potentially serve more than one.

We are also able to test whether the benefits of fee simple ownership vary with the extent of fractionation on allotted trust land. We predict that the benefits of fee simple ownership will be larger on reservations with more severe fractionation, which may impair development and cultivation by raising the transaction costs of making land use decisions. To test this hypothesis, we utilize a 2013 BIA report that provides information on various dimensions of fractionation (Department of Interior,

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

Table 6: Bank Access and Fractionation

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Banking Access						
Fee-Simple	0.2157	0.1826	0.1530	0.1047	0.09446	0.05352
	[8.1e-13]	[1.5e-10]	[7.7e-08]	[3.5e-05]	[2.4e-05]	[.0387]
	{1.6e-10}	{6.6e-08}	{1.4e-05}	{5.4e-05}	{6.1e-06}	{.1967}
Fee-Simple	0.2685	0.2325	0.2111	0.2011	0.1558	0.1247
x D(Bank Access)	[7.6e-07]	[7.5e-06]	[4.1e-05]	[1.0e-04]	[.0066]	[.0053]
	{.00058}	{.0006}	{.00503}	{.01168}	{.06124}	{.101}
Panel B: Fractionation						
Fee-Simple	0.3608	0.2959	0.2450	0.1741	0.1119	0.06163
	[1.5e-23]	[1.2e-20]	[3.2e-16]	[2.9e-11]	[3.8e-07]	[.0112]
	{0.00007}	{0.0000019}	{0.000039}	{0.00023}	{0.000064}	{0.1129}
Fee-Simple	0.03927	0.05681	0.07150	0.09461	0.1364	0.1182
x D(Highly Fractionated)	[.5117]	[.3267]	[.2033]	[.0894]	[.0255]	[.0096]
	{0.7197}	{0.5399}	{0.4355}	{0.3125}	{0.1265}	{0.08702}
Panel C: Banking Access & Fractionation						
Fee-Simple	0.2203	0.1770	0.1396	0.08177	0.05306	0.01836
	[1.1e-08]	[1.2e-06]	[1.1e-04]	[.0118]	[.0771]	[.5394]
	{2.8e-05}	{.00012}	{.00524}	{.07154}	{.2167}	{.7592}
Fee-Simple	0.2707	0.2298	0.2045	0.1893	0.1299	0.1009
x D(Bank Access)	[2.5e-07]	[3.4e-06]	[2.7e-05]	[7.1e-05]	[.0095]	[.0176]
	{.00158}	{.00082}	{.00794}	{.01074}	{.05913}	{.1552}
Fee-Simple	-0.01136	0.01369	0.03308	0.05614	0.1051	0.09255
x D(Highly Fractionated)	[.8443]	[.8054]	[.5379]	[.2807]	[.0545]	[.0338]
	{.9054}	{.8549}	{.6878}	{.4945}	{.1712}	{.2009}
Land Quality Controls		*linear*	*binned*	*binned*	*binned*	*binned*
Township FE	✓	✓	✓			
4 FE per Townshp				✓		
9 FE per Townshp					✓	
36 FE per Townshp						✓
Observations	62,582	62,582	62,582	61,926	61,286	54,182
# Fixed Effects	2,021	2,021	2,051	6,005	9,787	19,454
Adjusted R-squared	0.308	0.322	0.338	0.464	0.512	0.686

Notes: Panel A checks the interaction between fee-simple with a reservation's bank coverage; Panel B checks the interaction with a reservation's degree of land fractionation Panel C regresses the land utilization index on both measures at the same time. The Adjusted R-squared does not vary across panels, and is therefore reported only once.

2013). For each reservation, we know the total number of fractionated interests, the number of parcels held in trust, and the number of parcels that the BIA labels as "highly fractionated," i.e. with 50 interests or more.[30] From this we calculate the average number of interests per parcel and the share of highly fractionated trust parcels, 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 per parcel. We then interact this variable with the fee simple indicator.

Table 6 reports the results for the mechanism tests. Panel A addresses banking access, Panel B focuses on fractionation, and Panel C includes both banking and fractionation together. The results in Panel A 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. This suggests that expanded collateralizability is indeed part of the underlying mechanisms that leads fee-simple land to generate higher land utilization. Panel B focuses on the interaction between fee simple property rights and fractionation. The results indicate that the fee simple effect is substantially larger on reservations where trust land is highly fractionated. The column 6 coefficient suggests that highly fractionated reservations exhibit a fee-simple effect that is nearly three times as large as less fractionated reservations. This is consistent with the hypothesis that fractionation impairs land utilization on trust land by raising the transaction costs of making land use decisions.

Finally, Panel C includes both mechanisms at the same time. Focusing on columns 5 and 6, the baseline fee simple effect in non-fractionated reservations without access to Native American banking is an order of magnitude smaller than the main fee simple effect in Table 2. On the other hand, banking access and a high degree of fractionation both increase the benefit of fee simple ownership relative to trust land. The point estimates on both interactions in Panel C are very similar to those in Panels A and B, indicating that bank access and fractionation vary independently of one another. Overall, the results suggest that a substantial portion of the negative effect of transfer restrictions can be explained by the inability to collateralize land and the negative consequences of fractionation. The appendix checks on the robustness of these results to alternative measures. Appendix-Table A6 expands the definition of bank coverage to include banks that are "just off" the reservation; by either 10 or 25 miles. The resulting point estimates on the interaction term become marginally smaller but remain

[30] 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.

highly significant. The same table also considers as an alternative measure of fractionation based on the reservation-share of allotted-trust quarter sections that the Department of Interior (2013) dataset characterizes as highly fractionated.

Tribally owned land (*iv*): The majority of all reservation lands remains tribally owned today. An investigation of land use on tribal lands is therefore of intrinsic interest to anyone concerned with Native American economic development. At the same time, we view this investigation as orthogonal to our focus on transfer rights. To conserve space, we therefore report the tables from this investigation in Appendix E, and only discuss the headline results here: Across all tables, the core results on fee-simple land relative to the omitted category of trust land are only very marginally affected by including tribal land. Tribal land itself has a land utilization index that is about 0.03 standard deviations higher than trust land, and 0.17 standard deviations lower than fee-simple land. The difference between tribal lands and trust lands is exclusively driven by development and not agriculture. (See Appendix-Tables A8 and A9.) Panel results show that tribal lands were considerably *less* developed than trust land in 1974, and have since caught up with and even leapfrogged it at a steady rate similar to that of fee simple land. In contrast, tribal lands had somewhat more land in cultivation in 1974, but this share has since grown at a lesser rate than on trust lands. Overall, the picture for tribal lands is more mixed than for fee simple. In summary, tribal land is more efficiently used than trust land today; but this positive difference is small, it is concentrated in development, not cultivation, and its trajectory over time has not been as monotonic as for fee-simple land. (See Appendix-Table A10.)

6 Land Value Implications

In this section, we develop a back-of-the-envelope estimate of the impact of trusteeship on land *values*. Our approach is to utilize data on land use and land values for over 1.5 million reservation-adjacent parcels to estimate the effect of land utilization on land values at the parcel level. We then use these coefficients to translate the estimated effect of trusteeship on land utilization from Section 4 into land values. Finally, we discuss how our calculation could be applied out-of-sample to assessor data in rural majority-black counties in the South to generate what we view as first estimate of the cost of heir's property for a representative 160-acre parcel.

Estimating the Effect of Property Rights on Land Values: We cannot directly estimate the effect of trusteeship on land values because county assessor data on land values are not available for many of the reservations in our sample. Even where we do observe assessor data on reservations, there are several complications. First, many trust parcels are simply treated as "exempt" by county assessors because they are legally owned by the federal government. Second, the treatment and valuation of reservation lands varies from one county to the next — even within reservations — making comparisons difficult. Third, estimated values for trust parcels (when they exist) are systematically different because trust parcels can never have actual transactions from which to estimate market value.[31]

We therefore instead focus on off-reservation lands that are subject to a common set of assessment practices. We use these data to estimate a general relationship between land utilization and land value that can be applied to similar, but out-of-sample reservation lands. County assessor data are normally published at the county-level, and tend not to be available in counties that are close to, or overlap with reservations, as mentioned in the discuss of the GLO data. Fortunately, Montana and Washington State are exceptions to this rule, as each state makes available the universe of assessed land values.[32] These two states have the additional advantage that they are each home to several major reservations, 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 25 miles of reservations. Figure 8 depicts the set of parcels used for the analysis. We calculate NWALT land use as well as land characteristics for each property in the same way that we do for quarter-sections. After excluding tax exempt land we are left with roughly 1.5 million individual properties for which we know both land use and land value.

We estimate the effect of land utilization in 2012 on 2019 land values at the property level using the following linear regression model

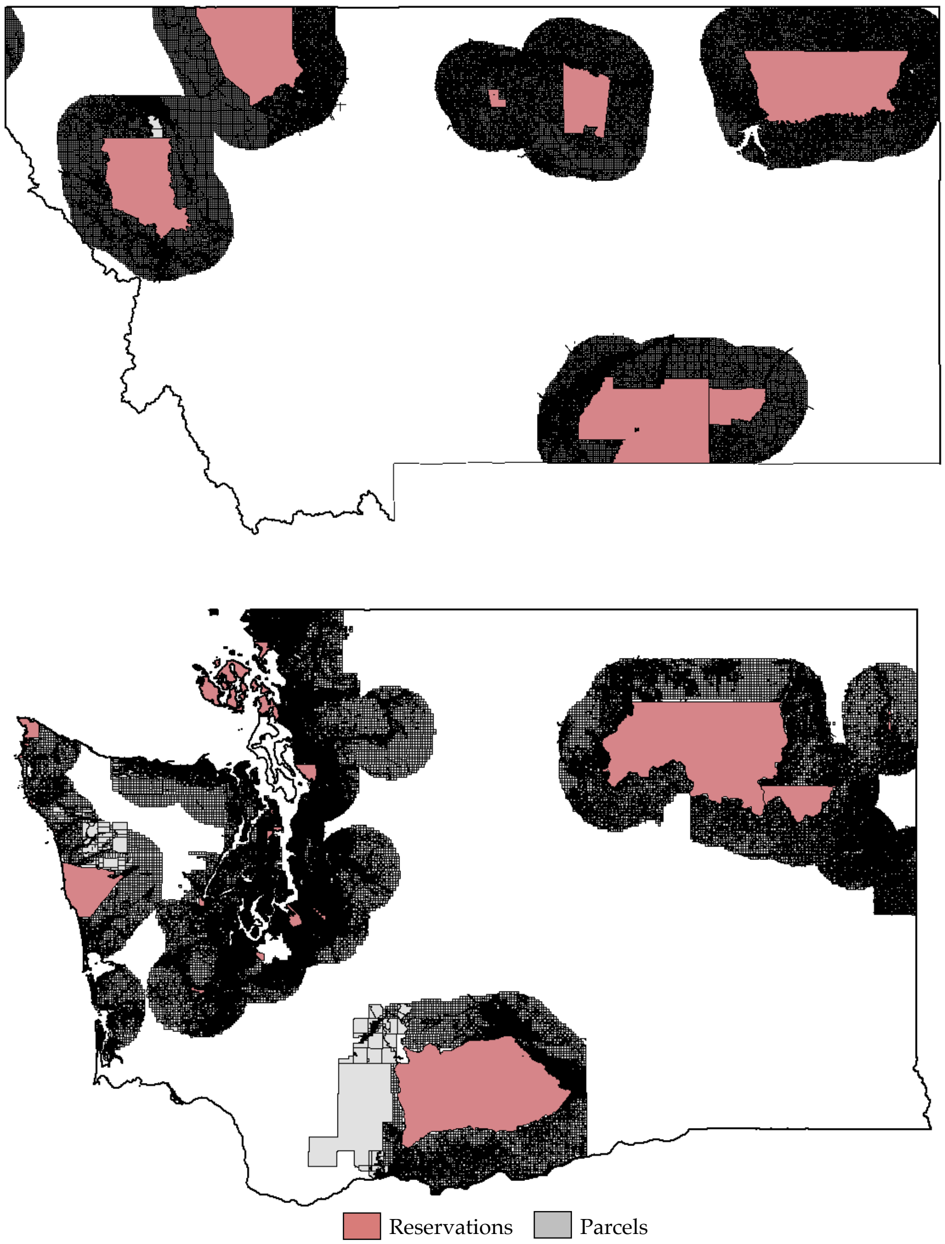
$$ln(y_{ij}) = \delta \times Z(Use)_i + \kappa_j + \lambda' X_i + \varepsilon_{ij}, \tag{6}$$

where $ln(y_{ij})$ is the natural log of land value per acre for property i in spatial region j and $Z(Use)_i$ is the standardized land utilization measure discussed in Section 4. We focus on *land value* per acre and

[31] By design, there are *zero* transactions of trust parcels on which to base value estimates. The upshot is that trust parcels are likely to be valued systematically differently than fee simple parcels for reasons other than land utilization.

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

Figure 8: Assessor Data Properties



Notes: This figure depicts assessed properties (grey) in Montana and in Washington state that satisfy two criteria: 1) they Are in reservation-adjacent counties (reservations indicated in red) and ii) they are within 25 miles of a reservation. The large, un-subdivided areas are government-owned property that we exclude from the estimation sample.

exclude the estimated value of buildings to provide a lower bound estimate of the increase in property value to due to greater utilization. The assessed value of buildings includes both value-added and the cost of developing infrastructure, whereas land value includes only the increase in the value of the land itself associated with increases in utilization.

Table 7: Estimated Effects on Land Value per Acre (LVPA)

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Pooled						
Fee Simple	\$11,808	\$7,058	\$3,146	\$15,466	\$9,662	\$4,394
Median LVPA	\$367,393	\$367,393	\$367,393	\$410,045	\$410,045	\$410,045
$\delta \times \theta$	0.431 x 0.0734	0.463 x 0.0411	0.292 x 0.0292	0.431 x 0.0859	0.0503 x 0.0503	0.292 x 0.0365
Panel B: Montana						
Fee Simple	\$20,925	\$19,811	\$10,170	\$13,931	\$13,731	\$6,877
Median LVPA	\$273,583	\$273,583	\$273,583	\$169,750	\$169,750	\$169,750
Panel C: Washington						
Fee Simple	\$7,465	\$4,228	\$2,035	\$9,275	\$5,511	\$2,709
Median LVPA	\$373,639	\$373,639	\$373,639	\$430,103	\$430,103	\$430,103
Township FE	✓			✓		
9 FE per Townshp		✓			✓	
Section FE			✓			✓
Distance	10 mi	10 mi	10 mi	25 mi	25 mi	25 mi

Notes: Columns 1–3 of the table use all properties within 10 miles of reservation and columns 4–6 use properties within 25 miles of a reservation. The estimates are based on regression estimates of land value on land utilization that include binned resource controls and township, 1/9-township, or section fixed effects, i.e. the equivalents of columns 3, 5, and 6 of Table 2.

The coefficient of interest is δ, which reflects the percentage increase in land value per acre for a one-unit increase in the land utilization measure for property i. We estimate equation (6) on the pooled sample was well as separately for each state to get state-specific estimates of δ. We also estimate equation (6) utilizing two different samples that include properties within 10 vs. 25 miles of reservations in each state and report results with township, 1/9 township, and PLSS section fixed effects. 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. The results are reported in Appendix-Table A12. Across nearly all models, there is a statistically significant increase in land values associated with an increased in the land utilization measure.

Finally, we combine our estimates of δ from Appendix-Table A12 with estimates of θ from Table 3 and information on median land values to estimate the effect of fee simple property rights as:

$$\frac{\partial LVPA}{\partial FeeSimple} = [exp^{\hat{\delta}\times\hat{\theta}} - 1] \times \text{Median(LVPA)} \tag{7}$$

Table 7 presents the results of this calculation as well as the median land value used in each calculation. Panel A reports the results for the pooled sample, whereas Panel B reports results for Montana and Panel C reports results for Washington State. The pooled estimates for the effect of fee simple property on land values in Panel A range from \$3,000 to \$11,600 per acre. This suggests that the total value of a 160-acre fee simple quarter section would exceed a comparable quarter section held in trust by \$480,000 to \$1.8 million. The per quarter section results are reported in Appendix-Table A13. The effect becomes smaller with progressively finer spatial fixed effects, reflecting the change in the estimated effects of fee simple ownership on land utilization from Table 3.

Panels B and C reveal important heterogeneity between Montana and Washington. The Montana estimates range from roughly \$10,000 to \$20,000 within 10 miles of reservations and from \$6,700 to \$13,300 within 25 miles of reservations. The estimates are lower for the sample that includes parcels further from the reservation primarily because median land value per acre is smaller in this sample (the coefficients in Appendix-Table A12 do not differ much across the two samples). Washington exhibits the inverse pattern: the expanded 25-mile sample has a higher median land value per acre and hence a larger estimated effect of fee simple. The estimates of fee simple ownership in Washington range from \$2,000 – \$7,300 in 10-mile sample to \$2,700 – \$9,200 in the 25-mile sample.

The differential pattern of estimates across Montana and Washington can be explained by differences in land utilization across the two states. Land values in Montana are, on average, much lower than land values in Washington. In Montana, land just outside reservations happens to be relatively valuable, likely due to proximity to amenities including Glacier National Park, Flathead Lake, and several ski resorts. Land values fall when moving to the 25-mile sample because this expanded radius pulls in less valuable land in remote areas with less development. Washington exhibits the opposite patterns — land values are lower closer to reservations — because most reservations are in the Puget Sound Region, which includes Seattle and has much greater levels of development overall. Hence, expanding to a larger set of parcels in Washington is more likely to include highly developed and highly valuable properties within the Seattle metropolitan area.

The results from both states also suggest that the impact of trusteeship on land values may be highest in relatively undeveloped areas: the net effect of land utilization on land values is much larger in areas where the land utilization and land values are lower. This pattern — larger effects when land values are lower — holds both within and between states. The upshot is that the scope for improving land values by resolving the issues associated with trust lands may be greatest where land utilization and land values are both low, a situation that characterizes many reservation lands.

To obtain equivalent calculations for a counterfactual comparison to tribally-owned lands, we can scale the numbers reported in Table 7 by the ratio of $\hat{\theta}_{\text{fee}}$ and $\hat{\theta}_{\text{tribe}}$ in Appendix-Table A8, i.e. by $\times 0.15 \approx 0.0326/0.2139$.[33]

Applying our Estimate to Heir's Property Land: One area of the U.S. that faces very similar land tenure problems to those on reservations is Black-owned land in the South, where a history of intestacy (the lack of will-writing), and historic credit limits have conspired to make fractionated land ownership a serious problem. Thirty-five to fifty percent of all Black-owned land in the rural South is such heir's property (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 that arises from this. It is viewed as a major contributor to rural poverty in the South. Yet, there are no causally identified studies of its impact. We recognize that allotted-trust land and heir's property are not identical and we discuss the differences in detail in Appendix F.1. However, allotted-trust land and heir's property are sufficiently similar in their economic problems that we nonetheless view the calculations we present here as a best available estimate of the cost of heir's property, in the absence of any existing causally identified estimates of this cost.

[33] This calculation compares two partial correlations; as opposed to dividing the OLS coefficient on tribal land 0.0326 in Appendix-Table A8 by the causal estimate 0.4633 in Table 2.

7 Conclusion

Property rights are a cornerstone of economic development. Yet they are often incomplete or imperfect in practice. This is particularly true of the land rights of many already disadvantaged groups, e.g. indigenous peasants in Latin America and sub-Saharan Africa, Southern Black landowners, Native Americans in the U.S. and Canada. These groups have usufruct and exclusion rights over their land, but cannot transfer these rights. Without control over the transfer of their property, land owners cannot collateralize their land and under certain conditions cannot prevent the proliferation of fragmented ownership claims that raise transaction costs.

This paper estimates the consequences 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. For this comparison, we address statistical identification concerns in two ways: one approach relies on ever-finer spatial fixed effects, down to a level where we compare one quarter-section land to at most three adjacent quarter-sections within the same one-mile-square radius. A second approach instruments fee simple title with exogenous variation in the date an allotment was made, interacted with the exogenous rotation of the BIA agents who had historically decided if and when land allotments were converted to full property rights. In our most conservative specification, we find that full property rights increase the share of land under development by about twenty percent, and the share of land under agricultural cultivation by about thirty-five percent. A panel analysis reveals that the land development effect is entirely driven by post-1974 divergence, whereas eighty percent of the agricultural cultivation effect was already present in 1974. We discuss that this pattern is consistent with the over-time evolution of structural transformation of economic activity on reservations.

Finally, we develop a back-of-the-envelope estimate of the negative impact of trusteeship on land values by combining the NWALT data on land use with county assessor data on land values for over 1.5 million reservation-adjacent parcels with the estimated effect of trusteeship on land utilization on reservations. This exercise indicates that fee simple title adds between $4,000 and $15,000 in value to an acre of land, or between $500,000 and $1.8 million to a quarter section.

While our core focus is on comparing privately held trust land to fee-simple land, we also extend the analysis to include tribally owned land. In the 2012 cross-section, tribally owned land falls in between trust and fee-simple land in both land development and agricultural production, and in the panel, development on tribally owned land increased over time relative to trust land at about half the rate of divergence of fee-simple land. In summary, land with non-transferable private property rights not only fared worse than land with complete private property rights, but it also fared worse than land with communal property rights.

It is important to be careful when considering policy implications based on our findings. Clearly, allotted-trust appears to be the worst possible state of affairs for land on Native American reservations: it is inefficiently used *and* tribes do not exert sovereign control over it. Our results suggest that converting this land to full fee simple private property rights would clearly be the best outcome in terms of the economic value freed up for the owners of the land. However, economic value is clearly not the sole consideration. Tribal sovereignty matters, and fee simple may not be the preferred outcome if tribes are concerned about preserving the integrity of their land base. While converting allotted-trust land to tribal control may be better in that respect, it would likely free up fewer economic gains and would also involve the tricky question of compensation to the owners of trust land. However, the choice between the two need not be this stark: owners of trust land could be granted fully transferable property rights, thus maximizing the value from these lands. but it could be left to tribes to decide collectively whether this transferability extends only within the tribe or beyond. Mexico's second land reform (*Procede*) in the 1990s and 2000s offers a useful template in this regard: indigenous farmers were given full title to the land that they had long held usufruct rights to, but it was the communal *ejidos* who then collectively decided whether these rights were transferable only within or also outside the ejido. 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

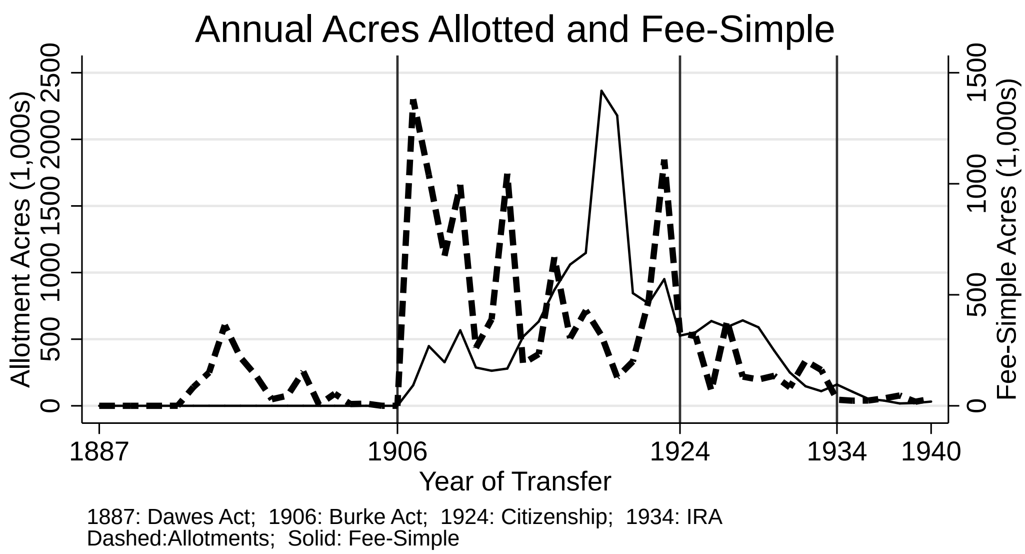
Appendix A Background and Data Appendix

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.

Economic development on reservations from allotment to today: The *Assimilation Era* ended with the 1934 IRA, which also ended allotment. 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

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.

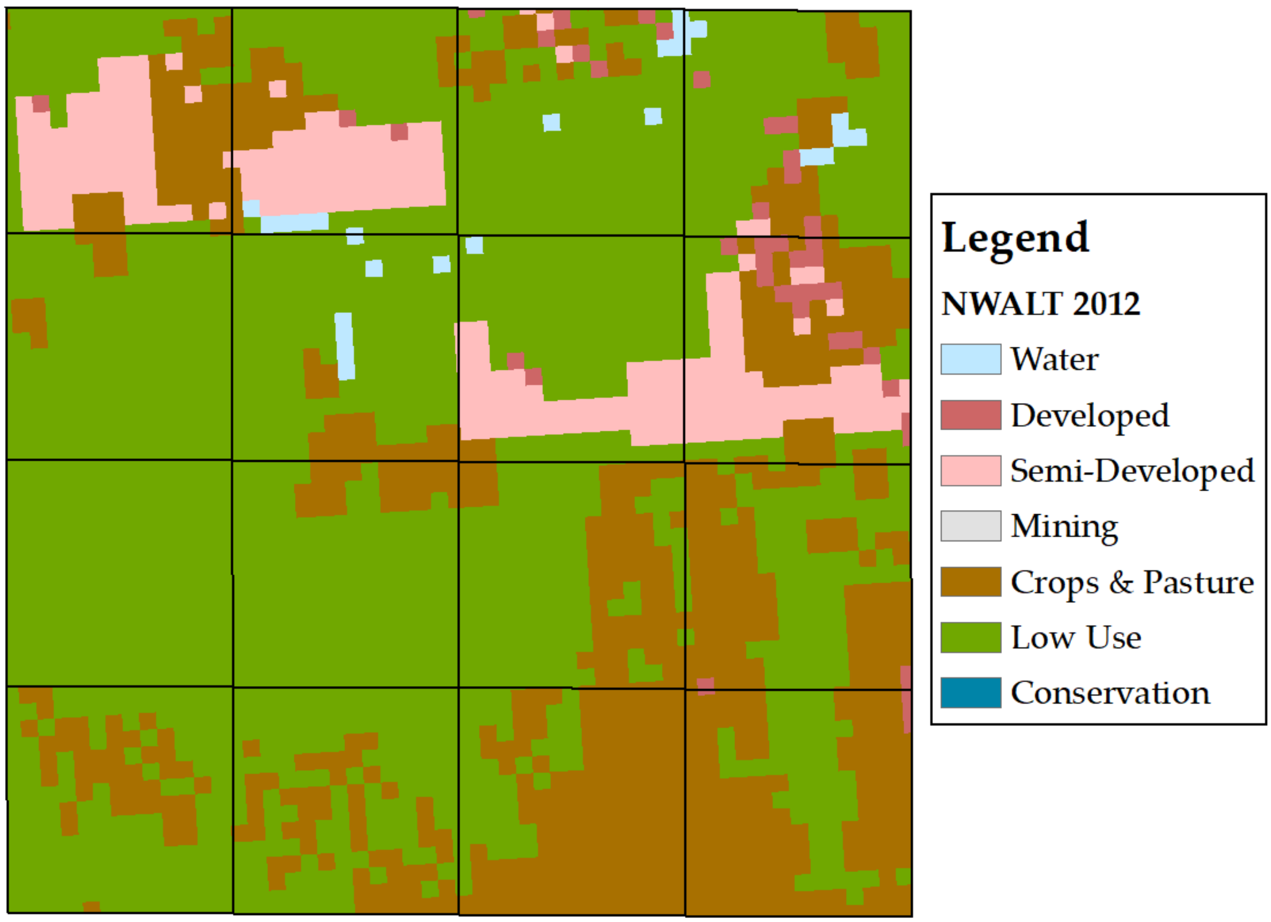
from those of the previous Roosevelt administration. This period was defined by the passing of two concurrent federal acts in 1953—the *Termination Act*, and *Public Law 280*— which Treuer (2019, p255) describes as "a dry pair of names for two exceptionally bloody acts." These acts put control of federal 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).[34] 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).

[34] 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.

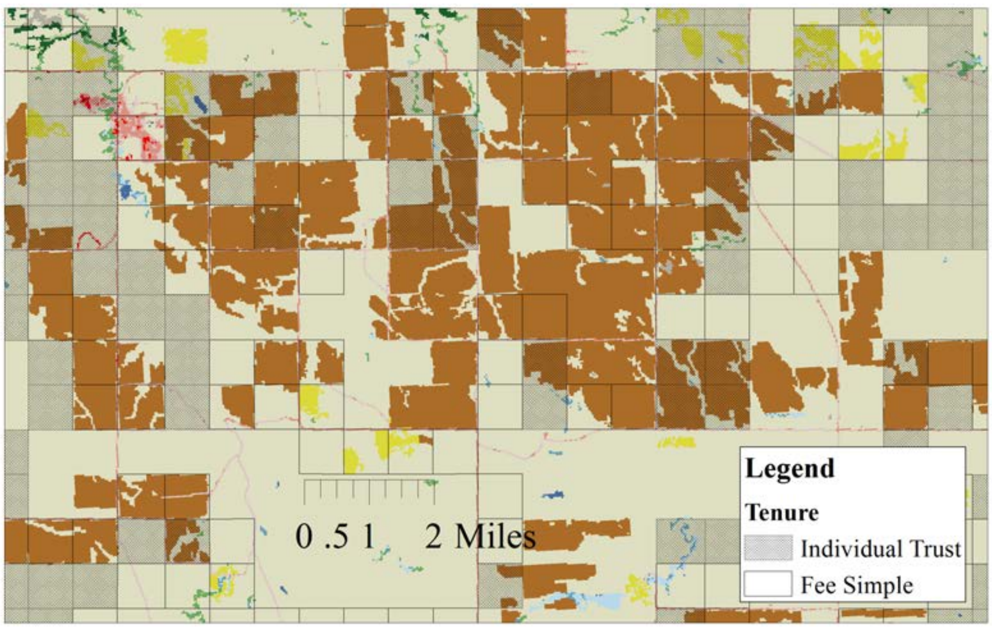
Figure A3: NWALT Data Finest Breaksdown



Notes: This figure shows the most fine-grained version of the NWALT data, which breaks the 'other' category in Figure 4 into finer sub-categories.

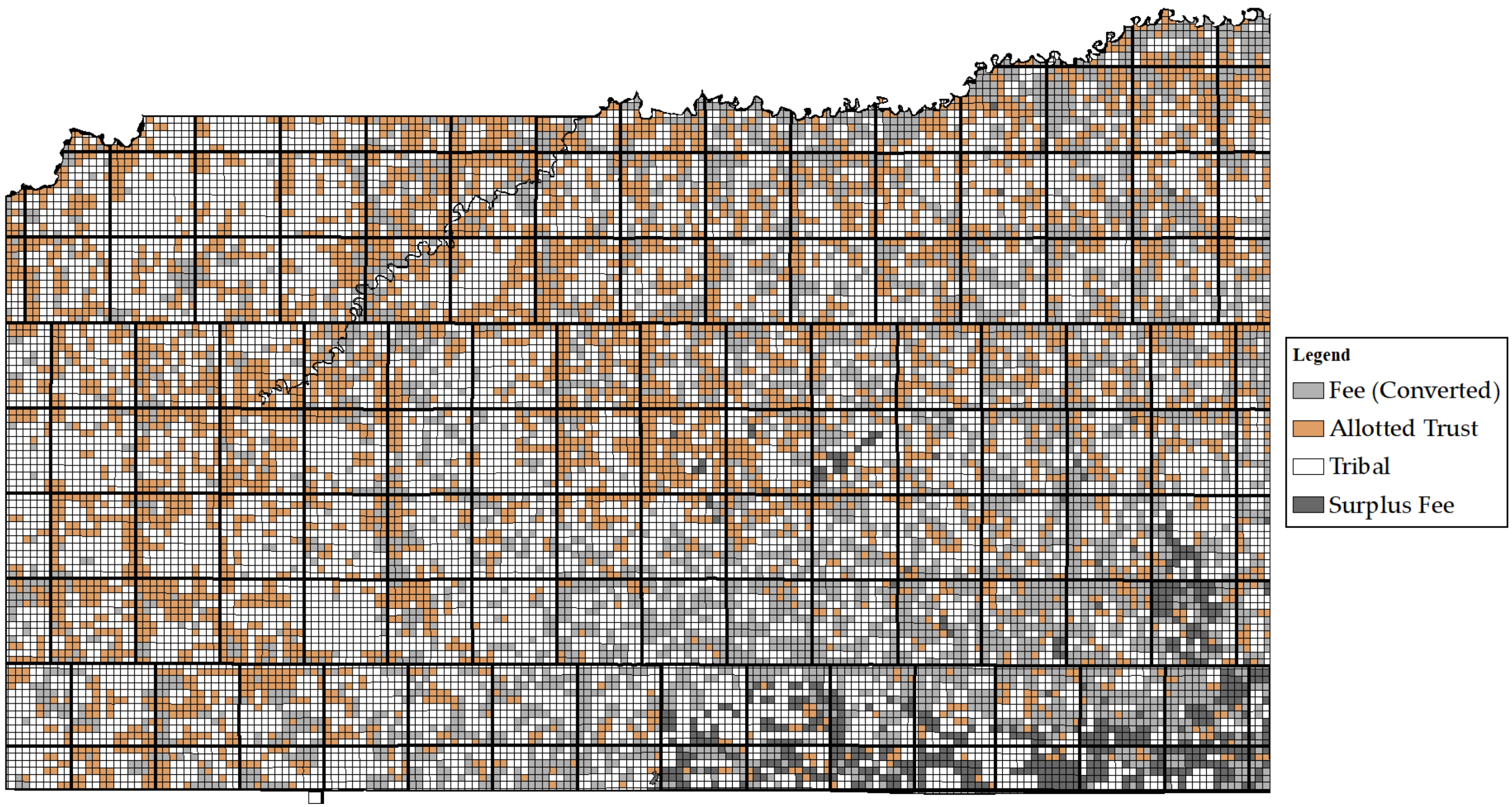
Appendix B Data Appendix

Figure A4: Land Cover Data (NLCD)



Notes: This figure shows the NLCD version of Figure 4. This figure depicts the land tenure in addition to land use data from the National Land Cover Database for a subset of the Pine Ridge Reservation. Cross-hatched parcels are in allotted trust and unshaded parcels are in fee-simple. Shading of the 30×30-meter pixels indicates different land uses. Dark brown areas are cultivated crops, pink and red areas are developed (either residential, urban, or built infrastructure), yellow areas are pasture, and tan areas are brush. Green areas indicate forested lands and blue areas indicate water.

Figure A5: Checkerboard Pattern of Land Tenure on the Pine Ridge Reservation



Notes: This is a version of Figure 3 that includes 'Surplus Fee' land.

Appendix C Extensions and Robustness Checks to Section 4.2

Table A1 reports on the geo-graphic controls on column 2 in Table 2 and in Panels A and B in Table 4.

Table A2 re-estimates Panels A and B in Table 4 with spatially adjusted standard errors following Conley (1999, 2010).

Table A3 re-estimates Panels A and B in Table 4 with the NLCD outcome data discussed in footnote 4. (See also Figure A4.)

Table A1: Coefficients on Geographic Controls for Baseline Estimation

	(1) *Z(Use)*	(2) Developed	(2) Cultivated
Fee-Simple	0.335	0.461	6.811
	[3.1e-32]	[6.7e-06]	[1.1e-60]
	{2.28e-10}	{.0011}	{1.7e-08}
Ruggedness	-6.67	-7.513	-186.0
	[1.3e-04]	[.1222]	[1.1e-04]
Elevation	-1.687	-8.826	-11.05
	[6.5e-12]	[1.2e-11]	[.0543]
Soil Quality	57.9	58.14	1459.6
	[9.2e-23]	[8.1e-04]	[4.5e-45]
Share Cultivated		-0.0204	
		[2.5e-09]	
Share Developed			-0.305
			[2.5e-18]
Adjusted R-squared	0.295	0.422	0.557

Notes: Column 1 reports the coefficients on the linearly added geo-controls in column 2 of Table 2 Column 2 reports the coefficients on the linearly added geo-controls in column 2 of the top panel of Table 4, column 3 does this for the bottom-panel.

Table A2: Baseline Cross-Sectional Results with Spatially Adjusted Std. Errors

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Z(Use)	5 KM	10 KM	20 KM	30 KM	40 KM	50 KM
Fee-Simple	0.194	0.194	0.194	0.194	0.194	0.194
	[7.3e-13]	[6.6e-11]	[1.2e-09]	[1.2e-08]	[2.1e-07]	[9.9e-07]
Panel B: Developed	5 KM	10 KM	20 KM	30 KM	40 KM	50 KM
Fee-Simple	0.167	0.167	0.167	0.167	0.167	0.167
	[.0292]	[.0365]	[.048]	[.0575]	[.073]	[.0867]
Panel C: Cultivated	5 KM	10 KM	20 KM	30 KM	40 KM	50 KM
Fee-Simple	3.929	3.929	3.929	3.929	3.929	3.929
	[1.1e-38]	[5.5e-32]	[2.7e-23]	[9.3e-19]	[1.0e-15]	[7.5e-14]
Observations	67,429	67,429	67,429	67,429	67,429	67,429

Table A3: Baseline Cross-Sectional Results using NLCD

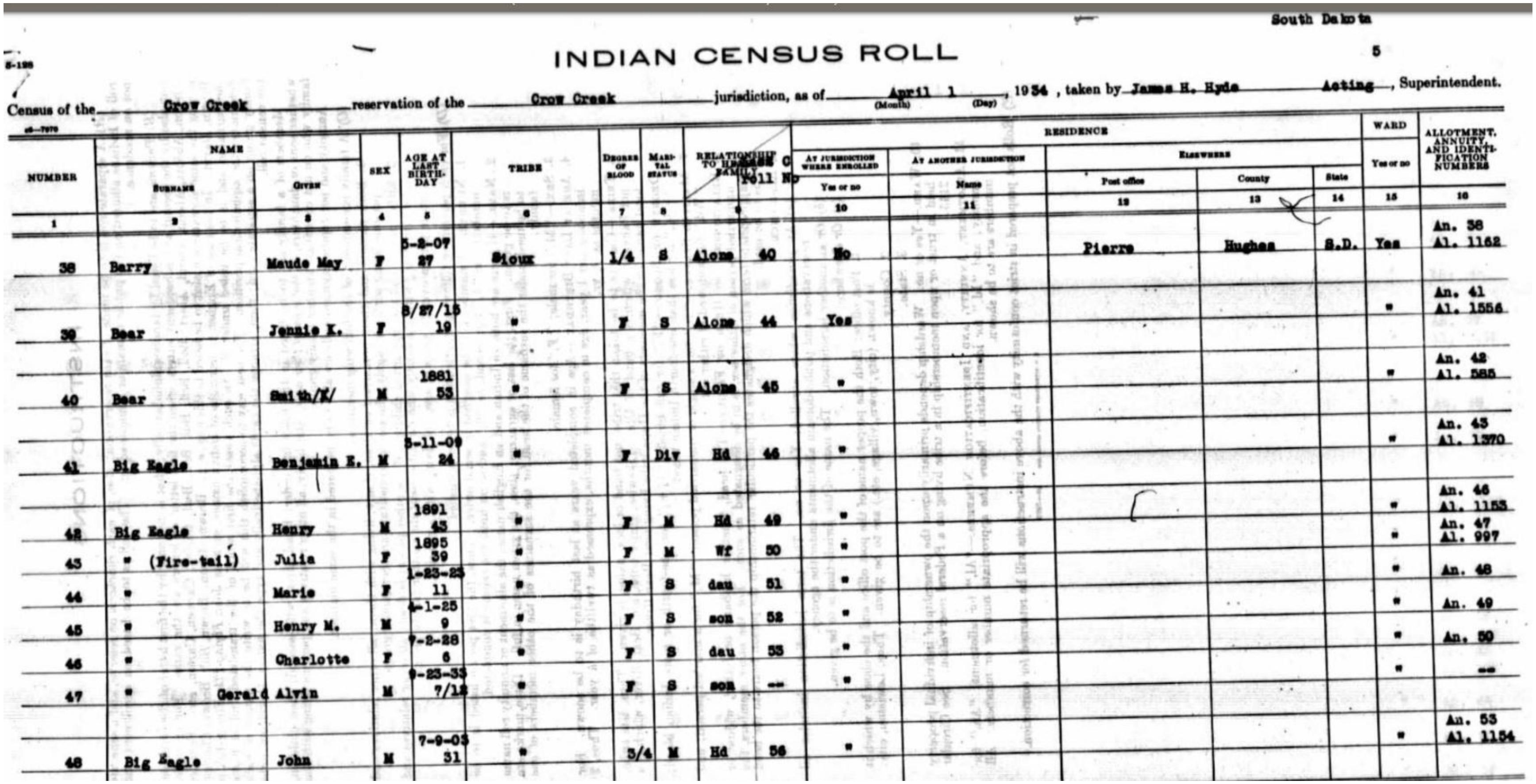
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Z(Use)						
Fee-Simple	0.410	0.351	0.303	0.234	0.174	0.121
	[1.4e-49]	[3.7e-44]	[7.0e-36]	[7.1e-22]	[1.2e-12]	[5.9e-10]
	{1.6e-09}	{3.4e-10}	{3.7e-09}	{4.9e-07}	{5.4e-06}	{.00024}
Adjusted R-squared	0.287	0.298	0.308	0.307	0.321	0.246
Panel B: Developed						
Fee-Simple	0.561	0.460	0.444	0.307	0.176	0.133
	[8.3e-15]	[1.8e-11]	[9.2e-11]	[1.8e-06]	[.0025]	[.0501]
	{3.1e-05}	{1.5e-05}	{7.3e-05}	{.00315}	{.03365}	{.09648}
Cultivated	-0.00603	-0.00926	-0.0133	-0.0140	-0.0146	-0.0149
	[.0168]	[4.8e-04]	[4.0e-06]	[2.7e-06]	[6.6e-07]	[3.9e-07]
Adjusted R-squared	0.401	0.410	0.412	0.493	0.553	0.653
Panel C: Cultivated						
Fee-Simple	8.141	7.181	5.986	4.813	3.900	3.024
	[2.5e-61]	[2.9e-57]	[3.9e-47]	[2.1e-39]	[3.0e-26]	[1.2e-14]
	{4.3e-09}	{5.7e-08}	{3.0e-07}	{1.9e-06}	{8.1e-06}	{.00225}
Developed	-0.151	-0.224	-0.300	-0.307	-0.318	-0.299
	[.0043]	[5.5e-06]	[4.4e-11]	[1.1e-11]	[4.3e-13]	[2.9e-12]
Adjusted R-squared	0.551	0.571	0.603	0.670	0.714	0.803
Land Quality Controls		*linear*	*binned*	*binned*	*binned*	*binned*
Township FE	✓	✓	✓			
4 FE per Townshp				✓		
9 FE per Townshp					✓	
36 FE per Townshp						✓
Observations	68,808	68,807	68,807	67,917	67,116	59,192
# Fixed Effects	2,516	2,516	2,546	6,888	10,973	21,329
Allot Shr Devel (2011)	1.5427	1.5427	1.5427	1.528	1.533	1.5127
Fee Shr Devel (2011)	3.0662	3.0662	3.0662	3.0642	3.0546	3.0594
Allot Shr Cultiv (2011)	10.982	10.982	10.982	10.991	11	11.05
Fee Shr Cultiv (2011)	29.932	29.932	29.932	30.039	30.211	31.358

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.

Figure A6: Sample Page of the Indian Census Rolls



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South Dakota

INDIAN CENSUS ROLL

5

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

Number	Name: Surname	Name: Given	Sex	Age at last birthday	Tribe	Degree of blood	Marital status	Relationship to head of family	1911 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	3-11-09 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

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).[35] 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.

Three 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, (*ii*) There needed to have enough rotation of agents. For exogeneity, (*iii*) 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). The second element is that there needs to be enough rotation of agents to gain the statistical power to estimate judges' propensity to transfer land into fee simple. For (*ii*), there needs to be enough rotation of agents to gain the statistical power to estimate judges' propensity to transfer land into fee simple. In our setting, the frequent rotation of BIA agents across reservations, and the long panel of annual transfer-decisions that covers all allotted reservations allows us to separate the agent fixed effect from reservation-traits.

For (*iii*), 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.[36] From the perspective of selection, the ideal institutional setting would be one

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

[36] 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

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 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.[37] To quantify the relationship between agents' pay and the agents' estimated fixed effects, we estimate regression.

$$AgentPay_{jrt} = \mu_r + \delta_t + \beta \cdot \widehat{\mu_{j(\cdot)}} + \epsilon_{jrt}, \tag{8}$$

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 A4 reports the results of estimating equation (8). 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.

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. $TrustLandQuality_j$.[38] We then ask whether $\widehat{\mu_{j(\cdot)}}$ correlated with $TrustLandQuality_j$, conditional on the land quality of the

lasting twelve years.

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

[38] 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.

Table A4: 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 (8). Column (2) reports the results of estimating equation (9). 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

available land pool:

$$TrustLandQuality_j = \beta \cdot \widehat{\mu_{j(\cdot)}} + \gamma \cdot TotalLandQuality_j + \epsilon_j \tag{9}$$

Column (2) of Table A4 reports the results of estimating equation (9). There is no evidence that higher land transfer propensity correlates with the quality of allotted land, relative to what land was available.

Appendix E Extensions to Panel-Results in Section 5

Table A5 shows the coarser-grained equivalents of Table 5.

Table A7 reports on an expanded version of Table 1 that includes 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.)

Table A6 reports on robustness checks for Table 6 by While Table 6 considers whether a reservation has a bank inside of it, Panels A and B of Table A6 expand the definition to include banks that are "just off" the reservation. While Table 6 takes as the measure of fractionation the average number of claims (interests) per allotted-trust quarter sections, Panel C of Table A6 uses instead the reservation-share of allotted-trust quarter sections that the dataset characterizes as highly fractionated.

Table A8 re-estimates Table 2 with tribal lands included.

Table A9 re-estimates Table 4 with tribal lands included.

Table A10 re-estimates Table 5 with tribal lands included. Similar to Table 5, development is estimated to have grown at a rate of two and a half times as fast on fee-simple land as on allotted-trust land; $(\gamma^{\hat{Fee}}{}_{2012} + \hat{\tau}_{2012})/\hat{\tau}_{2012} = (0.45 + 0.29)/0.29$. Development on tribal land also grew faster than on allotted-trust land, at about twice the rate; $(\gamma^{\hat{Tribe}}{}_{2012} + \hat{\tau}_{2012})/\hat{\tau}_{2012} = (0.34 + 0.29)/0.29$.

Table A11 re-estimates Table A5 with tribal lands included.

Table A5: Panel Results: Checks for Coarser-Grained Fixed Effects

	(1) Developed	(2) Developed	(3) Developed	(4) Cultivated	(5) Cultivated	(6) Cultivated
Fee-Simple	0.257	0.156	0.0316	7.503	5.392	4.368
	[.0165]	[.0819]	[.6773]	[3.5e-06]	[9.9e-06]	[2.7e-05]
Fee-Simple x 1982	0.133	0.134	0.133	0.163	0.171	0.178
	[.0013]	[.0011]	[5.3e-04]	[.0984]	[.0732]	[.0473]
Fee-Simple x 1992	0.211	0.209	0.211	-0.0723	-0.0529	-0.0373
	[2.3e-04]	[2.2e-04]	[8.8e-05]	[.3902]	[.4943]	[.5811]
Fee-Simple x 2002	0.323	0.322	0.325	0.0928	0.118	0.136
	[4.1e-05]	[3.9e-05]	[1.4e-05]	[.2873]	[.1719]	[.0963]
Fee-Simple x 2012	0.435	0.435	0.439	0.311	0.345	0.365
	[1.1e-05]	[1.0e-05]	[3.1e-06]	[.0135]	[.0076]	[.0039]
Share Cultivated	-0.0158	-0.0216	-0.0210			
	[4.8e-04]	[2.5e-04]	[3.0e-04]			
Share Developed				-0.275	-0.339	-0.335
				[5.5e-05]	[2.6e-05]	[3.7e-05]
year=1982	0.0825	0.0835	0.0834	0.197	0.202	0.202
	[5.5e-04]	[4.8e-04]	[2.5e-04]	[.0134]	[.0105]	[.0062]
year=1992	0.123	0.126	0.126	0.449	0.457	0.456
	[1.4e-04]	[1.2e-04]	[6.3e-05]	[6.6e-04]	[5.2e-04]	[2.9e-04]
year=2002	0.173	0.178	0.178	0.829	0.839	0.838
	[3.9e-05]	[3.4e-05]	[1.6e-05]	[6.2e-05]	[4.9e-05]	[2.7e-05]
year=2012	0.225	0.230	0.230	0.907	0.921	0.920
	[1.3e-05]	[1.2e-05]	[5.0e-06]	[4.1e-05]	[3.2e-05]	[1.7e-05]
Land Quality Controls		*binned*	*binned*		*binned*	*binned*
Township FE	✓	✓		✓	✓	
4 FE per Townshp			✓			✓
9 FE per Townshp						
36 FE per Townshp						
Parcel						
Observations	344,378	344,373	344,370	344,378	344,373	344,370
# Fixed Effects	2,929	2,959	8,184	2,929	2,959	8,184
Allot. Shr Devel. (1974)	.61792	.61794	.61794			
Fee Shr Devel. (1974)	1.3295	1.3295	1.3295			
Allot. Shr Cultiv. (1974)				10.328	10.329	10.329
Fee Shr Cultiv. (1974)				27.126	27.126	27.126
Adjusted R-squared	0.393	0.400	0.538	0.553	0.603	0.690

Notes: This table is the equivalent of Table 5, but uses the coarser-grained fixed effects from columns 1–4 in Table Table **??**.

Table A6: Robustness Checks to Collateralizability-Mechanism Results

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Banking Access within 10 mi						
Fee-Simple	0.2187	0.1972	0.1683	0.1162	0.09130	0.04385
	[3.4e-10]	[9.1e-10]	[1.9e-07]	[2.6e-05]	[1.1e-04]	[.1305]
	{7.0e-08}	{6.6e-08}	{4.4e-05}	{.00046}	{.00059}	{.3712}
Fee-Simple	0.2248	0.1781	0.1587	0.1533	0.1358	0.1197
x D(Bank Access)	[2.1e-05]	[3.5e-04]	[.0014]	[.0014]	[.0079]	[.0055]
	{.00427}	{.00967}	{.03348}	{.04486}	{.07385}	{.1077}
Panel B: Banking Access within 25 mi						
Fee-Simple	0.2142	0.1948	0.1785	0.1230	0.09281	-0.02572
	[1.0e-05]	[5.3e-06]	[3.4e-05]	[.0019]	[.0051]	[.5461]
	{.00138}	{.00093}	{.00595}	{.02122}	{.03838}	{.6677}
Fee-Simple	0.1968	0.1543	0.1230	0.1213	0.1115	0.1847
x D(Bank Access)	[9.7e-04]	[.0044]	[.0233]	[.0201]	[.0277]	[2.6e-04]
	{.03358}	{.05535}	{.1553}	{.1425}	{.15}	{.0185}
Panel C: Alternative Fractionation						
Fee-Simple	0.3807	0.3056	0.2595	0.1864	0.1277	0.07297
	[3.7e-23]	[2.2e-19]	[2.9e-16]	[1.5e-10]	[7.4e-07]	[.0056]
	{7.1e-05}	{1.0e-05}	{7.3e-05}	{.00018}	{2.2e-05}	{.07358}
Fee-Simple	0.001265	0.03572	0.04122	0.06665	0.09806	0.08568
x D(Highly Fractionated)	[.9829]	[.5315]	[.4509]	[.2198]	[.0907]	[.052]
	{0.991}	{0.7052}	{0.6573}	{0.478}	{0.2715}	{0.2199}
Land Quality Controls		*linear*	*binned*	*binned*	*binned*	*binned*
Township FE	✓	✓	✓			
4 FE per Townshp				✓		
9 FE per Townshp					✓	
36 FE per Townshp						✓
Observations	62,582	62,582	62,582	61,926	61,286	54,182
# Fixed Effects	2,021	2,021	2,051	6,005	9,787	19,454
Adjusted R-squared	0.308	0.322	0.338	0.464	0.512	0.686

Notes: This table reports on robustness checks for Table 6 by (*i*) expanding the definition of banking coverage (Panels A and B), and (*ii*) considering an measure of land ownership fractionation (Panel C).

Table A7: Summary Stats (Table 1) with Tribal Lands Added

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Fee-Simple vs. Trust				
Panel A:	*Trust*	*Fee-Simple*	Unconditional Difference	Conditional: Township-FE	Conditional: 1/4 Township	Conditional: 1/9 Township	Conditional: 1/36 Township
Z(Use)	3.1e-09	.7187	.7187	0.3630	0.2536	0.1685	0.1354
	(1.007)	(2.474)	[<1.0e-40]	[<1.0e-40]	[<1.0e-40]	[<1.0e-40]	[7.4e-09]
Developed	.6179	1.331	.7135	0.3008	0.1609	0.0443	0.0538
	(4.164)	(6.945)	[3.9e-09]	[5.6e-04]	[.0117]	[.4518]	[.3923]
Cultivated	10.33	27.15	16.82	7.3619	5.3877	4.0865	2.8644
	(25.74)	(35.98)	[<1.0e-40]	[<1.0e-40]	[<1.0e-40]	[<1.0e-40]	[1.6e-15]
Elevation	938.1	728.4	-209.7	-8.5616	-4.2150	-0.5593	-0.1606
	(459.6)	(354.4)	[1.7e-33]	[7.6e-09]	[1.9e-09]	[.1815]	[.6445]
Ruggedness	14.01	12.68	-1.334	-1.1509	-0.6702	0.0830	-0.0456
	(21.26)	(39.26)	[.1252]	[1.1e-05]	[5.8e-09]	[.537]	[.619]
Soil Quality	9.704	11.6	1.898	0.4543	0.2283	0.0251	0.0028
	(4.434)	(3.882)	[<1.0e-40]	[<1.0e-40]	[5.8e-11]	[.3206]	[.901]
Observations	42,164	26,393	68,557	…	…	…	…
Panel B:	*Trust*	*Tribal (Unalloted)*	Tribal vs. Trust				
Z(Use)		-.1614	-0.1614	0.026	0.021	0.0251	0.0013
		(1.766)	[9.7e-16]	[.0583]	[.0587]	[.0168]	[.8833]
Developed		.5797	-0.0382	0.0815	0.0473	0.0454	0.0224
		(5.347)	[.6449]	[.0825]	[.2011]	[.1554]	[.4624]
Cultivated		3.806	-6.522	-0.1131	0.1263	0.1791	-0.2124
		(16.88)	[6.5e-27]	[.732]	[.6125]	[.4301]	[.2451]
Elevation		1447	508.6	18.9772	11.6101	7.2832	3.8385
		(661)	[<1.0e-40]	[<1.0e-40]	[<1.0e-40]	[2.2e-16]	[1.4e-11]
Ruggedness		19.46	5.452	2.4468	1.6782	1.1711	1.023
		(25.09)	[1.8e-33]	[<1.0e-40]	[1.2e-14]	[5.3e-10]	[8.2e-06]
Soil Quality		7.406	-2.299	-0.1509	-0.1272	-0.1144	-0.0647
		(5.217)	[<1.0e-40]	[.0079]	[.0023]	[4.5e-04]	[.0313]
Observations	42,164	295,139	337,303	…	…	…	…

Notes: *(a)* 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.

Table A8: Table 2 with Tribal Lands Added

	(1)	(2)	(3)	(4)	(5)	(6)
Fee-Simple	0.3768	0.3604	0.3128	0.2415	0.2139	0.1354
	[5.4e-31]	[9.7e-29]	[5.7e-22]	[1.7e-18]	[3.5e-18]	[3.2e-13]
	{3.71e-09}	{9.91e-09}	{3.0e-06}	{1.7e-06}	{1.23e-08}	{3.6e-05}
Tribal (Unalloted)	0.01752	0.04585	0.03991	0.03788	0.03259	0.02003
	[.2233]	[.002]	[.007]	[.0024]	[.0039]	[.0931]
	{0.537}	{0.1104}	{0.0821}	{0.1130}	{0.1133}	{0.3922}
Adjusted R-squared	0.499	0.499	0.5	0.577	0.666	0.709
Observations	267,340	267,340	267,340	266,420	265,819	256,760
# Fixed Effects	4,339	4,339	4,369	14,285	23,837	71,603
Land Quality Controls		*linear*	*binned*	*binned*	*binned*	*binned*
Township FE	✓	✓	✓			
4 FE per Townshp				✓		
9 FE per Townshp					✓	
36 FE per Townshp						✓

Notes: This table has the exact identical structure to Table 2. In square brackets, we report *p-values* for standard errors clustered at the township level; In braces, we report *p-values* for standard errors clustered at the township level.

Table A9: Table 4 Results with Tribal Land Added

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:	Developed	Developed	Developed	Developed	Developed	Developed
Fee-Simple	0.605	0.611	0.567	0.355	0.257	0.193
	[2.9e-07]	[1.5e-07]	[8.5e-07]	[9.9e-05]	[.0031]	[.0188]
	{.00251}	{.00158}	{.00336}	{.0145}	{.07697}	{.20806}
Tribal (Unalloted)	0.0543	0.132	0.142	0.105	0.0658	0.0486
	[.37]	[.0367]	[.0226]	[.0417]	[.1665]	[.3404]
	{.52194}	{.21176}	{.13888}	{.18592}	{.33643}	{.56138}
Cultivated	-0.0257	-0.0258	-0.0296	-0.0307	-0.0308	-0.0396
	[6.5e-05]	[7.4e-05]	[7.0e-06]	[3.5e-05]	[1.5e-05]	[3.9e-04]
Adjusted R-squared	0.484	0.486	0.487	0.620	0.666	0.775
Panel B:	Cultivated	Cultivated	Cultivated	Cultivated	Cultivated	Cultivated
Fee-Simple	7.082	7.009	6.228	4.965	4.427	3.289
	[1.9e-66]	[6.0e-68]	[1.7e-61]	[3.1e-52]	[7.4e-47]	[2.3e-30]
	{2.9e-09}	{1.9e-09}	{2.2e-09}	{2.6e-08}	{8.5e-08}	{6.8e-06}
Tribal (Unalloted)	-0.133	0.0292	0.0174	0.239	0.226	-0.106
	[.6894]	[.9289]	[.9553]	[.3284]	[.3138]	[.5665]
	{.89948}	{.97722}	{.98494}	{.74512}	{.70758}	{.77043}
Developed	-0.127	-0.126	-0.138	-0.160	-0.158	-0.206
	[9.9e-06]	[1.1e-05]	[4.5e-07]	[1.5e-06]	[5.6e-07]	[1.3e-05]
Adjusted R-squared	0.595	0.600	0.619	0.689	0.733	0.824
Land Quality Controls		*linear*	*binned*	*binned*	*binned*	*binned*
Township FE	✓	✓	✓			
4 FE per Townshp				✓		
9 FE per Townshp					✓	
36 FE per Townshp						✓
Observations	363,747	363,746	363,746	362,567	361,714	351,301
# Fixed Effects	5,777	5,777	5,807	18,747	31,117	95,235
Allot Shr Devel (2012)	.8145	.81452	.81452	.80073	.80468	.77525
Fee Shr Devel (2012)	1.9604	1.9604	1.9604	1.9665	1.9492	1.9672
Tribal Shr Devel (2012)	1.1864	1.1864	1.1864	1.1742	1.1679	1.1149
Allot Shr Cultiv (2012)	11.186	11.186	11.186	11.191	11.197	11.099
Fee Shr Cultiv (2012)	28.207	28.207	28.207	28.27	28.363	28.938
Tribal Shr Cultiv (2012)	4.0072	4.0072	4.0072	4.0025	3.9995	3.9668

Table A10: Adding Tribal Lands to Panel Results in Table 5

	(1) Developed	(2) Developed	(3) Developed	(4) Cultivated	(5) Cultivated	(6) Cultivated
Fee-Simple	-0.04632	-0.07648		4.2061	3.1214	
	[.5015]	[.3517]		[1.6e-05]	[8.0e-05]	
Fee-Simple x 1982	0.1316	0.1299	0.1366	0.1514	0.1551	0.1418
	[9.1e-04]	[3.0e-04]	[2.0e-06]	[.0881]	[.0264]	[8.3e-06]
Fee-Simple x 1992	0.2070	0.2035	0.1931	-0.08432	-0.09605	-0.1163
	[1.4e-04]	[2.5e-05]	[1.3e-04]	[.2702]	[.093]	[.0024]
Fee-Simple x 2002	0.3205	0.3167	0.3142	0.06932	0.05671	0.02785
	[2.3e-05]	[2.6e-06]	[1.7e-04]	[.3559]	[.2656]	[.4474]
Fee-Simple x 2012	0.4315	0.4330	0.4446	0.2854	0.2669	0.2311
	[4.6e-06]	[2.6e-07]	[8.0e-05]	[.0113]	[.0031]	[.0037]
Tribal (Unalloted)	-0.1353	-0.1619		0.4991	0.1201	
	[.1434]	[.0929]		[.0433]	[.5578]	
Tribal x 1982	0.1333	0.1322	0.1235	-0.1355	-0.1353	-0.1461
	[1.1e-05]	[1.8e-06]	[2.7e-06]	[.0107]	[.0017]	[6.0e-06]
Tribal x 1992	0.2067	0.2043	0.1848	-0.3126	-0.3124	-0.3292
	[1.9e-06]	[3.3e-07]	[2.2e-05]	[4.9e-04]	[6.0e-05]	[1.1e-05]
Tribal x 2002	0.3335	0.3291	0.2933	-0.5804	-0.5801	-0.6074
	[4.3e-07]	[4.9e-07]	[4.2e-05]	[4.6e-05]	[5.6e-06]	[1.0e-05]
Tribal x 2012	0.3859	0.3814	0.3443	-0.5948	-0.5945	-0.6259
	[2.3e-07]	[3.5e-07]	[3.3e-05]	[3.9e-05]	[4.9e-06]	[1.1e-05]
Cultivated	-0.02506	-0.03205	-0.08942			
	[9.2e-04]	[.0013]	[.0042]			
Developed				-0.1270	-0.1279	-0.04980
				[4.2e-05]	[2.2e-04]	[.0019]
year=1982	0.08415	0.08538	0.09544	0.1856	0.1857	0.1794
	[6.4e-05]	[6.9e-06]	[8.8e-06]	[.0033]	[4.2e-04]	[2.5e-06]
year=1992	0.1272	0.1301	0.1540	0.4321	0.4323	0.4231
	[1.3e-05]	[2.1e-06]	[4.9e-05]	[1.3e-04]	[1.3e-05]	[3.8e-06]
year=2002	0.1807	0.1862	0.2312	0.8048	0.8049	0.7923
	[5.1e-06]	[2.2e-06]	[1.0e-04]	[1.1e-05]	[9.9e-07]	[3.2e-06]
year=2012	0.2330	0.2389	0.2876	0.8759	0.8761	0.8595
	[1.8e-06]	[9.2e-07]	[6.6e-05]	[7.2e-06]	[6.3e-07]	[2.8e-06]
Land Quality Controls	*binned*	*binned*	*binned*	*binned*	*binned*	*binned*
Township FE						
4 FE per Townshp						
9 FE per Townshp	✓			✓		
36 FE per Townshp		✓			✓	
Parcel			✓			✓
Observations	1820067	1820039	1819878	1820067	1820039	1819878
# Fixed Effects	33,745	1.1e+05	3.6e+05	33,745	1.1e+05	3.6e+05
Allot. Shr (1974)	0.6179	0.6179	0.6179	10.33	10.33	10.33
Fee Shr (1974)	1.33	1.33	1.33	27.13	27.13	27.13
Tribal Shr (1974)	.5797	.5797	.5797	3.806	3.806	3.806
Adjusted R-squared	0.585	0.713	0.832	0.752	0.865	0.989

Table A11: Adding Tribal Lands to Panel Results in Table A5

	(1) Developed	(2) Developed	(3) Developed	(4) Cultivated	(5) Cultivated	(6) Cultivated
Fee-Simple	0.2391	0.2087	0.04041	6.9067	6.0566	4.7681
	[.0079]	[.0139]	[.5254]	[2.5e-06]	[3.5e-06]	[9.3e-06]
Fee-Simple x 1982	0.1328	0.1330	0.1332	0.1391	0.1405	0.1511
	[.0022]	[.0022]	[.0013]	[.1853]	[.1658]	[.1109]
Fee-Simple x 1992	0.2098	0.2088	0.2081	-0.1070	-0.1016	-0.09084
	[4.3e-04]	[4.4e-04]	[2.5e-04]	[.2795]	[.2815]	[.2808]
Fee-Simple x 2002	0.3227	0.3220	0.3221	0.04107	0.04806	0.06197
	[8.5e-05]	[8.5e-05]	[4.1e-05]	[.6582]	[.5899]	[.4464]
Fee-Simple x 2012	0.4342	0.4337	0.4345	0.2469	0.2558	0.2690
	[2.2e-05]	[2.2e-05]	[8.9e-06]	[.0417]	[.0325]	[.0194]
Tribal (Unalloted)	-0.1453	-0.06669	-0.1051	0.1808	0.3214	0.5052
	[.1325]	[.4069]	[.2182]	[.3276]	[.1159]	[.0395]
Tribal x 1982	0.1341	0.1335	0.1333	-0.1372	-0.1354	-0.1342
	[3.0e-05]	[3.6e-05]	[1.9e-05]	[.0309]	[.0279]	[.0176]
Tribal x 1992	0.2084	0.2071	0.2067	-0.3154	-0.3125	-0.3106
	[6.3e-06]	[7.5e-06]	[4.0e-06]	[.0017]	[.0015]	[8.6e-04]
Tribal x 2002	0.3367	0.3344	0.3335	-0.5849	-0.5802	-0.5772
	[1.1e-06]	[1.3e-06]	[6.8e-07]	[1.6e-04]	[1.4e-04]	[7.9e-05]
Tribal x 2012	0.3891	0.3868	0.3859	-0.6000	-0.5946	-0.5911
	[5.9e-07]	[7.0e-07]	[3.5e-07]	[1.4e-04]	[1.2e-04]	[6.7e-05]
Cultivated	-0.02001	-0.02363	-0.02504			
	[.0011]	[7.0e-04]	[6.8e-04]			
Developed				-0.1141	-0.1277	-0.1363
				[6.7e-05]	[3.8e-05]	[2.3e-05]
year=1982	0.08326	0.08390	0.08415	0.1845	0.1856	0.1863
	[2.1e-04]	[2.3e-04]	[1.1e-04]	[.0118]	[.01]	[.0055]
year=1992	0.1251	0.1266	0.1272	0.4306	0.4322	0.4332
	[5.2e-05]	[5.6e-05]	[2.7e-05]	[5.2e-04]	[4.3e-04]	[2.3e-04]
year=2002	0.1767	0.1796	0.1807	0.8027	0.8049	0.8063
	[1.6e-05]	[1.7e-05]	[8.3e-06]	[4.6e-05]	[3.8e-05]	[2.0e-05]
year=2012	0.2287	0.2318	0.2330	0.8731	0.8760	0.8778
	[5.6e-06]	[6.0e-06]	[2.8e-06]	[3.1e-05]	[2.6e-05]	[1.3e-05]
Land Quality Controls		*binned*	*binned*		*binned*	*binned*
Township FE	✓	✓		✓	✓	
4 FE per Townshp			✓			✓
9 FE per Townshp						
36 FE per Townshp						
Parcel						
Observations	1,820,073	1,820,068	1,820,066	1,820,073	1,820,068	1,820,066
# Fixed Effects	6,374	6,404	20,521	6,374	6,404	20,521
Allot. Shr (1974)	0.6179	0.6179	0.6179	10.33	10.33	10.33
Fee Shr (1974)	1.33	1.33	1.33	27.13	27.13	27.13
Tribal Shr (1974)	.5797	.5797	.5797	3.806	3.806	3.806
Adjusted R-squared	0.403	0.407	0.536	0.599	0.622	0.702

Appendix F Extensions and Robustness Checks to Section 6

Table A12: Estimating the Relationship between Land Use and Land Valuations

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Pooled	ln(LVPA)	ln(LVPA)	ln(LVPA)	ln(LVPA)	ln(LVPA)	ln(LVPA)
Z(Use)	0.0734	0.0411	0.0292	0.0859	0.0503	0.0365
	[0.008144]	[0.009398]	[0.01850]	[0.0001500]	[0.0006627]	(0.001583)
Observations	593070	592520	589963	1561882	1560959	1554280
Adjusted R-Squared	0.794	0.818	0.831	0.803	0.827	0.840
Panel b: Montana	ln(LVPA)	ln(LVPA)	ln(LVPA)	ln(LVPA)	ln(LVPA)	ln(LVPA)
Z(Use)	0.171	0.151	0.125	0.183	0.168	0.136
	[0.05306]	[0.08432]	[0.1823]	[0.01327]	[0.01467]	[0.05313]
Observations	70831	70477	68564	200369	199767	194701
Adjusted R-Squared	0.871	0.880	0.885	0.867	0.878	0.884
Panel C: Washington	ln(LVPA)	ln(LVPA)	ln(LVPA)	ln(LVPA)	ln(LVPA)	ln(LVPA)
Z(Use)	0.0459	0.0243	0.0186	0.0495	0.0275	0.0215
	[0.04437]	[0.03965]	[0.05442]	[0.0007919]	[0.002361]	[0.005737]
Observations	522239	522043	521399	1361513	1361192	1359579
Adjusted R-Squared	0.781	0.801	0.816	0.792	0.814	0.827
Land Quality Controls	*binned*	*binned*	*binned*	*binned*	*binned*	*binned*
Township FE	✓			✓		
9 FE per Townshp		✓			✓	
Section FE			✓			✓
Distance Cutoff (mi)	10	10	10	25	25	25

Notes: This table shows the results of estimating equation (6).

Table A13: Estimated Effects on Land Value per Quarter Section

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Pooled						
Fee Simple	$1,859,622	$1,118,598	$501,207	$2,428,971	$1,527,921	$699,242
Median LVPA	$58,782,944	$58,782,944	$58,782,944	$65,607,264	$65,607,264	$65,607,264
Panel B: Montana						
Fee Simple	$3,226,133	$3,060,320	$1,597,724	$2,142,196	$2,112,618	$1,078,580
Median LVPA	$43,773,264	$43,773,264	$43,773,264	$27,160,064	$27,160,064	$27,160,064
Panel C: Washington						
Fee Simple	$1,182,665	$672,603	$324,689	$1,468,165	$876,205	$432,030
Median LVPA	$59,782,176	$59,782,176	$59,782,176	$68,816,448	$68,816,448	$68,816,448
Township FE	✓			✓		
9 FE per Townshp		✓			✓	
Section FE			✓			✓
Distance	10 mi	10 mi	10 mi	25 mi	25 mi	25 mi

Notes: This table shows Table 7 at the per-quarter-section instead of the per-acre index.

Appendix F.1 Intestacy Laws, Fractionation, and Heir's Property

In this section, we discuss the relationship between land fractionation and inheritance laws, and discuss how this connects allotted-trust and heir's property.

Intestacy law is among the oldest of the civil laws established in society (Blackstone, 1878). With the recognition of the individual as distinguished from family property in most cultures, rules of succession to adequately dispose of the decedent's property became necessary (Atkinson, 1953). Guidelines for the distribution of one's property can be found as far back as biblical times when the Israelites were given an intestacy scheme that allowed inheritance by the closest relative (Shumway, 2017, 647). Intestacy laws help in preserving order because, without some legal method of distributing a decedent's property, people may engage in violent conflicts to acquire property rights (Blackstone, 1878). Medieval England developed its intestacy laws around a system of primogeniture, where the eldest male child was afforded exclusive inheritance rights (Shumway, 2017, 648). The English Administration of Estates Act of 1925 effectively abolished the system of primogeniture (Shumway, 2017, 648). The English *strict per stirpes* system was the early standard for America (Dainow, 1937). Under strict per stirpes, the intestate estate is divided at the generation nearest to the decedent into as many shares as there are members of that generation living, or deceased with surviving lineal descendants (Shumway, 2017, 648). In enacting and interpreting intestacy statutes, legislatures and courts have attempted to mirror the desires and wishes of the intestate and also effectuate another goal of public policy: that of providing some security and protection for the surviving dependents of the deceased (Emergency Land Fund, 1980, 150). Intestacy fixes the proportionate share as well as the identity of heirs of an intestates property and generally, rights of inheritance are conferred by statute on blood relatives only (Emergency Land Fund, 1980, 150). The surviving spouse and adopted children are exceptions to this general rule. Intestate schemes designate the class of relatives or heirs who shall inherit and the order in which they inherit (Emergency Land Fund, 1980, 150). If there are no relatives, the next of kin, to the rules of Canon or Civil Law, defines the inheriting class (Emergency Land Fund, 1980, 150).

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 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; Palsson, 2018).

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.

Both Native American trust land and heir's property in the rural South are the result of a history of intestate succession coupled with legal and financial constraints that undermined the ability to resolve the resulting tenancy in common of many claimants. These histories differ in the details: (*i*) fractionation on reservation trust land was in part a result of the government imposing rules of intestate succession on Native Americans, whereas intestacy among Southern Blacks was more of a cultural default that was accentuated by a tendency to not formalize inheritance claims through probate (Gaither 2016, p22, Zabawa 1991, Emergency Land Fund 1980, p38–39);[39] (*ii*) reservation trust land cannot be collateralized by law, whereas heir's property often cannot be collateralized because its fractionated ownership makes contracting prohibitively expensive, and because Black-owned land in the South was historically shut out from capital markets (Collins and Margo, 2011; Aaronson et al.,

[39] Historically, slaves in the U.S. were barred from making wills, and were not allowed to inherit by will (Emergency Land Fund, 1980, p14). The lack of will making carried on in the African American community after the Civil War (Mitchell, 2000). Distrust of the court system also contributed (Emergency Land Fund, 1980, p115).

2017). These differences do imply that solutions to these problems will have to differ in the details: reservation trust land can only be collateralized if the BIA moves it out of trust, while heir's property requires uniform heirship codes that can cut through the messiness of ownership claims (Mitchell, 2019). The broader point that matters to our study is that the economic consequences of both lands' histories are very similar: a lack of collateralizability of one's property, and transaction costs arising from severe fractionation of ownership claims.

This is not to say there are no differences in the details of these end results. On heir's property—like all property held under tenancy in common—each co-owner has full rights to use the property in any manner, all claimants have a right to partition, and under the *ouster doctrine* one claimant can establish exclusive use over the land in return for paying rent to the other claimants. None of this is strictly true on reservation trust land (Shoemaker, 2014). On the flipside, heir's property can be lost due to non-payment of property taxes, while reservation trust land is not taxed.