Property Rights, Place-Based Policies, and Economic Development

Laurel Wheeler *

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Abstract

This paper examines the effect of property rights on economic development within local labor markets, including how property rights change the equilibrium response to place-based policies. It does so in the context of federally-recognized American Indian reservations, where a fraction of the land is held in trust by the US Federal Government and associated with restrictions on transactions. I find that incomplete property rights on reservations are responsible for lower wages and earnings and higher rates of unemployment. The direction of these findings is robust to an instrumental variables approach to dealing with the endogeneity of property rights. Next I shed light on how property rights play a role in determining the incidence of local labor demand shocks induced by casino openings. Particularly in rural areas, when a casino opens on a reservation, the income gap due to incomplete property rights disappears. My estimates suggest frictions in the housing market may be driving this result. This paper provides insights into how place-based policies and property rights jointly shape economic outcomes through changes in the labor market, the housing market, and the mobility of workers.

*contact: laurel.wheeler@duke.edu

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1 Introduction

Complete property rights are generally regarded to be important for economic development [North, 1981]. Property institutions have been found to explain cross-country differences in investment, per capita income, and economic growth [Acemoglu and Johnson, 2005, Acemoglu et al., 2001]. According to evidence from within countries, these differences arise through a number of channels. For instance, property rights have been shown to influence individual investment and labor supply behaviors through (i) security of tenure [Field, 2005, 2007, Besley, 1995]; (ii) access to credit [Carter and Olinto, 1998, Alston et al., 1996, Atwood, 1990]; and (iii) gains from trade [Lanjouw and Levy, 2002]. Although there is a large body of empirical evidence on the effects of property rights at the macro and micro levels, relatively little is understood about the role of property rights at the local level[1].

I address this question in the context of federally-recognized American Indian reservations, where average per capita income, employment rates, and housing quality persistently lag behind the rest of the United States [Akee and Taylor, 2014, Listokin et al., 2006]. Reservations are characterized by a patchwork pattern of land tenure ranging from full, private ownership of fee simple land to leasehold ownership of trust land, which is held in trust by the US Federal Government on behalf of an individual member of the tribe or on behalf of the tribe itself[2]. Fee simple land is free from transaction restrictions, whereas trust land is associated with a host of restrictions on transactions and collateralization[3].

Drawing from the literature on local labor markets, I hypothesize that trust status introduces specific market distortions that affect the functioning of the labor market, the housing market, and the movement of people [Kline and Moretti, 2014, Moretti, 2011, Glaeser and Gottleib, 2009]. In particular, I hypothesize that credit constraints and lease length restrictions imposed by trust status increase firm costs, resulting in lower wages and higher rates of unemployment. Credit constraints associated with trust land may additionally affect workers, contributing to the creation of a lower skilled, less mobile population. Finally, obstacles to transacting in the housing market likely restrict the supply of housing. In the absence of population changes, this would result in higher housing prices.

To test these hypotheses, I use restricted-use demographic census microdata combined with reservation-level data on land ownership. I overcome the classic challenge of the endogeneity of property rights by relying on an instrumental variables (IV) approach that arises from geography and the historical process that determined the assignment of property rights on reservations. My results are broadly consistent with the predictions of my conceptual framework. I find that the higher the share of land in trust on a reservation, the lower are wages and employment rates. IV wage regressions yield estimates up to

[1] Aragon [2015] examines the role of property rights on local economies in the context of First Nations' reserves in Canada. He finds that a policy change to strengthen property rights acted as a local demand shock on the reserves

[2] The term, land tenure, refers to the institution that determines rights to use of the land

[3] In contrast to other settings where property rights are incomplete, however, rights to trust land are well-defined and enforceable in a court of law.

three times as large as ordinary least squares (OLS) regressions, indicating that OLS estimates may suffer from attenuation bias due to measurement error. In addition, my results suggest that reservations with a larger share of land in trust experience higher average rental prices for housing units and that higher prices are likely driven by a relative lack of new construction.

The evidence that incomplete property rights depress the local labor market suggests that issuing fee patents to trust land would foster economic development on reservations; however, the question of whether to change the status of the land is not straightforward. There are several reasons why tribes may benefit from maintaining land in trust status. First, trust land is under federal or tribal jurisdiction and not subject to state or federal property taxes. Second, because there are no restrictions on sales on fee land, it is often owned by non-Indians and disenfranchised from tribal governments despite being part of the reservation. Scholars and tribes alike have expressed concern over the continued loss of land and threat to native cultural practices that accompany this disenfranchisement. The protections associated with trust status provide motivation to study whether other policies would foster development on reservations. In particular, could place-based policies[4] targeted at reservations overcome some of the deleterious effects of incomplete property rights?

Drawing from the literature on place-based policies, I propose that the market distortions associated with incomplete property rights may themselves provide justification for spatially targeted interventions on reservations [Kline and Moretti, 2014]. Following the Moretti [2011] framework, where workers are heterogeneous and hold idiosyncratic preference for place, I examine the impact of local labor demand shocks on reservations. In this setup, the first order effect of a labor demand shock is an increase in wages, followed by an increase in labor supply. Housing supply then increases to meet new levels of demand for housing. The housing response is delayed and incomplete, leading to an increase in housing prices. I hypothesize that the obstacles to transacting on trust land increase the cost to in-migration and attenuate the number of workers moving into the locality to take advantage of the raise in wages[5]. A smaller labor supply response would result in larger increases in wages for the local population. In addition, I hypothesize that the constraints in the housing market imposed by trust status make the housing supply very inelastic and result in a larger increase in housing prices conditional on the same demand for housing. Because demand for housing is a function of population size, the equilibrium depends on whether labor or housing is supplied more elastically.

To test these hypotheses about how incomplete property rights affect the incidence of local labor demand shocks, I rely on a type of local economic shock that is unique to American Indian reservations. Specifically, I use casino adoption, which past research has shown to be responsible for increased economic activity on reservations [Evans and Topoleski, 2002, Gerstein, 1999, Taylor et al., 2000]. I examine the incidence of tribal gaming in the local labor market context using a conditional differences-in-differences approach that accounts for selection into gaming based on observable characteristics. I find that

[4]Place-based policies are spatially targeted interventions designed to stimulate economic growth in a specific, economically lagging locality

[5]Trust status on a reservation does not preclude migrants from locating on fee simple land or in the area surrounding the reservation. I do see evidence that migrants locate around the reservation to a certain extent, especially when the reservation has a large share of its land in trust

casino adoption has large, positive effects on wages, earnings, housing rental prices, and mortgage payments. The treatment effect is heterogeneous by land tenure type. Casino adoption has a larger effect on incomes on reservations with a larger share of land in trust. Particularly in rural areas, the income gap due to incomplete property rights narrows almost to zero. In contrast, the gap in housing prices widens. My results suggest that frictions in the housing market on trust land probably discourage some amount of migration and likely encourage migrants to locate off the reservation.

With this research, I provide evidence on how place-based policies and property rights jointly shape economic outcomes through changes in the labor market, the housing market, and the mobility of workers. The literature on the incidence of local labor demand shocks implicitly assumes that all land is privatized and that ownership rights are well-defined and easily transferable. Although previous papers have introduced costly migration into the spatial equilibrium framework [eg. Morten and Oliveira, 2014, Bound and Holzer, 2000, Topel, 1986, Notowidigdo, 2011], they have not directly explored how costly migration may be a function of constraints in the land market. I provide empirical evidence on the equilibrium in a setting where land use regulations are responsible for restricting housing supply and worker mobility. My paper is one of the first to provide empirical motivation for directly positioning the study of property rights in the spatial framework[6].

My second contribution is to the literature on property institutions and economic development of American Indian reservations. A small but growing body of research links trust land on reservations to agricultural productivity and efficiency, income, housing values, and business investment [Trosper, 1978, Carlson, 1981, Anderson and Lueck, 1992, Akee, 2009, Akee and Jorgensen, 2014]. I complement these studies by directly studying how property institutions affect tribes' ability to translate local economic shocks into welfare improvements for tribal members. I explicitly consider how incomplete rights could affect the functioning of several interconnected markets in a general equilibrium framework. My identification strategy accounts for the endogeneity of property rights using a measure of land quality as an instrumental variable. I find that land quality is strongly predictive of the composition of property rights on a reservation, suggesting past estimates that did not take into account the endogenous assignment of rights were likely biased[7].

Finally, my study sheds light on ways in which American Indian workers on reservations may benefit from place-based policies that do not involve issuing fee patents to trust land. Although federal trusteeship over trust lands is marked by layers of bureaucracy and rigid constraints, effectively limiting the tribe's ability to assert its sovereignty, trust status may protect Indian lands from alienation and state interference. The results of my research provide motivation for a middle ground, such as pursuing policies that work to reduce transaction costs in the housing market while operating within the existing system of government trusteeship. These insights could also be applied to low-income countries sharing some of the same institutional

[6] Again, Aragon [2015] is the only other paper I am aware of that takes this approach.

[7] The papers with the cleanest identification strategy are Akee [2009] and Akee and Jorgensen [2014]. Both rely on the random assignment of property rights on the Agua Caliente Reservation in California. The first paper estimates the effects of lease length restrictions on housing values. The second tests for differential business investment on trust parcels and fee parcels. I add to these papers by broadening the scope of the study to include reservations from across the country and to include additional outcome measures.

features of Indian reservations.

2 Background

This section describes the local institutions and industry motivating my research design[8]. First, I discuss the systems of land tenure on federally-recognized reservations, which inform my approach to testing the role of property rights on the level of local economic outcomes. Next, I briefly introduce the evolution of tribal gaming, which will inform my approach to testing the way local economic outcomes respond to labor demand shocks. As will become clear in subsequent sections, an understanding of the institutional features of the setting is critical to my identification strategy.

2.1 Systems of Land Tenure on Federally-Recognized Reservations

Land tenure on federally-recognized reservations is characterized by a patchwork pattern of ownership that is largely due to one important piece of legislation: the 1887 General Allotment Act, or the Dawes Act. The Dawes Act was responsible for dividing up reservation land into individual parcels–typically of sizes consistent with the Homestead Act[9]–and assigning ownership of the allotments to individual members of the tribe [McChesney, 1990]. Allotted lands were initially issued "trust patents," creating a trusteeship with the US Federal Government, which abrogated management to the Bureau of Indian Affairs and prevented sales for 25 years[10]. Reservation lands in "surplus" after the process of allotment were issued fee patents and auctioned off to outside parties. Remaining land that was neither sold nor allotted was taken into trust by the Federal Government on behalf of the tribe.

The process of allotment was carried out in an idiosyncratic way. The agency superintendents assigned to each reservation had some discretion with respect to the size and location of the allotments, so the resulting ownership patterns differed across reservations. There is some evidence that reservations located on the most productive lands were allotted first and reservations in remote locations were not allotted until transportation improvements increased the price of land there [Carlson, 1983]. A small number of reservations, such as the Red Lake Indian Reservation in Minnesota and many of the reservations in the Southwest, avoided allotment entirely. Even within a given reservation, the process of allotment was strongly related to the economic interests of white settlers. Carlson [1983] uses a capture model and various pieces of legislation to demonstrate that the Office of Indian Affairs was influenced by budgetary pressures and responded by opening up reservation lands for sale to non-Indians. My estimation strategy uses information about the systematic aspects of the assignment of property rights to

[8] More of the historical background appears in Appendix 1: Relevant American Indian History.

[9] 160 acres per family, 80 acres per single person over the age of 18, and 40 acres per person under the age of 18

[10] In 1906, the Burke Act shortened the 25-year restriction on sales under certain conditions. More information about this revision to the stipulations of the Dawes Act is contained in the Appendix.

motivate an instrumental variables approach[11].

The systems of land tenure on federally-recognized reservations today are a relic of the Dawes Act. There are two main categories of land tenure: full, private ownership of fee simple land; and leasehold ownership of trust land. Land that was initially allotted for members of the tribe roughly corresponds to individual trust land today; land that was issued a fee patent and auctioned off corresponds to fee simple land (fee land); land that was neither allotted nor sold corresponds to tribal trust land[12]. Changes to land tenure status were common until the 1934 Indian Reorganization Act, which repealed the Dawes Act and officially ended the allotment of reservations. Between 1934 and now, a few notable events and policies[13] have been accompanied by changes in land tenure composition on reservations, but the historical allocation of land rights to a large extent has persisted throughout time.

Table 1: Land Tenure Categories on Reservations

Characteristics	**Trust Land**		**Fee Simple Land**
Land Tenure	**Individual**	**Tribal**	
Legal Title	US Federal Government holds in trust for the individual	US Federal Government holds in trust for the tribe	Individual
Beneficial Title	Individual	Tribe	Individual
Mortgage-Collateral Status	Mortgaged with approval of the Secretary of the Interior (SOI). With the consent of the SOI, interest in land may be sold to a person who is not a member of the tribe if foreclosure is inevitable or if the property cannot be transferred within the tribe	Land cannot be mortgaged or sold. Loans secured by leasehold interest in tribal trust lands are permissible	Can be readily mortgaged; however, in some cases, use of fee simple land on reservations may be subject to tribal sovereignty
Fractional Ownership	Fractional interests in individual trust land do occur	Not an issue	Not an issue
Subject to Federal/State Taxation	No	No	Yes

This table is largely based off of the table in Listokin et al. [2006, p.99].

[11] This is discussed in detail in the Empirical Approach section

[12] Note that there is another category of land tenure, restricted land, which includes federal land such as national parks. Restricted land makes up a small percentage of total land area. Although it is difficult to quantify due to the lack of public data, my 2018 land ownership data suggests the area of the reservation that is considered restricted is 2% of the area of the reservation in trust

[13] Prior to 2004, non-Indian spouses could not inherit trust land, generating an incentive to convert trust land to fee land. The American Indian Probate Act was passed in 2004, slowing this conversion of trust to fee. Following the Cobell v. Salazar class action lawsuit, settled in 2009 for billions of dollars, a push was made to buy back fractionated individual trust parcels and put into tribal trust. This would not affect the share of fee land on the reservation but would affect the individual to tribal trust ratio. I can quantify changes in land tenure between 2003 and 2018 with my data, but it is difficult to do so outside of that time range.

Table 1 describes several key distinctions between the different categories of land tenure on reservations. First, trust land is not readily transferable. Individual trust land may be sold or leased only with approval from the Secretary of the Interior; tribal trust land may not be sold at all. Trust land is also associated with restrictions on mortgages and collateralization, with restrictions being more binding for tribal trust than individual trust. Fee land–like other privately owned land in the United States–is free from restrictions on sales. Although there are distinctions between tribal and individual trust land–most notably in terms of the issue of fractionation[14]–both types of trust land are characterized by restrictions on transactions, which is in contrast to fee land[15]. Another key difference between trust and fee land is in terms of jurisdictional authority over the land. Fee land is under state jurisdiction and subject to state or federal property tax. Trust land is under federal or tribal jurisdiction and is not subject to state or federal property tax. According to my data, the median reservation has approximately 60% of its land base in trust, although there is a great deal of variation within and across reservations[16]. Because there are no restrictions on fee land, it is often owned by non-Indians, resulting in additional variation in terms of the demographic makeup of reservations. In my sample, an individual residing on a reservation is equally likely to be American Indian or White.

The complex systems of land tenure on federal reservations in the United States are unique in many ways, although they share some similarities with other indigenous property institutions around the world. For example, the process of allotment did not privatize reservation land in the traditional sense. Instead, it was responsible for creating a government trusteeship similar to the system governing the indigenous reserves in Canada. Tribal trust land in the United States also shares some of the characteristics of indigenous lands in Mexico, Ghana, Peru, and Sub-Saharan Africa. Unlike many of these settings, however, trust land on federal reservations in the United States is not uniformly communal in nature[Aragon and Kessler, 2018]. Furthermore, in contrast to Canadian reserves, leasehold interest in individual trust land may be transferred, albeit with approval of the Secretary of the Interior.

2.2 The Evolution of Tribal Gaming

The opening of a bingo hall on Seminole land in 1978 in Hollywood, Florida, spurred a series of court cases, ultimately reaching the Supreme Court and resulting in the 1988 passage of the Indian Gaming Regulatory Act (IGRA). The IGRA declared that, as sovereign nations, federally-recognized tribes such as the Seminole are permitted to conduct gambling operations that otherwise may not be legal under state or federal regulations. Technically, the IGRA established that state authority was

[14]Fractional ownership occurs when multiple parties hold undivided interests in the land. It is the result of inheritance rules. More information about land fractionation is included in the Appendix in the subsection describing reservation-level controls.

[15]For this reason, throughout this paper the main distinction I draw is between fee land and trust land. I do disaggregate tribal and individual trust land for some of the analysis, which I display in the Appendix

[16]Variation in land tenure type within a reservation is referred to as, 'checkerboarding'

prohibitory, not regulatory. In other words, IGRA only allows for tribal gaming in states where those activities are already permitted in some form. In practice, this provision is not strictly interpreted[17]. The IGRA created the National Indian Gaming Commission (NIGC) to regulate tribal gaming and established a three-class structure of gaming with different levels of state involvement[18]. Casino gaming rapidly proliferated following the passage of the IGRA, although the growth in casino adoption slowed dramatically in the 1990s (see Figure 7: "Evolution of Tribal Gaming" in the Appendix.)

Today, more than 400 tribal gaming facilities are operational across the United States, generating tens of billions of dollars annually in revenue (National Indian Gaming Commission, 2017). Past research has established that casino adoption is responsible for increased economic activity on reservations [Gerstein, 1999, Evans and Topoleski, 2002, Evans and Kim, 2006], but little is known about the effects of tribal gaming within the local labor market framework[19]. Even less is understood about how property institutions change the impact of casino adoption.

3 Conceptual Framework

In this paper, I examine how property rights affect the level of local economic outcomes and the way local economic outcomes respond to economic shocks. I do so within a conceptual framework that borrows from the literature on local labor markets and place-based policies [Moretti, 2011, Kline and Moretti, 2014, Glaeser and Gottleib, 2009]. First, I use this framework to generate hypotheses about how the nature of incomplete property rights on American Indian reservations introduce specific frictions that may affect the efficient functioning of the local markets on the reservation. Then I introduce casino gaming shocks into the framework and generate hypotheses about how incomplete property rights affect the re-equilibration of the markets on the reservation following a local labor demand shock.

After the publication of the seminal papers by Rosen [1979] and Roback [1982], economists working at the intersection of labor and public economics became increasingly likely to incorporate the spatial dimension of labor markets into their models. Localities that are geographically distinct are often characterized by different industries and local policies, resulting in regional differences in labor market activity within the same country. The concept of local labor markets has been used to explain regional disparity in worker wages, factor productivity, and firm innovation.

With this setup in mind, I define reservations to be local labor markets where individuals are inframarginal to place, and I explore the ways in which property rights may contribute to local economic disadvantage[20]. Specifically, I allow for trust

[17] For example, the Foxwoods Resort Casino, one of the largest casinos in the country, is located in Connecticut, which permitted nonprofits to host casino events for fundraising. Those agreements are worked out between the tribe and the State in the tribal-State compact.

[18] Class I gaming is traditional tribal card games, over which the state has no regulatory power. Class II gaming is bingo and related games, which is regulated by the tribal government and the NIGC. Class III gaming includes all other games like Las Vegas-style casino games. Tribes must negotiate compacts with the state to have Class III gaming, although states are not permitted to revenue share.

[19] The evidence on the social impact of casino adoption is mixed [Taylor et al., 2000, Wolfe et al., 2012, Evans and Topoleski, 2002]

[20] Neither the assumption that reservations are clearly delineated nor that people are inframarginal is trivial, yet I believe both to be plausible.

status to introduce market distortions through two key channels: the obstacles to accessing credit on trust land and the high cost to transacting on trust land. These channels introduce frictions in the labor market and the credit market, potentially affecting worker mobility and firm investment incentives.

As discussed, there are legal prohibitions on the collateralization of trust land. I hypothesize that these credit constraints imposed by trust status may affect both workers and firms. First, credit constraints have been shown to inhibit human capital accumulation [Jacoby and Skoufias, 1997]. In general, mobility is lower for workers who are credit-constrained, lower-skilled, and less educated [Bound and Holzer, 2000, Topel, 1986, Wozniak, 2010, Malamud and Wozniak, 2012], suggesting there may be a link between trust status and worker mobility. On the firm side, credit constraints may increase the cost to locating on a reservation based on the additional obstacles to financing business on trust land relative to fee land. These costs possibly affect firms at the extensive margin, deterring firm entry.

The other channel through which trust status may affect the functioning of the labor market is the transaction costs channel. The term, transaction cost, reflects the reality that selling or leasing trust land[21]is a slow and encumbered process. Transaction costs are not necessarily pecuniary costs; they are costs associated with uncertainty, administrative challenges, and waiting[22]. The high transaction costs associated with trust status likely serve to increase firms' operational costs. For example, lease length restrictions increase firm costs in the form of uncertainty[23]. There is some evidence of low levels of business activity on reservations irrespective of land tenure [Harrington, 2012, Miller, 2012, Akee et al., 2017]. The evidence on the link between land tenure and business investment, however, is small and inconclusive [Akee and Jorgensen, 2014, Aragon, 2015][24].

I hypothesize that these aforementioned mechanisms may be responsible for lower welfare on trust land in these testable ways[25]:

- Higher firm costs that restrict firm entry reduce employment opportunities and lead to higher levels of unemployment and lower wages
- Higher firm costs are partially passed onto workers through the wage bargain, resulting in lower wages [Hamermesh, 1989, Bloom, 2009]
- Lower levels of human capital accumulation due to credit constraints result in lower wages

More often than not, reservations are located in rural areas without easy access to other markets. I will discuss this more in detail in the empirical section of the paper. I believe the assumption of inframarginality is a plausible one, given that reservations are native homelands and cultural centers for tribal members and therefore not otherwise equivalent to another locality with other amenities being held constant

[21] And, to a certain extent, the establishments or housing units located on trust land

[22] Transaction costs in this setting can be thought of as market frictions rather than dollar costs

[23] Trust land is associated with tribal jurisdiction, and uncertainty may also be related to the tribal court's ability to adjudicate

[24] Aragon [2015]finds that the strengthening of property rights on Canadian reserves is responsible for an increase in the number of deals made with mining companies. Akee and Jorgensen [2014], on the other hand, find that trust status is not linked to firm investment. The Akee & Jorgensen study, however, only examined firm activity on one reservation and looked at the impact of trust status after the lease length restriction had been lifted.

[25] The best test of whether efficient and welfare-maximizing outcomes are being achieved is to test whether land values are being maximized [Brueckner, 1983]. I do not have data (eg. construction costs, housing density) that would allow me to run this test unfortunately.

Trust status additionally introduces frictions in the housing market, but the predicted effect on housing prices is unclear a priori. The costs to transacting in the housing market reduce construction and restrict the supply of housing and, to a certain extent, slow population growth [Glaeser and Gottleib, 2009]. All else being equal, a restricted supply of housing leads to higher housing prices; however, if trust status is responsible for some degree of out-migration, lower demand for housing may keep housing prices low.

Taken together, the predictions generated by the local labor market framework suggest that reservations with a large share of land in trust likely are characterized by excess labor supply and population decline[26]. To the extent that some unemployment is involuntary, demand-side development interventions may improve the welfare of workers [Kline and Moretti, 2014, Austin et al., 2018]. This is in contrast to the standard spatial equilibrium setting where workers are perfectly mobile, the housing supply is inelastic, and place-based policies benefit only the owners of non-traded capital in equilibrium [Rosen, 1979, Roback, 1982].

According to the standard spatial equilibrium framework, the direct effect of a place-based policy or local labor demand shock is an increase in nominal wages by an amount equal to the productivity increase[27]. Higher wages in the locality induce migration of workers from other localities. The local labor supply response is determined by a number of factors, including wages, cost of living, amenities, and heterogeneous preference for location. Higher wages increase the budget of the residents of the locality, raising demand for non-traded goods like housing. The number of housing units constructed is an increasing function of the number of workers, where the exact housing supply response is given by features of the land and land use regulations. Higher demand for housing, paired with an inelastic housing supply, leads to higher housing prices. Under standard assumptions[28], real wages therefore remain unchanged in equilibrium.

Adaptations of the standard Rosen-Roback model describe ways in which market distortions can change the equilibrium response to a labor demand shock [eg. Moretti, 2011]. Under certain conditions, spatially targeted interventions may benefit the targeted population. I hypothesize that the institutions that govern the land may generate these conditions. The underlying reason is that they may affect the ease with which outside workers are able to migrate to the locality that experienced the shock.

To explore this hypothesis, I use the case of casino adoption on American Indian reservations. Tribal gaming is a place-based economic activity, legally confined to the boundaries of an American Indian reservation to generate revenue for the tribe residing on the reservation[29]. I acknowledge the possibility that property institutions on reservations affect the important

[26] It is worth noting that population growth may not necessarily be desirable, as it introduces a congestion disamenity. Furthermore, relaxing the constraints described here would almost certainly induce in-migration of non-tribal members [Pendakur and Pendakur, 2018, Aragon and Kessler, 2018]. To the extent that tribes are interested in maintaining their sovereignty over their homelands, the arguments of the objective function would be extended to include these other considerations.

[27] This assumes homogenous labor, perfectly competitive labor markets, and no unemployment

[28] For example also assuming that local labor is not used for housing production.

[29] Although revenues may be shared in the form of per capita payments with tribal members living off the reservation, the majority of the profits

parameters that govern the re-equilibration of the markets in response to casino adoption. In particular, I allow transaction costs associated with trust land to introduce frictions in the labor market and the housing market.

First, trust status may change the labor supply response to the demand shock by changing the cost of migration[30]. Again, trust land is associated with credit constraints. Although most of the literature linking credit constraints to mobility focuses on how lack of access to credit results in asymmetric out-migration following negative demand shocks, lack of access to credit on trust land can be modeled as a cost to in-migration, as well. Not only does trust status increase migration costs, but it may do so in an asymmetric way. Specifically, the cost to non-tribal members may be higher than the cost to tribal members. Many of the amenities associated with living on trust land – i.e. tax benefits and tribal services—require tribal membership. Furthermore, tribal gaming operations may adopt preferential hiring practices that favor tribal members[31]. These practices, if they were to occur, could similarly be modeled as imposing a higher cost of migration on non-Indians.

Second, trust status may affect the housing supply response to an increase in demand for housing. Irrespective of land tenure, the quantity of occupied housing per capita on American Indian reservations is lower than it is in the rest of the country[32]. Despite the availability of land, much of the land on the reservation may be unsuitable for development. Given the myriad of administrative processes that inhibit the financing of housing on trust land, all else being equal, housing supply would be even less responsive on trust land than on fee land.

Using this framework, I can then generate two testable predictions about the role of trust land in the re-equilibration of the markets following casino adoption:

- Higher costs to in-migration suggests labor demand is largely met by excess supply, resulting in higher relative wage increases following casino adoption
- Land use regulations increase housing costs, suggesting for a given level of demand for housing, housing prices increase by more on trust land following casino adoption

The demand for local housing is a function of the number of workers who move into the locality, so the two predictions are interrelated. In the adapted spatial equilibrium framework where workers are not perfectly mobile, the equilibrium effect of

from gaming are invested in infrastructure, education, and other development projects on the reservation.

[30]Evans and Topoleski [2002]document that there is a migration response to casino adoption: gaming increases migration onto the reservation and slows out-migration from the reservation. In this paper they did not link this migration response to land tenure.

[31]There is some suggestive evidence that preferential hiring practices are in place. Akee and Taylor [2014] document that the proportion of American Indians employed in public service on reservations increased 20% over the past twenty years but that a commensurate increase was not experienced by non-Indians during the same period of time.

[32]American Indians on reservations typically live in crowded homes. Based on the housing statistics from the 2006-2010 ACS, 11% of American Indians on reservations met the Housing and Urban Development definition for overcrowding [Pettit et al., 2014]. Vacancy rates tend to be high even in areas where growth in housing stock is high, suggesting housing may be of poor quality. Although rent-to-own programs like the Mutual Help Program have improved rates of home ownership, the average reservation continues to have a disproportionate ratio of mobile homes to single family homes.

the casino shock on real wages depends on the relative elasticities of labor supply and housing supply. For a given housing supply elasticity, a lower labor supply elasticity means greater benefits accrue to the workers. For a given labor supply elasticity, a lower housing supply elasticity means greater benefits accrue to landowners on the reservation. Taken together, the predictions of this framework suggest that the benefits are most likely to accrue to the workers on reservations where there are larger constraints on mobility than on housing.

4 Dataset Creation and Description

To test the hypotheses laid out in the conceptual framework, I compiled a large dataset containing measures of well-being, economic activity, and land ownership for federally-recognized reservations across the United States. My final dataset also includes GIS data on soil quality, data on land values from historical agricultural censuses, and data on several institutional features of reservations[33]. My main dependent and explanatory variables are constructed from demographic data, land ownership data, and tribal gaming data.

The US Census Bureau provides the demographic data for this study. I use confidential microdata from the 1980-2000 decennial census long-form samples as well as confidential microdata from the 2005-2014 American Community Survey (ACS) samples[34]. These data provide my key measures of economic development on reservations, including income, employment, housing prices, and population characteristics.

Although there are public-use versions of the long-form datasets, only the restricted-use data allow me to locate individuals on or off reservations and identify heterogeneous effects of property rights and labor demand shocks[35]. The restricted-use census data contain geographic information down to the census block level. These geography files contain an American Indian area variable, allowing me to identify whether an individual lives in an area that has been designated as an indigenous homeland[36].

This study additionally relies on the ability to characterize the composition of land tenure on reservations. I combine the

[33] I use these data to account for endogeneity and selection and to control for potentially important reservation characteristics. They are described in more detail in the Data Appendix

[34] The census long-form survey instrument is administered to one-sixth of the US population, eliciting information about the housing unit and the social, demographic, and economic characteristics of each member of the household. The ACS is administered annually to 1% of the population. Due to small sample sizes on reservations, and to mitigate disclosure risk, I have pooled ACS data in 5-year increments: 2005-2009 and 2010-2014.

[35] Individual-level data from the long-form are released in 1 and 5% samples with the Public Use Micro Samples (PUMS). The smallest geographic level available in PUMS is the Public Use Microdata Area (PUMA), which is an aggregate of 100,000 individuals. PUMAs do not delineate reservation boundaries and are not sufficient for identifying whether an individual resides on a reservation; furthermore, the homeland variable (which indicates whether a PUMA contains a reservation) is not available dating back to 1980. Public-use versions of aggregate data are available for reservations as part of the Summary File (SF) data system, but the SF system does not report all variables and does not report data for all subpopulations of interest.

[36] The American Indian area variable distinguishes between different types of homelands: federal reservations, state reservations, off-reservation trust lands, Hawaiian homelands, Oklahoma tribal statistical areas, and Alaska Native villages. In my analysis, I only use areas designated as federally-recognized reservations, corresponding to codes less than 5000.

confidential census data with 2018 reservation-level data on land ownership for federal reservations across the United States. Data on land ownership in Indian Country have not been disseminated publicly since the mid-1980s, when the Bureau of Indian Affairs (BIA) stopped publishing their annual reports on land ownership[37]. I acquired the land data directly through the BIA Central Offices after appealing to the Director of the BIA, Bryan Rice, for the purposes of this study. These data enable me to estimate the effect of incomplete property rights on economic outcomes on reservations based on the most current and complete land data available.

Finally, in this research local labor demand shocks come through the casino gaming industry. I construct my dataset on casino gaming operations by piecing together data from other researchers who acquired gaming information through public sources[38]. The resulting dataset covering 1988-2013 indicates the name of the casino, the year it opened, the geographic coordinates of the casino, and two measures of size: number of slot machines and square feet[39]. These data allow me to estimate the effect of casino adoption on economic outcomes on reservations.

4.1 Census Data

The full sample of individuals residing on federally-recognized reservations between 1980 and 2014 covers 324 reservations on 36 states[40]. American Indian areas in Oklahoma, Alaska, and Hawaii are governed by different land tenure regimes and are not technically classified as reservations[41]. In addition, reservations that are recognized by states but not by the Federal Government are not afforded the same rights to operating gaming facilities. For these reasons, I restrict my analysis to those American Indian areas with the federal reservation designation in the data[42]. I also omit reservations that only gained federal recognition recently and are not included in the census boundary files, as well as homelands that have only off-reservation trust land and no reservation land[43]. Figure 4 of the Map Appendix graphically displays the reservations used in analysis.

My main sample comprises individuals over 16 years of age who reside on federally-recognized reservations. This sample contains approximately 575,000 observations from 230 reservations. It does not contain all the federal reservations in the United States. To comport with the Census Bureau's data confidentiality rules, I dropped observations that were missing data from any source. If I do not have casino gaming data for a given reservation, for example, I do not use observations from that reservation in analysis. In the Data Appendix, I discuss this process in more detail, and I provide a comparison of

[37] The BIA have a mandate to survey and record trust land at the parcel level on reservations annually, but they stopped releasing data, even summary data, in 1985

[38] Barbara Wolfe and Jessica Jakubowski provided a list of casinos and measures of casino size for 1988-2005 [Wolfe et al., 2012]; Michael Mathes provided a similar list for 2005-2013. I appended the two datasets, resulting in a list that spans 1988-2013.

[39] I match casinos to American Indian homeland codes in the census data using a combination of the casino name string and the geocoordinates

[40] The states without Indian reservations are: Arkansas, Delaware, Georgia, Illinois, Kentucky, Maryland, New Hampshire, New Jersey, Ohio, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia

[41] With the exception of the Osage in Oklahoma and Annette Island in Alaska

[42] When I do this, I drop observations from Delaware, New Jersey, and Indiana

[43] When I do this, I drop observations from Massachusetts

the reservations included and excluded from analysis.

Table 2 presents summary statistics for the final sample used in my main analysis. This table demonstrates that the average resident of a reservation is approximately equally likely to be American Indian or White. These tabulations also indicate that, while there has been a slow increase in high school graduation rates, employment rates, and conditional wage income, reservation averages have remained low. In fact, these averages are low even relative to the individuals residing off the reservation but in the same county as the reservation (see Table 3). Table 3 is based off of a sample of individuals residing in a county that contains a reservation but not residing on the reservation itself. Following the naming convention of Akee et al. [2017], I refer to part of the county that does not contain the reservation as the "county complement." More information about the construction of the county complement and its use in analysis is included in the Data Appendix.

Table 2: Sample Composition: Individuals Residing on Reservations

	1980	**1990**	**2000**	**2005-09**	**2010-14**
American Indian	0.46	0.47	0.48	0.48	0.5
White	0.5	0.48	0.46	0.46	0.43
High School Graduate	0.51	0.61	0.68	0.66	0.76
Employed	0.37	0.47	0.5	0.52	0.48
Homeowner	0.74	0.72	0.73	0.73	0.71
Pays Rent	0.19	0.23	0.22	0.23	0.24
Has Mortgage	0.16	0.3	0.31	0.33	0.29
Conditional Wage	20290	20720	22980	26500	26010
Male	0.54	0.52	0.51	0.51	0.51
Obs by year	66000	112000	165000	86500	147000

Notes: Author's tabulations from confidential Decennial Census and ACS data, 1980-2014. Wage is in 2000 dollars and is conditional on being employed. Sample restricted to individuals used in analysis

4.2 Land Data

For each federally-recognized reservation, my land ownership data provide the total amount of land in acres within each of the following land categories: individual trust, tribal trust, individual fee, tribal fee, individual restricted, and tribal restricted. Restricted land can be thought of as a relatively rare, third category of land tenure on reservations[44]. Due to concerns about the quality of the reporting on fee land, I did not use information from this category to construct the explanatory variable[45].

[44]The difference between restricted land and unrestricted land lies in the owner of the title to the land. The title to trust land is held by the US Federal Government, whereas the title to restricted land is held by an individual. All the legal restrictions against alienation and encumbrance hold whether the land is restricted or not.

[45]The BIA do not have a mandate to survey fee land, so the amount of land in fee status is likely underreported in their statistics. I cross-referenced

Table 3: Sample Composition: Individuals Residing in Surrounding County

	1980	1990	2000	2005-09	2010-14
American Indian	0.01	0.01	0.02	0.01	0.01
White	0.89	0.85	0.81	0.81	0.8
High School Graduate	0.66	0.75	0.77	0.74	0.83
Employed	0.42	0.6	0.61	0.61	0.57
Homeowner	0.73	0.68	0.69	0.69	0.65
Pays Rent	0.25	0.3	0.29	0.3	0.33
Has Mortgage	0.37	0.47	0.5	0.51	0.47
Conditional Wage	25410	27420	29480	33540	32470
Probability Male	0.55	0.51	0.51	0.51	0.51
Obs by year	1738000	2457000	3132000	1790000	2015000

Notes: Author's tabulations from confidential Decennial Census and ACS microdata, 1980-2014. Wage is in 2000 dollars and is conditional on being employed. Sample restricted to individuals used in analysis

Instead, I constructed a trust share variable that takes the BIA-provided information on trust land acreage (tribal trust plus individual trust) as the numerator and Census-provided information on total reservation acreage as the denominator[46]. Therefore, the ratio of trust land to total land area, or the share of land in trust, forms my main explanatory variable. Fee land makes up the vast majority of the land that is not in trust, but federal lands (eg. national parks) and other restricted lands would also be included in the denominator[47]. I am able to decompose the share of land in trust into tribal trust and individual trust shares. These variables will be used in alternative specifications.

As seen in Figure 1, there is variation in the share of land in trust across reservations, and the distribution is skewed right. Trust land ranges from .1% of reservation land to 100%. The mean value is 77% and the standard deviation is approximately 33%.

Although I have access to two periods of modern land ownership data, I only rely on the 2018 data in my analysis. The first wave of data is from Anderson and Parker (2008), who surveyed regional BIA offices to collect information on the amount of land held in trust for each reservation in 2003[48]. I do not use the 2003 data in this study for a number of practical and econometric reasons. First, large changes to trust share between 2003 and 2018 are rare and are driven by a few reservations, so it would not be appropriate to use variation in trust share as an identifying source of variation. Second, the coverage of the 2003 data is poorer than the 2018 data: approximately 40% of the reservations contained in the 2018 data are missing in the 2003 data. Finally, using the 2003 data, the 2018 data, and a linear interpolation of the two all produce similar results. I quantify the changes in trust share over time in the Data Appendix.

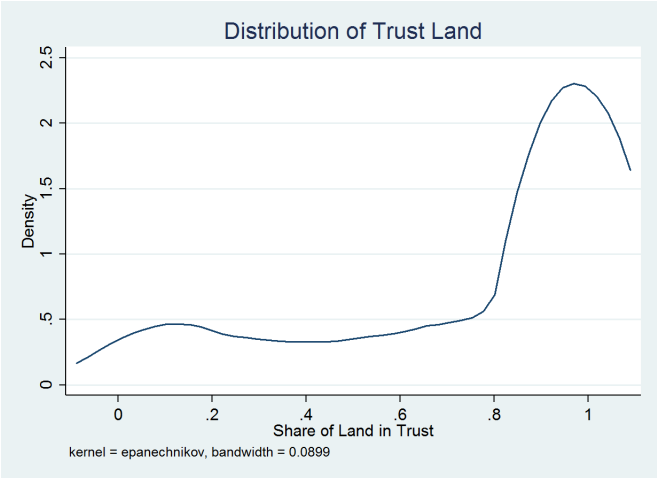
the BIA's 2018 reporting on fee land totals with estimates from other sources and found large discrepancies.

[46] Total reservation acreage comes from the 2017 Census shapefiles

[47] Restricted land comprises a small percentage of total land area on reservations. According to the 2018 land ownership data, among the reservations included in this study, restricted land amounts to less than 2% of trust land

[48] Their research assistant at the time, Tony Cookson, played a key role in this data collection effort and has also employed the land ownership dataset in some of his research (eg. Cookson, 2010; Cookson, 2014). The dataset has been used widely by other researchers working in this area

Figure 1: The Distribution of Trust Share Across Reservations



4.3 Casino Data

Among the reservations in my sample, 70% adopted a casino at some point between 1988 and 2013. In Table 4, I provide summary statistics comparing adopters and non-adopters based on land and population characteristics. According to my sample, reservations that adopted casino gaming between 1988 and 2013 tended to be smaller and have lower American Indian population shares than reservations that did not adopt casino gaming. In a regression of casino adoption on trust share and land area, I find no evidence that the share of land in trust affects a reservation's propensity to open a casino[49]. In fact, I find a negative, albeit statistically insignificant, correlation between trust share and casino adoption.

Table 4: Characteristics of Casino Adopting Reservations: Sample Averages

	Adopters	**Non-Adopters**
Trust Share	0.71	0.8
Land Area (Acre)	240000	310000
Reservation Population	3908	3009
AIAN Population Share	0.59	0.71
Number Reservations	150	80

Notes: Author's tabulations from a variety of public data sources. Number of observations rounded due to Census confidentiality requirements

[49] It is prohibited to operate a casino on trust land acquired after 1988, which mitigates the concern that land tenure changes status to accommodate casino gaming

5 Empirical Specification and Identification

This research naturally lends itself to separation into two parts: (i) an examination of the effect of trust status, and (ii) an examination of the impact of tribal gaming. The second part will additionally test whether the impact of tribal gaming varies with trust status. In each part of the research, I estimate the effects on the labor market, on the housing market, and on population characteristics. I separately estimate the impacts for American Indians and Whites[50], as well as for the reservation and the community surrounding the reservation (the county complement). Taken together, these estimates provide evidence on how property institutions affect local economic outcomes and the incidence of labor demand shocks.

The effect of trust status is identified through variation across reservations. In comparing across reservations, I average over sources of tribal heterogeneity. To account for time-invariant heterogeneity due to regional influences, I include census region fixed effects[51] in each specification. I cannot include reservation fixed effects, which would account for time-invariant tribe/reservation characteristics, because I only use one wave of land ownership data[52]. I do not include state fixed effects, because there are several states with only one reservation. To improve the generalizability of my findings and account for potential omitted variable bias, in supplemental specifications I include covariates that reflect land fractionation, geography, culture, and institutions[53]. A full discussion of these covariates is included in the Data Appendix.

The unit of analysis in this study is the reservation, but the unit of observation is either the individual or the household, depending on the level at which the dependent variable was measured. For labor market regressions, I include controls that reflect demographic characteristics, including age and its square, race, sex, and an indicator of whether an individual speaks another language at home. For housing market regressions, I include controls that reflect the urban/rural nature of the census block within which the housing unit is situated. Each regression uses sample weights, clusters standard errors at the reservation level, and includes year fixed effects to capture time trends.

I can write the basic economic relationship I want to estimate in part (i) of the research as follows:

$$y_{irt} = \alpha + \beta_1 Share_r + \beta_2 X_{irt} + \beta_3 CR_r + \beta_4 Year_t + \epsilon_{irt} \quad (1)$$

where $y_{irt} = r_{irt}, w_{irt}, N_{irt}$ for individual i living on reservation r at time t. Census region fixed effects are differenced out with CR_r. X_{irt} is a vector of covariates, and $Year_t$ captures time trends. The three sets of dependent variables capture: (i) local housing prices, r_{irt}, including: mortgage payments, rental price, type of home, number of rooms and bedrooms in the

[50] Reservations are almost entirely comprised of either American Indians or Whites

[51] There are four Census Bureau regions: Northeast (including New England and the Middle Atlantic states), Midwest (East North Central and West North Central states), South (South Atlantic, East South Central, and West South Central states), and West (Mountain and Pacific states)

[52] Another econometric reason why I do not use reservation fixed effects is that my instrumental variable is time invariant and at the level of the reservation

[53] The inclusion of reservation-level control variables did not substantially change my results, but it did force me to drop more observations due to missing values. Census confidentiality rules make it challenging to release model output from multiple samples, so the results presented in this paper come from the specifications that do not include these reservation-level controls

house, and whether the housing unit was recently constructed; (ii) wages and employment, w_{irt}: wage income, total earnings, total income, typical hours worked per week, employment, and labor force participation; and (iii) population and migration, N_{irt}: reservation population, share of American Indians, whether someone recently moved into a home, and commute time.

In this specification, $Share_r$ represents the share of land on the reservation that is held in trust status, which is calculated as previously described. β_1 is the coefficient of interest. I first estimate Equation (1) using the aggregate trust share variable, and I subsequently estimate Equation (1) disaggregating trust share into the share of reservation land in individual trust and the share in tribal trust. Results of a partitioned regression suggest that trust share does not enter in a non-linear way, so I model the relationship between trust share and y_{irt} as a linear one[54].

The basic economic relationship I want to estimate for part (ii) of the research can be written as Equations (2) and (3):

$$y_{irt} = \alpha + \beta_1 Casino_{rt} + \beta_2 X_{irt} + \beta_3 CR_r + \beta_4 Year_t + \epsilon_{irt} \tag{2}$$

where all terms are as defined before, and $Casino_{rt}$ is a time-varying treatment indicator equal to one if reservation r has tribal gaming by time t and equal to zero otherwise.

$$y_{irt} = \alpha + \beta_1 Share_r + \beta_2 Casino_{rt} + \beta_3 (Share * Casino)_{rt} + \beta_4 X_{irt} + \beta_5 CR_r + \beta_6 Year_t + \epsilon_{irt} \tag{3}$$

The coefficient of interest in Equation (3) is β_3. Suppose $\beta_3 > 0$ and, for simplicity, take the outcome, w_{irt}. The positive sign of β_3 would indicate that the effect of the economic shock on reservation wages is greater (more positive) on a reservation with a larger share of land in trust.

My empirical strategy involves employing an instrumental variable approach for dealing with the endogeneity of property rights in Equations (1) and (3) as well as a conditional differences-in-differences approach for dealing with selection into gaming in Equations (2) and (3). I will describe each of these approaches in turn.

5.1 The Endogeneity of Land Tenure

I first estimate Equation (1) by ordinary least squares (OLS); however, there are several reasons why this estimation strategy will likely produce estimates that do not reflect the causal impact of land tenure on economic outcomes. First, if the land tenure variable contains measurement error, OLS estimates will suffer from attenuation bias. Second, the explanatory trust share variable is endogenous, so OLS estimates may suffer from reverse causality or omitted variable bias.

There are two main endogeneity concerns. The first is that property rights were assigned endogenously at the time of

[54] I have tried other functional forms for trust share, including a polynomial as well as a binary high/low, but the results remain unchanged

allotment. There is a growing body of evidence that allotment was carried out in accordance with land value[55]. The value of the land affected the probability, timing, and manner of allotment. Specifically, the higher the price of land on a reservation at the time of allotment, the more likely it was to be allotted, and the more likely it was that allotted parcels would eventually be issued fee patents [Leonard et al., 2018, Carlson, 1983]. If higher quality land was more likely to be issued a fee patent, an observed, negative correlation between trust share and economic outcomes may be a function of land quality.

The second endogeneity concern is referred to in the literature as the *land quality selection problem* [Akee, 2009, Akee and Jorgensen, 2014]. The concern is that higher quality land is more likely to be issued a fee patent and taken out of trust in modern times. To account for this, Akee [2009] and Akee and Jorgensen [2014] instrument for present-day trust land status using original trust land status. This instrumentation works in their setting, because their analysis involves only one reservation[56], where property rights were plausibly randomly assigned in a checkerboard fashion at the time of allotment. In practice, during my 1980-2014 study period, taking land out of trust status has rarely occurred. That, to a certain extent, mitigates the land quality selection concern[57]. Nonetheless, I am able to address both potential sources of endogeneity using an instrumental variable method that arises from geography and the historical process of allotment. My empirical strategy is to estimate Equation (1) using two-stage least squares (2SLS) with a long-run measure of soil quality, the soil drainage index, as the instrumental variable[58]. (See Figure 8 in the Map Appendix)

The natural soil drainage index (DI) is a measure of long-term soil quality developed by geographers at Michigan State University[Schaetzl et al., 2009, p. 383]. The DI is derived from the soil's taxonomic subgroup classification using a number of morphological and chemical parameters. The scale ranges from 0 for the driest soils to 99 for open water. The soil's DI is not affected by human activity or technological innovations such as irrigation or artificial drainage, thus making the soil's DI a long-term measure of soil quality. The DI reflects "the amount of water the soil supplies to plants under natural conditions, over long time horizons" [Schaetzl et al., 2009, p. 383]. I use this information to posit that the soil's DI today approximates the soil's DI at the time of allotment. I derive the mean DI value for each reservation by overlaying the reservation shapefiles with DI polygons using GIS software. The mean DI value serves as my instrumental variable.

The soil's ability to make water available for plants, especially prior to innovations in irrigation, was paramount to agricultural productivity[59]. The rationale behind the instrument is that agricultural productivity would have determined the price of

[55] Anderson and Lueck [1992] serve as one notable exception. They make several arguments for the quasi-exogeneity of the assignment of property rights. As far as I know, no other published work takes this position

[56] The Agua Caliente reservation in Palm Springs, California

[57] There are a couple of policies that have been led to changes in land tenure in recent times. Prior to 2004, non-Indian spouses could not inherit trust land, generating an incentive to convert trust land to fee land. The American Indian Probate Act was passed in 2004, slowing this conversion of trust to fee. Following the Cobell v. Salazar class action lawsuit, settled in 2009 for billions of dollars, a push was made to buy back fractionated individual trust parcels and put into tribal trust. This would not affect the share of fee land on the reservation but would affect the individual to tribal trust ratio.

[58] Note that I have another instrumental variable that performs almost as well as the soil drainage index. Information about the alternative instrument, the historical value of farmland and buildings per acre, is contained in the Appendix.

[59] To a certain extent, the DI can capture the importance of growing crops, rearing animals, and cultivating timber. For reservations in the Midwest—in Minnesota and Wisconsin in particular—timber was a bigger industry than agriculture. Schaetzl et al. [2009] discuss how the DI has

land during the Allotment Period, because agriculture was the major industry in that era. In fact, agriculture was the main impetus for expansion to western parts of the United States, where the majority of the federal reservations were located (Davis et al., 1972). In these remote, underpopulated areas, agriculture was often the only industry. To the extent that soil quality captured the price of land during allotment, if more valuable land had a greater risk of allotment and appropriation, we should see a negative correlation between soil quality and the share of land preserved in trust. As predicted, I find a strong, negative correlation between mean DI and trust share.

The identifying assumption associated with this instrumental variable is that long-run soil quality affects economic outcomes today only through its effect on the assignment of property rights. There are two main threats to identification. The first is based on the concern that long-run soil quality is related to modern soil quality, which is responsible for economic outcomes today. To account for this, I control for a different measure of soil quality, the soil productivity index (PI), which is an ordinally-based soil index that uses soil taxonomies to rank soils from 0 (least productive) to 19 (most productive)[60][Schaetzl et al., 2012]. (See Figure 9 in the Map Appendix.) The PI reflects the capacity of the soil to produce crops within certain human land management systems. The PI is more likely to be changed by irrigation and drainage practices, or other activity like cropping or erosion, thus I use it only to reflect current soil productivity.

An additional argument to support the exogeneity of my instrument is that agriculture is not as important today as it was during allotment. Between 1910 and 1940[61], there was relatively little westward expansion and few technological improvements in the agricultural industry. The lull in agricultural progress created conditions for manufacturing to grow in importance. By 1920, agriculture had become a depressed sector, overtaken by manufacturing in terms of the fraction of the labor force it employed and its contribution to the national income. In addition, the 1902 passage of the Reclamation Act, which allocated federal funds to irrigation in remote areas in the West, largely reduced the importance of the soil's natural ability to provide water to plants. Large-scale irrigation at that point was able to overcome some of the natural deficiencies in the soil, thus softening the link between soil drainage and agricultural productivity.

The second threat to exogeneity would be if areas with more valuable land at the time of allotment saw faster growth, with economic development persisting today for reasons unrelated to agriculture. At the time of allotment, though, almost all economic activity hinged on agriculture, so accounting for agriculture should largely account for these differences in the level of economic development at that time.

applications to forest ecology, suggesting DI may be appropriate for different types of agriculture and farming.

[60] Again, I tabulate the mean PI value by reservation using GIS software

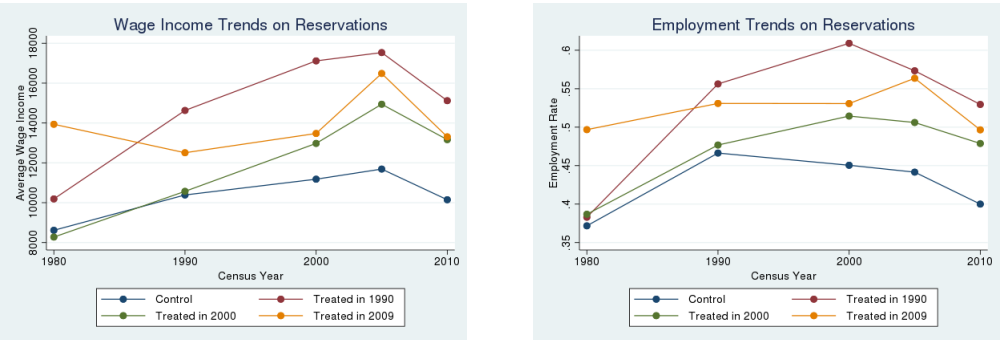
[61] Allotment officially ended in 1934 with the Indian Reorganization Act, but the majority of allotment occurred by 1910

5.2 Selection into Gaming

There is a great deal of evidence that the decision to open a casino is not random. For example, Cookson [2010] finds that the presence of a casino on a reservation is due in part to the reservation's legal and political institutions. Specifically, Cookson finds that state criminal and civil jurisdiction increases the incentive to invest in casino gaming relative to tribal jurisdiction. According to Anderson and Parker [2008], state jurisdiction is also responsible for economic growth[62]. Wenz [2008] finds that the two most important predictors of tribal gaming are population size and the size of the American Indian population. In other literatures, the economic conditions of a region have been shown to predict adoption of gambling activities more generally [Neibergs, 2007]. Intuitively, the size of the gaming operation may be endogenously determined, as well. In light of plausible selection into tribal gaming, I adopt an empirical strategy that relies on a differences-in-differences method with matching estimators.

The simple differences-in-differences model accounts for systematic differences between the characteristics of casino adopters and non-adopters, such as their historical tribal gaming culture [Jorgensen, 2000]. However, differences-in-differences techniques only produce unbiased estimates if treatment is essentially random, conditional on time and group fixed effects. Specifically, the identifying assumption is that trends in the variables of interest would be the same for casino adopters and non-adopters in the absence of treatment. One concern with the simple differences-in-differences model is that tribes that decide to operate casinos differ in ways that could affect their trends over time. Indeed, I find evidence that employment and wage trends differed across non-adopters and adopters in the period before adoption (See Figure 2)

Figure 2: Pre-Adoption Trends on Reservations



In order to address the concern that the parallel trends condition is not satisfied, I estimate Equations (2) and (3) as weighted

[62]State versus tribal jurisdiction is determined by Public Law 280, which is described in more detail in the Appendix. Although Cookson [2010] and Anderson and Parker [2008] treat PL280 as exogenous, Dimitrova-Grajzl et al. [2014] find evidence to suggest otherwise. Nevertheless, the implication that political institutions may predict casino adoption and also affect economic development remains worth consideration.

differences-in-differences, exploiting variation in treatment timing to assign weights in such a way that adopters are compared to non-adopters that look similar prior to treatment based on observable characteristics. I do so in the spirit of Abadie [2005], who proposed the use of matching estimators to estimate the average treatment effect on the treated. I construct my weights using pre-treatment measures of the factors that been found to predict adoption: population size, American Indian share of the population, proximity to the nearest urban area, and whether the reservation is governed by state or tribal jurisdiction [Cookson, 2010, Wenz, 2008]. I additionally include measures of education, income, and labor market participation, which I found to be highly predictive of adoption based on the results of analysis using the least absolute shrinkage and selection operator (Lasso analysis)[63].

6 Results

6.1 The Effect of Land Tenure

My first set of findings are broadly consistent with the predictions generated by the conceptual framework I outlined in Section 3. Table 5 demonstrates that the share of land in trust is negatively related to income, employment, and labor force participation[64]. Income measures have been transformed by the inverse hyperbolic sine function[65], and trust share appears as a continuous variable taking values between zero and one. Therefore, the difference between a reservation with no land in trust and a reservation with its entire land base in trust corresponds to an approximate difference in wage income of 55%, based on the OLS estimates presented in the third column of the table. According to that same point estimate, a one standard deviation increase in trust share corresponds to an 18% decline in average wage income[66]. The average wage of an employed individual in this sample in 2000 was approximately $22,900, so this difference corresponds to more than $4,000 annually[67]. Effects on total income are similar.

Effect sizes produced by the instrumental variables regressions of income measures are up to three times as large as those

[63] Lasso analysis is a supervised machine learning method that uses regression analysis to identify the set of explanatory variables with the highest predictive value for a given dependent variable. This technique relies on an algorithm to run through all combinations of the proposed control variables and identify the subset of variables that minimize the prediction error.

[64] Results disaggregating trust share into its component parts–individual and tribal trust–appear in the Appendix

[65] Because income is highly skewed right but contains zeros, I use the inverse hyperbolic sine (IHS) of income, defined as $log(y_i + \sqrt{(1+y_i)^2})$. Unlike the logarithmic function, the IHS function is defined at zero and for negative values. For large values of y_i, the estimated coefficients can be interpreted in much the same way for the IHS and logarithmic functions [Burbridge et al., 1988].

[66] Based on my sample, a one standard deviation difference in trust share across reservations is approximately 33 percentage points

[67] The OLS point estimates are comparable to the findings of other papers. Aragon [2015] finds that the strengthening of property rights on Canadian reserves resulted in 13% increases in income; Leonard et al. [2018] finds that trust land has between 15-30% effect on incomes, depending on the specification.

Table 5: The Effect of Land Tenure on the Labor Market

	Total Income		**Wage Income**		**Employment**		**Labor Force**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Trust Share	-0.399**	-1.215***	-0.552**	-1.504***	-0.0321	-0.0668**	-0.0276	-0.0736***
	(0.193)	(0.364)	(0.235)	(0.332)	(0.0203)	(0.0301)	(0.0188)	(0.0279)
Observations	575000							
Clusters	230							

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV test stats: Chi-Sq P-value: 0.003; C-D Wald F stat: 180000. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects and the following set of covariates: age, age^2, gender, race, indicator of speaking another language. Trust share appears as a fraction less than 1. Total income and wage income are in 2000 dollars and have been transformed by the inverse hyperbolic sine function. Number of observations have been rounded according to Census confidentiality rules.

produced by ordinary least squares (OLS) regressions, indicating that the causal effect of trust status is underestimated by OLS specifications. For employment and labor force participation, OLS results are not statistically significant whereas IV results are. These findings initially may seem counterintuitive. There is a strong, negative first stage relationship between land quality (as measured by the mean drainage index) and trust share, suggesting that reservations with historically better land were more likely to be allotted and issued fee patents. To the extent that better quality land is better for development, we would expect to see an attenuation of the relationship between trust share and development outcomes when we control for land quality. That we see the opposite suggests there may be measurement error in the trust share variable [Griliches, 1977, Card, 2001]. In particular, it may be the case that the trust share variable and the disturbance in the income function are positively correlated.

Based on the results of the IV regressions, there is a significant, negative relationship between trust share and employment. The IV results indicate that a 100 percentage point increase in trust share corresponds to a 6.7 percentage point decrease in employment and 7.4 percentage point decrease in labor force participation. A one standard deviation increase in trust share would therefore correspond to a 2.2 percentage point decrease in employment and 2.5 percentage point decrease in labor force participation.

The negative income and employment effects are even larger for American Indians than for Whites living on the same reservation (See Table 6). These results suggest that the credit constraints and transaction costs associated with trust land are more binding for American Indians. This could be because they are relatively less mobile, they have fewer outside options, or they have lower levels of human capital accumulation, all of which could affect the wage bargain.

Table 7 demonstrates the effect of trust status on the housing market. All regressions indicate there is a strong and significant, negative relationship between trust share and mortgage price, the probability of owning a home, and the number of rooms

Table 6: Labor Market Effects by Race

	Wage Income				**Employment**			
	American Indian		White		American Indian		White	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Trust Share	-0.274	-2.896**	-0.580**	-0.749**	-0.0216	-0.211**	-0.0112	0.0318
	(0.297)	(1.137)	(0.294)	(0.327)	(0.0262)	(0.0954)	(0.0269)	(0.0440)
Observations	233000		309000					
Clusters	230							

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV test stats: For AIAN: Chi-sq P-val: 0.0196; C-D Wald F stat: 24000; For White: Chi-sq P-val: 0.0091; C-D Wald F-stat: 150000. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects and the following set of covariates: age, age^2, gender, race, indicator of speaking another language. Trust share appears as a fraction less than 1. Total income and wage income are in 2000 dollars and have been transformed by the inverse hyperbolic sine function. Number of observations have been rounded according to Census confidentiality rules.

in a housing unit. Interpretation of the effect on mortgage payments is not straightforward. Mortgage payments reflect both housing price and borrower attributes. Monthly payments are also a function of the size and the term of the loan. Therefore, the negative relationship between mortgage payments and trust share could be explained by (i) lower housing prices; (ii) a larger down-payment (and smaller loan); (iii) lower interest rates; or (iv) longer loan periods. The effect on mortgage payments likely is driven by the Section 184 Indian Home Loan Guarantee Program (HUD 184), which guarantees loans made to American Indian borrowers. Until 2005, this program only applied to homes on trust land. The positive coefficient on trust share in the rental price regression suggests that housing prices are higher on reservations with more trust land, although the effect is imprecisely estimated[68].

Table 7: Effect of Trust Land on the Housing Market

	Mortgage		**Rental Price**		**Homeowner**		**Number of Rooms**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Trust Share	-1.859***	-2.971***	0.139	0.364	-0.0802**	-0.151**	-0.204***	-0.317***
	(0.444)	(0.512)	(0.195)	(0.368)	(0.0349)	(0.0671)	(0.0635)	(0.0603)
Observations	575000							
Clusters	230							

*** p<0.01, ** p<0.05, * p<0.1

Notes: Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Trust share appears as a fraction less than 1. Mortgage and rental price are in 2000 dollars and have been transformed by the inverse hyperbolic sine function. Rental price is the midpoint of an interval variable. Number of rooms is a binary indicator of whether number of rooms is greater than the median. Number of observations have been rounded according to Census confidentiality rules.

[68] In order to comport with Census confidentiality rules (i.e. to avoid creating additional implicit samples), rental prices are counted as zeros for households that do not pay rent. Other measures are constructed similarly, and information about variable construction is in the Data Appendix. Because trust status is associated with less homeownership, it may appear that the positive coefficient on rental prices is coming through an increase in the number of households paying rent, or an increase in the number of non-zero entries. When I constructed rental price differently, such that missing values were counted as missing, the rental price regression produced a positive coefficient on trust share that was much more precisely estimated.

If rental prices for housing are higher on reservations with a larger share of land in trust, the mechanism may be the constrained housing supply. IV estimates in Table 8 indicate that a 100 percentage point increase in the share of land in trust decreases the probability that a housing unit on that reservation was recently constructed by 7 percentage points. A one standard deviation increase in trust share corresponds to a 2.3 percentage point decrease in that probability. Longer commute times on reservations with more land in trust may hint at the mechanism responsible for lower income. Longer average commute times may be suggestive of fewer employment opportunities on the reservation[69]. Finally, as expected, reservations with more land in trust have a higher American Indian share of their population. Given the obstacles to selling trust land to non-tribal members, we would expect to see few non-Indians living on trust land on reservations. In that sense, the relationship between the share of land in trust and the size of the Indian population may be a mechanical one.

Table 8: Effect of Trust Land on the Housing Market

	AIAN Pop Share		**Commute Time**		**New Construction**	
	OLS	IV	OLS	IV	OLS	IV
Trust Share	0.305***	0.391**	0.0703**	0.123***	-0.0330***	-0.0702***
	(0.0899)	(0.190)	(0.0271)	(0.0287)	(0.0120)	(0.0179)
Observations	575000					
Number of clusters	230					

*** p<0.01, ** p<0.05, * p<0.1

Notes: Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Trust share appears as a fraction less than 1. Commute time is an indicator of whether an individual travels more than 45 minutes to get to work. New construction is an indicator of whether house was built in past five years. Number of observations have been rounded according to Census confidentiality rules.

6.2 The Impact of Tribal Gaming

In light of the evidence from the previous subsection that incomplete property rights depress the local economy, is it necessary to change the status of the land in order to foster economic development on reservations? Instead of taking land out of trust status, tribes may prefer to adopt place-based policies, including tribal gaming. In line with other research on the topic, I find that tribal gaming dramatically changes the economic landscape of reservations. Casino openings increase income, employment, labor force participation, and housing prices. There is also evidence that they change the population composition of the reservation.

[69] I found no statistically significant correlation between trust share and size of reservation, so the commute time result likely is not being driven by the size of the reservation

Table 9: The Impact of Casino Adoption on the Labor Market

	Total Income	**Wage Income**	**Employment**	**Labor Force**	**Hours Worked**
Casino	0.471***	0.285***	0.0221**	0.0422***	0.779*
	(0.0984)	(0.0971)	(0.00945)	(0.00873)	(0.467)
Observations	575000				
Clusters	230				

*** p<0.01, ** p<0.05, * p<0.1

Notes: Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects and the following covariates: age, age^2, sex, race, and an indicator of whether the individual speaks another language. Total income and wage income are in 2000 dollars and transformed by the inverse hyperbolic sine function. Observations are weighted by the inverse probability of casino adoption. Number of observations are rounded per Census confidentiality rules.

Table 9 displays the results of the conditional differences-in-differences estimation of Equation 2. The results indicate that gaming has large, positive effects on the labor markets of adopting reservations. Again, income measures are transformed by the inverse hyperbolic sine function, so the difference between an average reservation without a casino and an average reservation with a casino is approximately 47% in terms of total income and 29% in terms of wage income. Casino adoption is associated with a 2 percentage point increase in employment and a 4 percentage point increase in labor force participation. There is evidence that the working population works more hours, as well.

In line with past research, the labor market effects of tribal gaming appear to be larger for American Indians than for non-Indians [Evans and Kim, 2006]. Table 10 indicates that wage income increases are significant for American Indians but not for Whites living on the reservation. In addition, after casino adoption, American Indians are significantly less likely to travel more than 45 minutes to work, whereas Whites are significantly more likely. The difference in commute times suggests either that (i) American Indians living on the reservation are more likely to take advantage of the new employment opportunities generated by the opening of the casino, or (ii) among the migrants post-shock, the American Indians are more likely to locate in close proximity to the casino center.

Figure 3 demonstrates that wage income and employment rates increase prior to casino adoption on reservations in anticipation of the shock[70]. This is consistent with an explanation involving labor supply being used to construct the casino, related facilities, and additional housing units. Moreover, this figure depicts employment trends that are largely the same for American Indians and non-Indians prior to the casino shock. American Indians living on the reservation experience larger increases in wage and employment around the time of the shock but then experience a subsequent decline that is not matched

[70] Based on an equation of the form: $y_{irt} = \alpha + \beta_1 YrsBefore_t + \beta_2 Casino_{rt} + \beta_3 YrsAfter_t + \beta_4 X_{irt} + \beta_5 CR_r + \beta_6 Year_t + \epsilon_{irt}$

Table 10: The Impact of Casino Adoption on the Labor Market by Race

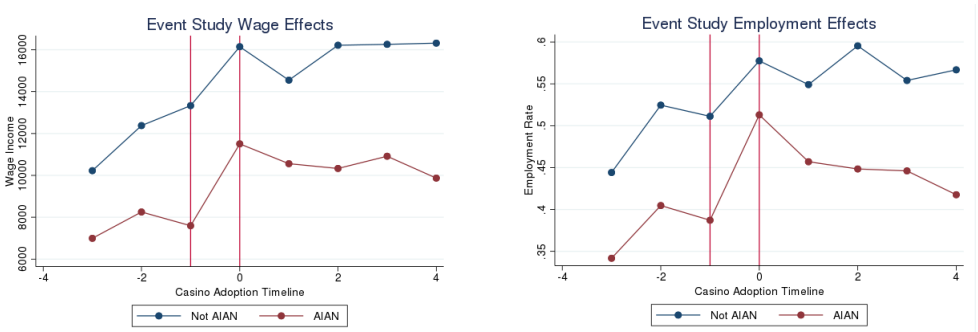
	Wage Income		**Commute Time**	
	AIAN	White	AIAN	White
Casino	0.510***	-0.0136	-0.115***	0.0488**
	(0.147)	(0.170)	(0.0127)	(0.0206)
Observations	233000	309000		
Clusters	230			

*** p<0.01, ** p<0.05, * p<0.1

Notes: Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Commute time is an indicator of whether an individual travels more than 45 minutes to get to work. Wage income is in 2000 dollars and transformed by the inverse hyperbolic sine function. Observations are weighted by the inverse probability of casino adoption. Number of observations are rounded per Census confidentiality rules.

by non-Indians living on the reservation. This suggests the importance of studying the incidence of the shock over time, not just in the period immediately following the shock.

Figure 3: Wage and Employment Effects of Casino Adoption over Time



Notes: These figures depict an event study specification with a 20-year estimation window, only including individuals residing on reservations that adopted tribal gaming at some point. The casino was opened at some point in the period between -1 and 0. Each unit on the x-axis represents a 5-year bin of time.

In terms of the housing market, I find that tribal gaming leads to higher housing prices and better housing quality. Table 11 indicates that casino adoption is associated with an approximate 114% increase in mortgage payments and 20% increase in rental payments. Casino adoption is also responsible for increasing the number of rooms, which may suggest improvements to housing quality.

There is also some evidence (Table 12) that casino adoption induces migration onto the reservation, because individuals living

Table 11: Effect of Casino Adoption on the Housing Market

	Mortgage	**Rental Price**	**Homeowner**	**Number Rooms**
Casino	1.142***	0.197**	-0.0337*	0.148***
	(0.281)	(0.0885)	(0.0182)	(0.0396)
Observations	575000			
Clusters	230			

*** p<0.01, ** p<0.05, * p<0.1

Notes: Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Mortgage and rental price are in 2000 dollars and transformed by the inverse hyperbolic sine function. Number of rooms is a binary indicator of whether housing unit consists of above the median number of rooms. Observations are weighted by the inverse probability of casino adoption. Number of observations are rounded per Census confidentiality rules.

on the reservation are 6.8 percentage points more likely to report that they moved there within the past 5 years. Because the American Indian population share decreases in response to casino adoption, the migration response is likely higher among non-Indians on average.

Table 12: Effect of Casino Adoption on Population Characteristics

	AIAN Pop Share	**Moved Recently**	**Commute Time**
Casino	-0.156*	0.0680***	-0.114***
	(0.0875)	(0.0216)	(0.0298)
Observations	575000		
Clusters	230		

*** p<0.01, ** p<0.05, * p<0.1

Notes: Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Commute time is an indicator of whether an individual travels more than 45 minutes to get to work. New construction is an indicator of whether house was built in past five years. Observations are weighted by the inverse probability of casino adoption. Number of observations are rounded per Census confidentiality rules.

6.3 The Effect of Land Tenure on the Impact of Tribal Gaming

In this subsection, I examine whether treatment effects associated with tribal gaming are heterogeneous by land tenure. To do so, I narrow my analysis to a subset of all reservations: those that are predominantly rural in nature[71]. I do this because reservations that are geographically remote constitute more clearly delineated local labor markets. In contrast, reservations that are in close proximity to metropolitan areas provide workers with more outside labor and housing opportunities. As demonstrated in the Appendix Tables 24 through 26, the effect of land tenure on the impact of tribal gaming is more noisily

[71] I define the rural reservation sample in the Data Appendix

estimated when using the full set of reservations, although the direct of the findings tends to parallel that of the rural reservations.

For the set of rural reservations, I find that tribal gaming does have a differential effect by trust status. I present the results of the weighted differences-in-differences design of the interacted specification (Equation 3) estimated by OLS in Tables 13-15[72]. In general, I find that after a reservation adopts tribal gaming, wages, earnings, and housing prices increase by more on reservations with a higher share of land in trust. The differential housing price increases are most stark, underscoring the inelastic nature of housing due to trust status.

The final row of Table 13 presents the coefficients on the interaction between the casino adoption indicator and the trust share variable centered at its mean value[73]. The first three columns of this table suggest that the change in income and earnings is increasing with trust share. In fact, the casino shock is enough to overcome the income gap caused by incomplete property rights. Following casino adoption, rural reservations with a larger fraction of land in trust do better in terms of average income, earnings, and labor force participation rates.

Table 13: Labor Market Effects of Casino Adoption by Land Tenure: Rural Reservations

	Total Income	**Wage Income**	**Total Earnings**	**Employment**	**Labor Force**	**Hours Worked**
Casino	0.223**	0.13	0.239**	0.0155	0.0296***	0.422
	(0.105)	(0.0983)	(0.0947)	(0.0116)	(0.00999)	(0.444)
Trust Share Demeaned	-0.951***	-0.484	-0.497*	-0.0384	-0.0512**	-1.940*
	(0.245)	(0.336)	(0.259)	(0.0275)	(0.0212)	(1.146)
Casino*Trust	1.053***	0.504	0.554**	0.0378	0.0640***	2.701**
	(0.257)	(0.313)	(0.277)	(0.0295)	(0.0239)	(1.196)
Observations	381000					

*** p<0.01, ** p<0.05, * p<0.1

Notes: Ordinary least squares estimates. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects and the following set of covariates: age, age^2, gender, race, indicator of speaking another language. Trust share is demeaned and appears as a fraction less than 1. Total income, wage income, earnings are in 2000 dollars and have been transformed by the hyperbolic sine function. Observations are weighted by inverse probability of casino adoption. Observations come from set of rural reservations. Number of observations have been rounded according to Census confidentiality rules.

These findings could be interpreted in a number of ways. One interpretation is that tribal gaming increases the demand for labor but that the majority of the new labor being supplied comes from excess labor supply on the reservation. Another explanation is that tribes with a larger share of land in trust are better able to leverage their sovereign status to enact policies that benefit tribal members, such as preferential hiring practices. This would take the form of asymmetric migration costs imposed by trust status. Mobility costs reduce the labor supply response, preventing wages from re-equilibrating following the shock. Mobility costs may alternatively come through frictions in the housing market.

[72] IV estimates produced by the interacted specifications tend to have high standard errors. In addition, the IV estimates from the two different instruments I have tried often are not consistent with each other. Thus, I do not present the IV results here. IV estimates may be imprecise be due to the fact that IV regressions often produce a low power to size ratio [Young, working paper]. This is likely particularly true in the interacted IV. I have included the results from both sets of IV regressions in the Appendix.

[73] Because the trust share variable is now demeaned (centered at its mean value), the effect of casino gaming can be interpreted as the effect for a reservation of average trust share

Table 14: Housing Market Effects of Casino Adoption by Land Tenure: Rural Reservations

	Mortgage	**Rental Price**	**Pay Rent**	**Number of Rooms**	**Commute Time**
Casino	0.0135	0.275***	0.0460***	0.00648	-0.0681**
	(0.361)	(0.100)	(0.0170)	(0.0438)	(0.0312)
Trust Share Demeaned	-2.959***	-0.0279	0.0216	-0.474***	0.194***
	(0.745)	(0.148)	(0.0255)	(0.102)	(0.0555)
Casino*Trust	2.188***	0.520**	0.0755*	0.428***	-0.188***
	(0.797)	(0.245)	(0.0444)	(0.101)	(0.0570)
Observations	381000				

*** p<0.01, ** p<0.05, * p<0.1

Notes: Ordinary least squares estimates. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Trust share is demeaned and appears as a fraction less than 1. Mortgage and rental price are in 2000 dollars and have been transformed by the hyperbolic sine function. Rental price is the midpoint of an interval variable. Number of rooms is a binary indicator of whether housing unit has more than the median number of rooms. Observations are weighted by inverse probability of casino adoption. Observations come from the set of rural reservations. Number of observations have been rounded according to Census confidentiality rules.

In Table 14, I display the results from the interacted specification pertaining to the housing market. From the second column, we see that rental prices increase by more on reservations with a larger fraction of land in trust. The additional percent increase in rental prices due to a one standard deviation increase in trust share is higher than the additional percent increase in wage income or earnings due to a one standard deviation increase in trust share. This is in line with predictions from the spatial equilibrium framework in a setting where both labor and housing are supplied inelastically but housing market frictions are more important[74]. Land use regulation hampers the housing supply response, thus preventing housing supply from meeting demand in a frictionless manner and resulting in higher housing prices. The results presented in Table 15 suggest that housing constraints are, indeed, more binding on reservations with more land in trust. The last column of the table indicates migrants increasingly locate within the surrounding communities and off the reservation when the reservation has a larger fraction of land in trust.

[74]I am working on calculating welfare changes. As a very rough approximation, to cacluate changes in real wages and how these vary based on land tenure, we can compare increases in rental price with increases in wage income. A back of the envelope calculation suggests that the positive effect of trust status on wages is approximately the same as the negative effect on real wages due to housing prices in percentage point terms but that the wage effect may be greater than the housing price effect in dollar terms. Based on the OLS estimates for wage income, for a reservation of average trust share, the overall effect of casino adoption is an increase in income of approximately 13% and an increase in rental prices of approximately 28%. For a reservation with trust share that is one standard deviation above the mean, the effect of casino adoption is a 30% increase in total income $(1/3 * 0.504 + 0.275)$ and a 45% increase in rental prices $(1/3 * 0.520 + 0.12)$. Given average annual income of \$xx,xxx on rural reservations and average annual rental payment of \$x,xxx, the wage effect trumps the housing price effect. Going from mean trust share to one standard deviation above the mean increases the effect on wages by approximately \$x,xxx but increases the effect on rental prices by approximately \$xxx. These calculations suggest welfare improvements due to casino adoption increase with an increasing share of land in trust.

Table 15: Spillover Effects of Casino Adoption by Land Tenure

	Wage Income		**Employment**		**Rental Price**		**Recently Moved**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Casino	0.321*	0.139	0.0242*	0.0463**	0.248***	0.166	-0.0123	-0.0706*
	(0.165)	(0.213)	(0.0133)	(0.0229)	(0.0746)	(0.193)	(0.00898)	(0.0372)
Trust Share Demeaned	0.118	0.449	0.0014	0.153	0.167	0.325	-0.0330***	-0.250**
	(0.144)	(0.972)	(0.0166)	(0.0974)	(0.153)	(0.659)	(0.0118)	(0.122)
Casino*Trust	-0.730**	-0.157	-0.0526**	-0.157**	-0.255	0.0391	0.0648***	0.307**
	(0.314)	(0.589)	(0.0237)	(0.0717)	(0.188)	(0.551)	(0.0199)	(0.138)
Observations	11130000							
Clusters	230							

*** p<0.01, ** p<0.05, * p<0.1

Notes: Robust standard errors clustered by county are in parentheses. All regressions include year and region fixed effects. Labor market regressions include the following set of covariates: age, age^2, gender, race, indicator of speaking another language. Trust share is demeaned and appears as a fraction less than 1. Total income, wage income, and rental price are in 2000 dollars and have been transformed by the inverse hyperbolic sine function. Recently moved is an indicator of having moved in the past ten years. Number of observations have been rounded according to Census confidentiality rules.

7 Concluding Discussion

In a 2009 publication of the Message Runner, the Indian Land Tenure Foundation writes that "trust land reacquisition is critical to the economic, cultural, and spiritual health of Indian nations and is often beneficial to the surrounding non-Indian communities as well." Implicit in this statement are the dual objectives of fostering economic growth and preserving tribal self-determination. To date, there is not much quantitative evidence on how these objectives can be compatible. How can trust land–the use of which is encumbered by a host of red tape–promote economic development when economic theory on property rights and transaction costs suggests otherwise? Motivated by a desire to respond to this question, in this paper I have treated reservations as local labor markets and studied the effects of indigenous property institutions on the impact of local labor demand shocks on reservations. My results suggest that frictions introduced by indigenous property institutions change the likelihood that certain place-based policies benefit the target population.

While I do find that indigenous property institutions are responsible for lower wages and levels of employment ceteris paribus, I also find evidence that indigenous property institutions generate larger increases in wages on reservations following tribal gaming shocks. I find that the larger increases in wages are partially met with larger increases in housing prices but that the wage effect trumps the housing price effect. I conclude that one channel through which this result may be generated is frictions in the housing market that constrain mobility and attenuate the migration response following the casino shock.

This study suffers from a few limitations that are worth mentioning. First, my analysis is based on reservation-level land ownership data. While my land ownership data are the most current data available[75], they describe ownership at the level of

[75] At least they are the most current among datasets that have coverage on reservations across the United States

the reservation. More granular land data, such as data at the parcel level, would allow for additional analysis. For one, I could study the role of checkerboarding, or the degree to which different types of land tenure are scattered across the reservation in a patchwork pattern or are clustered together. Perhaps more importantly, land data at the parcel level, in combination with information about how the population is distributed across the reservation, would provide insights into how property institutions affect residential choices. These data would lay the groundwork for estimation of a fully structural model, which would provide insight into the relative importance of the parameters in each market in determining the general equilibrium. Finally, I acknowledge that this study does not tease out the various constraints associated with trust land. Akee [2009] finds that removal of the lease length restriction was sufficient to lead to convergence in housing prices and values. In my study, I treat transaction costs as a bundle and prevent only suggestive evidence on mechanisms.

My paper contributes to an emerging literature on indigenous property institutions that, taken together, suggest that the privatization of indigenous land may have unintended consequences for the indigenous population. Aragon and Kessler [2018] compare property regimes on reserves in Canada and find that private property rights do not lead to higher incomes or employment rates for the indigenous population, at least partially because the removal of the restrictions on the land induces migration of non-indigenous individuals. Pendakur and Pendakur [2018] similarly find that privatization of reserve land in Canada is associated with larger income gains for the non-indigenous population. I find a positive interaction between trust share and tribal gaming on wage income for American Indians but not for Whites (see Appendix Table 24), suggesting trust status may be more beneficial to tribal members than non-members. That said, it is hard to ignore the evidence that reduction of land use restrictions on reserves engenders a general equilibrium response that increases real wages and housing prices [Aragon, 2015].

Policymakers and practitioners familiar with Indian Country issues have long understood the conflict between protecting Indian land from appropriation and easing land use restrictions. Accordingly, there are a few extant policies that work within the system of government trusteeship while reducing some of the inefficiencies in transacting on trust land. One topic that has been gaining attention recently is the difficulty of obtaining mortgages on trust land. The Helping Expedite and Advance Responsible Tribal Home Ownership (HEARTH) Act of 2012 bestows upon approved tribes the authority to bypass the Secretary of the Interior and execute leases of trust land based on their own tribal leasing regulations. Although there is little evidence on the impact of the HEARTH Act, and its recent passage is beyond the temporal scope of this study, adoption of this legislation may provide tribes the opportunity to preserve their sovereign status while mitigating the transaction costs introduced by involvement of the Secretary of the Interior[76]. Another relevant piece of legislation around housing in Indian Country is the Section 184 Indian Home Loan Guarantee Program (HUD 184), which was passed in 1992 to facilitate homeownership on trust land[77]. The Office of Loan Guarantee within Housing and Urban Development's Office

[76] Note that the HEARTH Act still requires a Land Title Status Report, which is provided by the BIA, potentially slowing down the process
[77] HUD 184 applies to off-reservation trust land, as well. In 2005 it was expanded to include homes on fee land on reservations

of Native American Programs guarantees the HUD 184 home mortgage loans made to American Indian borrowers, with the effect of lowering interest rates. Another proposed solution to the dual objective problem may be the hybrid land tenure type: restricted fee land. As discussed, restricted fee land is land that cannot be sold in a way that alienates ownership from Indian status, yet it is free from most of the transaction costs associated with trust land. The results of my research do not allow me to conclude that a certain type of land tenure is optimal for Indian Country; however, my results provide motivation to consider policies of this nature seriously.

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8 Appendix

8.1 Relevant American Indian History

Modern American Indian history has been shaped by a series of federal policies that were designed to accommodate Euro-American expansion and resulted in tribal displacement, land loss, and a weakened ability to self-govern [Cornell and Kalt, 1998]. The Indian Appropriations Act of 1851 allocated funds to move American Indians from their traditional homelands primarily to marginal lands in the West, creating the formalized reservation system that exists today (Message Runner, 2009)[78]. Twenty years later, the US Government no longer recognized Indian Nations as independent actors, ceasing the practice of treaty-making with tribes and chipping away at tribal sovereignty. During this time, support was growing for federal policy that would introduce private property rights and promote agricultural practices on reservations. Accordingly, the General Allotment Act, or the Dawes Severalty Act, was passed in 1887 to formalize the practice of allotment that had begun on a small scale as early as 1798. Ostensibly, the Dawes Act, would protect Indian land from the Oklahoma land rush and, by conveying European-style private ownership of land, would incentivize farming on reservations. Ironically, the Dawes Act contributed to the alienation of 60 million acres of tribal land at the onset – and paved the way for further alienation of land down the road – and served to encumber Indian farming on reservations [Carlson, 1981, 1983].

The first reservations to be allotted were in the eastern Great Plains and the Pacific Northwest. Where the Dawes Act was put into effect, reservation lands were divided into individually owned parcels (individual trust land) of sizes that were consistent with the Homestead Act: 160 acres per family, 80 acres per single person over the age of 18, and 40 acres per person under the age of 18 [McChesney, 1990]. The reservation lands in "surplus" after the process of allotment were issued fee patents and auctioned off to outside parties. Remaining land that was neither sold nor allotted was taken into trust by the US Government, abrogating management to the Bureau of Indian Affairs, becoming tribal trust land.

Under the Dawes Act, allotted land was issued a "trust patent" and protected for 25 years, meaning that sales were prohibited and the government would hold the land in trust for that period of time. The 1906 Burke Act authorized the Secretary of the Interior to grant a patent in fee simple, making a trust to fee conversion, if an Indian was declared "competent" to manage his/her own land. Once the patent was granted, the land could be sold. The result was a loss of 27 million acres of Indian land. Some of the allotted land was lost because, on occasion, Indians were declared "competent" without their knowledge and land was seized due to failure to pay taxes on land they did not know they owned. The speed of land loss was fast: in 1881 Indians held 155,632,312 acres; by 1890, 104,314,349 acres; by 1900 only 77,865,373, of which 5,409,530 had been allotted [McChesney, 1990].

[78] Unless otherwise noted, much of the details of the history of land loss come from The Message Runner publications put out by the Indian Land Tenure Foundation

In practice, allotment did not privatize land in the traditional sense. Instead, it created a government trusteeship that introduced distortions in the land market by restricting the ability to sell the land both within and outside of the tribe. Although at first, allotted land could be neither leased nor sold, amendments to the Dawes Act in 1891 and 1906 allowed for leasing or selling of allotments with approval from the Secretary of the Interior [Shoemaker, 2003]. These policies relaxed the constraint on transferring land to non-Indians but effectively made transferring land to Indians more difficult. Until land was issued a fee patent, it could not be used as collateral. Furthermore, another provision of the Act was that an heir must be declared through a legal will or the ownership title of an individual's allotment was divided among all the original owner's heirs, leading to the problem of highly fractionated land titles on individual trust lands, generating more inefficiencies. The bottom line is that there are many reasons why allotment may not have been welfare improving despite relaxing a constraint on reservation land sales.

Following the allotment period, federal policy toward American Indians seemingly vacillated between a desire to lend support to American Indian sovereignty and a desire to disband tribal communities. The Meriam Report, a study commissioned by the BIA, documented the exploitation and land loss resultant from the Dawes and Burke Acts, which generated publicity and gave rise to the 1934 Indian Reorganization Act (IRA). By the time the IRA was passed to stop allotment and recognize Indian sovereign status, 86 million acres of reservation land had been appropriated from Indian ownership [Akee et al., 2015b]. In a reversal of this push toward tribal self-determination, the 1950s were known as the, "Termination Era," including legislation such as Public Law 83-280, which gave some states civil jurisdiction within reservation boundaries. The 1960s and 70s began the "Self-Determination Era," bearing witness to the passage of legislation written in the vein of supporting tribal autonomy. In recent decades, federal policy has increasingly granted tribal governments the scope to handle matters related to crime, employment, natural resources, healthcare, and finance.

The "Self-Determination Era" proved to be a favorable period of time for some tribal governments to assert their right to adopt gaming on reservations located in states that did not have explicit laws against it. The opening of a bingo hall on Seminole land in 1978 in Hollywood, Florida, spurred a series of court cases, ultimately reaching the Supreme Court. This resulted in the 1988 passing of the Indian Gaming Regulatory Act (IGRA). The IGRA created the National Indian Gaming Commission (NIGC) to regulate tribal gaming and established a three-class structure of gaming with different levels of state involvement[79]. Since the passing of the Indian Gaming Regulatory Act, well over 400 tribal gaming operations have opened across the United States.

[79]Class I gaming is traditional tribal card games, over which the state has no regulatory power. Class II gaming is bingo and related games, which is regulated by the tribal government and the NIGC. Class III gaming includes all other games like Las Vegas-style casino games. Tribes must negotiate compacts with the state to have Class III gaming, although states are not permitted to revenue share

8.2 Alternative Instrument

My alternative instrument for trust share comes from the historical agricultural census data, available for download through the IPUMS National Historical Geographic Information System. The instrument is land value at the county level, dating back to the era of allotment. I use the average value of farmland and buildings per acre (VFPA)[80], which has been shown to predict the propensity for a reservation to be allotted and the timing of allotment [Leonard et al., 2018][81]. As a covariate, I use the VFPA variable from 1959, which is the most recent year for which that variable is made publicly available.

I use the VFPA variable to reflect agricultural productivity because, according to Carlson [1983], the best measure of the scale of farms is the value of the land and the buildings per farm. To the extent that the VFPA captures the price of land at the time of allotment, if more valuable land had a greater risk of allotment and appropriation, we should see a negative correlation between historical VFPA and the share of land preserved in trust.

Reservations are not identified in these early waves of the census, so I am forced to match to county boundaries instead of reservation boundaries. In the instances where reservations span boundaries, I take a weighted average of the county values. The quality of land of course varies across the reservation, and this methodology does not allow me to assign land quality to parcels of land within the reservation. Instead, I am assigning the average quality of the land in the county to the entire reservation. I average across decadal values between 1880 and 1910 to average over sampling error, and to recover more counties, as there were parts of the United States that had not achieved statehood in the late 19th and early 20th centuries[82].

8.3 Data Appendix

In this data appendix, I first describe the process by which I generated the main sample used in analysis, the sample of individuals residing on federally-recognized reservations. I separately describe how I generated other samples used in analysis, such as the county complement and the rural reservation samples. Finally, I define the variables used in analysis and describe their construction.

[80] Winsorized at the 95th percentile

[81] There are more measures of the agricultural value of land for 1880 than for other years, including total value of livestock on farms, total agricultural output, cash value of farms, value of asset livestock, improved land in farms, and unimproved land in farms. As a robustness check, I created an index of these measures, but I found that this index served as a weaker instrument than the 1880-1910 average VFPA

[82] The measure of historical VFPA is not available for reservation counties in New Mexico, Montana, Louisiana, and Florida. New Mexico did not gain statehood until 1912 and thus was not included in these censuses, whereas the other states are included in the historical agricultural census, but the specific counties that contain reservations were not. More broadly, across the country, county boundaries changed from the period of allotment to today. In order to merge the historical agricultural data with contemporary census data, I merged based on today's definitions of county boundaries. For the most part, the changes were such that counties previously were small and combined to form bigger counties that we see today. To account for the duplicates within state-county-years, I average across the small county values

8.3.1 Sample Definitions

Main Sample:

The main sample used in analysis contains individuals over the age of 16 who reside on federally-recognized reservations and not on off-reservation trust land. To comport with Census confidentiality rules, I dropped individuals who were missing data for any of my key dependent or explanatory variables. First, to the extent that it was possible, I set missing values equal to zero for dependent variables. For example, hours worked would be set equal to zero if an individual is unemployed. Then I dropped individuals who were missing any of the following types of data: data on soil quality (DI values), data from the historical agricultural census, 2018 land ownership data, or data on any of the dependent variables from the confidential census surveys. Finally, I dropped observations that did not have an inverse probability weight associated with them. This process created a dataset containing individuals from approximately 250 reservations. In Table 16, I present sample averages comparing the federally-recognized reservations that are covered in my main sample to the federally-recognized reservations that are not covered.

Table 16: Characteristics of Reservations used in Analysis: Sample Averages

	Included	**Excluded**
AIAN Population Share	0.64	0.68
Land Area (Acre)	250000	130000
Probability Opened Casino	0.66	0.38
Reservation Population	3500	1500
Number of Reservations	250	70

Notes: Author's tabulations from a variety of data sources. Probability opened a casino refers to probability reservation ever had a casino. Number of observations rounded due to Census confidentiality requirements

Definition of the County Complement:

There is a small body of evidence that tribal gaming does affect economic growth in adjacent areas [Akee et al., 2015a, Evans and Topoleski, 2002]. To test whether there are spillovers associated with tribal gaming shocks, I compare economic outcomes for individuals residing on reservations to individuals residing on nearby county complements[83]. The county complement is defined to be the county less the intersection of the county with the reservation.

If the county contains only one reservation, the trust share and casino adoption explanatory variables from that one reservation

[83] Based loosely on the definition in Akee et al. [2017]

are ascribed to the county complement. If one reservation spans two counties, individuals from both of the two counties would appear in the county complement sample. If the county contains more than one reservation, I assigned to the county complement the maximum value associated with casino adoption and the mean value associated with trust share. In regressions that use the county complement sample, I use cluster robust standard errors that are clustered at the county level, not the reservation level.

Definition of Rural Reservations:

Reservations are disproportionately located in rural areas, yet the ones that are located close to metropolitan areas likely have different labor market opportunities. In particular, they may have a higher supply of labor and may be able to generate more revenue through tribal gaming. In order to focus on reservations that do not have easy access to other labor markets, I develop a method for classifying reservations as rural and I stratify my sample on this dimension.

The confidential census data contain a variable that indicates whether a housing unit is located on a densely populated census tract or census block. An area is considered an urban area if it contains more than 50,000 individuals. I consider a reservation to be a rural reservation if at least 70% of the observations in my sample for that reservation are coded as being not urban.

8.3.2 Data Dictionary

Labor

- Wage income: This variable reflects wage income for current job. It is transformed using the inverse hyperbolic sine function to account for the skewed distribution and adjusted for inflation[84]. Unemployed are counted as zeros
- Total earnings: This variable includes wage income and self-employment income, transformed using the inverse hyperbolic sine function and adjusted for inflation. Unemployed are counted as zeros
- Total income: This variable includes wage income, self-employment income, and transfers. It is also transformed using the inverse hyperbolic sine function and adjusted for inflation. Unemployed are counted as zeros
- Typical hours worked per week: This variable reflects the typical hours per week the respondent worked in the last year. It is transformed by the logarithmic function. Unemployed are counted as zeros
- Employment: This variable is a binary indicator of whether an individual is employed or in the labor force. Those who are not in the labor force are considered unemployed.

[84] Note that when I adjust for inflation, I am using the national CPI deflator

- Labor force: This is a binary indicator of whether an individual participates in the labor market.
- Commute time: Binary indicator of whether an individual travels more than 45 minutes to reach place of employment. Unemployed individuals are counted as zeros.

Housing

- Mortgage payment: This variable reflects the inflation-adjusted, log transformed monthly mortgage payment on the housing unit. Housing units without mortgages are counted as zeros.
- Rental price: This variable reflects the inflation-adjusted, log transformed monthly rental price. The rental price variable puts rent into categories, so the rental price variable used in analysis is based on the midpoint of the interval[85]. Housing units not rented are counted as zeros.
- Number of rooms: This is a binary indicator of whether the housing unit contains a number of rooms that is greater than the median number of rooms for the reservation on which the housing unit is located. This variable reflects housing quality.
- Recently Constructed: Binary indicator of whether housing unit was constructed in past 10 years.

- Homeowner: Indicator that the housing unit is owned either outright or with a mortgage
- Pay rent: Indicator that rent is paid for the housing unit

Population

- Population: Reservation population, constructed using number of observations in data and sample weights
- AIAN Population Share: Share of the reservation population that is American Indian, constructed using number of observations in data, sample weights, and racial identification
- Recently moved: Binary indicator of whether an individual moved into current residence within the past five years
- High School Degree: Indicator of whether individual has a high school diploma or higher

Covariates in the Labor Market Regressions

The following variables are the variables that I use as covariates in the labor market and population regressions.

- Age: Continuous variable indicating respondent's age. Only individuals over the age of 16 are included in the sample

[85] There is no statistically significant difference between results produced by regression analysis that uses the midpoint and interval regression that uses both points of the interval

for analysis

- Age squared
- Race: An indicator of the respondent's preferred single race[86].
- Sex: Indicator of whether respondent identified as male or female
- Other language: Whether respondent speaks a language other than English at home

Covariates in the Housing Market Regressions

I control for the following covariates in the housing market regressions:

- Urban: Binary indicator of whether housing unit is located on block considered to be urban by census definitions

8.3.3 Reservation-Level Controls

Ordinary least squares regressions average over tribal heterogeneity, because I cannot include reservation fixed effects for practical and econometric reasons discussed in the paper. Two-stage least squares instrumental variables regressions account for much of the heterogeneity across tribes and reservations, but to test explicitly whether specific characteristics are responsible for omitted variable bias in the OLS estimates, in supplemental specifications I control for various reservation/tribal characteristics. I detail the covariates, below. In most cases, I did not find that these sources of heterogeneity changed my estimates, so I do not include them as controls in the main specification. Where covariates are included in specifications, I indicate as much.

Strength of Institutions

I hypothesized that heterogeneous tribal political institutions may be an important determinant of the incidence of local labor demand shocks in Indian Country. One of the most important features of the legal environment is whether the reservation is governed by tribal civil law or state civil law as determined by the 1953 passage of Mandatory Public Law 83-280 (PL280). Past research has found that PL280 affects income and crime rates on reservations [Dimitrova-Grajzl et al., 2014, Anderson and Parker, 2008]. As discussed, above, state versus tribal jurisdiction has also been linked to tribal gaming adoption [Cookson, 2010]. I use mandatory PL280 adoption as one of the predictors of tribal gaming when I construct the weights for my weighted differences-in-differences specifications.

[86] Refer to the discussion, below, on how I dealt with the changing racial self-identification question in the census

Others have highlighted the link between tribal constitutions and economic development [Akee et al., 2015b, Cornell and Kalt, 1998]. To account for the possibility that a tribe's constitutional design affects long-run economic outcomes, I follow Akee et al. [2015b] and I include an indicator of whether the constitution mandates that the tribe directly or indirectly elects the chief executive. In their study, Akee and co-authors generate a list of 70 tribes, including tribes based on certain criteria like population size and having a written constitution. When the researchers provided me with their dataset, they removed data for one tribe that requested their data not be shared, and they randomly dropped four other tribes to preserve the confidentiality of that one tribe. Thus, I am left with data on the constitutions of 65 tribes. I find that the coefficient on the constitutions indicator is precisely estimated as 0 in most specifications, so I do not include it in the final analysis.

Finally, in the alternative specification, I controlled for whether the casino-adopting tribe divides casino profits among tribal residents in the form of per-capita cash transfer payments[87]. I hypothesized that the existence of these payments may change location and migration incentives as well as development outcomes. Per-capita payments may also alter the demographic composition of the tribes, taking the form of reducing the tribal population because larger per-capita benefits accrue to tribes of smaller membership size.

Culture

The degree of cultural preservation may have strong implications for the incidence of local labor demand shocks on a reservation. For example, it may represent differences in the way rents are distributed and the ability of the tribe to organize to promote investments and projects that benefit tribal members. To proxy for culture, I construct a variable that reflects the share of the reservation population that speaks another language at home. I assume that an individual living on a reservation who speaks another language most likely speaks his/her native language[88].

Land Fractionation

Inheritance rules have contributed to the process of fractionation, whereby ownership in individual trust land increases exponentially with each generation. Russ and Stratmann [2014] show that growth in fractional ownership continues in present day. Fractionation is a land characteristic arguably important for development, not fully captured in the share of land in trust variable[89]. In order to paint a more complete picture of the transaction costs imposed on reservations, I characterize the degree of fractionation on reservations using 2016 data from the Bureau of Indian Affairs Land Buy-Back Program, containing a number of measures of the degree of fractionation for 147 reservations and statistical areas. From those measures, I incorporate in analysis the following variables[90]: the number of fractionated tracts (i.e. then number of tracts

[87] The per-capita payment indicator comes from Wolfe et al. [2012]

[88] In her doctoral dissertation, Jorgensen [2000] uses knowledge of a traditional language to proxy for the intergenerational transmission of culture

[89] Note that the land controls: fractionation and buyback, are not included in the casino regressions.

[90] Note that while fractionation is not fully captured in the trust share variable, fractionation should be considered a function of trust share. In particular, the degree of fractionation is a function of the share of individual trust land. In the extreme case of having no individual trust parcels on a reservation, we would see no fractionation. Therefore, including both fractionation and individual trust share in the regression may substantially

held in trust or restricted status that have two or more unique owners), the number of fractionated interests (i.e. the number of aggregated interests within a tract), and the number of distinct owners that own fractional interests for the reservation[91]. I use fractionation variables that are classified as "Level 1". The levels are used to categorize different types of data, where Level 1 are the data extracted prior to the application of policy decisions around which tracts and owners are eligible to receive land buy-back offers. Level 1 data most accurately reflect fractionation insofar as it would contribute to transaction costs.

Of the 147 reservations in the fractionation data, there are 114 eligible reservations that I was able to match to my census data. There is some evidence that reservations with highly fractionated lands are more likely to show up in the fractionation dataset. The excluded reservations have approximately 85% of their land in trust but have a low individual trust share (3%). In addition, the excluded reservations also tend to be smaller, with an average population of approximately 1700, of which 1200 are American Indian. The excluded reservations are also somewhat less likely (58%) to have a casino.

Another relevant element of land fractionation is the recent effort to reclaim highly fractionated lands, placing them into tribal trust. These efforts, known as land buy-back, have been largely galvanized by the Cobell v. Salazar settlement. In 2009, the largest class-action lawsuit against the US Federal Government claimed $157 billion was owed to American Indians across the country for unpaid income from leases on trust land. The case was settled for $3.4 billion, with a large portion of the settlement designated for the purchase of highly fractionated individual trust land as part of a newly created land buy-back program. This program seeks to consolidate land and put it in tribal trust, restoring it for tribal use. To control for the changes in land tenure that result from land buy-back, I use 2018 data published by the Land Buy-Back Program that detail the monetary offers made, the number of offers accepted, and the equivalent acres purchased.

Reservation Size

Finally, I condition on the size of the reservation to account for the fact that reservations of different sizes may have different development opportunities, particularly at the tails of the distribution. The size of the reservations may matter, even for a given share of land in trust, so I construct a size variable using the logarithmic transformation of reservation acreage. I find that log size does not have a statistically significant effect when controlling for trust share, so I do not include it as a covariate in the main specifications.

8.3.4 Construction of the Race Indicator

Census racial self-identification questions in the census surveys changed over time, allowing for multiple race identification

increase standard errors

[91] Fractionation measures were selected from the set of measures in the report using least absolute shrinkage and selection operator (Lasso) analysis

post-1990. To avoid as much as possible conflating changing demographics with changes to the survey instrument, I implement the modified regression bridging method developed by Liebler and Halpern-Manners [2008] before using the race variable. This method uses combinations of individuals who identify as multiple races, in addition to individual and geographic characteristics, to predict the respondents' preferred single race.

8.4 Casino Size

To account for the possibility that the response to the local labor demand shocks is a function of the size of the shock, I estimate Equation (2) with an interaction between the casino indicator and a variable that proxies for the size of the casino. Casino size is represented by a time-varying aggregate index of the number of positions (slot machines) and square footage at each casino open on the reservation in that year. I constructed the index using the Anderson [2003] method of weighting variables using the inverse covariance matrix. The size index increases over time with the opening of additional casinos on the reservation. Aggregation over casinos is done by summation. The coefficient on the interaction between casino adoption and casino size would indicate that the size of the casino changes the impact of casino adoption. Because I didn't find a statistically significant interaction effect, I did not include casino size in the main specification[92].

8.5 Trust Status Changes

Comparing the 2003 to 2018 land ownership data, I am able to quantify the extent of the changes to trust status over the past fifteen years. These statistics are based on the subset of 176 reservations for which the 2003 data exist. I find that the amount of land in trust in total acreage in 2003 is highly correlated with the amount in 2018. The mean absolute value of the change in trust status is approximately 35%. (See Table 17). When I convert the land tenure variable to trust land as a share of total reservation acreage, the changes appear to be even smaller and rarer. This discrepancy could be due to reservation land acreage changing over time as well as trust acreage changing over time. It could also be due to measurement error. Between 2003 and 2018, 30% of reservations did not change in terms of the share of land in trust. The majority of those reservations are the ones at the upper tail of the trust share distribution, suggesting top-coding may partially explain the lack of variation.

In addition to the 2018 trust share variable, I generated a time-varying trust share variable through a process of linear interpolation whereby I ascribed the 2003 trust share value to census years 1980, 1990, and 2000; I ascribed the mean of the interpolated trust share values from 2005-2009 to the 2005-2009 pooled ACS data; and I ascribed the mean of the interpolated

[92] In addition, casino size is likely endogenous

Table 17: Change in Trust Land Between 2003 and 2018

	Min	P10	P25	P50	Mean	P75	P90	Max
Percent Change	0.0001	0.0117	0.0605	0.2025	0.3534	0.5798	0.93922	1.3606
Correlation between 2003 and 2018: 0.99***								

trust share values from 2010-2014 for the 2010-2014 pooled ACS data. The time-varying trust share variable produced largely the same results as the 2018 trust share variable, so I do not report the results associated with the time-varying variable.

8.6 Additional Results

Table 18: Effect of Individual and Tribal Trust on the Labor Market

	Total Income		**Wage Income**		**Employment**		**Labor Force**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Tribal Trust Share	-0.440**	-1.411***	-0.507**	-1.393***	-0.0285	-0.0513	-0.0277	-0.046
	(0.207)	(0.456)	(0.239)	(0.520)	(0.0211)	(0.0434)	(0.0203)	(0.0413)
Indiv Trust Share	-0.0903	-0.872	-0.886**	-1.698	-0.0590*	-0.0939	-0.0273	-0.122
	(0.285)	(0.930)	(0.356)	(1.065)	(0.0311)	(0.0869)	(0.0295)	(0.100)
Observations	575000							
Number of clusters	230							

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV test stats: Chi-sq P-value: 0.0648; C-D Wald F stat: 58000. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects and the following set of covariates: age, age^2, gender, race, indicator of speaking another language. Trust share appears as a fraction less than 1. Total income and wage income are in 2000 dollars and have been transformed by the inverse hyperbolic sine function. Two instrumental variables were used for identification: DI mean and historical VFPA. Number of observations have been rounded according to Census confidentiality rules.

Table 19: Effect of Individual and Tribal Trust on the Housing Market

	Mortgage		**Rental Price**		**Homeowner**		**Number of Rooms**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Tribal Trust Share	-1.913***	-3.990***	0.0428	-0.112	-0.0703**	-0.124*	-0.202***	-0.345***
	(0.471)	(0.569)	(0.187)	(0.348)	(0.0340)	(0.0685)	(0.0723)	(0.0728)
Indiv Trust Share	-1.353**	-0.524	1.044**	1.508	-0.173	-0.216	-0.226***	-0.249
	(0.635)	(1.818)	(0.481)	(0.985)	(0.109)	(0.144)	(0.0841)	(0.186)
Observations	575000							
Number of clusters	230							

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV test stats: Chi-sq P-value: 0.0648; C-D Wald F stat: 58000. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Trust share appears as a fraction less than 1. Mortgage and rental price are in 2000 dollars and have been transformed by the inverse hyperbolic sine function. Rental price is the midpoint of an interval variable. Number of rooms is a binary indicator of whether number of rooms is greater than the median. Number of observations have been rounded according to Census confidentiality rules.

Table 20: Labor Market Effects of Casino Adoption by Land Tenure: IV Estimates #1 for Rural Reservations

	Total Income	**Wage Income**	**Total Earnings**	**Employment**	**Labor Force**	**Hours Worked**
Casino	0.122	0.0938	0.166	0.0199	0.015	0.181
	(0.110)	(0.153)	(0.122)	(0.0129)	(0.0132)	(0.492)
Trust Share Demeaned	-1.687***	-0.925	-0.695	0.0214	-0.0878	-0.507
	(0.611)	(0.820)	(0.619)	(0.0471)	(0.0707)	(2.038)
Casino*Trust	0.424	-0.682	-0.523	-0.106	0.0367	-1.188
	(0.977)	(1.095)	(0.965)	(0.0760)	(0.0755)	(2.847)
Observations	381000					

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV estimates using mean drainage index instrument. Chi-sq P-val: 0.0049; C-D Wald F stat: 30000. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects and the following set of covariates: age, age^2, gender, race, indicator of speaking another language. Trust share is demeaned and appears as a fraction less than 1. Total income, wage income, earnings are in 2000 dollars and have been transformed by the hyperbolic sine function. Observations are weighted by inverse probability of casino adoption. Observations come from set of rural reservations. Number of observations have been rounded according to Census confidentiality rules.

Table 21: Labor Market Effects of Casino Adoption by Land Tenure: IV Estimates #2 for Rural Reservations

	Total Income	**Wage Income**	**Total Earnings**	**Employment**	**Labor Force**	**Hours Worked**
Casino	0.169	-0.137	-0.0127	-0.0114	-0.000959	-0.904
	(0.135)	(0.177)	(0.155)	(0.0118)	(0.0160)	(0.783)
Trust Share Demeaned	-1.363*	-0.844	-0.487	-0.0922	-0.108	-1.28
	(0.723)	(1.047)	(0.863)	(0.0613)	(0.0806)	(3.484)
Casino*Trust	0.18	1.754	1.468	0.134*	0.186**	9.429*
	(0.622)	(1.105)	(1.010)	(0.0778)	(0.0899)	(5.036)
Observations	381000					

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV estimates using historical VFPA instrument. Chi-sq P-val: 0.0425; C-D Wald F stat: 11000. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects and the following set of covariates: age, age^2, gender, race, indicator of speaking another language. Trust share is demeaned and appears as a fraction less than 1. Total income, wage income, earnings are in 2000 dollars and have been transformed by the hyperbolic sine function. Observations are weighted by inverse probability of casino adoption. Observations come from set of rural reservations. Number of observations have been rounded according to Census confidentiality rules.

Table 22: Housing Market Effects of Casino Adoption by Land Tenure: IV Estimates #1 for Rural Reservations

	Mortgage	**Rental Price**	**Pay Rent**	**Number of Rooms**	**Commute Time**
Casino	0.205	-0.147	-0.0241	-0.0179	-0.0654*
	(0.313)	(0.332)	(0.0548)	(0.0456)	(0.0373)
Trust Share Demeaned	-1.943**	-1.496	-0.2	-0.266	0.228
	(0.934)	(0.966)	(0.148)	(0.168)	(0.148)
Casino*Trust	-1.61	3.510***	0.593**	0.238	-0.0464
	(1.987)	(1.354)	(0.234)	(0.168)	(0.172)
Observations	381000				

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV estimates using mean drainage index instrument. Chi-sq P-val: 0.0049; C-D Wald F stat: 30000. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Trust share is demeaned and appears as a fraction less than 1. Mortgage and rental price are in 2000 dollars and have been transformed by the hyperbolic sine function. Rental price is the midpoint of an interval variable. Number of rooms is a binary indicator of whether housing unit has more than the median number of rooms. Observations are weighted by inverse probability of casino adoption. Observations come from the set of rural reservations. Number of observations have been rounded according to Census confidentiality rules.

Table 23: Housing Market Effects of Casino Adoption by Land Tenure: IV Estimates #2 for Rural Reservations

	Mortgage	**Rental Price**	**Pay Rent**	**Number of Rooms**	**Commute Time**
Casino	0.0118	0.0576	0.00588	-0.00201	-0.0261
	(0.363)	(0.292)	(0.0450)	(0.0503)	(0.0283)
Trust Share Demeaned	-3.135***	-1.089	-0.126	-0.391**	0.345***
	(1.055)	(1.043)	(0.157)	(0.192)	(0.109)
Casino*Trust	-0.567	1.734	0.345	-0.0242	-0.357**
	(1.741)	(1.344)	(0.210)	(0.244)	(0.146)
Observations	381000				

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV estimates using historical VFPA instrument. Chi-sq P-val: 0.0425; C-D Wald F stat: 11000. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Trust share is demeaned and appears as a fraction less than 1. Mortgage and rental price are in 2000 dollars and have been transformed by the hyperbolic sine function. Rental price is the midpoint of an interval variable. Number of rooms is a binary indicator of whether housing unit has more than the median number of rooms. Observations are weighted by inverse probability of casino adoption. Observations come from the set of rural reservations. Number of observations have been rounded according to Census confidentiality rules.

Table 25: Interaction Wage Effects by Race: Full Sample of Reservations

	Wage Income			
	American Indian		White	
	OLS	IV	OLS	IV
Casino	0.256**	-0.0238	0.0595	0.129
	(0.121)	(0.263)	(0.135)	(0.192)
Trust Share Demeaned	-0.728***	-2.744***	0.670*	2.045**
	(0.256)	(0.849)	(0.361)	(0.966)
Casino*Trust	0.661*	-0.606	-1.117***	-2.846***
	(0.345)	(1.915)	(0.358)	(0.970)
Observations	233000	309000		
Clusters	230			

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV test stats: For AIAN: Chi-sq P-val: 0.0196; C-D Wald F stat: 24000; For White: Chi-sq P-val: 0.0091; C-D Wald F-stat: 150000. Robust standard errors clustered by reservation are in parentheses. Regressions include year and region fixed effects and the following set of covariates: age, age^2, gender, race, indicator of speaking another language. Trust share appears as a fraction less than 1. Wage income is in 2000 dollars and has been transformed by the inverse hyperbolic sine function. Number of observations have been rounded according to Census confidentiality rules.

Table 24: Effect of Casino Adoption on the Labor Market by Land Tenure: Full Sample of Reservations

	Total Income		**Wage Income**		**Employment**		**Labor Force**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Casino	0.317***	0.221**	0.244**	0.211*	0.0199	0.0231**	0.0366***	0.0194
	(0.0915)	(0.0983)	(0.109)	(0.119)	(0.0121)	(0.0108)	(0.00983)	(0.0120)
Trust Share Demeaned	-0.744***	-1.761***	-0.368	-1.155*	-0.028	-0.0328	-0.0155	-0.130**
	(0.209)	(0.461)	(0.236)	(0.615)	(0.0257)	(0.0507)	(0.0237)	(0.0626)
Casino*Trust	0.591**	0.646	0.0535	-0.625	-0.00249	-0.0812*	-0.00227	0.0434
	(0.243)	(0.516)	(0.268)	(0.680)	(0.0276)	(0.0491)	(0.0246)	(0.0534)
Observations	575000							
Clusters	230							

*** p<0.01, ** p<0.05, * p<0.1

Notes: IV test stats: Chi-sq P-val: 0.003; C-D Wald F stat: 47000. Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects and the following set of covariates: age, age^2, gender, race, indicator of speaking another language. Trust share is demeaned and appears as a fraction less than 1. Total income and wage income are in 2000 dollars and have been transformed by the inverse hyperbolic sine function. Observations are weighted by the inverse probablity of casino adoption. Number of observations have been rounded according to Census confidentiality rules.

Table 26: Effect of Casino Adoption on the Housing Market by Land Tenure: Full Sample of Reservations

	Mortgage		**Rental Price**		**Homeowner**		**Number of Rooms**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Casino	0.406	0.483*	0.12	-0.185	-0.0345*	0.00583	0.0143	-0.00746
	(0.328)	(0.278)	(0.109)	(0.231)	(0.0194)	(0.0337)	(0.0419)	(0.0465)
Trust Share Demeaned	-2.815***	-2.381**	0.0243	-0.839	-0.0672***	0.0014	-0.444***	-0.396*
	(0.708)	(0.926)	(0.139)	(1.056)	(0.0248)	(0.166)	(0.0994)	(0.211)
Casino*Trust	1.341*	-0.244	0.592***	1.889**	-0.0885*	-0.255	0.337***	0.208
	(0.723)	(1.097)	(0.224)	(0.845)	(0.0465)	(0.161)	(0.0919)	(0.146)
Observations	575000							
Clusters	230							

*** p<0.01, ** p<0.05, * p<0.1

Notes: Robust standard errors clustered by reservation are in parentheses. All regressions include year and region fixed effects. Trust share is demeaned and appears as a fraction less than 1. Mortgage and rental price are in 2000 dollars and have been transformed by the inverse hyperbolic sine function. Rental price is the midpoint of an interval variable. Number of rooms is a binary indicator of whether housing unit has more than the median number of rooms. Observations are weighted by inverse probability of casino adoption. Number of observations have been rounded according to Census confidentiality rules.

8.7 Maps

Figure 4:

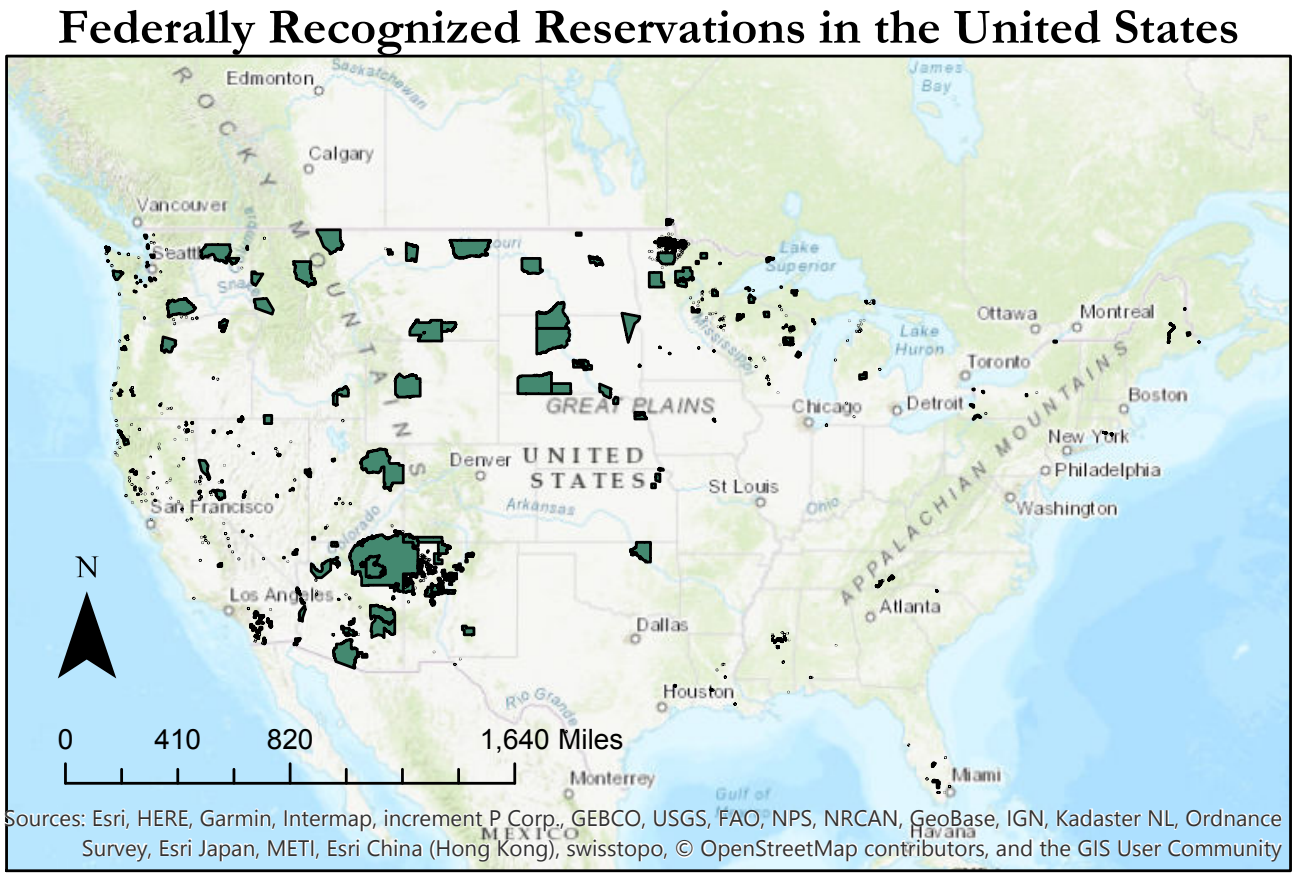


Figure 5:

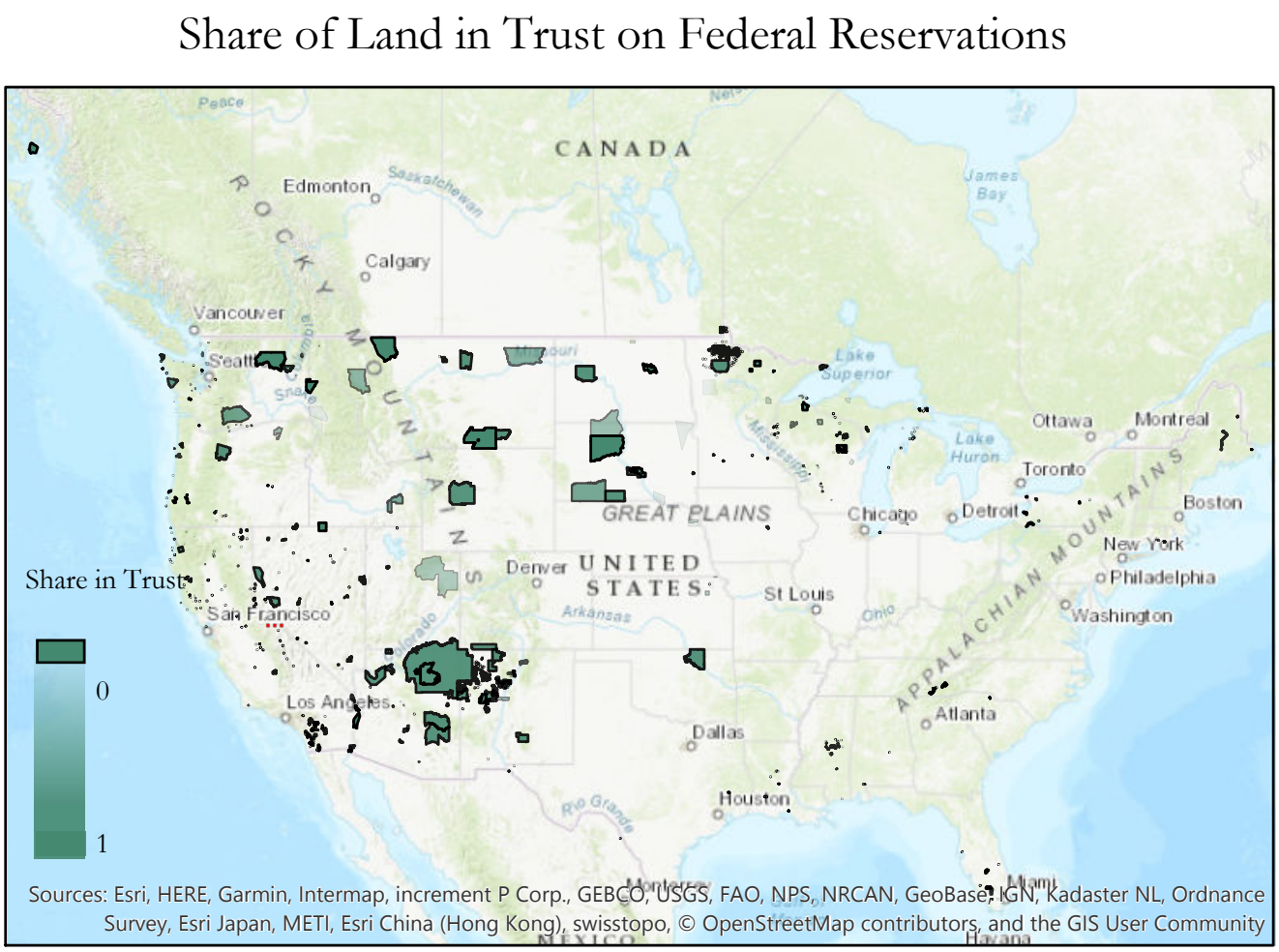
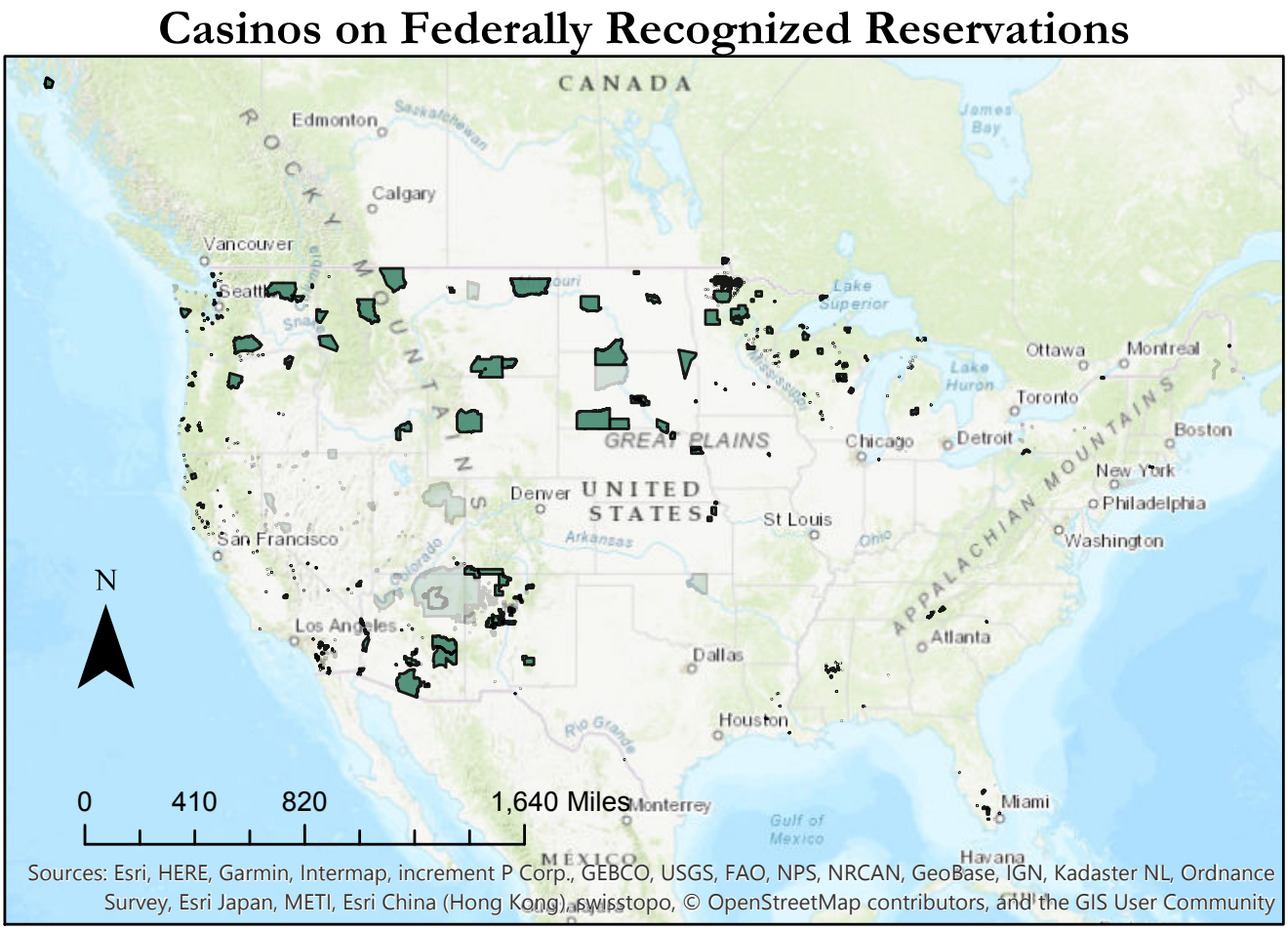

Share of Land in Trust on Federal Reservations
CANADA
Edmonton
Calgary
Vancouver
Seattle
Ottawa
Montreal
Toronto
Boston
New York
Philadelphia
Washington
Chicago
Detroit
Denver
UNITED STATES
GREAT PLAINS
St Louis
San Francisco
Los Angeles
Dallas
Houston
Atlanta
Miami
Havana
ROCKY MOUNTAINS
APPALACHIAN MOUNTAINS
Lake Superior
Lake Huron
James Bay
Share in Trust
0
1
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

Figure 6:



Information on tribal gaming was initially sourced from a variety of places, including the National Indian Gaming Commission website, Gamblinganswers.com, and Casinocity.com. The data used in this paper are from Wolfe et al. (2012)

Figure 7:

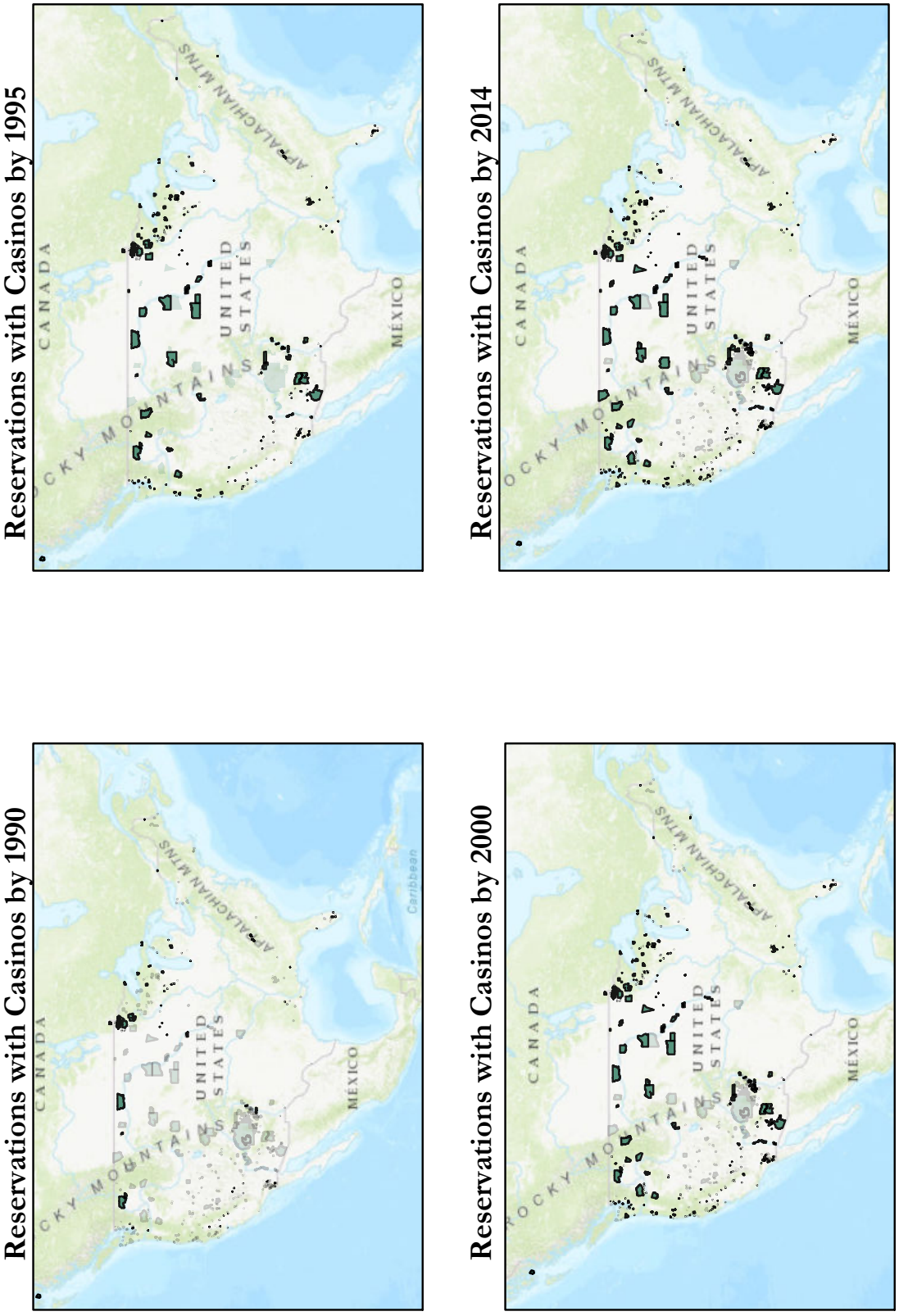
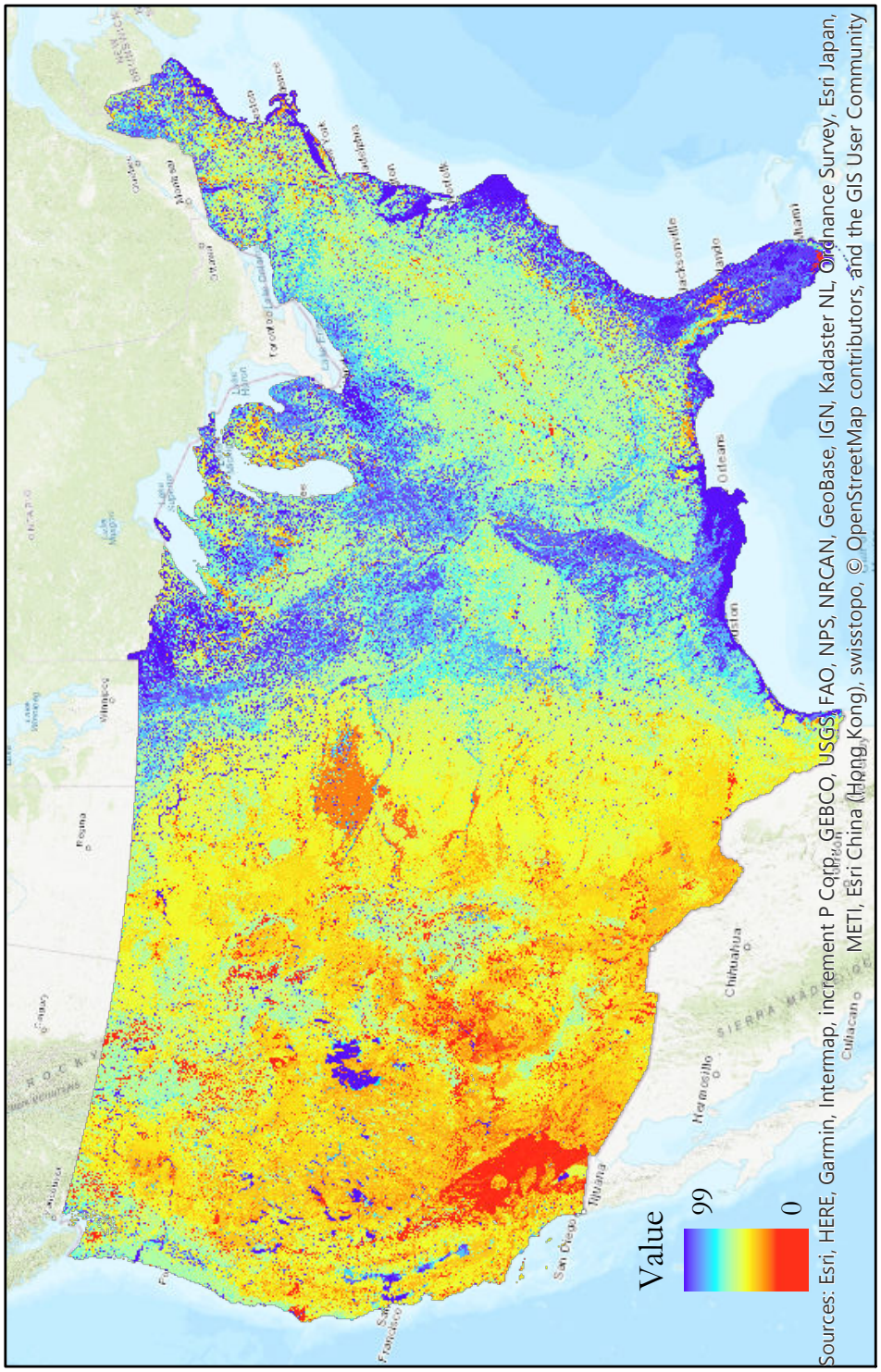
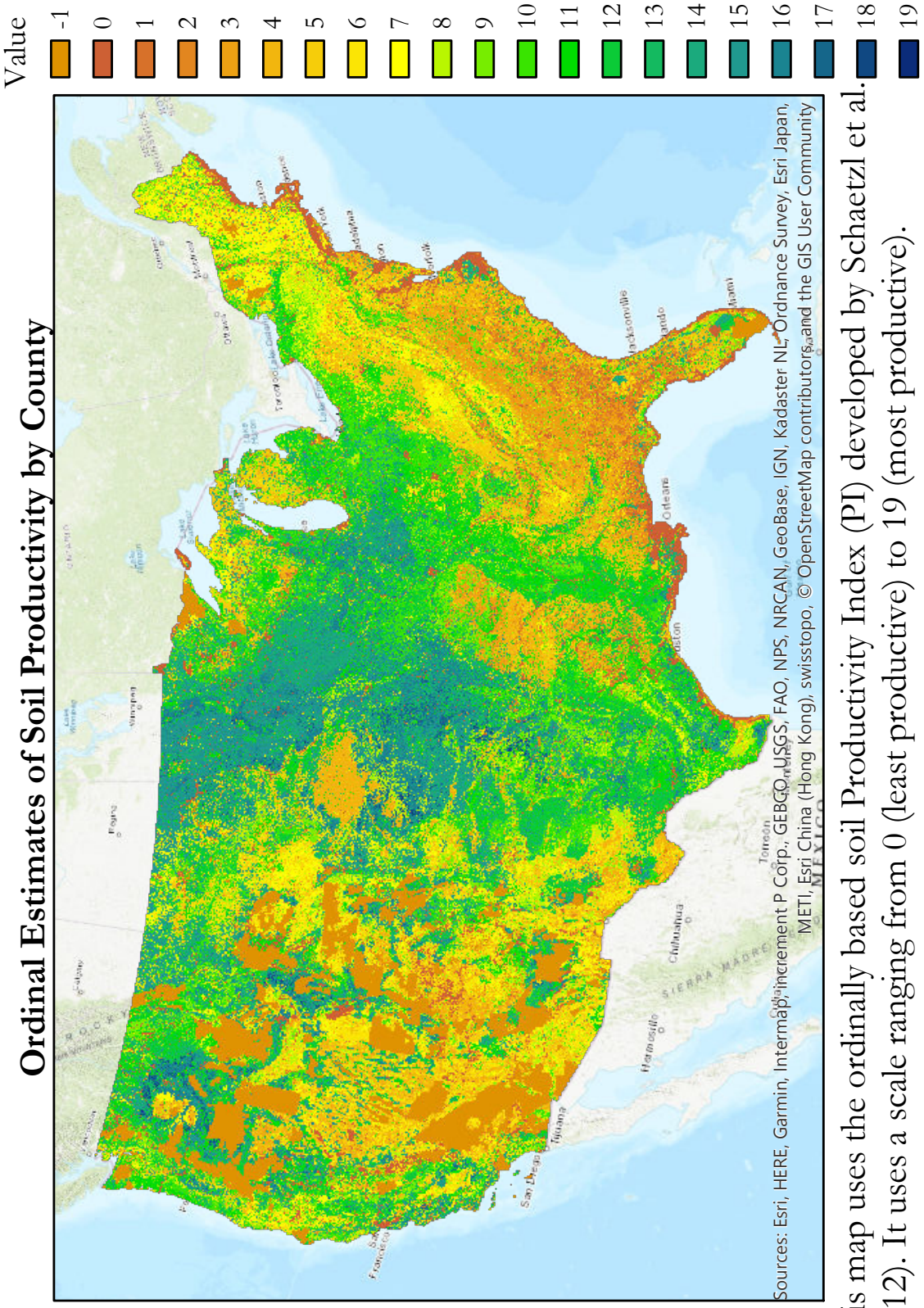

The Evolution of Tribal Gaming, 1990-2014
Reservations with Casinos by 1990
Reservations with Casinos by 1995
Reservations with Casinos by 2000
Reservations with Casinos by 2014
CANADA
UNITED STATES
MÉXICO
ROCKY MOUNTAINS
APPALACHIAN MTNS
Caribbean

Figure 8



This map uses the Natural Soil Drainage Index (DI) developed by Schaetzl et al. (2009). It uses a scale ranging from 0 (for the driest soils) to 99 (open water).

Figure 9



This map uses the ordinally based soil Productivity Index (PI) developed by Schaetzl et al. (2012). It uses a scale ranging from 0 (least productive) to 19 (most productive).