Property Rights, Place-Based Policies, and Economic Development

by

Laurel Wheeler
Duke University

CES 19-16 June, 2019

The research program of the Center for Economic Studies (CES) produces a wide range of economic analyses to improve the statistical programs of the U.S. Census Bureau. Many of these analyses take the form of CES research papers. The papers have not undergone the review accorded Census Bureau publications and no endorsement should be inferred. Any opinions and conclusions expressed herein are those of the author(s) and do not necessarily represent the views of the U.S. Census Bureau. All results have been reviewed to ensure that no confidential information is disclosed. Republication in whole or part must be cleared with the authors.

To obtain information about the series, see www.census.gov/ces or contact Christopher Goetz, Editor, Discussion Papers, U.S. Census Bureau, Center for Economic Studies 5K038E, 4600 Silver Hill Road, Washington, DC 20233, CES.Working.Papers@census.gov. To subscribe to the series, please click here.

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 higher levels 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 the extent to which place-based policies can improve economic outcomes on reservations. I use a spatial equilibrium framework to study the incidence of casino adoption, a place-based policy unique to reservations. The key insight from the model is that incomplete property rights impose frictions in the housing market that lower the migration response to casino adoption, improving the likelihood that the local population benefits. Consistent with the model's predictions, I find that casino adoption raises average wages and that the wage effect is greater on reservations with more land in trust. My estimates suggest that wage increases correspond to welfare improvements. 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. I would like to acknowledge the researchers who agreed to share their data, often after undergoing their own time-intensive data collection activities: Nick Parker, Terry Anderson, and Tony Cookson for their 2003 land ownership data; Brad Humphreys, Bill Evans, Michael Mathes, Barabara Wolfe, and Jessica Jakubowski for their casino gaming datasets; Tony Cookson for his casino gaming instruments; Valentina Dimitrova-Grajzl, Randy Akee, and Dick Todd for their list of mandatory PL280 states; Randy Akee and Miriam Jorgensen for their data on tribal constitutions; and Bryan Rice, Beth Wenstrom, and their colleagues at the Bureau of Indian Affairs for the 2018 data on land ownership. I would additionally like to acknowledge those working on Indian Country topics who have provided me with invaluable guidance and feedback, including Cris Stainbrook at the Indian Land Tenure Foundation and Terry Beckwith of ICC Indian Enterprises. I greatly appreciate the important comments from Randy Akee, Joseph Brewer, Patrick Button, Larry Chavis, Stephen Egbert, Valentina Dimitrova-Grajzl, Joseph Guse, Miriam Jorgensen, Joe Kalt, Patrice Kunesh, Juan Carlos Suarez Serrato, Laura Davidoff Taylor, Dick Todd, Ebonya Washington, and members of my dissertation committee Peter Arcidiacono, Robert Garlick, and Seth Sanders. Also gratefully acknowledged are the comments from participants of the NBER Conference on the Economics of Indigenous Peoples and Institutions, the Association for Public Policy Analysis and Management conference, the Midwest Economics Association conference, and seminars and workshops at Duke University. Support for this research at the Triangle Research Data Center from NSF(ITR-0427889) is also gratefully acknowledged.

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; Ace-moglu 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; At-wood, 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, or regional, level.[1]

I address this question in the context of federally recognized American Indian reservations, where average per capita income, employment, 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.[2] Trust land is held in trust by

[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.

the US federal government on behalf of an individual member of the tribe or on behalf of the tribe itself. Fee simple land is free from transaction restrictions, whereas trust land is associated with a host of restrictions on transactions and collateralization. Similar to low-income country settings where property rights are incomplete, the restrictions imposed by trust status reduce gains from trade and access to credit. In contrast to many of these other settings, however, rights to trust land are well defined and enforceable in a court of law.

To examine how incomplete property rights affect the level of local economic outcomes on reservations, I rely on a conceptual framework that borrows from the literature on local labor markets (Kline and Moretti, 2014; Moretti, 2011; Glaeser and Gottlieb, 2009).[3] I treat reservations as geographically distinct localities where labor market activity is a function of local policies such as property institutions. I allow trust status to introduce specific market distortions that affect the functioning of the labor market, the housing market, and the movement of people on the reservation. I hypothesize that credit constraints and contracting constraints imposed by trust status shift the demand for labor downward. This effect operates through firm investment and human capital accumulation. Market distortions of various forms increase firm costs, deterring firm entry. Credit constraints contribute to the creation of a lower-skilled population, reducing the local productivity of labor. Both forces suggest that reservations with a larger share of land in trust experience lower average wages.

To test this hypothesis, I construct a novel dataset that combines restricted-use demographic Census microdata with new reservation-level data on land ownership. With these data, I am able to address long-standing questions about the effects of property institutions on reservations. The confidential Census data identify whether an individual resides on a reservation, enabling me to define reservations as local labor markets and disentangle economic outcomes on the reservation from the surrounding areas. In contrast, especially if population sizes are small, public data sources do not report many of the variables of interest within reservation boundaries. The land ownership data, which I obtained directly from the Bureau of Indian Affairs (BIA) in 2018, are the most comprehensive data of their kind since the BIA last publicly released the data in the 1980s. These data provide an up-to-date snapshot of the composition of land tenure on every reservation in the United States.

I adopt an empirical approach that enables me to overcome the classic challenge of the

[3] 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.

endogeneity of property rights. I rely on an instrumental variables (IV) approach that arises from geography and the historical process that determined the assignment of property rights on reservations. My strategy uses information about the relationship between soil quality, agriculture, and the price of land at the time of the assignment of property rights. Property rights were assigned in accordance with the price of land in the late 19th and early 20th century. At that time, the price of the land was determined by the land's agricultural productivity. Prior to technological innovation, agricultural productivity hinged on soil quality. My instrument is a long-run measure of soil quality that predicts the share of land in trust by reservation. I condition on a different measure of soil quality that reflects the productivity of the land today to account for the potential link between long-run soil quality and economic outcomes today.

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 the wages and levels of employment. IV regressions yield estimates that are larger than those from ordinary least squares regressions. 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 the 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 targeted at reservations overcome some of the deleterious effects of incomplete property rights?[4]

According to standard theory, the direct effect of a place-based policy that increases the demand for local labor is an increase in wages, inducing migration into the targeted locality

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

(e.g. Rosen, 1979; Roback, 1982). 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. Assuming perfect mobility, real wages remain unchanged, and the local population does not necessarily benefit. This equilibrium suggests that it is difficult to justify place-based policies from a welfare perspective when markets are functioning perfectly. Based on the literature on place-based policies, frictions in the labor market, the housing market, or worker mobility change the process of re-equilibration, thereby changing the incidence of the demand shock (Kline and Moretti, 2014). I hypothesize that the market distortions associated with incomplete property rights increase the likelihood that the local population benefits from labor demand shocks on American Indian reservations.

Drawing on Busso et al. (2013) and Suarez Serrato and Zidar (2016), I build a general spatial equilibrium model where the elasticity of housing supply varies by land tenure category. Because transactions in the housing market are encumbered on trust land, the housing supply is less responsive to increases in demand. I show that the lower the elasticity of housing supply, the lower the elasticity of effective labor supply, yielding the prediction that wages increase by more on reservations with a larger share of land in trust. The model does not provide a clear prediction about how property rights affect rental prices or migration. The welfare effects are theoretically ambiguous, because real wages depend on the relative size of wage increases and rental price increases.

To test whether 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, D. et al., 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 casino adoption has large, positive effects on wages, earnings, and rental prices. On the average reservation, wages increase by almost 30%. As predicted, the treatment effect is heterogeneous by land tenure type. Casino adoption has a greater effect on wages on reservations with a larger share of land in trust. In fact, the wage gap due to incomplete property rights disappears. In contrast, the gap in housing prices widens. My results suggest that frictions in the housing market on trust land discourage some amount of migration and 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. The literature on the incidence of local labor demand shocks typically implicitly assumes that all land is privatized and that ownership rights are easily transferable. Several previous papers have introduced costly migration into the spatial equilibrium framework (e.g. Morten and Oliveira, 2014; Bound and Holzer, 2000; Topel, 1986; Notowidigdo, 2011); however, with the exception of Hsieh and Moretti (2015), few have directly explored how costly migration may be related to constraints in the land market. I provide empirical evidence on the equilibrium response to a demand shock in a setting where land use regulations are responsible for restricting housing supply. This is relevant to the broader literature on land and housing market frictions like residential construction regulations (Quigley and Raphael, 2005; Kok et al., 2014; Miller, 2012). My paper is one of the first to provide empirical motivation for directly positioning the study of one specific type of land use regulation, property institutions, in the spatial framework.[5]

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; Leonard et al., 2018; 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 that past estimates that did not take into account the endogenous assignment of rights were likely biased.[6]

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

[5] Again, Aragon (2015) is the only other paper I am aware of that takes this approach to studying property rights.

[6] 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.

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 features of Indian reservations.

The rest of the paper is organized as follows. Section 2 describes the systems of land tenure on federally recognized reservations and the evolution of casino gaming. Section 3 introduces the conceptual framework underlying my analyses, and Section 4 describes the data used to perform the analyses. Section 5 details the identification strategy, including my approach to dealing with the endogeneity of land tenure and with non-random selection into gaming. In Section 6, I present the results from three sets of analysis: the level effect of land tenure (Section 6.1), the level effect of tribal gaming (Section 6.2), and the interaction between land tenure and tribal gaming (Section 6.3). In Section 6.4, I discuss how to interpret these results as welfare effects. Section 7 gives my concluding remarks.

2 Background

This section describes the local institutions motivating my research design.[7] I exploit heterogeneity in the systems of land tenure on reservations to study economic outcomes in places where there are more and fewer restrictions on land use, sales, and mortgaging. In this section, I describe how variation in land tenure systems today is largely the result of historical legislation. Variation in the assignment of property rights in the late 19th and early 20th centuries was driven by variation in observable land quality. I use this information to construct instruments that capture long-run land quality and predict variation in property rights. With this research, I also study how systems of land tenure affect the general equilibrium response to local labor demand shocks. I rely on casino gaming shocks as local labor demand shocks unique to federal reservations. Casino adoption is an example of a place-based policy that induces a large, permanent, one-time increase in demand for local labor. In this section, I briefly discuss the legislation that gave rise to the evolution of tribal gaming.

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

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 those in the Homestead Act—and assigning ownership of the allotments to individual members of the tribe (McChesney, 1990).[8] 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.[9] 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 information about various pieces of legislation to demonstrate that the Bureau 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 motivate an instrumental variables approach.[10]

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

[8] 160 acres per family, 80 acres per single person over the age of 18, and 40 acres per person under the age of 18.

[9] 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.

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

and auctioned off corresponds to fee simple land (fee land); land that was neither allotted nor sold corresponds to tribal trust land.[11] 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 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.[12]

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—both types of trust land are characterized by restrictions on transactions, which is in contrast to fee land.[13] 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 the 2018 land ownership 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.[14] 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

[11]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 a reservation that is considered restricted is 2% of the area of the reservation in trust.

[12]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 them 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.

[13]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. 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.

[14]Variation in land tenure type within a reservation is referred to as "checkerboarding"

the sample used in analysis, an individual residing on a reservation is equally likely to be American Indian or White.

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

Notes: This table is largely based on Listokin et al. (2006, p.99).

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 in 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 on trust land that otherwise may not be legal under state or federal regulations. Technically, the IGRA established that state authority was prohibitory, not regulatory. In other words, the 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.[15] 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.[16] 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, D. et al., 1999; Evans and Topoleski, 2002; Evans and Kim, 2006), but little is known about the effects of tribal gaming within the local labor

[15] 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.

[16] 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, but states are not permitted to revenue share.

market framework.[17] Even less is understood about how property institutions change the impact of casino adoption.

3 Conceptual Framework

In this section, I adapt a spatial equilibrium model to illustrate how property institutions on reservations affect local economic outcomes and affect the way local economic outcomes respond to economic shocks. First I use the model to discuss how credit constraints and contracting constraints associated with trust status introduce frictions in the labor market that shift the demand for labor. The model suggests that the level effect of incomplete property rights is lower average wages. Drawing on Suarez Serrato and Zidar (2016), I then use the model to generate predictions about how property institutions affect the re-equilibration of the housing and labor markets following a local labor demand shock in the form of tribal gaming. The key insight from the model is that trust status lowers the elasticity of housing supply, which in turn reduces the effective labor supply, yielding the prediction that wage increases due to the demand shock are increasing with the share of land in trust.

In accordance with the literature, I define federal reservations to be relatively clearly delineated local labor markets (Kline and Moretti, 2014; Moretti, 2011; Glaeser and Gottlieb, 2009). They are geographically distinct localities, characterized by specific industries and local policies, resulting in regional differences in labor market activity.

3.1 Labor Demand

Assume ach reservation r has one type of firm that hires workers to maximize profits.[18] Firms produce goods according to Cobb-Douglas decreasing returns to scale technology with labor L_r and capital K_r inputs:

$$y_r = Z_r L_r^{\theta} K_r^{\gamma}$$

where $\theta, \gamma \in (0, 1)$ and $\theta + \gamma < 1$. Z_r is the local productivity level on the reservation. Firms

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

[18] Here I have only one type of worker, although the model could be extended to include two types of workers differentiated by skill or by tribal affiliation.

set the wage rate w_r equal to the marginal product of labor, so labor demand is given by:

$$L_r^D(w_r) = \frac{(\theta Z_r K_r^{\gamma})^{1/(1-\theta)}}{w_r^{1/(1-\theta)}}$$

Workers hold heterogeneous preferences and supply a finite amount of labor, so differences in labor demand across reservations result in unequal wages across reservations. Derived demand for labor varies across reservations due in part to differences in property institutions. Property institutions are defined at the level of the reservation based on the composition of the two categories of land tenure $L = \text{Trust, Fee}$, where trust land is associated with incomplete property rights. Incomplete property rights affect the demand for local labor through at least two channels: the credit channel and the transaction cost channel. As discussed, there are legal prohibitions on the collateralization of trust land, which presents obstacles to accessing credit. Credit constraints have been shown to inhibit human capital accumulation, suggesting that Z_r is lower on a reservation with a larger share of land in trust (Jacoby and Skoufias, 1997). Therefore, a reservation characterized by a larger share of land in trust has a lower average marginal product of labor, yielding lower wages.

In addition, trust land is associated with disproportionately high transaction costs. The term "transaction cost" refers to the reality that leasing or buying structures on trust land is a slow and encumbered process. Transaction costs are not necessarily pecuniary costs; they are costs associated with uncertainty, administrative challenges, and waiting. Transaction costs increase firm operational costs. For example, lease length restrictions increase costs in the form of uncertainty.[19] Higher costs may deter firm entry, leading to lower wages conditional on labor supply.[20]

Taken together, this framework generates predictions about how incomplete property rights shift the labor demand curve both through firm investment and human capital accumulation.[21] Holding all else constant, reservations with a larger share of land in trust experience

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

[20] Lower average wages may also result from firms passing operational costs on to workers through the wage bargain (Hamermesh, 1989; Bloom, 2009).

[21] 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 for the link between land tenure and business investment, however, is small and inconclusive (Akee and Jorgensen, 2014; Aragon, 2015).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 and 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.

lower average wages.

3.2 Labor Supply

On the supply side, worker i chooses where to live and whether to work by maximizing her Cobb-Douglas utility given by:

$$u_{ir} = \log w_r - \alpha \log p_r + A_r + \xi_{ir}$$

$$= v_r + \xi_{ir}$$

which takes into account wages w_r, rental prices p_r, amenities A_r, and an idiosyncratic preference term.[22] The individual and choice specific error term, ξ_{ir}, represents heterogeneity in the valuation of local amenities, allowing workers to be inframarginal to place. Reservations are native homelands and cultural centers for tribal members and therefore not otherwise equivalent to another locality, with other amenities being held constant. The term α reflects the fixed share of income spent on housing and v_r represents the mean utility.

The size of the local population N_r is determined by the number of workers for whom:

$$u_{ir} = \max_{r'} \; v_{r'} + \xi_{ir'}$$

3.3 Housing

Each worker demands a single unit of housing rented at rate p_r. Housing demand is given by: $H_r^D = \frac{N_r \alpha w_r}{p_r}$. The supply of housing is an increasing function of rental prices p_r and local housing productivity, B_r: $H_r^S = G(p_r, B_r) \equiv (B_r p_c)^{\eta_r}$, assuming constant housing supply elasticity η_r. The number of housing units constructed is therefore an increasing function of the number of workers and land use regulations.

The category of land tenure dictates the degree to which the regulatory environment constrains housing production; however, the predicted effect of trust status on rental prices is

[22] Note that this specification implicitly includes transfer payments in wages and includes government services in amenities. I assume that land is owned by absentee landlords and that all workers can live in housing on land of either category of land tenure.

unclear a priori. Restricting the supply of housing leads to higher housing prices, but if trust status is responsible for some degree of out-migration, lower demand for housing may keep housing prices low. The effect of incomplete property rights on rental prices is therefore left as an empirical question.

3.4 Tribal Gaming Shocks

Now I introduce tribal gaming into the conceptual framework to examine how incomplete property rights affect the way local markets respond to a place-based policy responsible for a labor demand shock. Tribal gaming is a place-based economic activity, legally confined to the boundaries of a reservation to generate revenue for the tribe and tribal members residing there.[23]

According to the standard spatial equilibrium framework, the direct effect of a local labor demand shock is an increase in nominal wages by an amount equal to the productivity increase (Rosen, 1979; Roback, 1982).[24] 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, and amenities. Higher wages increase the budget of the residents of the locality, raising demand for non-traded goods like housing. Higher demand for housing, paired with an inelastic housing supply, leads to higher housing prices. Real wages therefore remain unchanged in equilibrium and only the owners of non-traded capital benefit.[25]

Adaptations of the standard Rosen-Roback model describe ways in which market distortions change the equilibrium response to a labor demand shock, generating the result that spatially targeted interventions benefit the targeted population (e.g. Moretti, 2011). For example, 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). I hypothesize that the institutions that govern the land may generate these conditions. The underlying reason is that housing market frictions imposed by incomplete property rights affect the labor supply response to the demand shock.

[23] Although revenues may be shared in the form of per capita payments with tribal members living off the reservation, the majority of the profits from gaming are invested in infrastructure, education, and other development projects on the reservation.

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

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

Suarez Serrato and Zidar (2016) demonstrate that, given the assumption that ξ_{ir} in the worker problem is i.i.d. type I extreme value, the housing market clearing condition yields the following effective elasticity of labor supply:

$$\epsilon^S \equiv (\frac{1+\eta_r-\alpha}{\sigma(1+\eta_r)+\alpha}) = \frac{1-\frac{\alpha}{1+\eta_r}}{\sigma+\frac{\alpha}{1+\eta_r}} \tag{1}$$

where the local labor supply response is a function of the housing supply elasticity and σ reflects the dispersion of the idiosyncratic preferences.

Equation (1) clearly illustrates how differential housing supply elasticities generate differential labor supply elasticities. The effective labor supply is higher with higher values of η_r. In the extreme case of $\eta_r = \infty$, labor supply depends only on idiosyncratic preferences: $\epsilon^{S,\infty} = \frac{1}{\sigma}$. Toward the other extreme, when $\eta_r = 0$, $\epsilon^{s,0} = \frac{1-\alpha}{\sigma+\alpha} < \frac{1}{\sigma} = \epsilon^{S,\infty}$. In other words, when no new housing units can be constructed, the effective labor supply is low and depends on individual preferences and the fixed housing expenditure share. Intuitively, workers are less likely to choose to move to a locality where there is a relative shortage of housing.

In this setting, the tightness of the housing market depends on land tenure. As discussed, trust land is associated with high transaction costs. The costs of transacting in the housing market reduce construction, restrict the supply of housing, and, to a certain extent, slow population growth (Glaeser and Gottlieb, 2009).[26] Differential transaction costs generate differential housing supply elasticities. η^T and η^F reflect the housing supply elasticity on trust land and on fee land, respectively, where $\eta_r^F > \eta_r^T$. This relationship captures the fact that housing production is more constrained on trust parcels than on fee parcels. The aggregate housing supply elasticity is therefore a weighted average based on the share of land in trust status s^T and the share in fee status s^F:

$$\eta_r = \eta_r^T(s_r^T) + \eta_r^F(s_r^F)$$

[26] 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. 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) Although rent-to-own programs liek 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. Despite the availability of land, much of the land on the reservation may be unsuitable for development. Given the myriad 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.

Following earlier arguments, the lower the elasticity of housing supply, the lower the elasticity of labor supply. From Equation (1), $\eta_r^F > \eta_r^T$ implies $\epsilon^{S,F} > \epsilon^{S,T}$. The model illustrates that, through frictions in the housing market, trust status inhibits the labor supply response to a local labor demand shock like casino adoption.

The opening of a casino on reservation r permanently shifts labor demand outward. Following Suarez Serrato and Zidar (2016), assuming full labor force participation and market clearing conditions, tribal gaming has the following effect on wages, rental prices, and population:

$$\frac{\partial w_r}{\partial Casino_r} = \frac{\triangle L_r^D}{\epsilon_r^S - \epsilon_r^D} \tag{2}$$

$$\frac{\partial p_r}{\partial Casino_r} = (\frac{1+\epsilon_r^S}{1+\eta_r})(\frac{\partial w_r}{\partial Casino_r}) \tag{3}$$

$$\frac{\partial N_r}{\partial Casino_r} = \epsilon_r^S(\frac{\partial w_r}{\partial Casino_r}) \tag{4}$$

where the symbol $\triangle$ denotes a percentage change, L_r^D is labor demand, and ϵ_r^D is the elasticity of labor demand. Equations (2) through (4) indicate that the level effect of casino adoption is an increase in wages, rental prices, and local population. Because ϵ_r^s and η_r are not constant across land tenure categories, the treatment effects are heterogeneous by land tenure.

Equation (2) indicates that reservations with a greater share of land in trust, which have a lower effective labor supply elasticity, experience greater increases in wages due to the tribal gaming shock. Intuitively, higher wages are required to compensate workers to move to a locality where they incur higher costs. The effect of property institutions on rental price inflation and population growth is theoretically ambiguous.

3.5 Welfare

Higher nominal wages alone do not signify welfare improvements. Busso et al. (2013) demonstrate that changes in worker welfare can be calculated from changes in mean utilities on

the shocked locality.[27] It follows that the effect of tribal gaming on the welfare of workers on reservation r is given by:

$$(\frac{\partial N_r}{\partial Casino_r})\sigma = \frac{\partial w_r}{\partial Casino_r} - \alpha \frac{\partial p_r}{\partial Casino_r} \tag{5}$$

which can be approximated as the percent change in real wages: $ln(w_r) - \alpha ln(p_r)$. Equation (5) is a reformulation of Roy's Identity, indicating that welfare depends on nominal wages and rental prices.

This model generates the prediction that a tribal gaming shock induces a greater change in wages on reservations with a larger share of land in trust. In order for the change in wages to translate to an improvement in welfare, the following condition would need to be met: $\epsilon^S < \frac{1+\eta_r}{\alpha} - 1$. Because α is exogenously given, the welfare effect comes down to the relative size of the housing supply elasticity and the effective labor supply elasticity.

Intuitively, the demand for local housing is a function of the number of workers who move into the locality, so the two predictions are interrelated. 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.

3.6 Other Considerations

For the sake of simplicity, there are several potential forces at work in the general equilibrium that I have not modeled. One such force is differential migration costs. Trust status may change the labor supply response to the demand shock by changing the cost of migration.[28] Again, trust land is associated with credit constraints. Most of the literature linking credit constraints to mobility focuses on how credit-constrained workers are less likely to move out

[27] They show that the partial derivative of the indirect utility function V with respect to the mean utility across agents v_r is equal to the number of workers in the locality: $\frac{\partial V}{\partial v_r} = N_r = \mathbb{E}[\max_r \; v_r + \xi_{ir}]$. Assuming ξ_{ir} are type I extreme value, this is equivalent to $\sigma \log(\exp \frac{v_r}{\sigma})$.

[28] 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.

of a locality that experiences a negative demand shock. Lack of access to credit on trust land can be modeled as a cost of in-migration as well (Bound and Holzer, 2000; Topel, 1986; Wozniak, 2010; Malamud and Wozniak, 2012). 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.[29] These practices, if they were to occur, could similarly be modeled as imposing a higher cost of migration on non-Indians. The predictions of the model would be largely unchanged if migration costs were explicitly modeled.

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. The main dependent and explanatory variables in this paper are constructed from demographic data, land ownership data, and tribal gaming data. The 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. These data are used to account for endogeneity and selection and to control for potentially important observable characteristics of reservations.[30]

Demographic data used in this paper are provided by confidential microdata from 1980-2000 Decennial Census long-form samples as well as confidential microdata from 2005-2014 American Community Survey (ACS) samples.[31] These data include key measures of economic development on reservations, including income, employment, housing prices, and population characteristics.

[29] 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 20 years but that a commensurate increase was not experienced by non-Indians during the same period of time.

[30] They are described in more detail in the Data Appendix.

[31] 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 five-year increments: 2005-2009 and 2010-2014.

Although there are public-use versions of the long-form datasets, they would be inadequate for the purposes of this study. The restricted-use Census data contain geographic information at a much finer level of granularity than the public-use Census data.[32] Most importantly, the geography files contained in the restricted-use Census data contain an American Indian variable, identifying whether an individual lives in an area that has been designated as an Indigenous homeland.[33] The restricted-use data are required for two main activities: comparing economic outcomes on reservations with economic outcomes in surrounding areas, and performing subgroup analysis for populations of interest.

I combine the 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 its annual reports on land ownership.[34] 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 using the most current and complete land data available.

Finally, I construct a dataset on casino gaming operations by piecing together data from other researchers who acquired gaming information through public sources.[35] 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 footage.[36] These data are used to estimate the effect of casino adoption on economic outcomes

[32]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.

[33]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.

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

[35]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.

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

on reservations.

4.1 Census Data

The full sample of individuals residing on federally recognized reservations between 1980 and 2014 covers 324 reservations in 36 states.[37] American Indian areas in Oklahoma, Alaska, and Hawaii are governed by different land tenure regimes and are not technically classified as reservations.[38] In addition, reservations that are recognized by state governments but not 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.[39] I also omit reservations that gained federal recognition only 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.[40] Figure 4 of the Map Appendix graphically displays the reservations used in analysis.

The sample used in analysis 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 land ownership data for a given reservation, for example, I do not use observations from that reservation in any part of the analysis. In the Data Appendix, I discuss this process in more detail, and I provide a comparison of the reservations included and excluded from analysis.

Table 2 presents summary statistics for the final sample used in analysis. These tabulations indicate that the average resident of a reservation is approximately equally likely to be American Indian or White. In addition, while there has been a slow increase in high school graduation rates, employment rates, and conditional wage income, averages have remained low over time. Notably, 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 on a sample of individuals who live in a county that contains a reservation but do not live

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

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

[39] Dropping observations from Delaware, New Jersey, and Indiana.

[40] Dropping observations from Massachusetts.

on the reservation itself. Following the naming convention of Akee et al. (2017), I refer to the 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 (Age 16 and Older)

	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

The land ownership data used in this research provide the total amount of land in acres for each federally recognized reservation, decomposed into the following land categories: individual trust, tribal trust, individual fee, tribal fee, individual restricted, and tribal restricted. Restricted land is a relatively rare, third category of land tenure distinguished by ownership 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 or not the land is restricted.

The main explanatory variable in this research uses only the information on trust land acreage from the BIA land ownership data due to concerns about the quality of the reporting on other categories of land tenure.[41] The variable used in analysis takes the BIA-provided

[41] The BIA does not have a mandate to survey fee land, so the amount of land in fee status is likely underreported in its statistics. I cross-referenced the BIA's 2018 reporting on fee land totals with estimates from other sources and found large discrepancies.

Table 3: Sample Composition: Individuals Residing in Surrounding County (Age 16 and Older)

	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.

information on trust land acreage (tribal trust plus individual trust) as the numerator and Census-provided information on total reservation acreage as the denominator.[42] 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 (e.g. national parks) and other restricted lands would also be included in the denominator.[43] Alternative specifications rely on a trust share variable that is decomposed into individual and tribal trust shares.

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

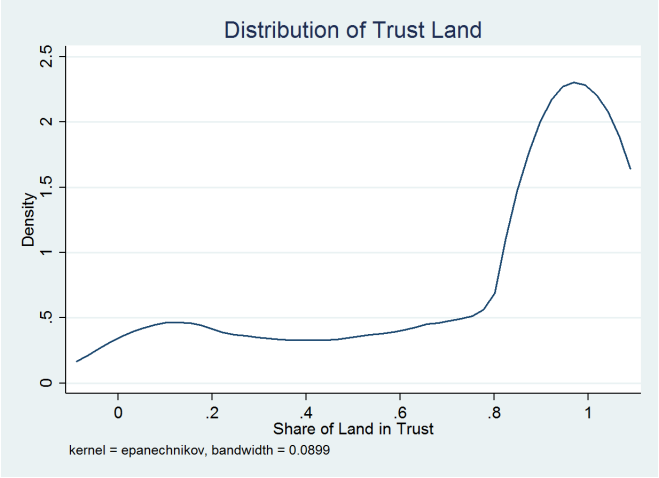
Although I have access to two periods of modern land ownership data, I only rely on the 2018 data in my analysis. The first wave of data is from Anderson and Parker (2008), who surveyed regional BIA offices to collect information on the amount of land held in trust for each reservation in 2003.[44] I do not use the 2003 data in this study for a number of practical

[42]Total reservation acreage comes from the 2017 Census shapefiles.

[43]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.

[44]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 (e.g. Cookson, 2010). The dataset has

Figure 1: The Distribution of Trust Share Across Reservations



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 that of 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 produces similar results. I quantify the changes in trust share over time in the Data Appendix.

4.3 Casino Data

70% of the reservations in the sample used in analysis adopted a casino at some point between 1988 and 2013. Table 4 presents summary statistics comparing casino adopters and non-adopters based on land and population characteristics. Reservations that adopted casino gaming between 1988 and 2013 were smaller in terms of land area. Adopters had a larger population on average, but they tended to have lower American Indian population shares.

The IGRA dictates that Class III gaming operations are permitted on federal reservations; however, it does not require that a reservation have more trust land than necessary to construct the casino facilities. Furthermore, it is prohibited to operate a casino on trust land acquired after 1988.[45] 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

been used widely by other researchers working in this area.

[45]Mitigating the concern that land tenure changes status to accommodate casino gaming.

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.

a casino. In fact, consistent with the summary statistics in Table 4, I find a negative, albeit statistically insignificant, correlation between trust share and casino adoption.

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 share. 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, as well as for the reservation and the community surrounding the reservation (the county complement).[46] Taken together, these estimates provide evidence for how property institutions affect local economic outcomes and the incidence of labor demand shocks.

The effect of land tenure is identified through variation in trust share across reservations. Comparing across reservations averages over sources of tribal heterogeneity. To account for time-invariant heterogeneity due to regional influences, I include Census region fixed effects in each specification.[47] To improve the generalizability of my findings and account

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

[47]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). 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. 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. I do not include state fixed effects, because there are several states with only one reservation.

for potential omitted variable bias, supplemental specifications include covariates that reflect land fractionation, geography, culture, and institutions.[48] 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. Labor market regressions 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. Housing market regressions 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.

The first part of the research examines the effect of incomplete property rights. The basic economic relationship being estimated in the first part of the research is given by Equation (6):

$$y_{irt} = \alpha + \beta_1 Trust_r + \beta_2 X_{irt} + \beta_3 CR_r + \beta_4 Year_t + \epsilon_{irt} \tag{6}$$

where $y_{irt} = p_{irt}, w_{irt}, N_{irt}$ 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, p_{irt}: rental price, mortgage payments, type of home, number of rooms and bedrooms in the 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, $Trust_r$ 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. The conceptual framework in Section 3 predicts that β_1 is negative for the outcome w_{irt}. Equation (6) is estimated first using the aggregate trust share variable, and subsequently using trust share disaggregated into individual and tribal trust shares. Results of a partitioned regression

[48] 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.

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.[49]

The second part of the research examines the effects of casino adoption. The economic relationships being estimated in the second part of the research are given by Equations (7)[50] and (8):

$$y_{irt} = \alpha + \beta_1 Casino_{rt} + \beta_2 X_{irt} + \beta_3 CR_r + \beta_4 Year_t + \epsilon_{irt} \tag{7}$$

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.

$$y_{irt} = \alpha + \beta_1 Trust_r + \beta_2 Casino_{rt} + \beta_3 (Trust * Casino)_{rt} + \beta_4 X_{irt} + \beta_5 CR_r + \beta_6 Year_t + \epsilon_{irt} \tag{8}$$

The coefficient of interest in Equation (8) is β_3. The conceptual framework in Section 3 predicts that $\beta_3 > 0$ for the outcome w_{irt}. This indicates that the effect of the economic shock on 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 (6) and (8) as well as a conditional differences-in-differences approach for dealing with selection into gaming in Equations (7) and (8). I describe each of these approaches in turn.

5.1 The Endogeneity of Land Tenure

An ordinary least squares regression of Equation (6) may 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

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

[50] Equivalently, Equation (7) could be written using the standard differences-in-differences setup: $y_{irt} = \alpha + \beta_1 Casino_r + \delta(Casino_r * Post_t) + \beta_2 X_{irt} + \beta_3 CR_r + \beta_4 Year_t + \epsilon_{irt}$ where $Casino_r$ is an indicator of ever having a casino open in the sample time frame, and $Post_t$ is an indicator of whether t is in the post-period.

causality or omitted variable bias.

There are two main endogeneity concerns. The first is that property rights were assigned endogenously at the time of allotment. There is a growing body of evidence that allotment was carried out in accordance with land value.[51] 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 land is more likely to be issued a fee patent and taken out of trust in modern times if it is of higher quality. 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, where property rights were plausibly randomly assigned in a checkerboard fashion at the time of allotment.[52] In practice, during the 1980-2014 study period, fee patents were rarely issued to trust land, somewhat mitigating the land quality selection concern.[53] 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 (6) using two-stage least squares (2SLS) with a long-run measure of soil quality, the soil drainage index, as the instrumental variable.[54] (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 de-

[51] 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.

[52] The Agua Caliente reservation in Palm Springs, California.

[53] 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 them into tribal trust. This would not affect the share of fee land on the reservation but would affect the individual-to-tribal-trust ratio.

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

rived 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 closely approximates the soil's DI at the time of allotment. I tabulate the mean DI value for each reservation after overlaying the reservation shapefiles with DI raster files using GIS software. The mean DI value serves as the instrumental variable.

The soil's ability to make water available for plants, especially prior to innovations in irrigation, was paramount to agricultural productivity.[55] The rationale behind the instrument is that agricultural productivity would have determined the price of 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, L. 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) (Schaetzl et al., 2012).[56] (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

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

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

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, there was relatively little westward expansion and adoption of new technologies was slow due to funding shortages caused by World War I and the Great Depression.[57] 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 diminished 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.

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.[58] 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

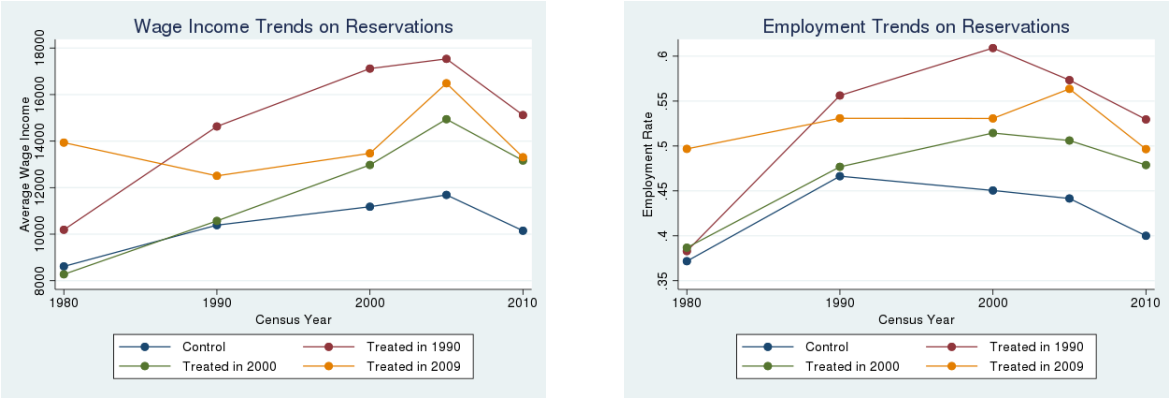
[57] Allotment officially ended in 1934 with the Indian Reorganization Act, but the majority of had allotment occurred by 1910.

[58] 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.

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 are 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 (7) and (8) as weighted 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 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 are highly predictive of adoption according

to analysis using the least absolute shrinkage and selection operator (Lasso analysis).[59]

6 Results

6.1 The Effect of Land Tenure

The first set of results is broadly consistent with the predictions generated by the conceptual framework outlined in Section 3. Table 5 demonstrates that the share of land in trust is negatively related to wages, employment, and labor force participation.[60] Income measures have been transformed by the inverse hyperbolic sine function, and trust share is a continuous variable taking values between zero and one.[61] 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.[62] 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.[63] Effects on total income are similar.

[59]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.

[60]Results disaggregating trust share into its component parts—individual and tribal trust—appear in the Appendix.

[61]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).

[62]A one-standard-deviation difference in trust share across reservations is approximately 33 percentage points.

[63]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) find that trust land has between 15 and 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 has been rounded according to Census confidentiality rules.

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

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 has been rounded according to Census confidentiality rules.

Table 7 presents 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 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. 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.[64]

[64] 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 home ownership, 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.

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 has been rounded according to Census confidentiality rules.

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.[65] 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.

[65] 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 8: Effect of Trust Land on Population Characteristics

	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. AIAN population share is the American Indian share of the reservation population. Commute time is an indicator of whether an individual travels more than 45 minutes to get to work. New construction indicates whether the housing unit was built in the past five years. Number of observations has 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 opt 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.

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 has been rounded per Census confidentiality rules.

Table 9 displays the results of the conditional differences-in-differences estimation of Equation (7). 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.

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			

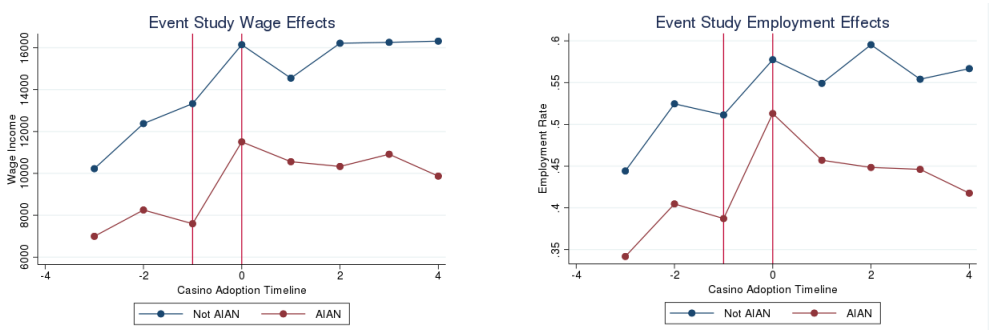
*** p<0.01, ** p<0.05, * p<0.1

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 has been rounded per Census confidentiality rules.

Figure 3 demonstrates that wage income and employment rates increase prior to casino

adoption on reservations in anticipation of the shock.[66] 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 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 using a sample of 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 five years.

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.

[66] 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 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 has been rounded per Census confidentiality rules.

There is some evidence (Table 12) that casino adoption induces migration onto the reservation, because individuals living on the reservation are 6.8 percentage points more likely to report that they moved there within the past five 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. Recently moved indicates whether an individual has moved in the past ten years. Commute time indicates whether an individual travels more than 45 minutes to get to work. Observations are weighted by the inverse probability of casino adoption. Number of observations has been 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.[67] I do this because the forces driving the general equilibrium response to a labor demand shock are different in urban and in rural areas. Reservations that are geographically remote constitute more clearly delineated local labor markets. In contrast, reservations in close proximity to metropolitan areas provide workers with more outside employment and housing options.[68]

I find that tribal gaming does have a differential effect by trust status. I present the results of the conditional differences-in-differences design of the interacted specification (Equation 8) estimated by OLS in Tables 13-15.[69] 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.[70] 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. Consistent with the predictions of the model in Section 3, rural reservations with a larger fraction of land in trust do better in terms of increases in average income following the casino shock.[71] The same is true for labor force participation rates.

[67] I define the rural reservation sample in the Data Appendix.

[68] Appendix Tables 24-26 present the results for the full set of reservations. The direction of the findings is consistent with the direction of the findings for the subset of reservations, although the effects are more noisily estimated using the full sample.

[69] IV estimates produced by the interacted specifications tend to have high standard errors. In addition, the IV estimates from the two different instrument options often are not consistent with each other. Thus, I do not present the IV results here. IV estimates may be imprecise due to the fact that IV regressions often produce a low power-to-size ratio Young (2018). This is likely particularly true in the case of the interacted IV. I have included the results from both sets of IV regressions in the Appendix.

[70] 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.

[71] The model has the result coming through frictions in the housing market, but there are other alternative explanations. 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.

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 has been rounded according to Census confidentiality rules.

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 has been rounded according to Census confidentiality rules.

Table 14 displays the results from the interacted specification pertaining to the housing market. The second column indicates 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 larger. 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 that migrants

increasingly locate within the surrounding communities and off the reservation when the reservation has a larger fraction 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 10 years. Number of observations has been rounded according to Census confidentiality rules.

6.4 Welfare Calculations

The results presented in Tables 9 and 11 indicate that tribal gaming shocks increase nominal wages and rental prices. The results presented in Tables 13and 14 indicate that reservations with a larger share of land in trust experience larger increases in nominal wages and rental prices following a tribal gaming shock. To understand how trust status affects welfare, it is necessary to understand the relative size of the changes in prices. In other words, changes in welfare are reflected in changes in real wages, given by Equation (5): $ln(w_r) - \alpha ln(p_r)$.

Values of the housing expenditure share parameter α range from 0.3 to 0.6 in the literature (Suarez Serrato and Zidar, 2016; Notowidigdo, 2011; Diamond, 2016). Suarez Serrato and Zidar (2016) use $\alpha = 0.3$ as their baseline value based on data from the Consumer Expenditure Survey. I do the same.

Variables that are transformed using the inverse hyperbolic sine function can be interpreted as approximately logarithmic, so coefficients from Tables 13 and 14 feed directly into Equation (5). Taking the coefficient on the casino indicator from the wage regression, the coefficient from the rental price regression, and a value of 0.3 for α, the effect of tribal gaming on real wages is approximately: $0.285 - 0.3(.197) = 0.229$. This calculation indicates that the

level effect of casino adoption on real wages is positive.

Performing the same exercise for the interacted specification demonstrates how the share of land in trust changes that welfare calculation. Taking the coefficient on the interaction term from the wage regression in Table 9 and the coefficient on the interaction term from the rental price regression in Table 11: $0.504 - 0.3(.520) = 0.348$. This calculation indicates that tribal gaming is associated with an additional, positive increase in real wages on reservations with a larger share of land in trust. In other words, my estimates suggest that casino adoption is welfare improving for the average reservation and even more welfare improving on reservations with a larger share of land in trust.[72]

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" (Indian Land Tenure Foundation, 2009). Implicit in this statement are the dual objectives of fostering economic growth and preserving tribal self-determination. To date, there is little 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 research I have treated reservations as local labor markets and studied the effects of Indigenous property institutions on the incidence 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 find that incomplete property rights 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 additional increase in wages is partially met by an additional increase in rental prices,

[72] Although the coefficient on the interaction term for the wage income regression is not significant, a similar exercise could be performed using the statistically significant results for total income (which includes transfers) or total earnings (which includes self-employment income), and similar conclusions about welfare would be reached.

but that the wage effect trumps the housing price effect. I show that one channel through which this result may be generated is frictions in the housing market that 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. 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 disperse or 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 enough for convergence in housing prices and values. In my study, I treat transaction costs as a bundle and present suggestive evidence on mechanisms.

My paper contributes to an emerging literature on Indigenous property institutions suggesting that the privatization of Indigenous land may have unintended consequences for the Indigenous population.[73] 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 lands from appropriation and easing land use restrictions.

[73] Tribal land on reservations in the United States is technically private land. When I use the term "privatization" here, I am referring to a process analogous to the issuance of fee patents, which would open up the sale of the land to outside parties.

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 about 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.[74] Another relevant piece of legislation pertaining to housing in Indian Country is the Section 184 Indian Home Loan Guarantee Program (HUD 184), which was passed in 1992 to facilitate home ownership on trust land.[75] The Office of Loan Guarantee within Housing and Urban Development's Office 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 is 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.

[74]Note that the HEARTH Act still requires a Land Title Status Report, which is provided by the BIA, potentially slowing down the process.

[75]HUD 184 applies to off-reservation trust land as well. In 2005 it was expanded to include homes on fee land on reservations.

References

Abadie, A. (2005). Semiparametric difference-in-difference estimators. *The Review of Economic Studies 72*(1), 1–19.

Acemoglu, D. and S. Johnson (2005). Unbundling institutions. *Journal of Political Economy 113*(5), 949–995.

Acemoglu, D., S. Johnson, and J. A. Robinson (2001). The colonial origins of comparative development: An empirical investigation. *American economic review 91*(5), 1369–1401.

Akee, R. (2009). Checkerboards and coase. *Journal of Law Economics 52*, 395–410.

Akee, R. and M. Jorgensen (2014). Property institutions and business investment on American Indian reservations. *Regional Science and Urban Economics 46*(2014), 116–125.

Akee, R., M. Jorgensen, and U. Sunde (2015). Critical junctures and economic development: Evidence from the adoption of constitutions among American Indian nations. *Journal of Comparative Economics 43*, 844–861.

Akee, R., E. Mykerezi, and R. M. Todd (2017). Reservation employer establishments: Data from the US Census longitudinal business database. Working paper, Center for Indian Country Development.

Akee, R. Q. K., K. A. Spilde, and J. B. Taylor (2015). The Indian Gaming Regulatory Act and its effect on American Indian economic development. *Journal of Economic Perspectives 29*(3), 185–208.

Akee, R. Q. K. and J. B. Taylor (2014). *Social and economic change on American Indian reservations: A databook of the US Census and American Community Survey, 1990-2010.* Sarasota, FL: Taylor Policy Group, Inc.

Alston, L., G. Libecap, and R. Schneider (1996). The determinants and impact of property rights: Land titles on the brazilian frontier. *Journal of Law, Economics, and Organization 12*(1), 25–61.

Anderson, T. L. and D. Lueck (1992). Land tenure and agricultural productivity on Indian reservations. *Journal of Law and Economics 35*, 427–454.

Anderson, T. L. and D. P. Parker (2008). Sovereignty, credible commitments, and the prosperity of American Indian reservations. *Journal of Law and Economics 51*, 641–66.

Anderson, T. W. (2003). *An introduction to multivariate statistical analysis* (3rd ed.). Series in Probability and Statistics: Wiley.

Aragon, F. M. (2015). Do better property rights improve local income? Evidence from First Nations' treaties. *Journal of Development Economics 116*, 43–56.

Aragon, F. M. and A. Kessler (2018). Property rights on First Nations' reserve land. Working paper.

Atwood, D. A. (1990). Land registration in Africa: The impact on agricultural production. *World Development 18*(5), 659–671.

Austin, B., E. Glaeser, and L. H. Summers (2018). Saving the heartland: Place-based policies in 21st century America. *Brookings Papers on Economic Activity, BPEA Conference Drafts, March*, 8–9.

Besley, T. (1995). Nonmarket institutions for credit and risk sharing in low-income countries. *Journal of Economic Perspectives 9*(3), 115–127.

Bloom, N. (2009). The impact of uncertainty shocks. *Econometrica 77*(3), 623–685.

Bound, J. and H. J. Holzer (2000). Demand shifts, population adjustments, and labor market outcomes during the 1980s. *Journal of Labor Economics 18*(1), 20–54.

Burbridge, J. B., L. Magee, and L. Robb (1988). Alternative transformations to handle extreme values of the dependent variable. *Journal of the American Statistical Association 83*(401), 123–127.

Busso, M., J. Gregory, and P. Kline (2013). Assessing the incidence and efficiency of a prominent place based policy. *American Economic Review 2*(103), 897–947.

Card, D. (2001). Estimating the return to schooling: Progress on some persistent econometric problems. *Econometrica 69*(5), 1127–1160.

Carlson, L. A. (1981). Land allotment and the decline of American Indian farming. *Explorations in Economic History 18*(2), 128–154.

Carlson, L. A. (1983). Federal policy and Indian land: Economic interests and the sales of Indian allotments 1900-1934. *Agricultural History 57*, 33–45.

Carter, M. R. and P. Olinto (1998). *Do the "poor but efficient" survive in the land market? Capital access and land accumulation in Paraguay.* Chicago: In XXI International Congress of the Latin American Studies Association.

Cookson, J. A. (2010). Institutions and casinos on American Indian reservations: An empirical analysis of the location of Indian casinos. *Journal of Law and Economics 53*(4), 651–687.

Cornell, S. and J. P. Kalt (1998). Sovereignty and nation-building: The development challenge in Indian country today. *American Indian Culture and Research Journal 22*(3), 187–214.

Davis, L. et al. (1972). *American economic growth: An economist's history of the United States*. New York, N. Y.: Harper and Row.

Diamond, R. (2016). The determinants and welfare implications of us workers' diverging location choices by skill: 1980-2000. *American Economic Review 3*(106), 479–524.

Dimitrova-Grajzl, V., P. Grajzl, and A. J. Guse (2014). Jurisdiction, crime, and development: The impact of public law 280 in Indian country. *Law & Society Review 48*(1), 127–160.

Evans, W. and W. Kim (2006). The impact of local labor market conditions on the demand for education: Evidence from Indian casinos. Discussion Paper 614, US Census Bureau Center for Economic Studies.

Evans, W. N. and J. H. Topoleski (2002). The social and economic impact of native American casinos. Working Paper 9198, NBER.

Field, E. (2005). Property rights and investment in urban slums. *Journal of European Economic Association 3*(2-3), 279–290.

Field, E. (2007). Entitled to work: Urban property rights and labor supply in Peru. *The Quarterly Journal of Economics 122*(4), 1561–1602.

Gerstein, D. et al. (1999, April). Gambling impact and behavior study: Report to the national gambling impact study commission. *National Opinion Research Center at the University of Chicago, Chicago, IL*.

Glaeser, E. L. and J. D. Gottlieb (2009). The wealth of cities: Agglomeration economies and spatial equilibrium in the United States. *Journal of Economic Literature 47*(4), 983–1028.

Griliches, Z. (1977). Estimating the returns to schooling: Some econometric problems. *Econometrica 45*(1), 1–22.

Hamermesh, D. S. (1989). What do we know about worker displacement in the US? *Industrial Relations: A Journal of Economy and Society 28*(1), 51–59.

Harrington, C. (2012). American Indian entrepreneurship: A case study for sustainability. *Journal of Leadership and Organizational Studies 2*(1), 1–10.

Hsieh, C. and E. Moretti (2015). Housing constraints and spatial misallocation. *National Bureau of Economic Research* (w21154).

Indian Land Tenure Foundation (2009). The message runner. *4*.

Jacoby, H. G. and E. Skoufias (1997). Risk, financial markets, and human capital in a developing country. *The Review of Economic Studies 64(3)*, 311–335.

Jorgensen, M. R. (2000). *Bringing the background forward: Evidence from Indian Country on the social and cultural determinants of economic development*. Harvard University. Doctoral dissertation.

Kline, P. and E. Moretti (2014). People, places, and public policy: Some simple welfare economics of local economic development programs. *Annual Review of Economics 6*(1), 629–662.

Kok, N., P. Monkkonen, and J. M. Quigley (2014). Land use regulations and the value of land and housing: An intra-metropolitan analysis. *Journal of Urban Economics* (81), 136–148.

Lanjouw, J. O. and P. I. Levy (2002). Untitled: A study of formal and informal property rights in urban Ecuador. *The Economic Journal 112*(482), 986–1019.

Leonard, B., D. Parker, and T. Anderson (2018). Poverty from incomplete property rights. Working paper.

Liebler, C. A. and A. Halpern-Manners (2008). A practical approach to using multiple-race response data: A bridging method for public-use microdata. *Demography 45*(1), 143–155.

Listokin, D., R. M. Leichenko, and J. King (2006). *Housing and economic development in Indian Country: Challenge and opportunity.* Rutgers University Center for Urban Policy Research.

Malamud, O. and A. Wozniak (2012). The impact of college on migration: Evidence from the vietnam generation. *Journal of Human Resources 47*(4), 913–950.

McChesney, F. S. (1990). Government as definer of property rights: Indian lands, ethnic externalities, and bureaucratic budgets. *Journal of Legal Studies 19*, 297–335.

Miller, R. (2012). *Reservation "capitalism": Economic development in Indian Country.* Santa Barbara: Praeger.

Moretti, E. (2011). Local labor markets. In *Handbook of labor economics*, pp. 1237–1313. Elsevier.

Morten, M. and J. Oliveira (2014). Migration, roads, and labor market integration: Evidence from a planned capital city. Unpublished manuscript.

National Indian Gaming Commission (2017). Gaming revenue reports. `http://www.nigc.gov/Gaming_Revenue_Reports.aspx`.

Neibergs, S. (2007). Spatial characteristics of gambling expansion: An analysis of cross border effects. Working paper, presented at the Conference on the Growth of Gambling and Prediction Markets, UC-Riverside, May.

North, D. C. (1981). *Structure and change in economic history.* Norton.

Notowidigdo, M. J. (2011). The incidence of local labor demand shocks. *National Bureau of Economic Research No. w17167.*

Pendakur, K. and R. Pendakur (2018). The effects of modern treaties and opt-in legislation

on household incomes in aboriginal communities. *Social Indicators Research 137*, 139–165.

Pettit, K. L. S. et al. (2014). *Continuity and change: Demographic, socioeconomic, and housing conditions of American Indians and Alaska Natives.* US Department of Housing and Urban Development Interim Report.

Quigley, J. M. and S. Raphael (2005). Regulation and the high cost of housing in California. *The American Economic Review 95*(2), 323–328.

Roback, J. (1982). Wages, rents, and the quality of life. *Journal of Political Economy 90*, 1257–1278.

Rosen, S. (1979). Wage-based indexes of urban quality of life. *Current Issues in Urban Economics:*, 74–104.

Russ, J. and T. Stratmann (2014). Creeping normalcy: Fractionation of Indian land ownership. Technical report, CES Working Paper: No. 4607.

Schaetzl, R. J., F. J. J. Krist, and B. A. Miller (2012). A taxonomically based ordinal estimate of soil productivity for landscape-scale analyses. *Soil Science 177*(4), 288–299.

Schaetzl, R. J., F. J. J. Krist, K. Stanley, and C. M. Hupy (2009). The natural soil drainage index: An ordinal estimate of long-term soil wetness. *Physical Geography 30*(5), 383–409.

Shoemaker, J. A. (2003). Like snow in spring time: Allotment, fractionation, and the Indian land tenure problem. *Wis*, 729–788.

Suarez Serrato, J. and O. Zidar (2016). Who benefits from state corporate tax cuts? a local labor markets approach with heterogeneous firms. *American Economic Review 9*(106), 2582–2624.

Taylor, J. B., M. B. Krepps, and P. Wang (2000). *The national evidence on the socioeconomic impacts of American Indian gaming on non-Indian communities.* Malcolm Wiener Center for Social Policy, John F. Kennedy School of Government, Harvard University: Harvard Project on American Indian Economic Development.

Topel, R. H. (1986). Local labor markets. *Journal of Political Economy 94*(3, Part 2), S111–S143.

Trosper, R. L. (1978). American Indian relative ranching efficiency. *The American Economic Review 68*(4), 503–516.

Wenz, M. (2008). The spatial evolution of casino gaming. *Cityscape 10*(3), 203–227.

Wolfe, B., J. Jakubowski, R. Haveman, and M. Courey (2012). The income and health effects of tribal casino gaming on American Indians. *Demography 49*, 499–524.

Wozniak, A. (2010). Are college graduates more responsive to distant labor market opportunities? *Journal of Human Resources 45*(4), 944–970.

Young, A. (2018). Consistency without inference: Instrumental variables in practical application. Working paper.

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 Indian Land Tenure Foundation (2009).[76] 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

[76] 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.

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).

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., 2015). In a reversal of this push toward tribal self-determination, the 1950s were known as the "Termination Era," which included 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.[77] Since the passing of the Indian Gaming Regulatory Act, well over 400 tribal gaming operations have opened across the United States.

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),[78] which has been shown to predict the propensity for a reservation to be allotted and the timing of allotment (Leonard et al., 2018).[79] 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.

[77] 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.

[78] Winsorized at the 95th percentile.

[79] 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.

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.[80]

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.

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

[80]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.

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., 2015; 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 those for individuals residing on nearby county complements.[81] 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 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

[81] Based loosely on the definition in Akee et al. (2017).

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 a current job. It is transformed using the inverse hyperbolic sine function to account for the skewed distribution and adjusted for inflation.[82] 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.
- Labor force: This is a binary indicator of whether an individual participates in the

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

labor market.

- Commute time: This is a binary indicator of whether an individual travels more than 45 minutes to reach a 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.[83] 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: This is a binary indicator of whether the housing unit was constructed in the past 10 years.
- Homeowner: This is an indicator that the housing unit is owned either outright or with a mortgage.
- Pay rent: This is an indicator that rent is paid for the housing unit.

Population

- Population: This variable captures the reservation population, constructed using the number of observations in data and sample weights.
- AIAN population share: This is the share of the reservation population that is American Indian or Alaska Native (AIAN), constructed using the number of observations in data, sample weights, and racial identification.
- Recently moved: This is a binary indicator of whether an individual moved into her current residence within the past five years.
- High school degree: This is an indicator of whether the individual has a high school diploma or higher.

[83] 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.

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: This is a continuous variable indicating respondent's age. Only individuals over the age of 16 are included in the sample for analysis.
- Age squared
- Race: This is an indicator of the respondent's preferred single race.[84]
- Sex: This is an indicator of whether respondent identified as male or female.
- Other language: This is an indicator of 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: This is a binary indicator of whether housing unit is located on a 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

[84] Refer to the discussion below for how I dealt with the changing racial self-identification question in the Census.

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.

Others have highlighted the link between tribal constitutions and economic development (Akee et al., 2015; 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. (2015) 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 its 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 control for whether the casino-adopting tribe divides casino profits among tribal residents in the form of per capita cash transfer payments.[85] 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

[85] The per capita payment indicator comes from Wolfe et al. (2012).

speaks his/her native language.[86]

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 the present day. Fractionation is a land characteristic arguably important for development, not fully captured in the share of land in trust variable.[87] 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:[88] the number of fractionated tracts (i.e. the number of tracts 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.[89] 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 1,700, of which 1,200 are American Indian. The excluded reservations are also somewhat less likely (58%) to have a casino.

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

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

[88] 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 increase standard errors.

[89] Fractionation measures were selected from the set of measures in the report using Least Absolute Shrinkage and Selection Operator (Lasso) analysis.

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 after 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 (7) 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.[90]

8.5 Trust Status Changes

Comparing the 2003 and 2018 land ownership data, I am able to quantify the extent of the changes to trust status over the past 15 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.

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***								

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

[90] In addition, casino size is likely endogenous.

values from 2005-2009 to the 2005-2009 pooled ACS data; and I ascribed the mean of the interpolated 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 has 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. Two instrumental variables were used for identification: DI mean and historical VFPA. Number of observations has 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 has 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 has 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 has 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 has 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 has been rounded according to Census confidentiality rules.

8.7 Maps

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 has 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 has been rounded according to Census confidentiality rules.

Figure 4:

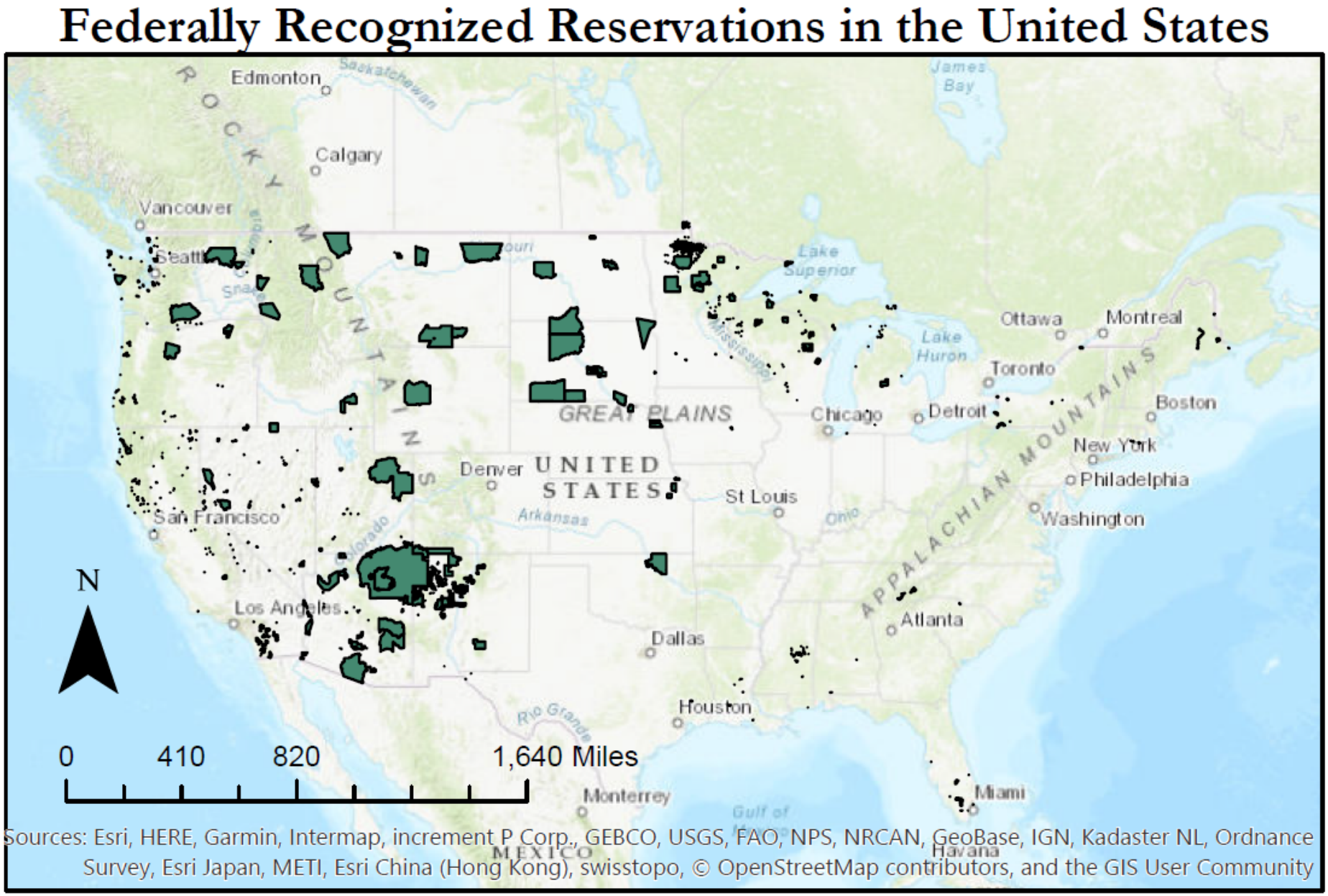

Federally Recognized Reservations in the United States
Edmonton
Calgary
Vancouver
Seattle
ROCKY MOUNTAINS
GREAT PLAINS
UNITED STATES
Denver
San Francisco
Los Angeles
St Louis
Dallas
Houston
Chicago
Detroit
Toronto
Ottawa
Montreal
Boston
New York
Philadelphia
Washington
Atlanta
Miami
Lake Superior
Lake Huron
James Bay
APPALACHIAN MOUNTAINS
Monterrey
MEXICO
Havana
N
0
410
820
1,640 Miles
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 5:

Share of Land in Trust on Federal Reservations

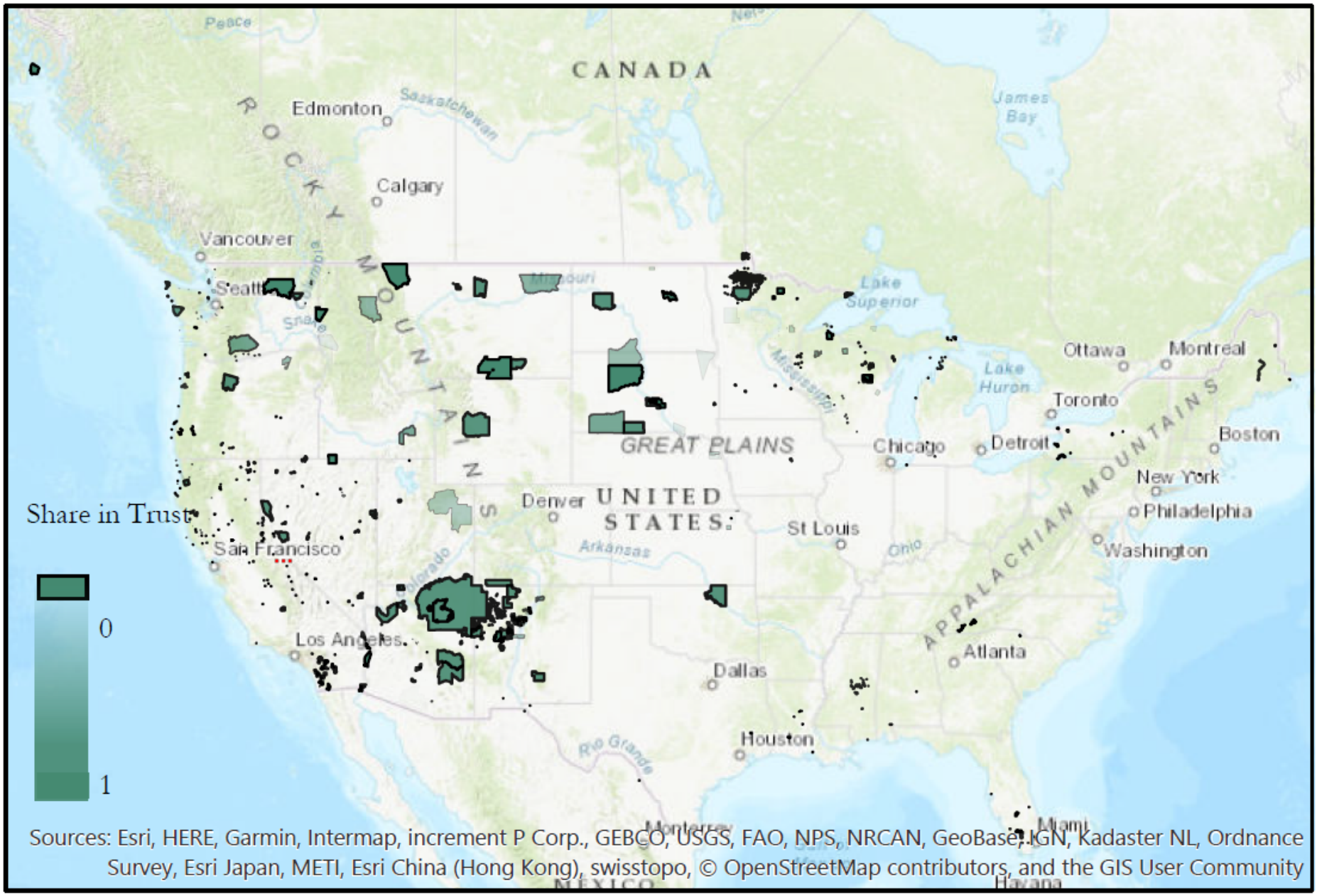
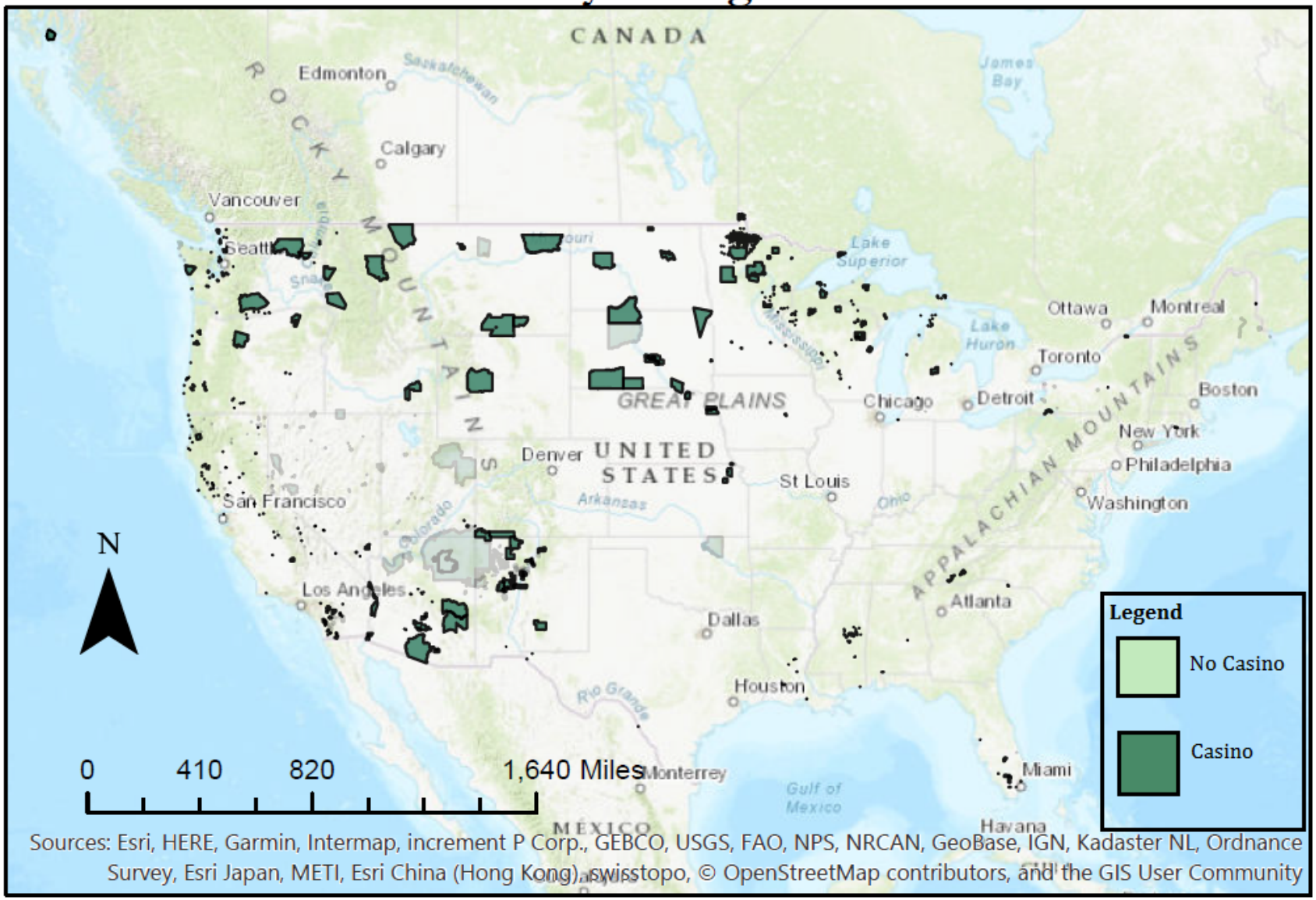


Figure 6:

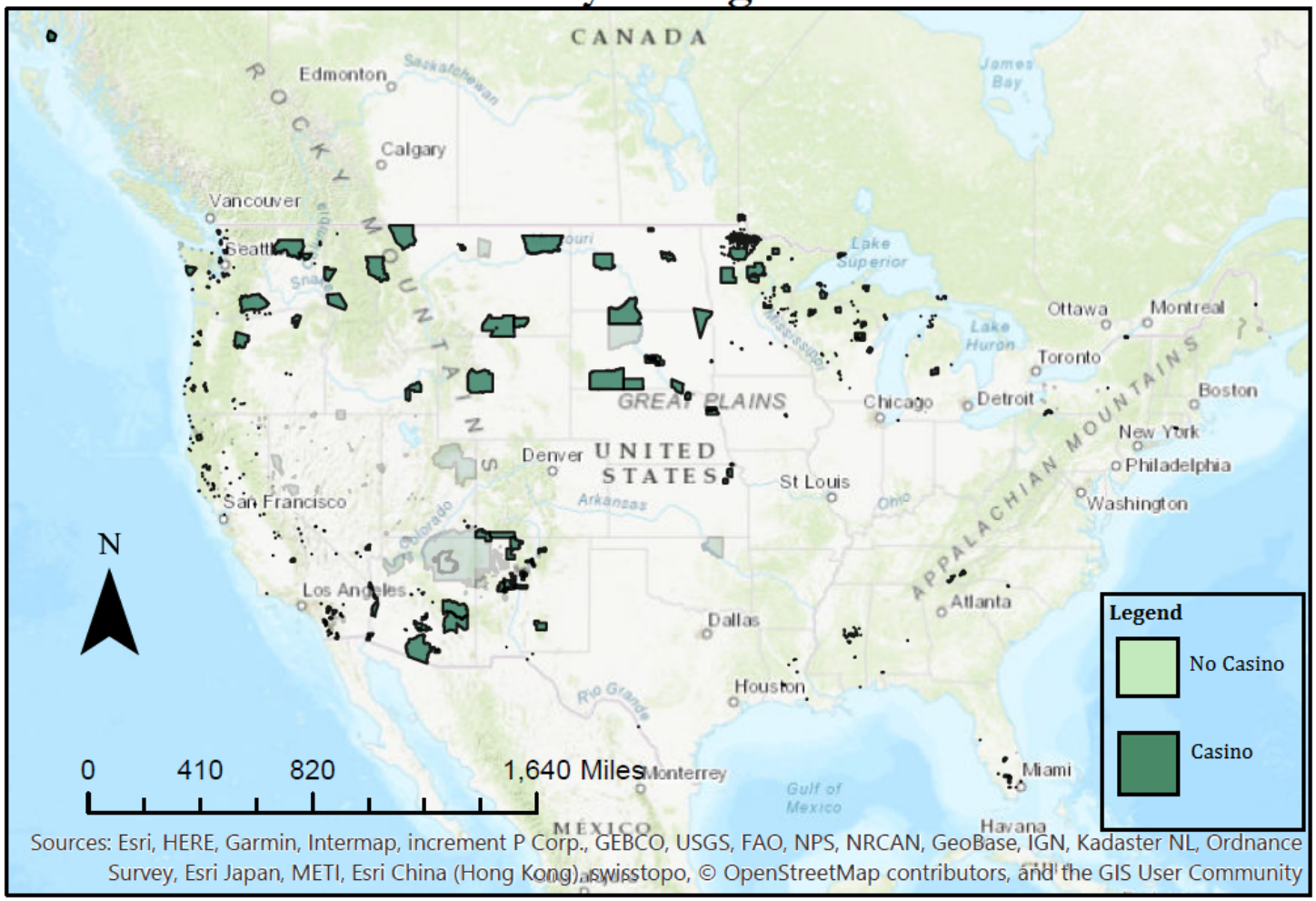
Casinos on Federally Recognized Reservations



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:

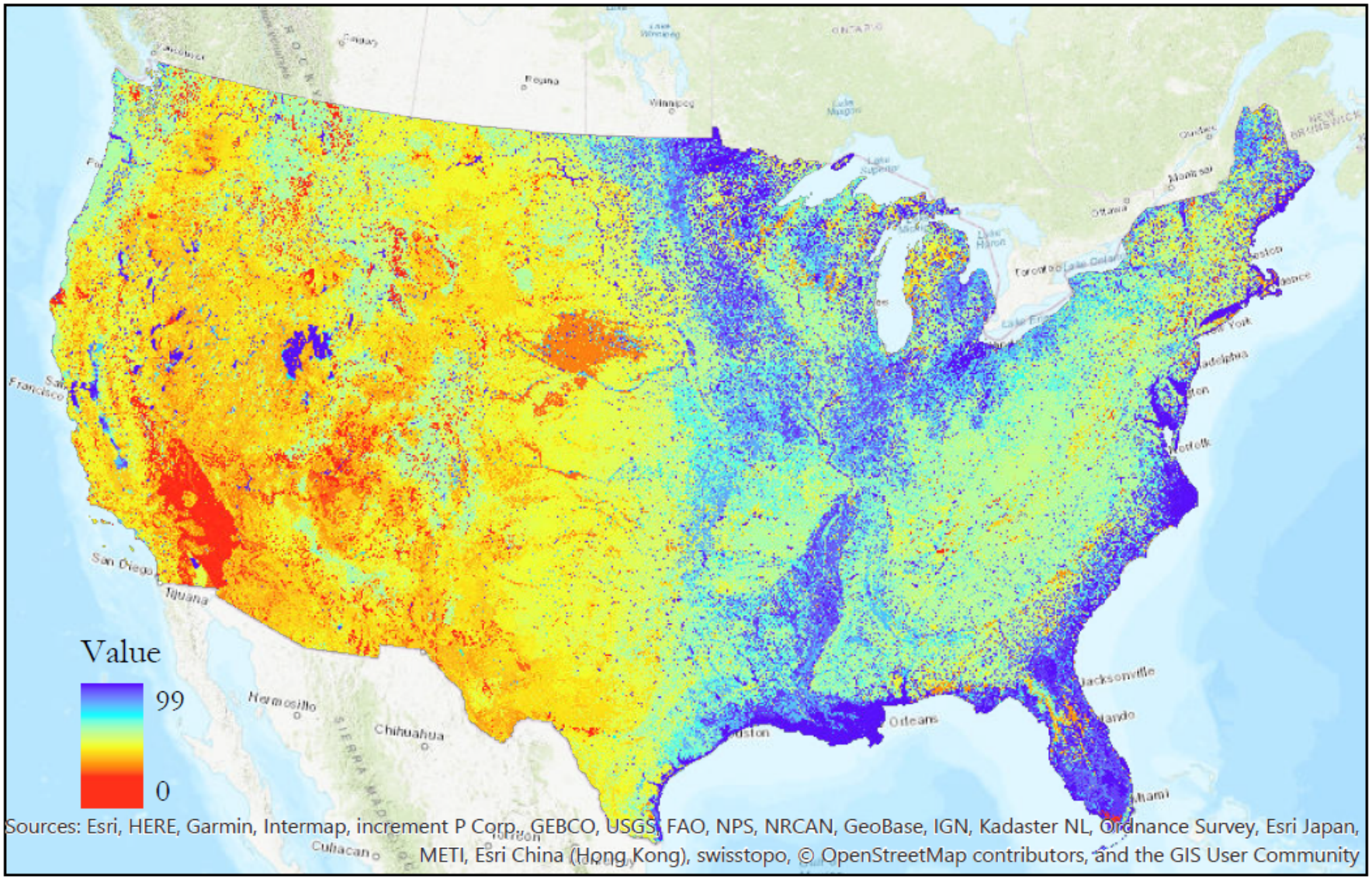
Casinos on Federally Recognized Reservations



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)

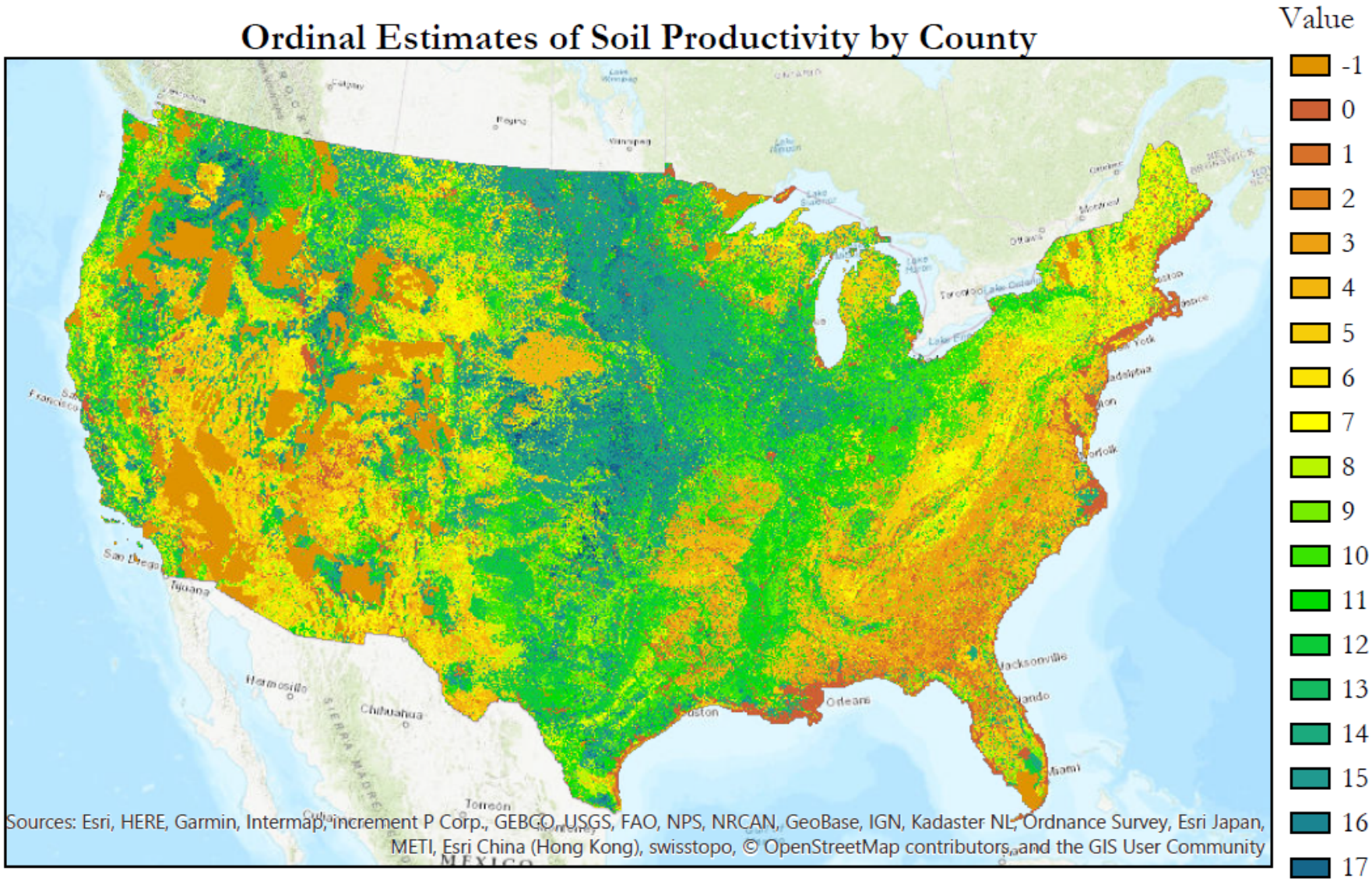
Figure 8

Ordinal Estimates of Long-Term Soil Wetness by County



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).