The Slaughter of the Bison and Reversal of Fortunes on the Great Plains*

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Abstract

In the late 19th century, the North American bison was brought to the brink of extinction in just over a decade. We show that the bison's slaughter led to a reversal of fortunes for the Native Americans who relied on them. Once the tallest people in the world, the generations of bison-reliant people born after the slaughter were among the shortest. Today, formerly bison-reliant societies have between 20-40% less income per capita than the average Native American nation. We argue that federal Indian policy that limited out-migration from reservations and restricted employment opportunities to crop based agriculture hampered the ability of bison-reliant societies to adjust in the long-run, generating lasting regional disparities associated with other indicators of social dislocation, such as suicide and unrest.

Keywords: North American Bison, Buffalo, Extinction, Economic History, Development, Displacement, Native Americans, Indigenous, Income Shock, Intergenerational Mobility
JEL classification: I15, J15, J24, N31, N32

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"But when the buffalo went away the hearts of my people fell to the ground, and they could not lift them up again." (Crow Plenty-Coups quoted in Lindermann (1930, p. 169))

I. Introduction

At the end of the 19th century, the North American bison reached near-extinction after declining from a stock of approximately 8 million to less than 500 (Taylor, 2011). For the Native Americans of the Great Plains, the Northwest, and the Rocky Mountains, this was the elimination of a resource that served as their primary source of livelihood for over 10,000 years prior to European settlement (Frison, 1991; Gilmore, Tate, Tenant, Clark, McBride, and Wood, 1999; O'Shea and Meadows, 2009; Zedeño, Ballenger, and Murray, 2014). For many tribes, the bison was used in almost every facet of life, not only as a source of food, but also skin for clothing, lodging, and blankets, and bones for tools. This array of uses for the bison was facilitated by generations of specialized human capital, which was accumulated partly in response to the plentiful and reliable nature of the animal (Daschuk, Hackett, and MacNeil, 2006). Historical and anthropometric evidence suggests that these bison-reliant societies were once the richest in North America, with living standards comparable to or better than their average European contemporaries (Carlos and Lewis, 2010; Prince and Steckel, 2003; Steckel, 2010; Steckel and Prince, 2001). When the bison were eliminated, the resource that underpinned these societies vanished in an historical blink of the eye. We show that the loss of the bison had substantial and persistent negative effects for the Native Americans who relied on them.[1] We suggest that federal Indian policy that limited out-migration from reservations and restricted employment opportunities to crop-based agriculture, coupled with lasting psychological effects, prevented these nations from recovering in the long-run.

In some regions, the decline of the bison was a gradual process, beginning with the introduction of the horse and the arrival of European settlers. In other regions, the bison were eliminated through a mass slaughter that occurred within a period of just over ten years. The slaughter was, at least in part, spurred by a drastic improvement in European tanning technology that

[1] We use the term Native American to broadly refer to the original inhabitants of North America but acknowledge that this term is imprecise and is not without controversy (Corntassel and Witmer, 2008). We use it here because of its generality and common acceptance.

allowed bison hides to be transformed into commercially viable leather, thereby increasing the demand for bison hides internationally (Lueck, 2002; Taylor, 2011). Our empirical strategy exploits regional variation in the speed at which the bison disappeared as well as tribal variation in bison-reliance to determine the impact of the loss of the bison on the Native American societies that relied on them.

Our primary measures of bison-reliance are constructed by overlaying maps of the historic bison range and the timing of the bison's destruction (Hornaday, 1889) with maps of tribal ancestral territories (Gerlach, 1970; Sturtevant, 1981). This allows us to calculate the proportion of a nation's ancestral territory covered by the bison's range during the slow and rapid periods of its decline. To establish the contemporaneous impact of the elimination of the bison, we merge our measures of bison-reliance with data on the height, gender, and age of over 15,000 Native Americans collected between 1889 and 1903 by physical anthropologist Franz Boas (Jantz, 1995).[2] The tribe-age structure of Boas' data allows us to use a difference-in-differences strategy to compare age-height trends between societies that were affected by different stages of the bison's depletion. We find that nations that lost the bison most quickly suffered a 5 to 9 cm decline in height relative to those that lost the bison slowly. This decline more than eliminates the initial height advantage of bison-reliant people, providing the first empirical support for the contention of Steckel and Prince (2001) and Prince and Steckel (2003) that the people of the Great Plains derived this advantage due to their access to the bison. We also find that bison-reliant nations suffered non-trivial increases in mortality, suggesting that our estimates may be viewed as lower bounds on the height differential.

Given that other research that has found long-term persistence of historical events (e.g., Acemoglu, Johnson, and Robinson (2001, 2002); Caicedo (2018); Dell (2010); Dippel (2014); Nunn (2008, 2009); Nunn and Puga (2012); Nunn and Qian (2011); Voigtländer and Voth (2012)) we investigate whether the negative effects of the loss of the bison can be seen into the present. We use data from the Census Fact Finder compiled by Dippel (2014) to show that per capita income on reservations comprised of previously bison-reliant societies was approximately 30% lower in 2000, compared with reservations comprised of non-bison-reliant peoples. Further, we

[2]We supplement our primary measure of bison-reliance with an anthropological index derived from historical accounts of bison-reliance, the share of a tribe's traditional territory that is covered by short grasses, a measure of cattle carrying capacity based on the 2012 U.S. Census of Agriculture, and tribal self-selection into the Inter-Tribal Buffalo Council.

find that reservations whose members belonged to societies that lost the bison gradually had approximately 20% less income on average, while those whose members belonged to societies that lost the bison rapidly had roughly 40% lower incomes on average. The contrast in persistence among those belonging to "rapid-loss" and "gradual-loss" bison-societies contributes to a more general question in the economics literature regarding the ability of economies to adjust to gradual versus sudden economic shocks.

An alternative explanation as to why formerly bison-reliant nations are systematically less wealthy than non-bison-reliant nations over 150 years after the slaughter is that the pre-contact, colonial, and post-colonial experiences of formerly bison-reliant nations were different from those of non-bison-reliant nations. We consider this possibility through four empirical strategies. First, we restrict our sample to include only formerly bison-reliant nations and compare those that lost the bison rapidly to those that lost the bison slowly. In doing so, unobservable characteristics that are consistent across bison-reliant nations are held constant, and identifying variation comes from the speed at which the bison disappeared from each nation's traditional territory. Second, we include an extensive set of covariates: cultural controls, including historical centralization, forced coexistence, and experience with agriculture, to capture the pre-contact characteristics of tribal groups; colonial controls, including the timing and quality of treaties, involvement in the fur trade, and the expansion of the railway into tribal territories, to account for tribes' interactions with European settlers; and modern controls, including social mobility and soil quality, to capture other contemporary factors that may differ across reservations. Third, following Oster (2018), we bound our estimates under a proportional selection hypothesis. Finally, we construct a set of instrumental variables that leverage the cost-adjusted distance between tribes' traditional territories and cities that were historically important for the trade in bison robes. Each of these strategies yield estimates that suggest that the rapid-loss bison-societies suffered significantly in the long-run.

Considering that short-run economic events tend to be mitigated by societies' ability to adjust to shocks over the long-run, we suggest three possible explanations for the long-run divergence in well-being between bison-reliant and non-bison-reliant nations. First, since migration has been shown to be an important margin of adjustment in other literature (e.g., Blanchard and Katz (1992); Hornbeck (2012)), we examine its relevance for bison-reliant societies. We find a convergence in occupational rank among bison-reliant communities after restrictions that limited movement off reservations were lifted in 1924 (Marks, 1998).[3] Additionally, the penalty for belonging to a previously bison-reliant nation is smaller outside of native homelands, which suggests that bison-reliant people who left their traditional homelands, and would have had more opportunities to participate in the mainstream economy, experienced modest economic convergence on average.

Second, we find that the largest mitigating factor was likely the ability of some Native Americans to transfer pre-existing human capital to crop-based agriculture, which was one of the only sectors permitted and incentivized by the Bureau of Indian Affairs (Daschuk, 2013; Iverson, 1997). We show that bison-reliant communities who had also engaged in agricultural practices prior to the bison's slaughter experienced a near complete economic recovery by 2000, despite facing a similar initial biological and economic shock.[4] This suggests that when nations had opportunities to draw on pre-existing human capital, they were better equipped to adjust to loss of the bison in the long run.

A final possibility is that the modern economic penalty associated with belonging to a formerly bison-reliant nation is explained by a form of historical trauma. Common in the psychology literature, this hypothesis posits that groups suffering traumatic events experience a biological response that is transmitted across generations, manifesting itself in maladaptive behavior, such as depression, suicide, and violence, which in turn can affect economic performance among later generations (Sotero, 2006). That past traumatic events may be related to current economic behavior and social functioning has been noted in the economics literature (e.g. Acemoglu et al. (2011); Alsan and Wanamaker (2017)), but the psychological transmission mechanism associated historical trauma has not been investigated. We use mortality estimates from the 1988 National Vital Statistics System of the National Center for Health Statistics to show that suicide rates are higher among previously bison-reliant nations, and particularly so for those who were affected by the rapid slaughter.[5]

In addition to contributing to the literature on historical persistence, this research also pro-

[3]This time period was also followed by federal efforts to incentivize Native Americans to relocate to urban centers (Gundlach and Roberts, 1978; Sorkin, 1969).

[4]A natural alternative use of land during the twentieth century may have been cattle ranching; however, as suggested by Trosper (1978), limited access to capital markets as late as the 1960s prevented Native American ranchers from producing the same level of output as non-Native ranchers.

[5]We use this year because it is the most recent date that does not censor estimates for small counties.

vides a novel explanation for the geographic clustering of poverty observed among Indigenous communities in North America,[6] and contributes to the growing literature on regional disparities, job displacement, and intergenerational mobility (Chetty, Friedman, Hendren, Jones, and Porter, 2018; Chetty and Hendren, 2018a,b; Chetty, Hendren, and Katz, 2016; Chetty, Hendren, Kline, and Saez, 2014; Oreopoulos, Page, and Stevens, 2008; Solon, 1999; Stevens, 1997). Arguably, the decline of the bison was one of the largest devaluations of human capital in North American history, where a mass industrial restructuring was accompanied by low rates of inter-regional migration. The socioeconomic effects this type of restructuring have been of concern in relation to the decline of the American coal and steel industries in the 1980s (Black, McKinnish, and Sanders, 2003; Obschonka, Stuetzer, Rentfrow, Shaw-Taylor, Satchell, Silbereisen, Potter, and Gosling, 2017), and of the manufacturing sector in the early 2000s (Autor, Dorn, and Hanson, 2018). Our historical setting allows us to analyze how such a restructuring generates regional differences over a long time horizon.

Our findings are also connected to the work of economic historians who have examined the overuse and depletion of renewable resources in a colonial context (e.g., Allen and Keay (2004) and Carlos and Lewis (1993, 1999)). Taylor (2011), Hanner (1981), Lueck (2002) and Benson (2006) all examine the nature and causes of the bison's near extinction. We add to this literature by examining the effect of the loss of the bison on those communities that relied on it, instead of the economic reasons behind the depletion of the resource itself. In this sense, we also add the literature on how institutional conditions shape the responses to economic shocks (Robinson and Torvik, 2013). In particular, we offer insight into how economies that rely on a single resource respond when that resource is depleted over a short period of time and when the governing institutions limit responsiveness.

Finally, and perhaps most importantly, we offer a counter-narrative about the colonization of North America. The existing literature proposes that North America's wealth is a function of Europeans' choice to settle, which brought human capital and technology and led to the

[6]For a discussion of the geographic distribution of poverty in Canada and the United States see AANDC (2015); Anderson and Parker (2009); Hurst (1997). The literature on Native American economic development has emphasized the role of institutions in shaping economic development (Akee, 2009; Akee, Jorgensen, and Sunde, 2015; Akee, Spilde, and Taylor, 2015; Anderson and Parker, 2008, 2009; Aragón, 2015; Cornell and Kalt, 2000; Dippel, 2014; Gregg, 2018), and on the role of modern natural resource development on modern outcomes (Anderson and Parker, 2008, 2009; Aragón, 2015; Aragón and Rud, 2013; Dell, 2010; Leonard and Parker, 2016). Our work deviates from past studies by focusing on the loss of a natural resource that was central to the lives of many Native Americans and the potential intergenerational effects of that loss.

development of institutions that promoted growth (Acemoglu et al., 2001; Easterly and Levine, 2016; Nunn, 2014). However, Europeans were not importing their institutions or bringing their human capital to a blank slate; Indigenous institutions and human capital were affected in the process. In the case we study, the core institutions of bison-reliant societies were eliminated and their human capital devalued in the process, resulting in implications for their growth and prosperity.

In the next section, we discuss the historical relationship between bison-reliant societies and the animal, how this relationship evolved over time, the eventual decline and slaughter of the bison, and the policies enacted by the United States government that limited the ability of Native Americans to use transferable human capital associated with bison hunting. In Section III, we discuss the main data sources we use and outline our methodological framework. We then present our results in Sections IV, including an analysis of the mechanisms through which the effect of the bison's decline has persisted into the long-run. Section V concludes with a discussion of the main findings and suggestions for future work.

II. Background on Bison-Reliance and the Bison's Near-Extinction

Before European settlement, between ten to thirty million bison roamed the territory enclosed by the Rocky and Appalachian Mountains, the Mexican states of Chihuahua and Coahuila and the Canadian Northwest Territories (Hornaday, 1889; Lueck, 2002; Taylor, 2011). Anthropological evidence suggests that Indigenous peoples in these regions hunted the bison for at least 10,000 years prior to contact (Frison, 1991; Gilmore et al., 1999; O'Shea and Meadows, 2009; Zedeño et al., 2014).

Originally, the bison were hunted on foot with spears, and eventually by bow and arrow (Isenberg, 2000; Kornfeld et al., 2010). Perhaps the most iconic method of the pedestrian hunt was the "buffalo jump", where hunters set fire to grasses to force herds over a cliff. These large-scale hunts were often conducted in conjunction with several nations and entire communities participated to ensure no part of the animal was wasted (Kehoe, 1967). In smaller scale alternative methods, hunters would separate a portion of the herd, leading them into a pen of branches and blankets using fires or domesticated dogs. Following the hunt, the large animals were generally skinned and disassembled on-site in order to make the carcasses manageable. Women were primarily responsible for this task and would make use of nearly every part of the animal. They tanned and softened hides for clothing, blankets, and lodging, using the brains as grease. Bones formed tools, marrow was consumed for its nutritional content, and stomachs were converted into bags or vessels. Bison meat was often preserved by drying, or it was combined with processed berries and bison fat to produce a mixture called pemmican. Enclosed in a bag made from the bison's stomach, pemmican could be stored for years and sustained the bison nations during times of game shortages or crop failures.

Archaeological records indicate that many bison-reliant peoples did not diversify their economic activity, even though other resources were present, suggesting that the bison provided a reliable source of food and wealth (Daschuk et al., 2006; Zedeño et al., 2014). Due in part to the plentiful nature of the bison and the ability to store its food products for years, the bison peoples were arguably the wealthiest peoples in North America and at least as well off as their average European counterparts (Carlos and Lewis, 2010; Prince and Steckel, 2003; Steckel and Prince, 2001). While early anthropologists often characterized bison hunting societies as egalitarian and lacking organizational complexity; recent work by anthropologists suggests that bison-reliant societies had well-defined systems of ownership over hunting grounds, permanent sites of residence, complex kinship networks, and economic power relationships designed to secure the best bison herds (Zedeño et al., 2014). Bison societies also cultivated the short grasses preferred by the bison to encourage its flourishing (Isenberg, 2000; Zedeño et al., 2014).

While methods of hunting and employing the bison evolved over time, the largest change occurred when the horse was introduced to North America. Horses spread from Spanish controlled regions of South America to as far north as Canada, likely through pre-existing Native American trade routes (Hämäläinen, 2003). By the 1650s, colonists had become aware of mounted Indians after encountering the riders of the Apache tribe. The introduction of the horse decreased the costs associated with hunting bison, leading some societies to shift from agriculture towards bison hunting as their main source of economic activity (Gwynne, 2010); however, it also brought the first waves of European diseases, infecting the people of the plains through their contact with native horse traders who had been exposed to Europeans (Daschuk, 2013).[7] The earliest contact bison-reliant societies had with the English and French was through the fur trade, although this trade was typically indirect. Bison robes and pemmican were traded, but neither commodity was as lucrative as the furs being sought for resale in Europe. Bison-reliant peoples had been tanning hides for centuries, but the process was labor intensive and unprocessed leather from bison hides was not commercially viable from a European perspective (Taylor, 2011).

As settlement continued, the bison were hunted at higher rates, which when combined with years of drought and competition for food sources from settler cattle, slowly began depleting the bison populations east of the Mississippi (Isenberg, 2000). The pace of the bison's extermination drastically increased with the construction of the Pacific Railroad between 1863 and 1869. Upon completion of the railway, settlers had access to the herds of the interior in an unprecedented manner (Hanner, 1981; Hornaday, 1889). Even so, the historical accounts suggest that settlers and native communities did not anticipate the bison's rapid extermination (Daschuk, 2013; Hanner, 1981). In fact, the construction of the railway through the Great Plains was made possible because of a series of treaties the United States negotiated during the late 1860s with the Apaches, Cheyenne, Kiowas, and the Comanche in the south, and North-Western Sioux and Northern Cheyenne—specifically the Teton Sioux, known as the Lakota—in the north.[8] Through these treaties, Natives exchanged large tracts of their ancestral territories for public goods, annuities, and protection of their exclusive right to hunt the bison herds. Many of the treaties included clauses that protected the bison from being hunted by settlers, which had resulted in a gradual decline of the herds in other areas of the country (Gwynne, 2010). One narrative advanced by some scholars is that the bison's slaughter forced the signing of treaties for bison-reliant nations. However, in Table A8 of the online appendix we show that this is unlikely, since over two thirds of the lands ceded by both bison-reliant and non-bison-reliant

[7] The extent to which Plains peoples were depopulated by European diseases has been intensely debated (Cameron, Kelton, and Swedlund, 2015). Early estimates suggest that, between 1774 and 1839, depopulation among Plains Natives was in the realm of 50%-60% (Decker, 1991), but later estimates suggest that this figure may be closer to 20% (Carlos and Lewis, 2012). Some historians have suggested that depopulation among the peoples of the Great Plains did not occur until *after* the extermination of the bison, when bison-reliant societies were on the brink of starvation and vulnerable to disease from malnutrition (Cameron et al., 2015; Daschuk, 2013; Daschuk et al., 2006).

[8] These treaties include, but were not limited to, the Medicine Chest Treaties of 1867 in the South and the Fort Laramie Treaty of 1868 in the North.

peoples were done so prior to 1870, before the bison were eliminated.[9]

The fate of the bison changed unmistakably in 1871 when tanners in England and Germany developed a commercially viable method of tanning buffalo hides (Taylor, 2011). The European demand for hides spiked and in response, hide hunters flooded bison territory. Figure A2 compiles estimates of bison hide exports to England and France from Taylor (2011) between 1865 and 1889. This figure shows a large spike in bison hide exports after the innovation in European tanning technology. Taylor (2011) estimates that in 1875, 1 million bison hides were shipped from the United States to France and England alone. The hide men initially focused on the more accessible southern herd, and by the spring of 1874, the herds on the middle plains had been decimated. A country once "black and brown with bison was left white by bones bleaching in the sun" (Gwynne (2010), p.260-261). By 1879, the southern herd was completely eliminated (Hornaday, 1889). Gwynne (2010) provides a moving account of a group of Comanche men who left the reservation for a traditional bison hunt in the spring of 1878:

> *" They understood that the hide hunters had taken a terrible toll on the buffalo. But they had never doubted that there were herds left to hunt. What they found shocked them. There were no buffalo anywhere, no living ones anyway, only vast numbers of stinking, decaying corpses or bones bleached white by the sun. The idea of traveling a hundred miles and not seeing a buffalo was unimaginable. It had not been true at the time of their surrender.* (p. 294)

Several scholars have argued that the slaughter of the bison would not have happened in an environment with well-defined property rights (Benson, 2006; Hanner, 1981; Lueck, 2002; Taylor, 2011). As far as the Native nations were concerned, property rights existed through the treaties and those rights were simply not protected. One reason for this was political. Many military commanders believed that Native people would not be truly settled onto reservations until the bison were exterminated (Smits, 1994). General Phil Sheridan, then Commander of the Military Division of the Missouri stated in 1875:

> *"These men [hunters] have done in the last two years and will do more in the next year to settle the vexed Indian question, than the entire regular army has done in*

[9] These data were taken from digitized maps of the total lands ceded to the United States by Native Americans between 1784 and 1972 from Hilliard (1972). The original version of this map can be found in Figure A4.

the last thirty years...let them kill, skin and sell until the buffalos are exterminated.”

– quoted from Gwynne (2010), p.262

Army Generals actively encouraged their troops to kill the bison for food, sport, or “practice”. MacInnes (1930) argues that American soldiers drove bison herds south into the region of the hide hunters. According to estimates compiled by Taylor (2011), hide exports from the northern herd were one tenth of those of the earlier southern slaughter. One explanation for this is that after the slaughter began in the south, the American military saw it as an opportunity to weaken nations and their corresponding treaty rights and began to participate in the slaughter without commercial intentions. The bison were exterminated in northern Montana and Saskatchewan by 1878; in Wyoming and Alberta by 1880; the last bison hunt by the Sioux was in 1882 (Ostler, 2001); and the last bison in the remaining territory was gone by 1883 (Hornaday, 1889).

Within less than two decades, the economic and social core of the great bison nations was gone. By the early 1880s, there were no bison, little game, and inadequate or non-existent government food supplies. Records from trading posts, native leaders, Indian Affairs officials and media outlets reported widespread malnutrition and hunger among the native populations (Cameron et al., 2015). Communities resorted to eating horses, mules, soiled food, and old clothing to prevent starvation (Daschuk, 2013; Gwynne, 2010). The resource that underpinned centuries of human capital acquisition was eliminated with few alternative options. Some communities resorted to collecting bison bones that littered the plains after the slaughter and selling them for fertilizer (Ostler, 2001).

Economic activity and mobility were severely constrained during this time period and arguably left few dimensions upon which Native Americans could adjust. Specifically in both Canada and the United States Native Americans could only leave their reservations with the permission of government officials on reservations, known as Indian Agents, until close to the 1930s (Daschuk, 2013; Marks, 1998). Cattle ranching, a plausible alternative use of skills for many bison peoples, was either actively prevented by Indian Agents or subject to credit constraints until the 1940s (Iverson, 1997; Trosper, 1978). Agriculture was effectively the only economic activity supported or promoted by North American governments. However, agriculture was abhorred by many in the former bison-reliant nations and few individuals had experience in the area (Gwynne, 2010; Iverson, 1997; Ostler, 2001). That being said, several nations had varying degrees of agricultural reliance prior to the bison's decline, which we show may have provided them with an economic alternative to help mitigate the negative consequences resulting from the loss of the bison (Iverson, 1997).

In the next two sections, we outline the approach we take to empirically evaluate how the loss of the bison altered the historical trajectory for the societies that relied on them.

III. Data and Methodology

III.A Main Data Sources

We draw on a number of newly digitized and existing data sources from the 19th to 21st centuries, including data from anthropologists, ecologists, economists, historians, and government censuses. Here we briefly describe the construction of our main measures of bison-reliance, the timing of bison loss, as well as the primary outcomes and controls used throughout our empirical section. A more detailed description of our sources, variables, and data construction procedures, can be found in Section A of our online appendix.

Our primary measures of bison-reliance are generated from Hornaday (1889). At the end of the 19th century, William Temple Hornaday was commissioned by the Smithsonian Institute to construct a detailed account of the North American Bison and its elimination. As part of an extensive monograph, Hornaday published maps of the original bison range and of the timing and geographic nature of the bison's extinction. Figure 1 is a digital reproduction of Hornaday's map.[10] The lightest region is the bison range as of 1730, the middle region is the bison range as of 1870, and the final black regions are the remaining herds as of 1889 with their corresponding sizes. The 1889 range was in ranched captivity. We construct our primary measures of bison-reliance by overlaying these ranges with digitized maps of ancestral territories from the Map of Early Indian Tribes in the National Atlas of the United States (Gerlach, 1970), which are also displayed in Figure 1.[11]

We form a measure of initial bison-reliance using the overlay of the map of tribes' ancestral territories with the map of the bison's range as of 1730 to compute the proportion of a tribe's

[10]The original map of Hornaday (1889) can be found in Figure A3 of the online appendix.

[11]Following Dippel (2014), we use the ancestral territory maps from the National Atlas with augmentations from the Smithsonian Handbook of North American Indians (Sturtevant, 1981) to achieve a finer level of detail for some tribal territories.

territory that was covered by the bison's range as of this time period. The next two variables we construct measure the timing of bison loss. The first is the proportion of territory that was covered by bison as of 1730 minus the proportion that was covered as of 1870. The second is the proportion of territory that was covered by bison as of 1870 minus the proportion that was covered in 1889. A large value of the first measure means that the region lost the bison gradually, as discussed in Section II, over a 140 year period. A large value of the second measure implies that the territory lost the bison rapidly, as a result of over-hunting in response to European demand for bison hides. Figure 2 displays histograms of the share of ancestral lands overlapping the original and 1870 ranges. As of 1730, many nations' ancestral lands significantly overlapped with the bison range. However, by 1870 the number of nations whose ancestral lands were covered by more than 90% by the bison range had dropped from over 60 to approximately 10. In Table A9, we present the estimated proportion of ancestral territory that overlapped the bison range as of 1730 and as of 1870 for each tribe.

Using Hornaday's maps and the ancestral territory maps to construct measures of bison-reliance present some obvious drawbacks including both their potential lack of precision and the fact that the measures are entirely based on geography. The degree of bison-reliance among Native Americans–even in areas that were densely populated by bison–varied notably. For example, the Mandan peoples lived in the bison-dense territory of what is now North Dakota, yet they relied predominantly on agriculture and traded for bison meat and other supplies (Fenn, 2014). Our geographic measures would identify the Mandan as fully bison-reliant and among those that lost the bison rapidly. In order to account for these cases, we supplement our original measures of bison-reliance with anthropological accounts of bison-reliance taken from Waldman (2009). We also construct three additional measures of bison-reliance that rely on ecological factors (including grassland ecology and a proxy for cattle carrying capacity) or self-identification (membership in the InterTribal Buffalo Council) to test the sensitivity of our results.

Given the lack of comprehensive income and occupation data for Native Americans pre-1900, we measure the immediate effects of the bison's decline using anthropometric evidence on childhood and adult height as biological indicators of well-being (Steckel, 1995, 2008). Between 1888 and 1903, a team of anthropologists led by Franz Boas collected measures of height, sex, age, tribal membership and "racial purity" of approximately 15,000 Native Americans in nearly all areas of North America (Jantz, 1995).[12] We supplement Boas' data with publicly available census data from the 1900 and 1910 IPUMS historical over-samples of Native Americans to evaluate changes in population size and child mortality (Ruggles, Genadek, Goeken, Grover, and Sobek, 2015) .

To measure the long-run effects of the bison's decline, we focus on income per capita, relying on the sample of reservations compiled by Dippel (2014) from the 2000 American Census Fact Finder. These data include contemporary information on income per capita, population size, geographic isolation, ruggedness of terrain, and size of reservations; colonial information on forced co-existence and displacement from traditional territories; and pre-contact cultural characteristics from Murdock (1967), including measures of historic centralization, calories from agriculture, level of sedentariness, wealth distinctions, and the complexity of the location of each community. Our preferred specifications supplement Dippel's sample by controlling for whether a tribe was ever involved in one of the 23 major "Indian Wars" using an indicator from Spirling (2011), and the degree of differential depopulation from early exposure to European disease from the HYDE 3.1 database (Goldewijk, Beusen, and Janssen, 2010).

To evaluate the role of other characteristics and experiences that may have differed systematically between the slow- and rapid-loss bison-reliant nations, we estimate specifications with an expanded set of controls. These specifications account for the expansion of the railway into traditional territories (Atack, 2016), pre-settlement involvement in the fur trade, treaty-making, and differences across modern reservation environments. We also make use of a number of additional data sources to evaluate the mechanisms that explain the persistence of the shock. All additional controls and data sources are outlined in detail in Section A of the online appendix.

Table 1 presents summary statistics for Boas' sample in panel A and Dippel (2014)'s sample in panel B, as well as some of the additional controls we discussed above.[13] We display summary statistics by classifying a nation as bison-reliant if 60 percent of its ancestral territory overlapped

[12]While there have been questions regarding the representative nature of Boas' sample (Komlos and Carlson, 2014), and of height data more generally (Guinnane, Bodenhorn, and Mroz, 2014), recent work comparing the Cherokee in Boas' sample to the Cherokee census suggests that Boas sample is representative on average, though it may over-represent the upper and lower classes (Miller, 2016). What is important for our empirical strategy is that, conditional on our set of covariates, over- or under-representation does not vary between age groups or between bison-reliant and non-reliant nations.

[13]Table A10, Table A11, and Table A12 present the full summary statistics for the Boas sample, the 1900-1910 Historical over-samples, and the data generated and combined with the data of Dippel (2014).

with the historic bison range and split the sample along this dimension in Table 1. In our empirical specifications, we use continuous measures of the proportion of share lost during various time periods as our primary variables of interest.

For Boas' sample we focus on men to be consistent with prior literature (Prince and Steckel, 2003; Steckel and Prince, 2001), although we report our main results for women in the online appendix. The male sample consists of 8,788 individuals after restricting the sample to those under the age of 60 and dropping tribes that we are unable to clearly match to our primary measures of bison-reliance. From the first row of Table 1 we can see that bison-reliant nations are approximately 6 centimeters taller than non-bison-reliant nations and slightly less likely to have some non-Native American ancestry. They also tend to be slightly older.[14] On average, operational railways entered the ancestral territories of bison-reliant nations at a later date. Since railways may proxy for the timing of contact and pace of settlement of non-Indigenous peoples, we control for the date of operation in a number of specifications. As described in the historical section, settlement on reservations occurred for bison-reliant peoples largely before the loss of the bison and the introduction of the railway. However, the date of local railway operation will proxy for relative timing of these factors as well.

Turning to the second panel of Table 1, we see that in 2000 per capita income on reservations comprised of formerly bison-reliant nations was approximately $2,100 lower compared to reservations comprised of non-bison-reliant nations. Bison-reliant nations were equally as likely as non-bison-reliant nations to engage in warfare, be displaced from their ancestral territories, be sedentary and have similar population densities in 1600; however, there are also notable differences. For example, perhaps not surprisingly, bison-reliant nations consume fewer calories from agriculture. They are also located next to slightly poorer counties, and are located farther from large cities.

III.B Methodology

Our empirical strategy uses two primary specifications depending on whether we are analyzing the immediate or long-term effects of the bison's decline. The structure of Boas' data allows us to use a difference-in-differences estimation strategy based on a person's year of birth and the

[14]Figure A6 shows that the differences in mean height in Table 1 are due to a uniform left shift in the height distribution, suggesting that the difference is not driven by differences in the tails of the distribution.

bison-reliance of their tribe, in order to identify the effect of loss of the bison on childhood and adult height. Let i denote the individual, n the Native nation, t the cohort, and H_{int} the height of the individual in centimeters. Then our estimating equation for the immediate effects of the decline of the bison can be written as:

$$\mathrm{H}_{int} = \beta_0 + \beta_1 \mathrm{B}_n + \beta_2 \mathbb{1}_t(\mathrm{BornNoBison}) + \beta_3 \mathbb{1}_t(\mathrm{BornNoBison}) \times \mathrm{B}_n + \mathrm{X}_{int}\boldsymbol{\theta} + \varepsilon_{int}, \quad (1)$$

where bison-reliance is given by B_n, one of our continuous measures of bison-reliance or loss, and $\mathbb{1}_t(\mathrm{BornNoBison})$ is an indicator for the individual being born after the bison were eliminated. The coefficient of interest is β_3 which is the coefficient on the interaction of bison-reliance and the indicator for being born after the bison were eliminated. Each specification includes a matrix of controls, X_{int}, which includes a full set of age fixed effects to control for trends in height, as well as indicators for whether the individual is full blood, from Canada, and the expansion of the railway into traditional territories. Standard errors are clustered at the tribe-level. Given that bison-reliance is likely spatially correlated, we also report our main results using Conley (1999) standard errors in the online appendix. In some instances, these standard errors are slightly larger than those computed using tribe-level clustering, and in others they are slightly smaller.

The key assumption required for our difference-in differences specification to be identifies is that the height-trends of bison-reliant nations would have been the same as those of non-bison-reliant nations, were it not for the loss of the bison. To evaluate this aspect of the research design we present results using a more flexible event study, which allows us to map out the relationship between bison-reliance and height for cohorts born in two-year groups. The estimating equation is:

$$\mathrm{H}_{int} = \gamma + \sum_{t=-20, t\neq 0}^{20} \delta_t \mathrm{cohort}_t \times \mathrm{B}_t + \zeta \mathrm{B}_n + \mathrm{cohort}_t + \mathrm{X}_{int}\boldsymbol{\theta} + \varepsilon_{int}, \quad (2)$$

where, the interaction of bison-reliance and the indicator for being born after the bison's decimation in equation 1 is replaced by a set of interaction terms, $\sum_{t=-20,t\neq 0}^{20} \delta_t \mathrm{cohort}_t \times \mathrm{B}_t$, that measure the differential change in heights between bison-reliant and non-bison-reliant cohorts for a forty-year window surrounding the beginning of the slaughter. We leave out cohorts born in $t = 0$, so that all coefficients are measured relative to the year in which the slaughter began.

In addition to lending support to the parallel trends assumption, the event study specification is useful to assess which cohorts were most affected by the bison's decimation. We also use the event study specification to infer the impact of the loss of the bison on cohort-size from the 1900 and 1910 IPUMS historical over-samples.

In some cases, we present estimation results from specifications that restrict the sample to include only individuals whose traditional territory overlapped the bison's original range by at least 60%. This allows us to compare those that lost the bison quickly–over a 10- to 20-year period–to those that lost the bison relatively slowly–over a hundred-year period–effectively holding unobservable characteristics constant across bison-reliant nations who would have been subject to similar government policies and had similar cultural backgrounds. In our most stringent specifications, we restrict the sample to those between the ages of 5 and 35.

Both the difference-in-differences and event study methodologies compare trends in the heights of bison-reliant societies to trends in the heights of non-bison-reliant societies, before and after the decline of the bison. We consider those born after 1870 as being affected by the bison's decline. In our specifications that compare trends in the heights of those that lost the bison rapidly to those that lost the bison slowly, we use the date of 1886 as the cut-off for being born after the extinction of the bison. We use this year since the Sioux's last bison hunt was in 1882 and pemmican can last for nearly 3 years (Ostler, 2001), so that cohorts born after 1886 were almost surely born into a time without bison. Varying this date slightly has no qualitative effect on the results.

To determine how the loss of the bison affected long-run per capita income, we estimate OLS regressions at the "reservation-tribe" level, following Dippel (2014), since tribal nations that may vary in historic bison-reliance may also share a reservation. Denote i as a reservation-tribe and n as a nation, then the estimating equation is given as:

$$\mathrm{Y}_{in} = \alpha_0 + \alpha_1 \mathrm{B}_n + \mathrm{X}_{\boldsymbol{i}} \boldsymbol{\theta} + \mathrm{Z}_{\boldsymbol{n}} \boldsymbol{\Psi} + \varepsilon_{in}, \tag{3}$$

where Y_{in} is income per capita. We control for reservation-level characteristics in $\mathrm{X}_{\boldsymbol{i}}$, like the ruggedness of reservation terrain and surrounding counties' economic characteristics, cultural controls that vary at the level of the tribe in $\mathrm{Z}_{\boldsymbol{n}}$, such as whether the society was traditionally nomadic, the proportion of their calories derived from agriculture, whether the society exhibited observable wealth distinctions, or whether the society had an aristocracy. Finally, Z_n also includes colonial controls that vary by tribe–whether the average society experienced forced co-existence (Dippel, 2014), the speed and timing of settlement in a society's ancestral territories, and whether the nation was displaced from their traditional territory which are all discussed in Section III.A. We cluster standard errors at the tribe-level, but report Conley (1999) standard errors for our main results table in the online appendix. As with the immediate effects, we find that in some cases the Conley (1999) standard errors are slightly larger and in others they are slightly smaller.

We examine the long-run impact of the bison's decline in two main ways. First, we use our full sample and differentiate between tribes whose traditional territories experienced the either a rapid or gradual loss of the bison. For these specifications we include two measures of bison-reliance: the reduction in a nation's traditional territory's bison-coverage as of 1870, "Share lost between 1730-1870", and the additional reduction between 1870 and 1889, "Share lost between 1870-1889". Our second and most stringent specification restricts the sample to those whose traditional territories overlap with the original range by more than 60%, allowing us to compare the outcomes of bison-reliant nations that lost the bison quickly to those that lost the bison gradually. The causal interpretation of our results relies on the speed of loss being conditionally uncorrelated with other unobservable differences between these societies. We then progressively add measures of observable differences that could otherwise explain differences in outcomes.

It is worth noting that our geographical measures of bison-reliance and the timing of bison depletion are likely correlated with bison density and thus with economic diversification of the Native nations.[15] This is not a concern with the alternative measures of bison-reliance discussed in Section III.A.

In addition to our base methodology, we use two additional empirical strategies that account for the possible importance of selection on unobservable factors. First, we use the methodology of Oster (2018) to bound the selection on unobservables, assuming the same degree of selection as on observables, as well as a threshold for the maximum allowable R-squared.[16] The second

[15]For example, we would be considering bison in the woodlands and bison in the high plains as equivalent. However, bison herds in the woodlands were less dense and, given the relative scarcity of the woodlands bison, other game such as deer, and hare were often hunted.

[16]We follow the recommendations in Oster (2018) and assume a maximum R-squared of 1.3 times the R-squared

method uses an instrumental variables approach that leverages variation in the cost of traveling between tribes' ancestral homelands and cities that were historically important for either the trade in bison robes or, during the period of the slaughter, the trade in bison hides. These strategies will be discussed in more detail in the sections that follow.

IV. Results

IV.A The Immediate Effects of the Bison's Decline

Figure 3 displays estimates from the event study design to examine the effect of the bison's decline on heights over time, along with 95% confidence intervals. Figure 3(a) uses the full sample, comparing bison-reliant to non-bison-reliant individuals. The coefficients of interest, δ_t, display changes in the relationship between bison-reliance and standing height across event-cohorts relative to 1870, the year before the slaughter began. The coefficients for $t = \{-20, \ldots, -1\}$ act as a placebo test for whether the parallel trends assumption holds. Each of these coefficients is both small in magnitude and not statistically different from 0, suggesting that prior to the disappearance of the bison, there were no differential trends in height between those who lost the bison gradually and those who lost it quickly. After 1870, the difference in the heights of bison-reliant and non-bison-reliant nations relative to 1870 increases steadily in successive cohorts. The largest differences are found among those born roughly 18 cohorts after the slaughter.

The event study design suggests that it was not until three years after start of the rapid slaughter that there were any notable differences in height-trends between cohorts of bison-reliant and non-bison reliant societies. Since pemmican can be stored for up to three years, foodstuffs from the bison should have been declining quickly around this time period. Consistent with this, the pattern in Figure 3(a) suggests those born in years with progressively less access to the bison saw progressively larger declines in stature relative to those born in periods with more access. We find larger effects if we compare those who lost the bison slowly to those that lost the bison rapidly (see Figure 3(b)) although these effects are estimated with substantially less precision in later years because of smaller sample sizes. Thus we collapse these later years and estimate equation 1, the results of which can be found in Table 2.[17]

from the controlled regression.

[17] In Table A13 of the online appendix, we display the main coefficient estimates with standard errors estimated

The first column shows that nations who lost the bison gradually, as measured by a large value of "Share lost between 1730-1870", were about 2 cm taller than all other Native nations, on average, but lost this height advantage after 1870.[18] In column (2), we restrict our sample to nations that had at least 60 percent of their ancestral territory overlapping the 1730 bison range. Because nations could store pemmican for up to three years, we use being born after the date of 1886 as a cut off for being born into a world with no access to bison for those that were still bison-reliant as of 1870.

On average, nations that lost the bison quickly were slightly taller than other bison-reliant peoples, but after 1886 *more than their entire height advantage* was eliminated, with declines in height of up to 5 cm.[19] These findings are consistent across specifications with additional controls and those that focus on individuals aged 5 to 35 years.[20] The most dramatic estimates suggest that among those born into bison-reliant nations that lost the bison as part of the rapid slaughter, heights declined by 9 cm relative to those that lost the bison gradually.[21]

Komlos and Carlson (2014) note a decline in the height of Plains Indian scouts in the U.S. Army after the Civil War; however, they do not connect this to the loss of the bison, nor do they explicitly examine trends in heights by the age or bison-reliance of the individual. Our results present an explanation for their findings. It is also important to note that it is unlikely that settlement on reservations is able to offer a reasonable alternative explanation for our findings for two rea sons. First, there was a lack of a sharp change in reservation policy after this time

using the methodology of Conley (1999). In general, the Conley (1999) standard errors are slightly larger when we use the full sample, and slightly smaller when we restrict to only bison-reliant peoples.

[18]Recall that each of our bison-reliance measures are continuous variables $\in [0, 1]$, so that a one unit change in "Share lost between 1730-1870", for example, can be thought of as moving from the scenario where there is no reduction in bison-coverage in a tribal territory by 1870 to that where the reduction in bison-coverage in a tribal territory is 100%.

[19]The exact coding of the Sioux and Ojibway sub-tribal groups turns out to be important for the magnitude of the reversal of fortunes when focusing solely on the former bison-reliant societies. We have taken the approach that uses an average of bison-reliance among the Sioux and Ojibway when the precise tribal grouping is ambiguous, however, any reasonable coding of these groups yields estimates that suggest the bison's decline at the very least eliminated the height advantage of formerly bison-reliant peoples.

[20]Different age restrictions can be used with similar results.

[21]Table A14 shows that the results from using our alternative measure of bison-reliance constructed from anthropological accounts yields a similar pattern and magnitude for the comparison of bison-reliant nations who lost the bison quickly and those who lost it slowly. We replicate Table 2 for female Native Americans in Table A15. In the most restrictive specification, the results for females support a similar narrative. Females are notably under-represented in Boas' sample, so the results should be treated with caution. We have also estimated specifications that allow us to infer the effect of an additional growing year spent after the slaughter. These results suggest that for bison-reliant tribes that experienced the rapid slaughter, an additional year between the ages of zero to twenty-one without the bison would reduce one's height by 1.511cm (s.e. 0.811) relative to bison-reliant tribes who experienced the gradual decline. These results are unreported, but available upon request.

period. Second, Steckel (2010) shows that the number of years on a reservation if anything is positively correlated with height on the Great Plains. That being said, there may be a concern that our results are driven by differential penetration of the railway and thus European settlement over this time period. Hence, in columns (3) to (6), we control for the number of years since the railway first entered an individual's tribal territory and whether an individual was born after the first railway entered their traditional territory. Although we see that for every year after someone was born after the introduction of the railway to their territory they are approximately 0.5 cm shorter, this does not significantly diminish the effect of the loss of the bison.

Table 1 showed that bison-reliant nations were slightly older than non-reliant nations. Motivated by this finding, we plot the age distribution of bison-reliant and non-reliant nations in Figure 4, which reveals large differences in the number of individuals under the age of 20, suggesting higher levels of youth mortality among bison-reliant nations. We further examine whether there is evidence of a population decline after the rapid extinction of the bison in Figure 5 by using the event-study design to estimate the effects of the bison's decline on cohort size. We focus on the 1900 and 1910 IPUMS historical over-samples. Panel 5(a) displays the results using the full sample. Panel 5(b) restricts the sample to only those whose societies were at one point bison-reliant and compares those who lost the bison gradually to those who lost the bison rapidly. Relative to non-bison-reliant tribes, bison-reliant tribes experienced an increase in cohort size. Restricting the sample to only bison-reliant nations reveal that those who experienced the rapid decline saw declines in cohort size of up to approximately 60 people relative to those who experienced the gradual decline; however, these results are estimated with a substantial degree of noise. We replicate the specification estimated in Table 2 in Table A16 for cohort size for completeness. We again find that cohort sizes of bison-reliant tribes who were affected by the rapid slaughter decline by approximately 25-35 people relative to those who experienced the gradual slaughter, although clustering at the tribe level produces large standard errors.[22] Since these data are from 1900 and 1910, before Native Americans were citizens of the United States and before there was freedom of mobility from reservations, it is not likely that

[22] In both the event study and the difference-in-differences framework, the standard errors are substantially smaller if heteroskedasticity-robust standard errors are used.

the smaller population sizes were due to out-migration.[23]

As a final analysis of mortality, we use data on the proportion of children ever born who survive from the 1900 and 1910 IPUMS historical over-samples as a direct measure of child mortality. Due to the nature of the data, we cannot use a difference-in-differences structure for this exercise. We estimate equation 3, where our dependent variable is the proportion of children surviving for a given mother. The equations are estimated using OLS, but are robust to using a binomial model on counts of births and deaths. We weight the regression by the census person weight multiplied by the number of children a woman has and the standard errors are clustered at the tribe level.

Table 3 presents the results from this exercise. The first three columns display the results for the full sample and the last three columns restrict the sample to only those who were bison-reliant. Conditional on age, whether the mother is literate, and geographic region, women who belonged to bison nations that lost the bison rapidly have 10 percent fewer of their children surviving relative to those mothers whose tribes were never bison reliant. Restricting the sample to only include mothers whose tribe was at one-time bison-reliant reveals that those who lost the bison rapidly have about five percent fewer of their children surviving as of 1900 and 1910. We see this as direct evidence of higher mortality in bison societies after the slaughter of the bison.

Taken together, our results consistently indicate that bison-reliant nations experienced substantial declines in physical well-being after the bison's decimation. These results hold across numerous data sources and are particularly poignant for nations that experienced the rapid slaughter. Given that the declines in height among bison-reliant nations were coupled with increases in mortality, the height effects we observe are likely a lower bound on the true consequences of the loss of the bison.

[23] In the online appendix we complement the results on cohort size by compiling the available statistics from the Historical Statistics of the United States on the population counts of American Indians by tribe (Carter, Gartner, Haines, Olmstead, Sutch, Wright, and Snipp, 2006). We use the tables Ag392-433, Ag265-330, Ag17-129, and Ag130-264. There is a large gap in data availability between 1780 and 1907, with population counts from 1845 available only for a small selection of tribes, thus we focus on 65 tribes for which we have consistent data in 1780 and 1907. Nations that were bison-reliant had a population that was much larger than non-bison-reliant tribes in 1780, and we find that by 1907 their population size statistically converges to that of the non-bison-reliant tribes (Table A17). Further, bison-reliant nations lost nearly 70 percent of their population over this period. The sample of tribes contained in the Historical Statistics does not allow us to compare the rapid loss of the bison to the gradual loss.

IV.B Long-Run Persistence Among Bison Societies

This section examines whether the economic shock generated by the bison's decline led to long-run differences in well-being between bison-reliant and non-bison-reliant nations. Unconditionally, reservations comprised of tribes whose territories completely overlapped with the historical bison's range have roughly $2,500 lower income per capita in 2000 compared to those whose territories did not overlap with bison's original range. Losing the bison as part of the slaughter is associated with $3,800 lower income per capita, while losing the bison as part of the gradual decline is associated with $1,600 lower income per capita. These differences are substantial given that the average income in 2000 of reservations in our sample is only $10,500.[24] However, in the descriptive statistics of III.A, we show that formerly bison-reliant nations are systematically different than non-bison-reliant nations, thus Table 4 reports estimates of the relationship between bison-reliance and income per capita, conditional on a set of cultural, geographic, colonial, and modern economic factors.[25]

Systematically, we find that formerly bison-reliant nations make less on average, even after conditioning on the income per capita of nearby counties. Those that lost the bison as part of the slaughter (columns (4)-(6)) make less than those that had time to adjust to the bison's gradual elimination from their territory. The results are less precisely estimated in our most restrictive specifications, but the point estimate remains large and negative.[26] In Table A21, we show that our results are qualitatively consistent for each of our alternative measures of bison-reliance and in Table A23 we show that our results hold if we use nighttime light density to proxy for economic activity, allowing us to expand our sample size to include reservations for which public data on income per capita is not available.[27]

In Table 5, we strengthen the selection on observables assumption by including a number of

[24]Table A18 presents the average differences in per capita income on reservations based on bison-reliance and the speed of bison loss.

[25]Table A19 of the online appendix displays these results along with standard errors estimated according to (Conley, 1999).

[26]Similar results are shown for Canada in the online appendix in Table A20 where we condition on a number of available controls that are comparable to those used with the American data. We do not find large differences between bison-reliant nations who lost the bison gradually compared to those that lost the bison quickly. Presumably this is because there is not sufficient variation between those that lost the bison quickly compared to slowly, as evident in Figure 1.

[27]Indian reservations that are included in publicly available income data have been shown to differ systematically from those that are excluded in the Canadian case and that this has implications for the conclusions drawn from analyses that use the restricted samples (Feir, Gillezeau, and Jones, 2018).

additional controls.[28] In all specifications we include regional fixed effects to generically control for fixed factors that would be correlated within Bureau of Indian Affairs regional divisions. In column (1), we account for the speed and timing of settlement by conditioning on the presence and timing of the railway entering into a nation's ancestral territory. Column (2) shows that our results are robust to controlling for the date the last treaty was signed between each nation and the federal government. We use this information as an additional proxy for settlement and federal policy towards Native Americans.[29]

Column (3) of Table 5 attempts to control for the early exposure to European trading using a proxy for the degree of involvement in the fur trade: the proportion of traditional territory that was covered by the historical range of the beaver. Beaver pelts were lucrative commodities that were frequently traded between natives and Europeans and could have likely resulted in earlier initial contact.[30] Conditioning on this measure has little impact on our results. We show that the correlations between our measures of bison-reliance and income decline in magnitude when we account for our expanded set of contemporary controls in column (4), suggesting that differences in income between bison-reliant and non-bison-reliant nations is partially explained by differences in their reservation environment. Column (5) controls for differences in soil quality across reservations. While soil quality is likely endogenous to factors like irrigation, we continue to find that bison-reliant nations who lost the bison rapidly have lower incomes than other nations.

Although Table 5 shows that our results cannot be fully explained by observable confounding factors, there may still be concern that some remaining unobservable factor that is both correlated with the loss of the bison as well as income per capita, may bias our findings. We use two separate methodologies to account for the potential selection on unobservables. The first uses the methodology of Oster (2018) to bound the influence of unobservables assuming the same degree of selection as on observables. The second method uses an instrumental variables approach. We use both these methodologies focusing on only those nations who were histori-

[28]All estimated coefficients can be found in Table A22.

[29]Spirling (2011) shows that the time period in which treaties were signed is a strong predictor of treaty quality.

[30]The beaver was also depleted, but it was not a traditional food source or primary resource for the communities that traded it (Carlos and Lewis, 1993; Innis, 1999). Reliance on the beaver as a source of livelihood may be more of a concern for Indigenous groups in Canada, as declining fur prices towards the end of the nineteenth century affected the demand for treaties, as well as conditions for Indigenous peoples in the north of the country (Miller, 2009).

cally bison-reliant and compare tribes who lost the bison quickly to those who lost the bison gradually, effectively balancing the unobservables that are common across all bison-reliant nations. The OLS coefficient from this exercise, repeated from column (6) of Table 4, is reported in column (1) of Table 6 for comparison. Column (2) applies the methodology of Oster (2018) to the coefficient on "Share lost between 1870-1889" to compute the implied bias of the coefficient estimate. Following the recommendation in Oster (2018) we assume that the degree of selection on unobservables is proportional to that on observables and set our maximum R-squared to be equal to 1.3 times the R-squared using our standard controls.[31]. The coefficient estimate increases slightly in magnitude from the OLS estimate of -1551.0 to -2030.3.[32]

Next, we turn to an IV specification that leverages the cost of traveling between tribes' ancestral homelands and historical cities that were important for the trade in bison robes. Identification here is grounded in the idea that these costs would be correlated with the speed at which bison were removed from traditional homelands, but uncorrelated with outcomes over 100 years later, other than through their effect on the loss of the bison. Since it is possible that proximity to important historical cities may be correlated with other forms of colonial contact or pre-contact conditions, we include our standard set of controls from Table 4 in all regressions.

The historical accounts suggest that a number of cities may have been important either as transit points or destination points for the trade in bison hides. At the beginning of the nineteenth century many buffalo hides made their way along the Missouri river to St. Louis to be traded (Taylor, 2011). Fort Leavenworth, Kansas was also an important transit point for hides being collected from the interior (Taylor, 2011), while the cities of New York, Chicago, and Montreal were involved in the sale of bison robes (Hornaday, 1889). By the time of the slaughter, the ports of New York and Baltimore were most involved in shipping the bison robes overseas to be treated in the tanneries in Germany, France, and the United Kingdom (Taylor, 2011). We compute transport costs based on the cost estimates from Donaldson and Hornbeck (2016) for American cities, and from Inwood and Keay (2013, 2015) to compute transport cost estimates to Montreal. The details of our procedure can be found in Section A of the online appendix.

[31]This recommendation is based on a threshold value for the maximum R-squared for which 90% of a sample of randomized results from leading economics journals would survive.

[32]Since the implied bias provides an adjustment to the coefficient estimate, there is no standard error to report from this exercise.

Since the estimates in Inwood and Keay (2013, 2015) differ slightly from those in Donaldson and Hornbeck (2016), we estimates separate IV specifications with Montreal–column (3)–and without Montreal–column (4).[33] The IV estimate in column (3) is slightly larger in magnitude than the OLS estimate in column (1).[34] It indicates that tribes whose territory lost 100% of bison during the rapid slaughter have an average of $1826.0 less per capita income today. Excluding Montreal does not alter this finding. The OLS estimates are further supported by the endogeneity test: the p-value for the test of the null hypothesis that the share of territory lost between 1870 and 1889 can actually be treated as exogenous is 0.513 in column (3) and 0.618 in column (4). If anything, the results from using the bias correction from Oster (2018) and the IV strategy provides evidence that our main OLS results slightly underestimate the magnitude of the effect of the bison's decline.

IV.C Mechanisms: Margins of Adjustment and Channels of Persistence

In this section, we consider the mechanisms that might explain the persistently lower economic well-being of bison-reliant nations into the present. Our main objective is to determine the margins along which individuals and societies were able to adjust to the loss of the bison and along which margins they were inhibited from adjusting. We begin by examining two standard channels that affect the degree to which economic shocks persist: geographic mobility, and population growth. We show that these channels do not fully explain the differences in modern per-capita income between former bison-reliant and non-bison-reliant nations. We then propose two additional channels through which bison-reliant individuals and societies may have been prevented from adjusting economically after the decline of the bison. First, we show that bison-reliant tribes that had pre-existing experience in agriculture fared much better than bison-reliant tribes without such experience, suggesting that, under the restrictive reservation system, occupational diversification in industries that were promoted by the Bureau of Indian Affairs was paramount to the long-run economic prosperity of tribes. Second, we show that

[33] The first stage and reduced form results can be found in Tables A24 and A25.

[34] We have also estimated the IV specification using a set of instruments containing the "as the crow flies" distance between the centroid of each tribe's ancestral territory and St. Louis, Fort Leavenworth, New York, Chicago, Montreal, and Baltimore to instrument for whether the tribe was subject to the rapid slaughter. It is unclear as to whether these instruments are particularly meaningful, given that transport routes were rarely a straight line between two points; however, these results also suggest that the OLS estimate understates the true magnitude of the effect of the bison's loss, and are available on request.

suicide rates and news stories of corruption and conflict are higher among bison-reliant tribes compared to those who were not bison-reliant. While these results are only suggestive, they provide evidence in line with the idea that societal channels beyond economic forces may also aid in explaining the long-run persistence of the economic shock.

IV.C.1 Intergenerational Persistence, Mobility, and Population Growth

We use data from the American Census and American Community Survey (ACS) from 1900, 1910, 1930, 1990, 2000 and 2010 on occupational rank to study how the bison's decline affected societies over time.[35] Information on both occupational rank and tribal membership is only available for the aforementioned years, and tribal groupings become increasingly aggregated between 1900 and 2010. This has implications for our ability to estimate the effects of the loss of the bison. For example, in 1990, the reported tribal membership may be "Apache"; however, the Apache can hardly be thought of as one unified cultural group, let alone homogeneous in bison-reliance or in the timing of bison loss. Nevertheless, we use the available data to gain a sense of whether the effects of the loss of the bison have changed over time for the peoples that relied on them, as would be expected from an income shock.

Table 7 presents the results of estimating equation 3 using occupational rank in each of the available years as a dependent variable. Our results focus on male occupational rank, given the large changes in female labor force participation over the twentieth century. We acknowledge that if the rank of occupations that are more common in specific geographic areas change over time, this may affect the conclusions we draw about economic convergence. To partially address this concern, all specifications include region fixed effects.[36]. We also control for a quadratic in age and whether the individual is literate. Standard errors are clustered by tribe, and since data availability requires that we aggregate to large tribal groupings, we also report bootstrap p-values from the wild cluster bootstrap using 999 replications (Roodman et al., 2018).

Our results suggest that individuals who were members of nations that still relied on the bison at the time of the slaughter have systematically lower occupational rank scores. These effects are substantially larger in 1900, 1910 and 1930. Since tribal information is not included

[35] Since the historical censuses do not contain information on income, we use the concept of occupational rank to examine convergence in economic outcomes over time. See Section A of the online appendix for a description of this variable.

[36] The top five occupations by race and year are listed in Table A26.

in the censuses between 1940 and 1980, we are unable to determine exactly when the convergence occurred. Moreover, it is difficult to pinpoint one particular policy between 1930 and 1990 that may have contributed to the convergence, as a number of important federal policies were implemented throughout the twentieth century that fundamentally changed the economic and social landscape for many Native nations. Notable policies included the *Indian Reorganization Act* [1934],[37] the *Indian Relocation Act* [1954],[38] *Indian Civil Rights Act* [1968], and the *Indian Self Determination Act* [1975]. That being said, the fact that we continue to observe a strong correlation between income and bison-reliance for the present-day reservation-level sample suggests that whatever policies contributed to the adjustment were not sufficient to fully offset the negative effects from the rapid loss of the bison.

Given data limitations, it is not possible for us to investigate whether any one of these particular policies mitigated the shock generated by the bison's decline. To shed further light on the extent to which migration may have acted as a mitigating factor, we examine whether the effect of the bison's decline is different for those living on Native homelands and those living outside of homelands. We use information available in the 2000 Census and 2010 ACS 5 year sample, which report an individual's tribal association and whether they were living within native homelands.[39] Since average income per capita is much lower on homelands than off homelands, using the level of income per capita could mechanically generate smaller coefficients on bison-reliance for the sample living on Native homelands. Thus to assess the relative differences in income per capita we regress the logarithm of individual total income on our measure of bison-reliance. Standard errors are clustered by tribe and wild-cluster bootstrap p-values are reported below standard error estimates.

[37] The Act was suggested to provide a path for tribes to regain sovereignty, but has been shown to be correlated with reduced long-run economic growth (Frye and Parker, 2016).

[38] This Act was implemented concurrently with a number of termination acts that were designed to reduce Indian tribes' dependence on the Bureau of Indian Affairs, sought to assist Native Americans in relocating to cities. While Native Americans who ended up moving to urban centers as a result of the relocation policy experienced additional hardships (Walls and Whitbeck, 2012), the agglomeration of urban Indians may have spurred the movements the created legislation like the *Indian Civil Rights Act* [1968] and the *Indian Self Determination Act* [1975].

[39] According to IPUMS documentation, Native homelands can include federal American Indian reservations and off-reservation trust land areas, the tribal subdivisions that can divide these entities, state reservations, Alaska Native Regional Corporations, Hawaiian homelands, Alaska Native village statistical areas, Oklahoma tribal statistical areas, tribal designated statistical areas, and state designated American Indian statistical areas. Ideally we would compare the population living on American Indian reservations to those not living on Indian reservations; however, given the limitations of the data we cannot differentiate between any of these Native homelands and therefore can only split our sample between those living on or off homelands.

Table 8 presents the results of this exercise. The effect on occupational rank is much larger for those living on homelands–column (1)–compared to off homelands–column (2). The effect is still negative for those living off homelands, although this effect is not statistically different from 0 when taking into consideration the bootstrap p-value. In column (3) we show that we cannot reject that the effects on occupational rank are statistically different between those living on and off homelands. Since occupational rank is tied to the distribution of occupations in 1950, we check whether our results also hold for per capita income in Columns (4) through (6), as we can observe this outcome for later years. Once again we see that the effect of the bison's decline is much larger for those living on homelands compared to those living off homelands, but that we cannot reject the null hypothesis that the estimates are the same. For both occupational rank and the log of per capita income, the magnitude of the coefficient estimates suggests that those who were able to move off homelands may have been able to recover partially from the shock of the bison's decline, although these effects are not statistically different from one another. These findings suggest that, although migration is a channel of adjustment that has been highlighted in the existing literature (see, e.g., Hornbeck (2012)), it does not seem to have played as large a role for Native Americans after the decline of the bison.

Another possible explanation for the persistently lower income on previously bison-reliant reservations is that the increase in mortality following the bison's demise affected communities in the long-run by initially lowering their populations and consequently preventing future agglomerations from spurring development. Table 9 considers this possibility by regressing the log of population on our measures of bison-reliance. If anything, the positive coefficient estimates on each of the bison shocks suggest that this was not the case. In fact, if bison were eliminated from 100% of a tribe's traditional territory between 1870 and 1889, the tribe is, on average, 1.64 log points larger today, conditional on income per capita. Excluding the Navajo, the average population of a Native American reservation in our sample is 2,082 and the maximum is 14,255. 1.64 log points is equivalent moving from a population of 2,082 to a population of 8,661.[40] Although this result may seem counter-intuitive in tandem with the results for long-run income and short-run mortality, they should be interpreted with caution. Our observations are measured at the reservation-level, thus if bison-reliant tribes had less opportunity for migrating

[40] The results are unchanged if we exclude the Navajo.

off reservations, or were less able to as a result of their situation after the bison's loss, then we should expect reservation population to be larger in present day.

IV.C.2 Occupational Diversification and Non-Transferable Human Capital

Given that there was modest economic convergence within bison-reliant nations across the twentieth century, we now attempt to understand whether nations that had some additional ability to adjust to the loss of the bison were able to mitigate the negative effects of the bison's decline. Specifically, we hypothesize that after the bison's decline, the human-capital acquired by bison-reliant communities with traditional experience in agriculture would have been valuable, especially since the agriculture sector was promoted by the Bureau of Indian Affairs. Table 10 shows the results of interacting bison-reliance with a measure of tribal experience in agriculture. This measure is an index of calories consumed from agriculture that we take from Murdock's Ethnographic Atlas. For nations that lost the bison rapidly, a larger share of calories from agriculture mitigates up to 90% of the negative long-run effect of the bison's loss. These results are consistent with the hypothesis that bison-reliant tribes that were diversified in sectors agreeable to the Bureau of Indian Affairs were able to mitigate most of the negative effects of the bison's decline.

One reason why bison societies that had more historic experience with agriculture do not seem to have suffered the same long-run consequences as those with less experience with agriculture is simply that the initial biological and economic shocks were not the same.[41] We present the results from Table 2 on height and Table 3 on child mortality in columns (1) and (2) of Table 11. Column (3) shows the results for the effect on occupational rank in 1900 and 1910 from Table 7. The first thing to note from column (1) is that the interaction between being born after the end of the slaughter, the share lost between 1870 and 1889, and the percentage of calories from agriculture is positive, but small in magnitude and statistically insignificant. In the second column, the interaction between the share lost between 1730 and 1870 and calories from agriculture is small and negative, and for those that lost the bison as part of the rapid slaughter (share lost between 1870 and 1889), small and positive. Column (3) shows that in

[41] We expect biological shocks to have economic consequences that persist intergenerationally from the economic implications of the fetal origins hypothesis and the work on epigenetics (Aizer and Currie, 2014; Almond, 2006; Almond and Currie, 2011; Heckman and Mosso, 2014; Karlsson et al., 2014).

1900 and 1910, bison-reliant nations that had pre-existing experience in agriculture also had higher occupational ranks compared to other bison-reliant nations. Taken together, the results of Table 11 suggest that the long-run mitigating effects of agriculture were not due to initial differences in the health-extent of the shock, rather they operated through an economic channel.

It is worth noting that it is diversification in crop-based agriculture in particular that is relevant here. A natural alternative use of the land and human capital previously acquired by the non-agricultural bison nations may have been cattle ranching. However, as suggested by Trosper (1978), limited access to capital markets as late as the 1960s prevented Native American ranchers from producing the same level of output as non-Native ranchers. In addition, in Table 12 we use data from the 1910 IPUMS historical over-sample to demonstrate that formerly bison reliant nations were significantly less likely to be engaged in live-stock occupations than whites within their same county.[42] The first three columns present the results for all Native Americans relative to whites and the final three columns restrict the sample to bison-reliant nations. While Native Americans were marginally more likely to engage in stock-based agriculture on average, the nations that were still bison reliant in 1870 were significantly less likely to be employed in stock-based agricultural occupations – approximately eight percentage points less likely with no change over time. If we further restrict the sample to those that had some occupation, they are still five percentage points less likely to be employed in stock-based agriculture than their white counterparts in the same county. Columns (4) and (5) in Table 12 also show that those that lost the bison quickly were far more likely to have no recorded occupation in 1900, and that nearly the *entire* shift away from having no reported occupation in 1910 and 1930 is towards farming. Again, it is important to note that this is relative to whites within their own county. To put this in to context, it is also worth noting that the vast majority of this is towards farm labor occupations rather than farm owner.

The patterns observed in Table 12 are consistent with bison-reliant nations experiencing restricted entry into an occupational sector in which their previously acquired human capital may have been transferable. Thus, while diversification explains part of the persistence of the economic shock, an equally important dimension of this historical persistence is the extent to which pre-existing human capital stocks were transferable given the restrictive conditions of the

[42] We only use this year because, to our knowledge, it is the only year that breaks out stock-based agriculture from other agriculture.

time.

IV.C.3 The Persistence of Historical Trauma

A final explanation for the persistent impact of the loss of the bison is psychological. It is not out of the realm of possibilities that the dramatic fashion in which the bison where brought to near extinction, and the biological and economic consequences that followed, were traumatic for the people that had relied on them for over 10,000 years prior to their near-extinction. The resulting trauma may have led to disparities in socioeconomic outcomes for successive generations. Historical trauma as an explanation for many of the socioeconomic problems faced by today's Native Americans has been proposed in the psychological literature (e.g., Brown-Rice (2013)), but is a less well-known channel of persistence in the economics literature.[43]

Proponents of the historical trauma hypothesis in psychology suggest that historical loss symptoms, like depression, substance dependence, and diabetes are the result of intergenerational transmission of trauma resulting from historical losses. The process occurs in three stages (Sotero, 2006). In the first stage, a mass trauma is inflicted upon a minority population by the dominant population. In the current analysis, the bison's deliberate slaughter can be thought of as the traumatic event. This is followed by a biological, societal, and psychological response. The decline in heights and increase in child mortality we observed in Section IV.A are consistent with the second stage of historical trauma. In the final stage, the trauma response is transmitted intergenerationally, manifesting in socioeconomic disparities among future generations, often in the form of higher levels of depression, suicide, and other instances of maladaptive behavior.

We consider this channel by compiling Multiple Cause of Death Mortality Data from the National Vital Statistics System of the National Center for Health Statistics. We construct both county-level estimates of various causes of deaths among bison-reliant and non-bison-reliant Native Americans, as well as reservation-level estimates of causes of death.[44]. We use data from 1988, as this is the earliest date for which inclusive county and race data is available.

Table 13 presents the results from this exercise for causes of mortality associated with

[43]Most closely related to the concept of historical trauma is the study of Acemoglu et al. (2011) of the long-run effects of the Holocaust, although they do not specifically outline historical trauma as a possible mechanism to explain the persistence they observe.

[44]A detailed description of this process can be found in Section A of the online appendix.

historical trauma (Sotero, 2006): suicide, homicide, alcohol, diabetes, as well as all deaths.[45] Panel A displays the county-level estimates, and Panel B displays the reservation level estimates. Given the discrete nature of the data, and that the data contain a disproportionate number of zeros, we estimate our equations with Poisson regressions. We include the full set of controls from Table 4, in addition to controls for the log of white mortality due to the form of mortality under examination, as well as the log of total Native mortality in the county. We present marginal effects, with the first five columns making use of the full sample, and the last five columns restricting to only bison-reliant tribes.

For both county-level and reservation-level estimations we observe that formerly bison-reliant nations that experienced the rapid slaughter have higher suicide rates. Looking within bison-reliant nations, we observe that this difference is statistically significant for the reservation-level estimates. Although not statistically different from zero in the county-level specifications, it is still large in magnitude. Interestingly, Native Americans in counties where reservations are comprised of formerly bison-reliant tribes who were affected by the rapid slaughter have higher total mortality. The marginal change in all deaths associated with being from a tribe who lost 100% of their territory in the rapid slaughter is nearly identical to the marginal change in suicides. Marginal changes in other causes of death, such as homicide, alcohol, and diabetes, are not statistically different from 0. This indicates that differences in overall mortality between bison-reliant nations who lost the bison gradually and those who were not bison-reliant are driven by differences in suicide rates. These "deaths of despair" are consistent with a decline in psychological well-being following the bison's demise, from which formerly bison-reliant nations had not recovered, at least by 1988

We provide additional evidence of social disruption, by taking advantage of counts of news stories involving conflict or corruption compiled by Dippel (2014). Table 14 presents marginal effects from Poisson regressions where the dependent variable is the count of the number of news stories related to various forms of social disruption. We include the full set of controls from Table 4 in addition to controlling for the logarithm of total news stories (both positive and negative). Column (1) analyzes stories relating to conflict in government, (2) relating to conflict not involving the government, (3) corruption in government, and (4) corruption not

[45] We do not have enough variation to study deaths due to drug use.

involving the government. Columns (5) through (8) repeat this exercise restricting the sample to only include bison-reliant nations.

We find evidence that both tribes affected by the gradual and rapid decline of the bison have higher counts of conflict within their tribal governments. These estimates are not statistically different from one another, as indicated by column (5). We also see that the gradual loss of the bison is associated with higher counts of conflict not involving governments. Looking within bison tribes, we find that those affected by the rapid slaughter have higher counts of corruption within their governments compared to those affected by the gradual loss of the bison. While instances of conflict and corruption are not systematically higher across the board, we view the results of Table 14 as providing additional evidence that bison societies suffered from increased social disruption in the long-run.

V. Conclusion

At the beginning of the 19th century, the North American bison roamed the Great Plains in the tens of millions, but by 1880, the bison were nearly extinct from a mass slaughter that occurred within as little as 10 years. This is the first paper to empirically quantify the long-run effects of the slaughter on the Native Americans who relied on the bison for over 10,000 years prior to its extinction. We compile historical, anthropological, ecological, geographic, and modern economic data to show that the elimination of the bison affected the well-being of the Indigenous peoples who relied on them, both immediately after the bison's decline, and up to 130 years later. We argue that the loss of the bison resulted in a reversal of fortunes: historically, bison-reliant societies were among the richest in the world and now they are among the poorest.

We study the channels through which this shock has persisted into the present day, highlighting several possible mechanisms that have been suggested by others scholars to be important margins of adjustment, and proposing one new channel through which economic shocks may persist in the long-run. We find that the ability to migrate played a role in some tribes being better equipped to adapt to the shock. Likely the largest contributing factor was the fact that a subset of tribes had pre-contact experience with agriculture, which allowed them to integrate into crop-based agriculture, one of the few occupations that was supported by the Bureau of Indian Affairs throughout the twentieth century. Finally, we find increased levels of suicide and news reports of social dislocation among formerly bison-reliant tribes, suggesting that the bison's decline may have generated a psychological impact that has persisted across generations. This result is consistent with the psychological literature on historical trauma, but has not yet been investigated as a channel of persistence in the economics literature.

In September 2014, a treaty was signed by several formerly bison-reliant nations to restore the bison to Indian country (ICMN, 2014). Although the economic environments and institutional structures have changed since the slaughter occurred, the restoration of this symbolic icon has both political and cultural significance for many formerly bison-reliant nations. While the loss of the bison was a unique historical event, large regional economic shocks are not. Given the growing understanding of the importance of place (Chetty et al., 2018) and persistence (Nunn, 2008), we see the experiences of bison-reliant peoples as relevant to the broader discussion of the sources of regional economic disparities.

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Tables

Table 1: Summary Statistics for Boas and Dippel Samples

	Not bison-Reliant (1)	Bison-Reliant (2)	Diff (3)
Panel A: Boas Sample 1889-1903			
Standing Height in cm	156.44	162.01	-5.57***
	(20.40)	(17.11)	
Year of Birth	1867.23	1865.40	1.83***
	(15.14)	(14.30)	
Age	25.33	26.33	-1.00**
	(15.14)	(14.12)	
Born After Rail	0.41	0.39	0.02*
	(0.49)	(0.49)	
Born During War	0.03	0.08	-0.06***
	(0.16)	(0.28)	
Only Native American Ancestors	0.80	0.78	0.02**
	(0.40)	(0.41)	
Observations	5104	3684	8788
Panel B: Dippel (2014) Sample 2000			
Per Capita Income	10751.89	8629.64	2122.25**
	(5066.94)	(4005.72)	
Indian War	0.50	0.62	-0.13
	(0.50)	(0.49)	
Distance Displaced	11.74	11.97	-0.23
	(1.03)	(0.95)	
No Railway in Territory	0.09	0.01	0.08*
	(0.29)	(0.12)	
EA Calories Agriculture	1.49	2.68	-1.19**
	(1.85)	(2.90)	
EA Sedentary	3.01	3.42	-0.41
	(1.63)	(2.26)	
Population in 1600	1.94	1.97	-0.03
	(3.47)	(3.24)	
Nearby Income Per Capita	18473.42	17438.36	1035.06*
	(2927.76)	(2874.21)	
Log Distance to Nearest City	3.42	4.07	-0.65***
	(1.14)	(0.81)	
Observations	123	72	195

Notes: This table displays sample means with standard errors below in parentheses. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Column (1) reports these summary statistics for non-bison-reliant tribes, which we define as having ancestral territory that overlaps less than 60% with the original bison's range. Column (2) reports the summary statistics for bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range. Column (3) reports difference in means tests between column (1) and (2), $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 2: The Impact of the Loss of the Bison on Male Native American Height

	(1)	(2)	(3)	(4)	(5)	(6)
I(Born After 1870)X Shr lost btw 1730-1870	-2.051**			-2.116*		
	(0.966)			(1.145)		
I(Born After 1886)X Shr lost btw 1870-1889		-5.507**	-9.435**		-4.467**	-4.606
		(2.316)	(3.543)		(2.161)	(3.607)
Shr lost btw 1730-1870	2.062*			1.792		
	(1.087)			(1.143)		
Shr lost btw 1870-1889		1.708**	1.651**		1.261	0.887
		(0.786)	(0.777)		(1.059)	(1.021)
I(Born After 1870)	1.467*			1.626**		
	(0.785)			(0.799)		
I(Born After 1886)		4.714***	6.486**		3.167	3.664
		(1.648)	(2.424)		(2.065)	(2.243)
Year of Birth	-1.416***	-1.711***	-2.082***	-1.407***	-1.679***	-2.064***
	(0.338)	(0.031)	(0.048)	(0.338)	(0.039)	(0.053)
Year Sampled	1.164***	1.304***	1.477***	1.141***	1.561***	1.846***
	(0.353)	(0.220)	(0.288)	(0.354)	(0.121)	(0.158)
Canada	-0.869	0.877**	0.783*	-0.756	0.874	0.734
	(0.902)	(0.422)	(0.435)	(0.780)	(0.625)	(0.585)
Only Native Ancestors	-1.153***	-1.207**	-1.263***	-1.180***	-1.250***	-1.296***
	(0.363)	(0.467)	(0.459)	(0.337)	(0.448)	(0.438)
# Yrs Since Rail				0.00197	0.0174	0.0298*
				(0.019)	(0.011)	(0.017)
Born After Rail				1.578**	-0.333	-0.684
				(0.619)	(0.619)	(0.684)
# Yrs Born After Rail				-0.0531**	-0.0423*	-0.0563*
				(0.025)	(0.024)	(0.029)
Born During War				2.055***	1.962***	1.656**
				(0.634)	(0.715)	(0.755)
Observations	8788	3684	2597	8788	3684	2597
Adjusted R^2	0.875	0.861	0.868	0.877	0.863	0.870
# of Clusters	132	49	47	132	49	47

Notes: This table reports OLS estimates of the difference-in-differences specification relating height to bison-reliance (equation 1). The dependent variable is standing height in centimetres. In addition to the controls displayed, we include a full set of age dummies in all columns. Note that the data on wars and railways is only available for American tribes. Thus specifications reported in columns 4-5 include a dummy and interaction for Canada to account for missing values. Column (1) and (4) use the full sample, while column (2), (3), (5), and (6) restricts the sample to include only bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 3: Correlation between Bison Reliance and Proportion of Children Ever Born Surviving in 1900 & 1910

	Full Sample			Bison-Reliant		
	(1)	(2)	(3)	(4)	(5)	(6)
Share lost btw 1730-1870	-0.0141	-0.0192	-0.0308			
	(0.030)	(0.030)	(0.035)			
Share lost btw 1870-1889	-0.104***	-0.105***	-0.106**	-0.0791**	-0.0590*	-0.0537
	(0.028)	(0.029)	(0.045)	(0.035)	(0.030)	(0.044)
I(1910)	0.0102	0.00397	-0.00497	0.0117	0.00135	0.00357
	(0.009)	(0.009)	(0.015)	(0.012)	(0.012)	(0.009)
I(Literate)		0.0533***	0.0535***		0.0765***	0.0765***
		(0.010)	(0.010)		(0.014)	(0.014)
I(1910)*Share lost btw 1730-1870			0.00216			
			(0.042)			
I(1910)*Share lost btw 1870-1889			0.0213			-0.00953
			(0.018)			(0.042)
Quadratic in Age	X	X	X	X	X	X
BIA Region FE	X	X	X			
Literate		X	X		X	X
Observations	14451	14451	14451	6040	6040	6040
Adjusted R^2	0.173	0.179	0.179	0.159	0.176	0.175
# of Clusters	126	126	126	48	48	48

Notes: This table reports OLS estimates of the relationship between child mortality and bison-reliance (equation 3). The dependent variable is the proportion of children ever born to a given woman who survive. Columns (1)-(3) use the full sample, while columns (4)-(6) restrict the sample to include only bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range. We do not control for Bureau of Indian Affairs (BIA) region when restricting to bison-reliant tribes because of the smaller subset of tribes and lack of variation in these regional indicators. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 4: Correlation between the Speed of Bison Loss and Income Per Capita by Reservation in 2000

	Full Sample			Bison-Reliant		
	(1)	(2)	(3)	(4)	(5)	(6)
Share lost btw 1730-1870	-1304.9	-1618.0**	-1393.0*			
	(831.196)	(765.026)	(792.797)			
Share lost btw 1870-1889	-4663.6***	-3714.1***	-2862.6***	-2677.4***	-1809.5	-1551.0
	(799.784)	(895.968)	(871.810)	(946.595)	(1155.132)	(959.504)
Historic Centralization	1646.9	3314.6***	3117.7***	1009.4	2244.4*	2070.8*
	(1081.444)	(983.264)	(880.459)	(749.155)	(1166.109)	(1058.023)
EA Calories Agriculture	-233.1	-322.3	-280.0	-304.8	330.1	240.1
	(356.008)	(227.477)	(205.883)	(420.169)	(547.660)	(574.939)
EA Sedentary	28.44	1.312	-67.57	596.0	-1108.1	-1028.8
	(310.385)	(267.813)	(233.504)	(514.264)	(899.652)	(920.086)
Jurisdictional Hierarchy	-304.4	-688.6	-408.7	-1117.8*	-922.4	-819.9
	(920.736)	(635.831)	(644.461)	(607.072)	(697.842)	(881.371)
Wealth Distinctions	-315.7	622.5	453.7	2590.1**	3355.2**	3449.2**
	(990.589)	(597.040)	(599.235)	(972.510)	(1346.606)	(1378.452)
Population in 1600	23.53	5.129	43.42	-15.57	308.0	285.5
	(90.743)	(86.810)	(81.318)	(118.958)	(214.758)	(226.665)
Log Ruggedness	474.8	362.2	286.7	-511.4	-734.1	-608.8
	(399.866)	(270.997)	(264.949)	(608.695)	(566.159)	(488.526)
Forced Co-existence		-5185.3***	-4750.4***		-7705.2*	-6886.4*
		(865.058)	(885.303)		(3858.110)	(3532.312)
Indian War		-722.9	50.75		156.9	452.2
		(676.928)	(742.687)		(1251.482)	(1324.757)
Distance Displaced		812.7***	636.1**		477.3	553.8
		(287.241)	(245.191)		(1055.099)	(977.840)
Nearby Income Per Capita			0.360***			0.340
			(0.126)			(0.235)
Constant	12349.9***	5887.4	353.1	5897.1***	6820.6	-781.7
	(1515.866)	(3684.071)	(4079.599)	(1825.770)	(13182.215)	(14418.583)
Observations	195	195	195	72	72	72
Adjusted R^2	0.060	0.300	0.332	-0.027	0.262	0.293
# of Clusters	99	99	99	37	37	37

Notes: This table reports OLS estimates of the relationship between income per capita and bison-reliance (equation 3). The dependent variable is income per capita at the reservation-tribe level. Columns (1)-(3) use the full sample, while columns (4)-(6) restrict the sample to include only bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 5: Correlation between the Share of Bison Covering Traditional Territory and Income Per Capita by Reservation in 2000: Robustness Checks

	(1)	(2)	(3)	(4)	(5)
Share lost btw 1730-1870	-1236.9*	-902.1	-1438.8*	-503.7	-718.3
	(735.250)	(704.968)	(820.473)	(992.446)	(1052.766)
Share lost btw 1870-1889	-4048.1***	-4178.1***	-4533.7***	-1977.1*	-1808.9
	(1453.639)	(1473.353)	(1507.395)	(1146.456)	(1173.531)
Constant	13783.4***	13767.7***	13667.0***	1408.7	-2018.8
	(2032.148)	(2047.352)	(2127.459)	(7145.762)	(6908.715)
Region FE	X	X	X	X	X
Cultural & Colonial Controls	X	X	X	X	X
Railway Indicators	X	X	X	X	X
Treaty Indicators		X	X	X	X
Beaver Share			X	X	X
Extended Modern Controls				X	X
Soil Quality Indicators					X
Observations	195	195	195	195	195
Adjusted R^2	0.077	0.071	0.068	0.284	0.292
# of Clusters	99	99	99	99	99

Notes: This table reports OLS estimates of the relationship between income per capita and bison-reliance (equation 3). The dependent variable is income per capita at the reservation-tribe level. All columns include cultural region fixed effects which include: California, the Great Basin, the Northeast, the Northwest, the Plains, the Plateau, the Southeast and the Southwest. Railway indicators include dummy variables for never having a rail line in your territory, the first developed in 1840-1850, 1851-1860, 1861-1870, 1871-1880, 1881-1890, and after 1890. The treaty controls include dummy variables for signing post-1880, between 1861-1870, 1871-1880, 1881-1890, and after 1890. The extended modern controls include log reservation kilometers squared, nearby GDP per capita, nearby absolute mobility, log distance to nearest city, log population, presence of a casino, log of land ruggedness on each reservation, and the adult population share. Soil quality controls include share of reservation land without constraints from excess salts, nutrient availability, nutrient retention, rooting conditions, oxygen availability, toxicity, and workability. The cultural and colonial controls are the same as in 4. For all estimated coefficients, please see Table A22. All columns use the full sample. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 6: Robustness: Accounting for Selection

	OLS (1)	Oster (2)	IV: With Montreal (3)	IV: No Montreal (4)
Share lost btw 1870-1889	-1551.0	-2030.3	-1826.0*	-1808.8*
	(959.504)	·	(1063.144)	(1062.897)
Constant	-781.7	·	-639.3	-648.2
	(14418.583)	·	(12999.292)	(13000.091)
Observations	72	·	72	72
R^2	0.413	·	0.412	0.412
# of Clusters	37	·	37	37
F-Statistic on excluded instruments	·	·	13.146	15.388
p-value for over-identification	·	·	0.457	0.3673
p-value for endogeneity	·	·	0.513	0.618

Notes: This table reports OLS and IV estimates of the relationship between income per capita and bison-reliance (equation 3). The dependent variable is income per capita at the reservation-tribe level. All columns include the full set of controls in Table 4 and include only bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range. The F-statistic on the excluded instruments is the Kleibergen-Paap Wald rk F statistic; the overidentification test is the Hansen J statistic. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 7: Correlation between Standardized Occupational Rank and Tribe Historic bison-reliance for bison-reliant Native Americans

	1900 (1)	1910 (2)	1930 (3)	1990 (4)	2000 (5)	2010 (6)
Panel A: All tribes						
Share lost btw 1870-1889	-0.391***	-0.310***	-0.341**	-0.117***	-0.237***	-0.0802**
	(0.110)	(0.103)	(0.148)	(0.035)	(0.022)	(0.033)
	[0.027]	[0.033]	[0.087]	[0.00]	[0.00]	[0.094]
Constant	-0.961***	-0.910***	-1.363**	-0.578***	-0.373*	-0.529***
	(0.102)	(0.209)	(0.510)	(0.045)	(0.162)	(0.107)
Observations	3102	3508	1216	8516	6909	6742
Adjusted R^2	0.135	0.071	0.092	0.034	0.028	0.023
# of Clusters	44	47	37	10	6	8
Panel B: Tribes that appear in all years						
Share lost btw 1870-1889	-0.513***	-0.539***	-0.664**	-0.101*	-0.238***	-0.0779
	(0.036)	(0.078)	(0.186)	(0.040)	(0.028)	(0.043)
	[0.241]	[0.241]	[0.140]	[0.054]	[0.000]	[0.441]
Constant	-1.273***	-1.356***	-1.544***	-0.533***	-0.360*	-0.448***
	(0.070)	(0.235)	(0.192)	(0.037)	(0.160)	(0.079)
Observations	1525	1918	817	7813	6715	6336
Adjusted R^2	0.181	0.089	0.118	0.031	0.027	0.021
# of Clusters	5	5	5	5	5	5

Notes: This table reports OLS estimates of the relationship between occupational rank and bison-reliance (equation 3). The dependent variable is income per capita at the reservation-tribe level. All columns control for region (census regions as defined by IPUMS: the New England Division, Middle Atlantic Division, East North Central Division, West North Central, South Atlantic Division Division, East South Central Division, West South Central Division, Mountain Division, and the Pacific Division), a quadratic in age, and literacy. We include only bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range, and restrict the sample to working aged men (20-65). For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Wild-cluster bootstrap p-values constructed with 999 replications using the software of (Roodman et al., 2018) are reported in brackets.

Table 8: Correlation Between Bison-Reliance and Occupational Rank and Income: Individuals On and Off Homelands in 2000

	Occupational Rank			Log PC Income		
	Off	On	Full Sample	Off	On	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)
Share lost btw 1870-1889	-0.0993***	-0.245***	-0.0993***	-0.269**	-0.873**	-0.269**
	(0.027)	(0.037)	(0.077)	(0.027)	(0.341)	(0.027)
	[0.241]	[0.047]	[0.662]	[0.241]	[0.067]	[0.241]
Homeland			-0.146**			-0.604*
X Shr lost btw 1870-1889			(0.054)			(0.299)
			[0.127]			[0.355]
Constant	-0.139	-0.260	-0.139	6.923***	7.479***	6.923***
Age & Age-Squared	X	X	X	X	X	X
Region of residence fixed effects	X	X	X	X	X	X
Observations	6226	7425	13651	6226	7425	13651
Adjusted R^2	0.032	0.039	0.037	0.027	0.033	0.034
# of Clusters	8	8	8	8	8	8

Notes: This table reports OLS estimates of the relationship between occupational rank or wages and bison-reliance (equation 3). The dependent variable is either occupational rank or the logarithm of real wages with a base year of 1999 at the individual level. All columns control for region (census regions as defined by IPUMS: the New England Division, Middle Atlantic Division, East North Central Division, West North Central, South Atlantic Division Division, East South Central Division, West South Central Division, Mountain Division, and the Pacific Division), birth place, a quadratic in age, and literacy. Columns (3) and (6) interact homeland with all other covariates. We include only bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range, and restrict the sample to working aged men (20-65). For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Wild-cluster bootstrap p-values constructed with 999 replications using the software of (Roodman et al., 2018) are reported in brackets.

Table 9: Correlation between Share of Bison Territory Lost and Log Population

	Full Sample		Bison-Reliant	
	(1)	(2)	(3)	(4)
Share lost btw 1730-1870	0.339	0.321		
	(0.249)	(0.247)		
Share lost btw 1870-1889	1.679***	1.641***	1.069***	1.005***
	(0.232)	(0.238)	(0.296)	(0.295)
Constant	6.263***	6.268***	9.277***	9.244***
	(1.099)	(1.095)	(3.322)	(3.278)
PC Income		X		X
Observations	195	195	72	72
Adjusted R^2	0.402	0.400	0.418	0.422
# of Clusters	99	99	37	37

Notes: This table reports OLS estimates of the relationship between population size and bison-reliance (equation 3). The dependent variable is population size at the reservation-tribe level. All columns include the full set of controls in Table 4. Columns (1)-(2) use the full sample, while columns (3)-(4) restrict the sample to include only bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 10: Correlation between Share of Bison Covering Traditional Territory and Income Per Capita Adjusted for Experience with Agriculture

	(1)	(2)	(3)	(4)
Share lost btw 1730-1870	-3253.9**	-610.6	668.8	-426.5
	(1460.738)	(1429.498)	(1508.064)	(1451.326)
Share lost btw 1730-1870 X AG Cal	834.0**	-348.9	-735.8*	-548.3
	(395.238)	(373.190)	(397.104)	(420.167)
Share lost btw 1870-1889	-6094.6***	-5137.3***	-4041.8***	-5251.9***
	(1375.641)	(1353.260)	(1468.226)	(1550.538)
Share lost btw 1870-1889 X AG Cal	1348.1	2499.3**	2775.2**	3060.6**
	(947.142)	(1089.520)	(1160.959)	(1187.192)
Cultural Controls	X	X	X	X
Colonial Controls		X	X	X
Contemporary Controls			X	X
Soil Quality Controls				X
Observations	195	195	195	195
Adjusted R^2	0.070	0.298	0.344	0.344
# of Clusters	99	99	99	99

Notes: This table tests whether the OLS estimates of the relationship between income per capita and bison-reliance vary based on pre-contact experience in agriculture (equation 3). The dependent variable is income per capita at the reservation-tribe level. “Cultural controls” include calories from agriculture, historic centralization, measures of nomadism, jurisdictional hierarchy, wealth distinctions, log ruggedness and population in 1600. “Colonial controls” include being involved in an Indian war, a measure of forced co-existence, and distance displaced from traditional territory. “Contemporary controls” include nearby income per capita, log distance to the nearest city, presence of a casino. “Soil Quality controls” include share of reservation land without constraints from excess salts, nutrient availability, nutrient retention, rooting conditions, oxygen availability, toxicity, and workability. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 11: Correlation between Agriculture and Outcomes

	Height in cm (1)	Proportion Children Surviving (2)	Occupational Rank (3)
Shr lost bwt 1730-1870		-0.0884**	-0.212*
		(0.035)	(0.111)
Share lost btw 1870-1889	0.602	-0.0843**	-0.456***
	(1.287)	(0.032)	(0.118)
Shr lost bwt 1730-1870 X Agr.		0.0232*	0.0634**
		(0.012)	(0.026)
Shr lost bwt 1870-1889 X Agr.	-0.291	-0.0216*	0.0724*
	(0.428)	(0.012)	(0.041)
I(Born After 1886) X Shr lost bwt 1870-1889 X Agr.	0.0812		
	(1.196)		
I(Born After 1886)	2.583		
	(2.530)		
I(Born After 1886) X Shr lost bwt 1870-1889	-3.460		
	(2.921)		
I(Born After 1886) X AG Cal.	0.390		
	(0.465)		
EA Calories Agriculture (Agr.)	-0.301	-0.00104	-0.00436
	(0.216)	(0.009)	(0.021)
Age FE	X		
Region FE		X	X
Quadratic in Age		X	X
Literate		X	X
I(Year=1910)		X	X
Year of Birth	X		
Year Sampled	X		
Only Native American Ancestors	X		
Canada	X		
Observations	3602	13996	15372
Adjusted R^2	0.858	0.186	0.080
# of Clusters	46	112	114

Notes: This table tests whether the estimates of the relationship between height (equation 1), child mortality (equation 3), or occupational rank (equation 3) and bison-reliance vary based on pre-contact experience in agriculture (equation 3). The dependent variable in column (1) is standing height in centimeters and restricts the sample to include only bison-reliant nations, which we define as having ancestral territory that overlaps more than 60% with the original bison's range (comparable to Table 2). The dependent variable in column (2) is the proportion of children ever born who survive (comparable to Table 3), and in column (3) it is occupational rank. The samples are smaller than the samples in other tables because of the imperfect match rate of the Ethnographic Altas with the tribal codes in the Boas and IPUMS samples. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by tribe are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 12: Probability of Engaging in Live-Stock based Occupations in 2010 Relative to White Counter Parts

	All Native Americans			Bison-Reliant		
	Farming	None	Live Stock	Farming	None	Live Stock
	(1)	(2)	(3)	(4)	(5)	(6)
Year 1910	-0.0357***	-0.000288	0.000232	-0.0357***	-0.000246	0.000216
	(0.003)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Year 1930	-0.0855***	0.00700***		-0.0855***	0.00704***	0
	(0.005)	(0.001)		(0.001)	(0.001)	
Native American	0.0550*	0.151***	-0.0133*	-0.301***	0.504***	-0.0807***
	(0.033)	(0.024)	(0.007)	(0.022)	(0.022)	(0.011)
1910 X Native American	0.00492	-0.000707	0.0406***	0.0879***	-0.0918***	0.0138
	(0.030)	(0.023)	(0.015)	(0.029)	(0.028)	(0.019)
1930 X Native American	0.0845**	-0.0588**		0.280***	-0.249***	
	(0.033)	(0.025)		(0.042)	(0.038)	
Constant	0.289***	0.118***	0.00240***	0.289***	0.118***	0.00229***
	(0.003)	(0.002)	(0.000)	(0.002)	(0.002)	(0.000)
Age Fixed Effects	X	X	X	X	X	X
County Fixed Effects	X	X	X	X	X	X
Observations	2126860	2126860	553417	2109818	2109818	538788
Adjusted R^2	0.317	0.034	0.106	0.317	0.033	0.105

Notes: This table reports OLS estimates of the likelihood of engaging in various occupations based on ethnicity. The dependent variable in column (1) and (3) is an indicator for farming, in column (2) and (4) it is an indicator for having no occupation, and in column (3) and (6) it is an indicator for working in live-stock. Columns (1)-(3) compares all Native Americans to whites, while columns (4)-(6) compares bison-reliant Native Americans to whites, where we define bison-reliance as having ancestral territory that overlaps more than 60% with the original bison's range. All specifications include age and county fixed effects. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by county are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 13: Correlation between Share of Bison Territory Lost and Mortality in 1988

	Full Sample					Bison-Reliant				
	Suicide (1)	Homicide (2)	Alcohol (3)	Diabetes (4)	All Deaths (5)	Suicide (6)	Homicide (7)	Alcohol (8)	Diabetes (9)	All Deaths (10)
Panel A: County Level										
Shr lost btw 1730-1870	-0.165	-0.275	-0.222	-0.267	-0.370					
	(0.323)	(0.424)	(0.265)	(0.327)	(0.287)					
Shr lost btw 1870-1889	0.824*	-0.220	-0.0714	0.331	0.879**	1.152	0.555	0.916	1.382*	0.585
	(0.434)	(0.552)	(0.332)	(0.443)	(0.400)	(0.807)	(0.821)	(0.695)	(0.784)	(0.402)
Constant	-5.174***	-2.295***	-3.850***	-4.256***	-1.124	-6.233***	-1.665	-5.754***	-7.756***	1.432
	(0.882)	(0.866)	(0.670)	(0.775)	(0.799)	(1.841)	(1.227)	(2.048)	(1.444)	(1.611)
Observations	422	422	422	422	422	203	203	203	203	203
Pseudo R^2	0.513	0.582	0.623	0.569	0.273	0.482	0.582	0.505	0.453	0.118
# Clusters	422	422	422	422	422	203	203	203	203	203
Panel B: Reservation Level										
Shr lost btw 1730-1870	0.278	-0.0247	-0.133	-0.948***	-0.175					
	(0.169)	(0.209)	(0.156)	(0.173)	(0.404)					
Shr lost btw 1870-1889	0.804***	0.460*	-0.228	-0.459	0.740	0.629**	0.353**	0.0238	0.635*	0.232
	(0.273)	(0.240)	(0.221)	(0.297)	(0.474)	(0.256)	(0.159)	(0.160)	(0.330)	(0.346)
Constant	-3.674***	-2.574***	-3.390***	-3.528***	-0.893	-3.450***	-2.458**	-4.902***	-7.342***	-0.102
	(0.523)	(0.578)	(0.449)	(0.643)	(1.539)	(0.843)	(1.067)	(0.734)	(1.241)	(1.327)
Observations	195	195	195	195	195	72	72	72	72	72
Pseudo R^2	0.649	0.672	0.783	0.749	0.595	0.432	0.593	0.565	0.487	0.439
# of Clusters	99	99	99	99	99	37	37	37	37	37

Notes: This table reports marginal effects from Poisson regressions of the relationship between bison-reliance and mortality (equation 3). The dependent variable is either the count of suicides, homicides, alcohol-related deaths, deaths from diabetes, or all deaths. All columns include the full set of controls in Table 4 as well as controls for the log of white deaths attributable to the mortality cause under investigation, as well as the log of all Native American deaths. Columns (1)-(5) use the full sample, while columns (6)-(10) restrict the sample to include only bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by county (panel A) or tribe (panel B) are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 14: Correlation between Share of Bison Territory Lost and News Stories Involving Corruption and Conflict

	Full Sample				Bison-Reliant			
	Conflict Government (1)	Conflict Not Government (2)	Corruption Government (3)	Corruption Not Government (4)	Conflict Government (5)	Conflict Not Government (6)	Corruption Government (7)	Corruption Not Government (8)
Shr lost btw 1730-1870	1.242***	0.788*	-0.260	0.0354				
	(0.475)	(0.437)	(0.226)	(0.174)				
Share lost btw 1870-1889	0.869*	0.577	0.271	0.139	-0.0953	-0.0552	0.509***	0.0160
	(0.473)	(0.400)	(0.201)	(0.166)	(0.123)	(0.197)	(0.162)	(0.063)
Constant	2.235	6.970**	-2.225	-3.970***	11.45	13.55***	7.268***	-1.803
	(4.075)	(3.456)	(1.532)	(1.460)	(8.537)	(4.913)	(1.970)	(1.915)
Observations	195	195	195	195	72	72	72	72
Pseudo R^2	0.671	0.753	0.739	0.836	0.799	0.777	0.754	0.828
# of Clusters	99	99	99	99	37	37	37	37

Notes: This table reports marginal effects from Poisson regressions of the relationship between bison-reliance and incidents of conflict or corruption (equation 3). The dependent variable is the count of categorized news stories. All columns include the full set of controls in Table 4 as well as controls for the log of the total number of news stories involving each tribe. Columns (1)-(4) use the full sample, while columns (5)-(8) restrict the sample to include only bison-reliant tribes, which we define as having ancestral territory that overlaps more than 60% with the original bison's range. For specific variable descriptions and sources please refer to Section III.A and Section A of the online appendix. Standard errors clustered by county (panel A) or tribe (panel B) are in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Figures

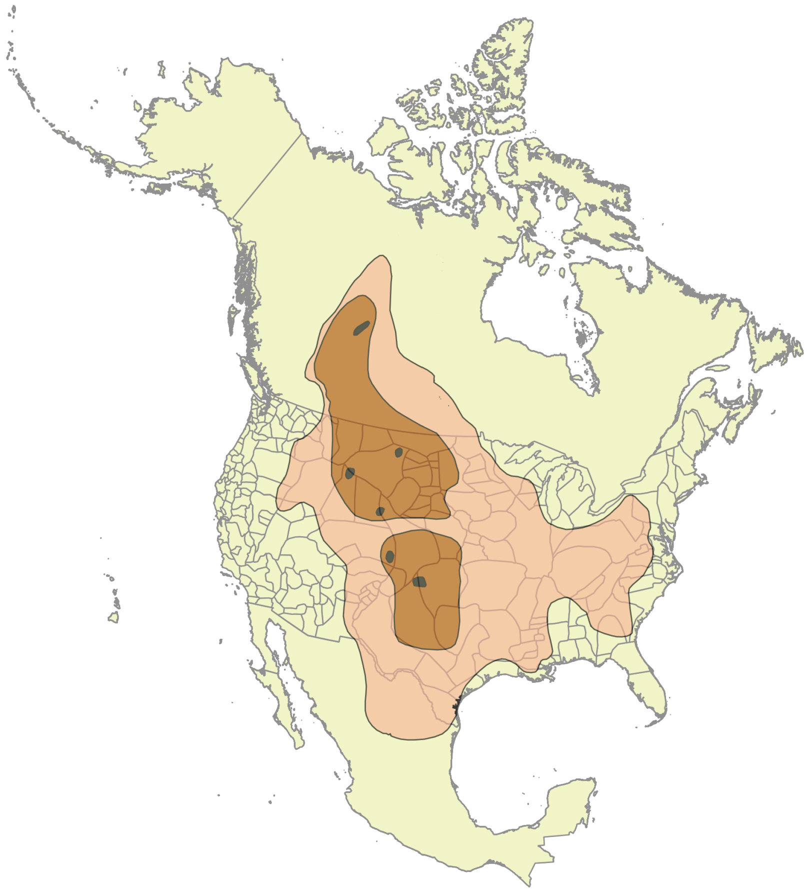


Figure 1: This is a digitized version of the map generated by Hornaday (1889), illustrating the original range of the North American bison and the timing of its decline. The lightest region is the range as of 1730, the middle region is the bison range as of 1870, and the final black regions are the remaining herds as of 1889 and their sizes. The 1889 ranges were in ranched captivity. Tribal territory boundaries are also displayed for the continental U.S.

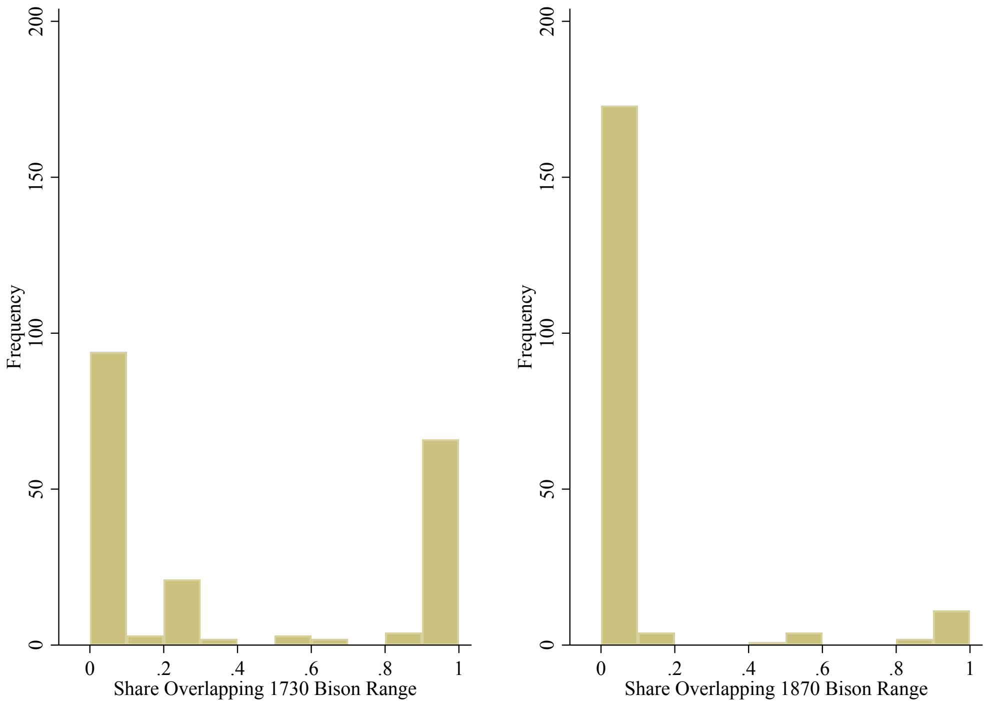
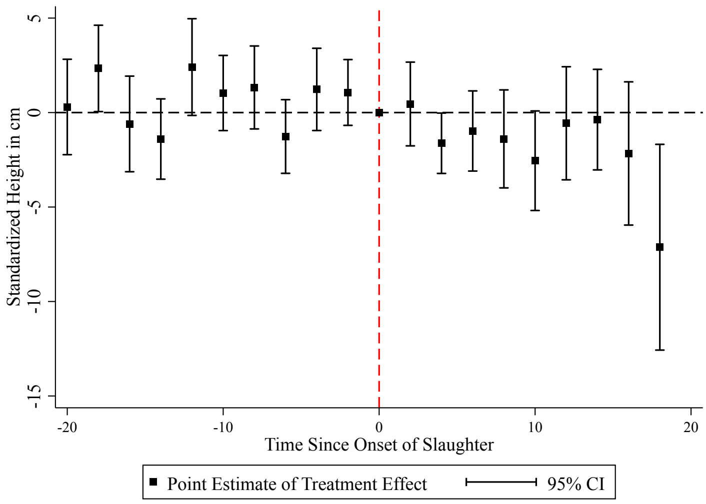
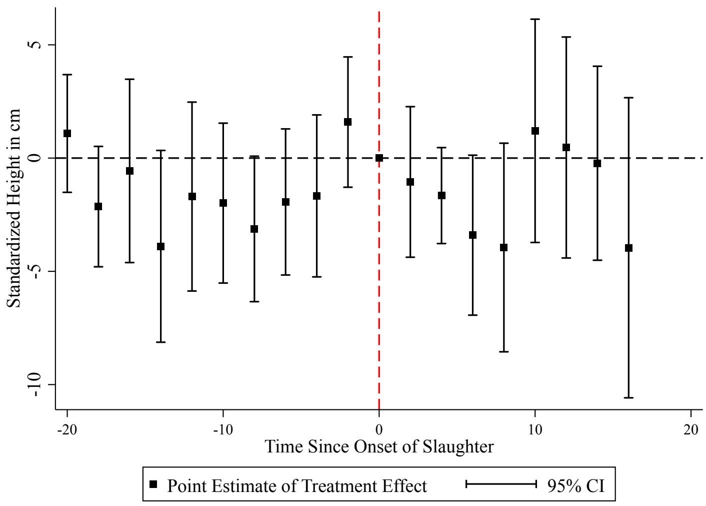


Figure 2: These histograms show the share of ancestral lands overlapping the original bison range (left) and the bison range as of 1870 (right).



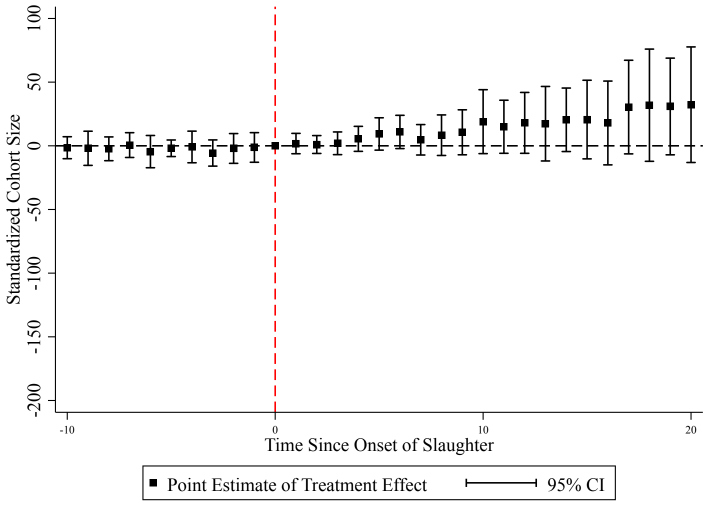
(a) Full sample



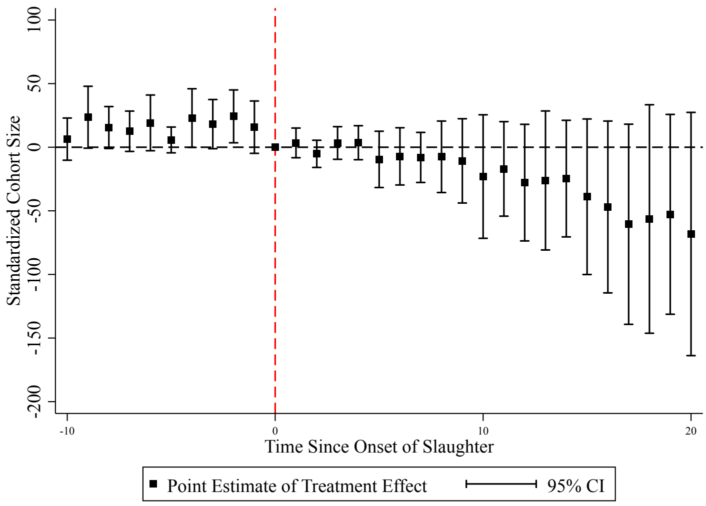
(b) Bison-reliant: gradual vs. rapid

Figure 3: Coefficients on indicators for each two-year of birth before and after the slaughter interacted with the share of the tribe's traditional territory that was originally covered by the bison (panel a), or the share lost between 1870 and 1889 (panel b). The dependent variable is height in centimeters. Specifications condition on whether the tribe was observed in Canada, the year they were observed, age fixed effects, as well as cohort and bison-reliance. Data is from Franz Boas' 1889 to 1903 sample.

Figure 4: This data comes from Franz Boas' sample 1890 to 1901. These data are all for males and N=3,717 for bison-reliant societies and 5,104 for non-bison-reliant societies. Societies are classified as bison-reliant when more than 60% of their ancestral territory was covered by the historic bison range and non-bison-reliant if it was less than this. A similar pattern is visible if a threshold of 80% or 40% is used.



(a) Full sample



(b) Bison-reliant: gradual vs. rapid

Figure 5: Coefficients on indicators for each two-year of birth before and after the slaughter interacted with the share of the tribe's traditional territory that was originally covered by the bison (panel a), or the share lost between 1870 and 1889 (panel b). The dependent variable is the weighted number of people observed in that cohort. For tribe-birth year combinations that have no observations, we impute a population size of zero. Specifications condition on age fixed effects, as well as cohort and bison-reliance. Data is from the 1900 and 1910 IPUMS historical over-samples.